Title

Boulevards: A Study of Safety, Behavior, and Usefulness

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Publication Date
1994-11-01

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Working Paper
UCTC No. 248

The University of California Transportation Center
University of California
Berkeley, CA 94720

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This paper was produced with support provided by the U.S. Department of Transportation and the California State Department of Transportation (CALTRANS) through the University of California Transportation Center.

* Jacobs conceived of the study; Rofé prepared the proposal and administered the project. While detailed tasks were jointly organized, and field work was done by all three authors, it was Rofé and Macdonald who did most of the time-lapse and video photography. Rofé was also responsible for researching existing guidelines and norms, and collecting and analyzing traffic and safety data. Macdonald was responsible for compiling street plans and cross sections, and gathering, organizing, and analyzing field measurements and counts.

Rofé and Macdonald wrote the initial drafts of the chapters in the report describing their areas of responsibility. Jacobs prepared first drafts of the introduction and two concluding chapters. All three authors reviewed all chapter drafts, and Jacobs was responsible for final editing. The observations and conclusions of the study, though, were arrived at jointly. As for graphic material: Street plans, sections, and various diagrams were prepared by Macdonald. Perspective drawings and context maps were prepared by Jacobs.

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ACKNOWLEDGMENTS

It is astonishing how many different people have helped us in the research and in writing this report. We have relied on people's willingness to send us information again and again, to gather the data and to make sense of it. Specifically they are the following: in Chico, Matthew Thompson from the Engineering Services Department. In Louisville, Suzanne Rademacker from the Olmstead Conservancy Foundation, Jim Pasakawski and Philip Williams from the Public Works Department, and Jeff Ackerman from LOJIC who provided the maps. In Washington, D.C., Joe Passaneau sent us interesting historic material on K-Street, Rashid Sleemi provided traffic and safety data, and Mr. Crowley provided maps. In New York, tremendous thanks should go to Todd Bressi for helping us get oriented, whizzing us through the subway system to enable us to see more streets in the limited time we had, and for actually doing some of the field work, when we were prevented from doing so because of the weather. He was with us again counting traffic in our second visit to New York, on Ocean and Eastern Parkways, and Linden Boulevard. We are also grateful for the help extended by Brian Leys and Jae Kang of the NYC Department of Transportation for sending us data and drafts of their reports, and Jack Knoll from New York State Department of Transportation, for swiftly sending us accident data. In Boston our thanks to Phil and Ty Ziegler for sending us maps of potential streets for study in the Boston area.

Obtaining data and information in Europe was one of our major worries at the start of the project. It is somewhat harder to negotiate these things in unfamiliar territory, and in a language you don't know. The help of Amy Jacobs-Colas, and her husband Dominique Colas, and of Jaques Stevenin of the Atelier Parisiene D'Urbanisme, has been extraordinary in Paris. In Barcelona, doors were opened for us by Jordi Borja i Sebastian, Amador Ferrer i Aixala, Julio Garcia Ramon, and Monica Salada, who graciously spent a morning with us. Their help in providing information, and in making it possible for us to access the top floors of several buildings on the boulevards to photograph and film from, was most important.

In Berkeley we were fortunate to have the advice of Mel Webber, director of the University of California Transportation Center, Adib Kanafani and Wolf Homburger from the Institute of Transportation Studies, and Robert Cervero from the Department of City and Regional Planning, who have responded to some of our early notions, and with their criticism and encouragement helped us formulate and improve the study. Obviously, though, they are not responsible for what we present here, and for any faults which it may contain.

Special thanks is due to our colleague and friend Peter Bosselman who has patiently instructed us in the arts of film and video photography, and is now doing the same with editing. Also in numerous discussions of our observations, he has helped us form some of the key concepts of this report.

Finally, thanks is due to Kathy Crum at UCTC, and to all the staff at IURD, particularly Barbara Hadenfeldt, Miho Rahm, Carey Pelton, and Christine Amado, for administrative support, and Martha Conway and David Van Arnam for their editorial effort. Without their kind and generous help, administering a project such as this one, and producing this report, would not have been possible.

I. INTRODUCTION

This study and report is about boulevard streets.

It starts with a pro-boulevard bias born of experience, a strong suspicion that boulevards have been getting a "bum rap," and, moreover, that they often represent excellent transportation/design solutions to complex urban movement and land use issues.

During the 1980s in Los Angeles, participating in the design of a major new development through which a high-volume arterial road passed, we proposed side access roads to serve the adjoining commercial and residential properties to be developed on each side and to slow and calm the local traffic. Lane-width standards for the new access roads were so wide as to take away the local quality desired and, more importantly, we were advised that intersections along such streets would be exceedingly dangerous. Solving the problems would take so much space under operative standards and norms that the idea died. Later, proposals to modify an existing arterial street in San Francisco into a boulevard faced the same objections — primarily, dangerous intersections and travel and parking lanes held to be too narrow. Finally, during the field research for the book *Great Streets*, we had occasion to spend considerable time on a variety of boulevard streets, mostly in Paris and Barcelona. Spending hours at intersections, observing them and the nature of motorist and pedestrian movements, they did not appear to be particularly dangerous. Rather, the overwhelming traffic characteristic at the intersections was adaptation. People simply adapted to what was there and did so safely. Perhaps most importantly, these streets were delightful places to be. They were, and are, peopled. Pedestrians, local motorists, and those passing through as fast as they can all seemed to get along together. And so, this study was born.

A Brief History of the Boulevard

Though strongly rooted in sixteenth-century Italy (particularly Rome), the boulevards we know today follow models developed in France (Paris) during the latter half of the nineteenth century when they were inserted into the existing medieval pattern. In addition to the objectives of beautifying the city and of asserting the public role of city building, these boulevards were designed to move people and goods through the essentially medieval city fabric that had become impossibly congested, to improve communications, to add sanitation lines and other infrastructure systems, and to open up crowded neighborhoods where social unrest was fermenting. The boulevards also provided building sites for major new development for a growing middle class. Among their most important functions was that of giving structure and comprehension to the whole city, often as large monumental ways that linked important destinations. These wide streets were conceived "not as a single unit, but as three distinct routes — the two sidewalks and the roadway itself — separated from each other by rows of trees."[1]

Boulevards were imported to the U.S. as a part of both the park movement of the late nineteenth century and the city beautiful movement of the early twentieth century. Coinciding with the rapid

Figure 1.1. Along the Cours Mirabeau, Boulevard in Aix en Provence, France

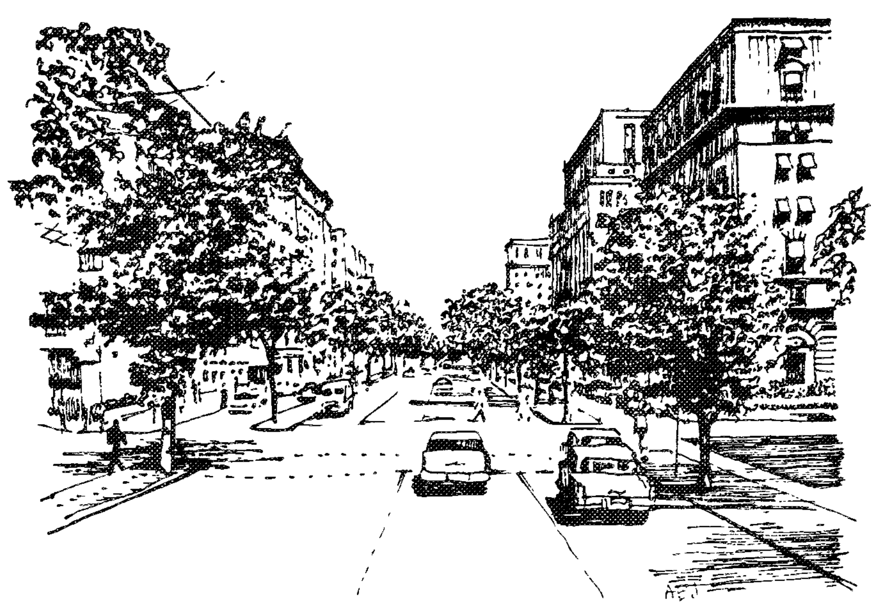

Figure 1.2. An Early Boulevard: K Street, Washington, D.C., at 16th Street.
Taken from a Photograph, in AASHTO 1957, Figure E-16

expansion of cities, they were more associated in the U.S. with new development than with streets cut through old quarters. Indeed, they were often part and parcel of land development promotions. Generally wide and invariably tree-lined, in one manifestation they have graceful curves, are shaded and cool in summer, are long, quiet, and lined with large homes set apart on deep lawns, and may have a planted median. Often built before the buildings that were to line them, they would give a sense of good things to come to the prospective, well-to-do owner.

Types of Boulevards

Of course, many different kinds of streets with many different designs were, and are, called boulevards. Basically, though, there are three types. One type has a wide central planted median flanked on either side by roadways (one in each direction) and sidewalks. The central median might be a pedestrian promenade, or it might once have had horse trails, or it might be simply planted, with no walks. Often street cars were located in the central median. Monument Avenue in Richmond, Virginia; Fairmount Boulevard in Cleveland Heights, Ohio; and Dolores Street in San Francisco are but three of many, many examples of such boulevards.

Another type of boulevard is really nothing more than a street with a wide central roadway and with wide, tree-lined sidewalks along each side. Called boulevards, it is the gracious tree planting, the wide walks, the anticipation of well-designed buildings along them, and a hoped-for high status address, rather than a distinct cross-section, that characterizes them. Intersections on these streets, aside from the amount of traffic they might be called upon to handle, are much like those of other streets.

The type of boulevard we are concerned with is distinctly different from the other two. The classic boulevard is designed to separate through traffic from local traffic and often provides special pedestrian ways. Like other streets, it provides access to abutting uses, but unlike others it is often designed for recreation.

The classic boulevard is characterized by a central roadway of at least four lanes, for generally fast and non-local traffic, separated from roadway and pedestrian traffic lanes on either side by medians that contain lines of trees. The medians can be of various widths, as are the side access roads for moving vehicles and (usually) parking. Medians may be nothing more than planting strips or they may contain walks, benches, transit stops, and even horse trails or bike paths. The sidewalks may or may not have their own lines of trees.

This classic boulevard is a unique street type, and it is this type of boulevard that is held to create complicated, difficult, and often dangerous intersections. These are the streets that seem most frowned upon by present-day road design standards and norms. And yet, this street type directly addresses the functional problems posed by the relationship between different types of movement and access on major urban streets. We suspect that boulevards of this type have been unduly maligned, even though they have offered and continue to offer a fine approach to gracious urban living.

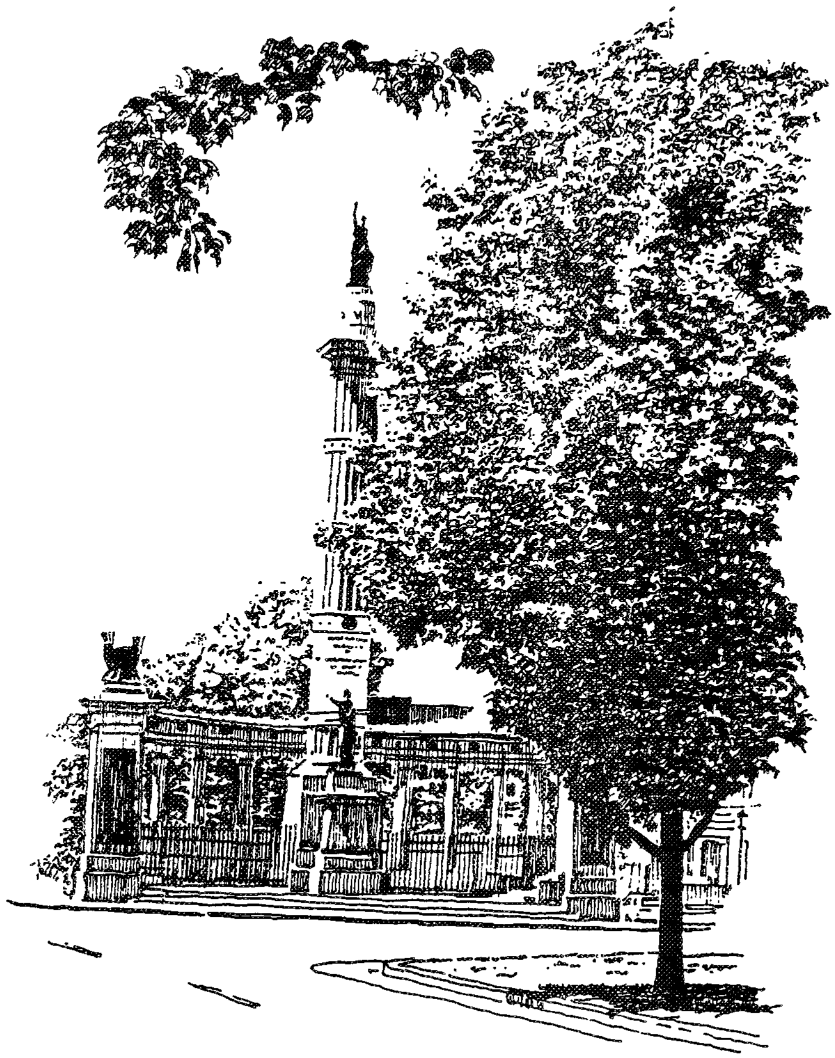

Figure 1.3. Monument Avenue, Richmond, Virginia

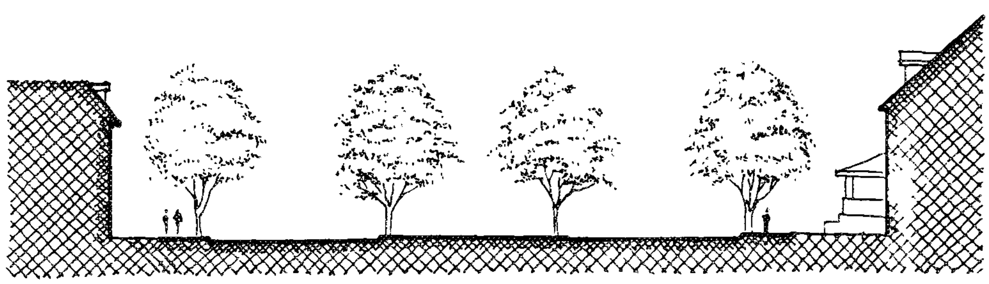

Figure 1.4. Cross-Section: Monument Avenue, Richmond, Virginia

Figure 1.5. Boulevard St. Michel, Paris

The Decline of Boulevards in the U.S.

As much as any reason, it may have been a new way of thinking and of classifying streets, starting in the 1930s, that has resulted in the decline of boulevards in the U.S.

During the 1940s, particularly after World War II, the emerging field of transportation planning embraced the notion of functional classifications of streets. In essence, this approach to transportation planning, especially concentrating on auto traffic, strove to achieve a specialization of urban streets according to the movement functions they were primarily to serve, and not necessarily for access. Beyond local

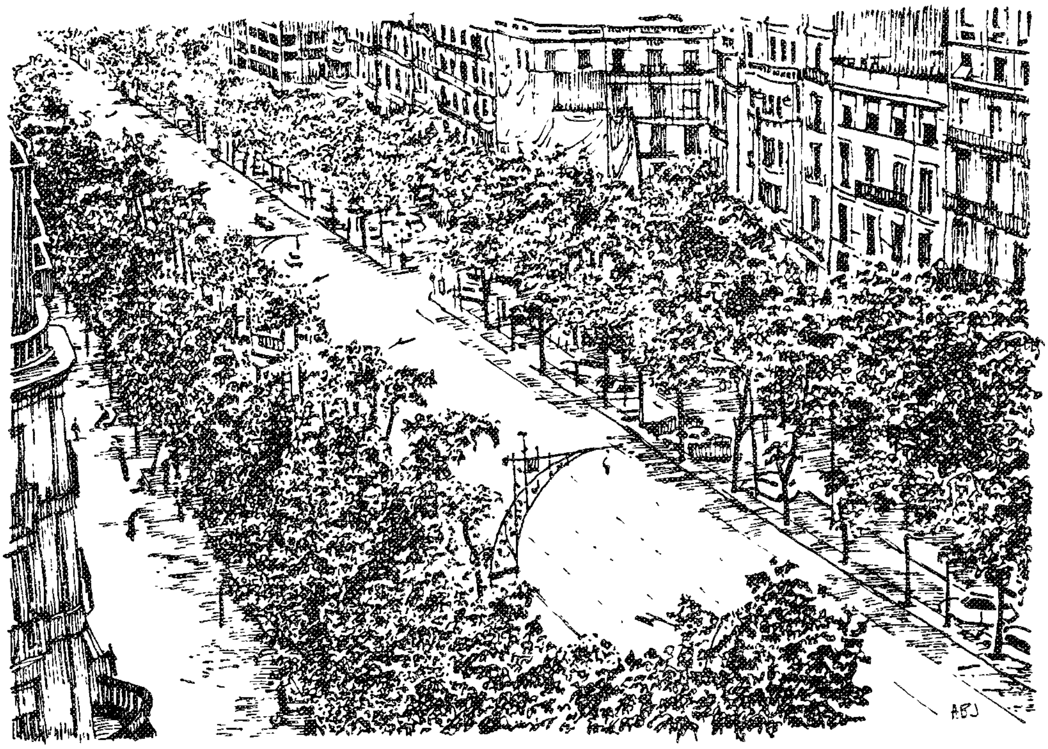

Figure 1.6. A Classic Boulevard: Paseo de Gràcia, Barcelona, Spain

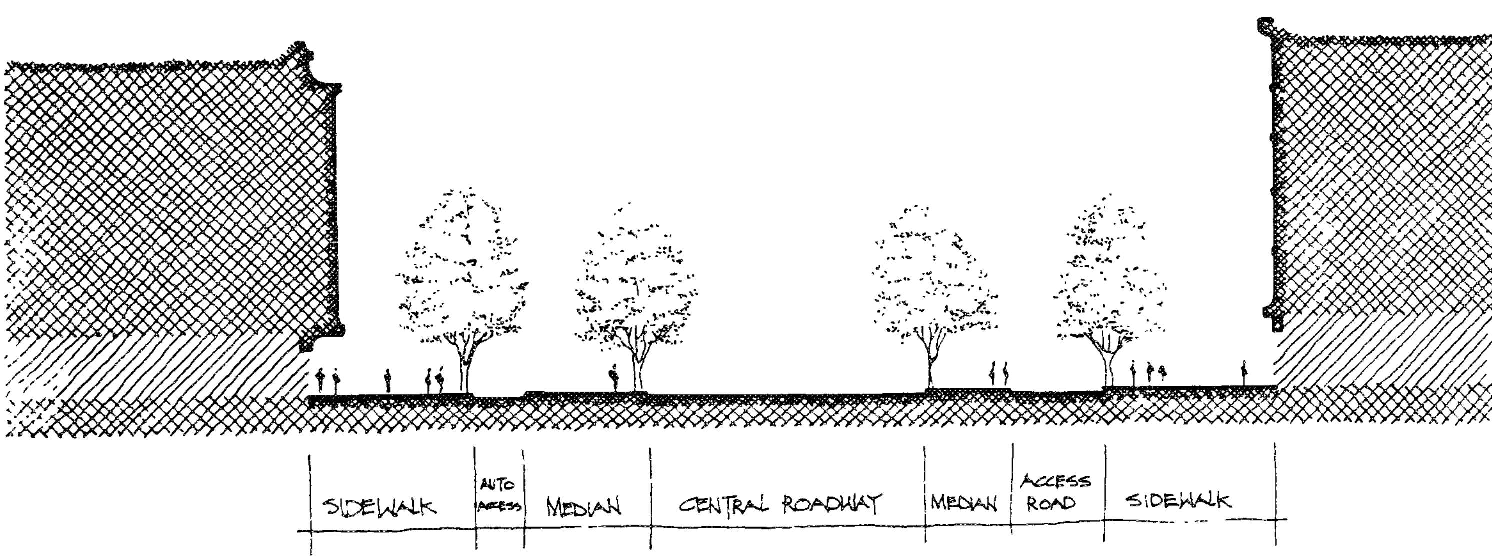

Figure 1.7. Cross-Section of Paseo de Gràcia, Barcelona, Spain

access streets, there were to be "collector" streets, "arterials," "expressways," and ultimately "freeways." Collector streets would take traffic from local streets and deliver it to an arterial, which might then be connected to an expressway or freeway. Many combinations would be possible. Each road type was associated with lane-width standards and norms, curvatures, superelevations, and intersection geometrics and spacing. The ultimate specialized roadway is the freeway, a road type made all the more possible by the extremely well-funded Federal Highway Act of 1956,[2] and its promise of roughly 90 percent federal funding for freeways to be part of a nationwide system.

Freeway design standards, directed in major part to continuous movement of vehicles and the ultimate in intersection design, the cloverleaf, or a variation of it, that permits no conflicting traffic movements, have had a major influence on design standards and norms used for all streets, of whatever function. Funding for freeways, much more available than for other street types, has increased the attention to them and their influence in design terms. Where funding has been available for other major urban streets, generally it has been to make them more specialized as vehicle movers in accordance with the functional classification system.

In this context, one problem with boulevards of the type we are concerned with is that they do not fit easily into any functional classification category. Analogous to mixed land uses, a victim of city planning and development preferences and standards since World War II, the boulevard is a mixed-use public way that is complex by its very nature, and was therefore discarded.

Boulevards have also fallen prey to changing standards of road building. Over the years, there has been a tendency to widen lane widths, for example, from eight or nine feet to twelve or thirteen feet. Acceptable median widths have increased, left and right turning lanes have become standard, and turning radii at intersections have become larger. Parking lanes have become wider. Acceptable tree-spacing standards and norms have become much greater, especially permissible planting distances from intersections. The reasoning for these changing standards always includes a major safety component. Safety considerations, especially related to boulevards, are often based on geometric and physical assumptions and applied logic, not necessarily on observation of real behavior on those streets. These considerations are especially focused at boulevard intersections. The sheer numbers of possible conflicting movements — weaves from side access roads to the central lanes and, vice versa, possible right turns from central lanes across straight moving traffic on the access roads, to name two examples — suggest logically that boulevards must not be as safe as other streets. Our research suggests otherwise.

Study Objectives and What Follows

Following a chapter that presents the general methodologies used in this study, Chapter III addresses two of the five major objectives of the work: to illustrate the physical complexity and richness of boulevards as settings for human action and interaction; and to show the complexity of movement patterns on existing boulevards. This long chapter is the product of considerable field research that included measurements of the physical qualities of boulevards, counts of pedestrian and vehicular traffic, and extended observation and documentation of behavior, that included time-lapse and video filming.

Chapter IV addresses a third objective: to corroborate our sense that existing boulevards are not less safe than comparable non-boulevard streets. To this end, accident and traffic volume data, including counts carried out in this research, are presented and analyzed.

A fourth objective of this research is to show that existing rules, guidelines, and norms make it extremely difficult if not impossible to design good boulevards today, this despite the existence of examples that are generally held as excellent circulation, shopping, walking, living streets that are highly valued where they exist. In other words, the study addresses a relatively simple but important question: if we wanted to, could we design and build a street that is every bit as good as one that is generally admired and held to be of extremely high quality? This is not exactly a new question. It could be asked of many other widely acclaimed and revered places and things. Nonetheless, it is a good question and, if the answer is negative —that we could not recreate something we like — then we should know why and we should know if the reasons are sound. That is the subject of Chapter V.

Finally, a major objective of this research was to investigate hypotheses that might explain the relationship between the physical qualities of boulevards, their usefulness as community builders, and their relative safety. This is done in Chapter VI, which includes an analysis of the hypotheses, using the data presented in the preceding chapters.

A concluding chapter ends this report, summarizing the conclusions and pointing to further research needs and the prospects for boulevards in this country.

We doubt if we will soon see massive highway building programs of the kind that characterized the 1950s, 1960s, 1970s, and even the 1980s. Certainly we are not likely to see them in built-up urban areas. The monetary and social costs of such undertakings are too high and people object mightily to them if they mean relocation of residents together with large-scale property destruction. Nonetheless, we will continue to be called upon to address movement, activity, and land use issues in existing cities and in the development of new places. We do not necessarily have to invent new types of streets as we address these issues. Limited funding for freeways may also allow the focus to shift from freeway-building to other street types. Multiple-purpose streets, streets that are integrated with their surrounding uses of land, are nothing new. Boulevards are such streets. They deserve to be looked at again for their usefulness today, not only to move vehicles, but also to satisfy the multiple needs of pedestrians and local residents. That is an overriding purpose of this study.

II. OBJECTIVES AND METHODS

This chapter presents, generally, the methods used in carrying out this study. For the most part, each of the study objectives was associated with one or two overreaching methods of investigation and analysis. These are described briefly here. Basically, the methods include a combination of empirical data gathered from a variety of public records having to do with traffic volumes and accident data, field measurements of streets, counting of vehicle and pedestrian movements, and a variety of behavior observation techniques in the boulevards in question, which include documentation in time-lapse film and in video. More detailed exposition of individual research activities and methods are included in each section of the study, associated with the specific finding of each method.

The Choices of Boulevards

At the outset, the choice of which boulevards to include in the study followed a rather straightforward, though time-consuming, procedure. Choice of the initial Paris and Barcelona boulevards, Avenue Montaigne and the Paseo de Gràcia, was relatively easy. Previous observation of these streets, as part of previous research, was significant in raising the questions about boulevards in the first place.[3] Both of these boulevards seemed to be safe. Each is different from the other: Avenue Montaigne is narrow, and not very long; Paseo de Gràcia is wider, long, grand in scale, and has much more traffic. Assuming data could be found for them, they seemed a natural starting point. Other nearby boulevards in these two cities would follow.

Beyond these first choices, U.S. boulevards were sought that could meet a variety of conditions. Boulevards in cities of various sizes were sought, as were boulevards with different volumes of traffic. It would be desirable to find boulevards that passed through different kind of land uses: residential, commercial, and downtown areas. Location in the U.S. was another consideration, representing different climates. Most important was the availability of traffic volume and accident data for the boulevards to be studied.

The method of finding the boulevards was also rather direct. Relying on research team members' memories, colleagues all over the country were consulted to help name streets; guide books and master plans of major U.S. cities were scrutinized to see if such streets could be found there. Leads were followed up with calls to city officials to see if the streets suggested were indeed boulevards of the particular type desired, and if necessary data and base maps existed. This part of the study required two to three months, and never really ended. While in Paris doing field work, a host of boulevards surrounding the Place Charles de Gaulle was "found," and Ocean Parkway was added to the list quite late after it was "discovered" by two of the researchers while doing field work on Eastern Parkway.

Objective: To Take as Close a Look as Possible at the Safety of Boulevards Compared to Normal Streets

This objective is two-fold. First, it is important to ascertain whether or not the physical arrangement of boulevards, and the complex intersections that they create, result in more accidents, particularly in light of the higher mathematical probability of accidents. The working hypothesis was that they do not. Then, the contribution to safety made by the rather expansive space standards used in American streets, as compared to the tighter conditions that exist on European streets, had to be assessed, specifically in boulevards.

Thus two levels of comparison were pursued:

1. Within cities, comparisons between boulevards and non-boulevards to test the hypothesis that in a similar environment boulevards are not less safe.
2. Between European boulevards and American boulevards to show that safety might not be related to geometric standards.

For each boulevard, traffic volumes and safety performance was compared to a similar major street in the vicinity. This allows the assumption that most of the contextual variables are the same, and the major difference between the streets will be in its physical design, as a boulevard or not.

As far as the data permit, European and American boulevards are compared in terms of their performance to see if there is any increase in capacity and safety that results from the wider and sparser environment in American streets.

It is important to reiterate here that the main hypothesis is that boulevards are *not less safe* than ordinary streets. It is not claimed that they are safer than ordinary streets. Also, it is desirable to show that they are able to handle as much traffic as an ordinary street of equivalent width. These were the two main arguments against boulevards, and the main purpose of this study was to see whether these arguments have a basis in reality. However, in the latter part of the report further analysis of the ways that boulevards work is carried out in some detail, as a way of explaining the phenomena observed, and to argue for their re-adoption on the basis of their positive merits.

Objective: To Illustrate the Physical Complexity and Richness of Boulevards as Settings for a Multitude of Possibilities for Human Action and Interaction.

This objective was pursued through detailed field observations and measurements of streets in question. Then, by mapping both boulevards and selected "control" streets at a similar scale, the differences can be more immediately perceived. Important physical measures that determine the organization of these streets, and their location in the city, are also included.

Objective: To Illustrate and Analyze the Complexity of Movement Patterns on Existing Boulevards.

This objective has to do in part with demonstrating the adaptability of people, drivers, and pedestrians in complex situations, and how they deal with situations that are potentially less safe than on normal streets.

Invariably, the information supplied to us by the planning and traffic engineering departments of the various cities, which was used to compare the safety of boulevards to control streets, was not of sufficient detail to allow an understanding of the way that the physical environment of a street affects its movement patterns, how it is that the boulevards actually function, and what is it in the physical design of a boulevard that makes it safe or unsafe. For example, traffic counts were volumes expressed in average daily travel (ADT) for the whole boulevard, and did not differentiate between traffic on the main thoroughfare and the side streets. Pedestrian counts were rarely available. The different crossing movements possible in boulevards were not documented. Often, exact location of accidents was not known. To begin this inquiry two methods were used:

1. Counting pedestrians and cars to augment statistics.
2. Observation and film and video documentation.

Detailed counts of pedestrian and car movements were performed, covering all the various movement possibilities that exist on boulevards. Similar counts were undertaken on most of our control streets. Due to the limited resources of this research, however, these counts are only suggestive of orders of magnitude.

Pedestrian and driver behavior was observed and recorded on video tape and in time-lapse photography to permit deeper probing of the patterns of movement, as well as its rhythms, its flow characteristics, and recurring conflicts and the ways they are resolved by the people in the streets. This research and observation has been extensive. In all, about nine hours of time-lapse photography covering a total of eight streets were taken; in addition, about 16 hours of video footage is in hand, documenting behavior on boulevards and their normal "control" streets.

It is our intention to produce a short documentary that describes this research and shows selections of this footage as a companion to this report.

Objective: To Review Existing Rules, Standards, and Norms and Their Impact on the Design of Existing Exemplary Boulevards.

Basically, this objective had its source in a doubt: would it be possible to design and build today a boulevard which is similar in physical features to those that are generally held in high regard.

The method chosen to do this is to show the effects of present road geometric design guidelines and norms would have on two particular boulevards: the Paseo de Gràcia in Barcelona, and the Avenue Montaigne in Paris. This is done by plotting, in plan and in section, or showing in tables and describing in words the spatial and physical effects of applying the guidelines contained in *Guidelines for Urban*

Major Street Design, published by the Institute of Transportation Engineers (ITE), and several other key texts relevant to boulevards.[4]

Objective: To Investigate Preliminary Hypotheses That Explain the Physical Elements Most Likely to Make Boulevards Safe.

The data accumulated in this study has not been extensive enough, or consistent enough between cities, to enable a statistical multivariate analysis of the effect of various physical geometries on accident rates. What has been done is to synthesize our traffic volume and accident data, the physical documentation, and the records of behavior patterns on boulevards into some general observations on the way that boulevards work. To achieve this, we posited some initial observations, and proceeded to analyze whether the evidence supported those observations; as more evidence accumulated, we continued to refine the observations.

A more detailed description of each method is to be found in the individual chapters that describe each part of the study.

III. THE PHYSICAL FORMS OF THE BOULEVARDS AND OF THE CONTROL STREETS AND ANALYSIS OF MOVEMENT PATTERNS

This chapter consists of four parts. First is a description of the process by which boulevards and control streets were identified and selected for inclusion in this study. This is followed by a description of the field-observation methods used to gather detailed information about the physical characteristics, movement patterns, and behavior on some of the streets. The third section, which makes up the bulk of this chapter, consists of street-by-street descriptions of eight boulevards and control streets which were selected for detailed illustration. Plans, sections, and movement diagrams, prepared from field observations, are presented for each boulevard. The final section compares the physical characteristics of the boulevards and the behavior that occurs on them, and presents some preliminary conclusions based on these comparisons.

Boulevard and Control Street Selection

The Boulevards

The boulevards included in this study were chosen in several ways. First, two of them — the Paseo de Gràcia in Barcelona and the Avenue Montaigne in Paris — were well-known, having been observed and studied as part of the research for *Great Streets*. It was important to learn more about them. Meetings with colleagues, students, and friends produced the names and locations of other boulevards that might be studied. Examples were pursued that would illustrate boulevards in various contexts: some in big cities, some in small cities, some that were commercial, and some that were residential.

Data was collected for a total of 19 boulevards. Included were eight streets in the United States: the Grand Concourse, Queens Boulevard, Eastern Parkway, and Ocean Parkway in New York City; K Street in Washington, D.C.; Southern Parkway in Louisville, Kentucky; The Esplanade in Chico, California; and Shattuck Avenue in Berkeley, California. Data was also collected for 11 boulevards in two European cities: the Avenue Montaigne, Avenue des Champs Elysée, Boulevard de Courcelles, Avenue Franklin D. Roosevelt, Avenue George V, Avenue Marceau, Avenue d'Iéna, and Avenue Kléber in Paris; and the Paseo de Gràcia, the Diagonal, and the Gran Via in Barcelona.

The Control Streets

Control streets selected are near the boulevards (as near as could be found) and are as similar as possible to the boulevard under consideration, differing mainly in geometry. Streets were sought in the same area of the city as the boulevards, of similar length and function, which carry similar traffic volumes, and for which it was possible to get data. It was often not possible to match building quality, land uses, and landscape features on the control streets with the boulevards in question.

Data Collected

Accident data was collected for all the boulevards and control streets, and an analysis of this information is presented in the next chapter. Field observations, undertaken on selected streets, are presented later in this chapter.

Field Observation of Selected Streets

Field observations were made on as many of the boulevards and control streets as time and money allowed, which included over half of the boulevards identified above. For each boulevard observed, three interrelated studies were undertaken. When time allowed, similar studies were undertaken on the control streets, although observations on them tended to be simplified.

1. *Physical Features Observation and Mapping*

An understanding of the boulevard was gained by first traveling along it to get a sense of the whole, in its context, and then by choosing one or two locations for in-depth study. One or two intersections were selected for detailed observation of movement patterns, and the physical qualities of the street were noted for one or more blocks each way from the intersection under consideration. This included street width, cross-section configuration, traffic and crosswalk configurations, tree spacing and canopy size, building and store entrances, ground-floor transparency or opaqueness, building height, street lighting, street furniture, and land use. This information was used to prepare scale plans on which observed vehicle and pedestrian behavior was mapped, as well as cross-sections.

2. *Volume and Movement Observations and Mapping*

Volume and movement observations of both vehicles and pedestrians were taken at one or two intersections along each boulevard, and, when time allowed, on the control streets as well. Observations were made at relatively busy times but not necessarily at peak hours. In general, most observations were taken neither at high peaks nor low troughs. It would have been preferable to collect all the data during peak hours, but this was not possible. To some extent, money constrained how much could be done.

Vehicle Observation

At each intersection under consideration, average traffic speed was measured, traffic volumes were counted, and traffic movements recorded. Where possible, average traffic speed was determined by driving along the boulevard — both in the center and on the access roads — with the flow of traffic, and recording the speed at several locations at regular intervals. Average speed was then computed. For both the boulevards and cross-streets, vehicle volumes were counted, as were turning movements. Typically, the counts were done sequentially by direction. Usually, a 15-minute count was made for one direction, then another 15-minute count for the opposite direction, and so on. Often, one researcher observed cars traveling in the center roadway while at the same time a second researcher observed cars traveling in the same direction on the access road.

Of particular interest were movements, whether legal or not, that created potential conflicts between traffic on or coming from the side access roads and traffic on or coming from the central roadway. Such movements might include right-hand turns from the center roadway across the access road, and U-turns from a side access road across the center roadway.

Pedestrian Observation

At each intersection under consideration, pedestrian volumes and movements were counted and mapped. Fifteen-minute volume counts both at mid-block and at the crossing were taken. Counts were usually done by a team of two researchers, with several counts occurring simultaneously. One researcher counted pedestrians moving along the sidewalk at mid-block on one side of the street. If pedestrians were walking along the median, these were noted separately. At the same time, the second researcher made two or more counts showing what happened at the intersection: one count of pedestrians crossing the side street on the same side of the block, one count of persons crossing the boulevard from or to that side of the block, and a count of crossings from median to median, if this occurred. The researchers then moved to the opposite side of the street and performed similar counts.

Initially, information on pedestrian movements approaching intersections was recorded by randomly selecting pedestrians traveling in a particular direction and mapping their movements on a prepared base map of the intersection. As the study progressed, this information proved less useful than the other observations, and was not pursued. The mapping that was done was carried out by a team of two researchers for a 30-minute period. One researcher would select from pedestrians coming from one direction, while the second researcher would select from pedestrians coming in an opposite or cross-direction. This method was then repeated, focusing on other directions as required, to get as complete a picture of pedestrian movement as possible. For each pedestrian observed, the researcher noted particulars about the person and his/her movement, such as sex, approximate age (young, middle-aged, etc.), whether they were walking alone or with others, the pace of movement (i.e., whether relaxed or hurried), where stops were made, and what the purpose of the stops seemed to be.

Mapping

All of the movement and volume data were mapped. Vehicle and pedestrian volumes were mapped together on one map to illustrate relative volumes and potential areas of conflicts. Volumes are shown by bands of varying width, with greater width indicating greater volume. Direction of movement represented is indicated by arrows on the volume bands.

Where pedestrian movements were taken, they were mapped separately. A single map shows the movements of all the pedestrians observed coming from a particular direction. Each pedestrian movement is shown with a single line, with lines layering upon each other and overlapping as necessary. A heavy dot at one end of the line shows the point at which the pedestrian came under observation, an arrow at the other end of the line shows the direction of travel. If a pedestrian stopped (either to sit or a pause while walking), this is indicated by a swirl. These maps give a good representation of the cumulative general movement along the street at a given time. Since movements were only observed on a few streets, these maps have not been included as part of this report.

3. Time-Lapse Film and Video

Time-lapse film and video were taken of each street included in the study. The films/videos were initially used to help analyze how differently configured boulevards work, what the conflict points are, and how vehicles and pedestrians typically act. Later, concentration shifted to video footage that could be used to study movements and to record typical behavior that can be used in a video about boulevards.

Time-Lapse Film

Time-lapse film is helpful to give a sense of the overall movement patterns along a street. Patterns that might be undetectable in real time become apparent in compressed time. Experience suggested that a good place to film is from the third floor of a building, either focused on an intersection or a wider area to encompass more of the street. The third-floor vantage-point provides a comprehensive view but is still low enough for a viewer to feel part of the action. Footage from rooftops was taken when lower locations were not possible. This footage, though more removed, also shows overall patterns.

Time-lapse filming was also undertaken at ground level, with the camera set-up either on the sidewalk or a median. This footage is dynamic to watch, since the viewer is in the action, but it is hard to get a sense of the large picture. It shows pedestrian activity well but has limits for showing car movements, since only one or two lanes can be observed.

Video

Several types of video footage were made. Street level footage includes some taken from a stationary point of view, some following specific car and pedestrian movements, street pans, and walking along with the camera to illustrate the pedestrian experience of the street. Where possible, footage was also taken from above street level, preferably from a third-floor vantage point. Finally, in order to get the driver's experience of the street, videos were made from the passenger seat of a car while driving down the center and the access roads, and while making transition movements.

Street-by-Street Descriptions and Analyses of Movement Patterns

Eight of the boulevards on which field observations were made were selected for detailed illustration because they represent a broad spectrum of boulevard possibilities in terms of size, configuration, use, function, and location. Included are the Grand Concourse and Ocean Parkway in New York City, the Avenue Montaigne and Boulevard Courcelles in Paris, the Paseo de Gràcia and Diagonal in Barcelona, K Street in Washington, D.C., and the Esplanade in Chico (two big cities, two medium-sized cities, and one small city). Five of the streets are major arterials (the Grand Concourse, Ocean Parkway, and the Esplanade, which are primarily residential, and the Boulevard Courcelles and the Diagonal, which have mixed uses), two are major shopping streets (Avenue Montaigne and the Paseo de Gràcia), and one is a downtown commercial street (K Street).

Following is a street-by-street description of each of these boulevards and control streets, giving the urban context of each, together with physical dimensions and particular activities along the boulevard, such as land uses, planting patterns, whether or not there is public transit, and the like. Plans and sections of the boulevards are presented, as well as sections of the control streets. Also included are descriptions of the behavior observed on the boulevards and diagrams of the movement patterns on them, taken from field observations.

It should be noted that physical dimensions are based on pacing and are therefore approximate. Counts presented are volumes per hour, interpolated from shorter counts, typically of 15 minutes.

Boulevard #1

THE ESPLANADE, CHICO, CALIFORNIA

(small city, major arterial, primarily residential)

Urban Context

Chico is a small city in the central valley of California, located about 75 miles north of Sacramento. The Esplanade is a major north/south traffic street, serving the city but also acting as a regional through-way in its function as the State Highway 99 business route. It has a boulevard configuration for about 15 blocks near the downtown area, where it is predominantly residential with some pockets of neighborhood commercial and some medical offices. Most of the residences are bungalow-type houses, with some newer 2-3 story apartment complexes mixed in. This street is unusual in that it was not originally a boulevard, but was reconfigured to be one in the 1950s. Residents of Chico have voted the Esplanade the best street in the city for many years.

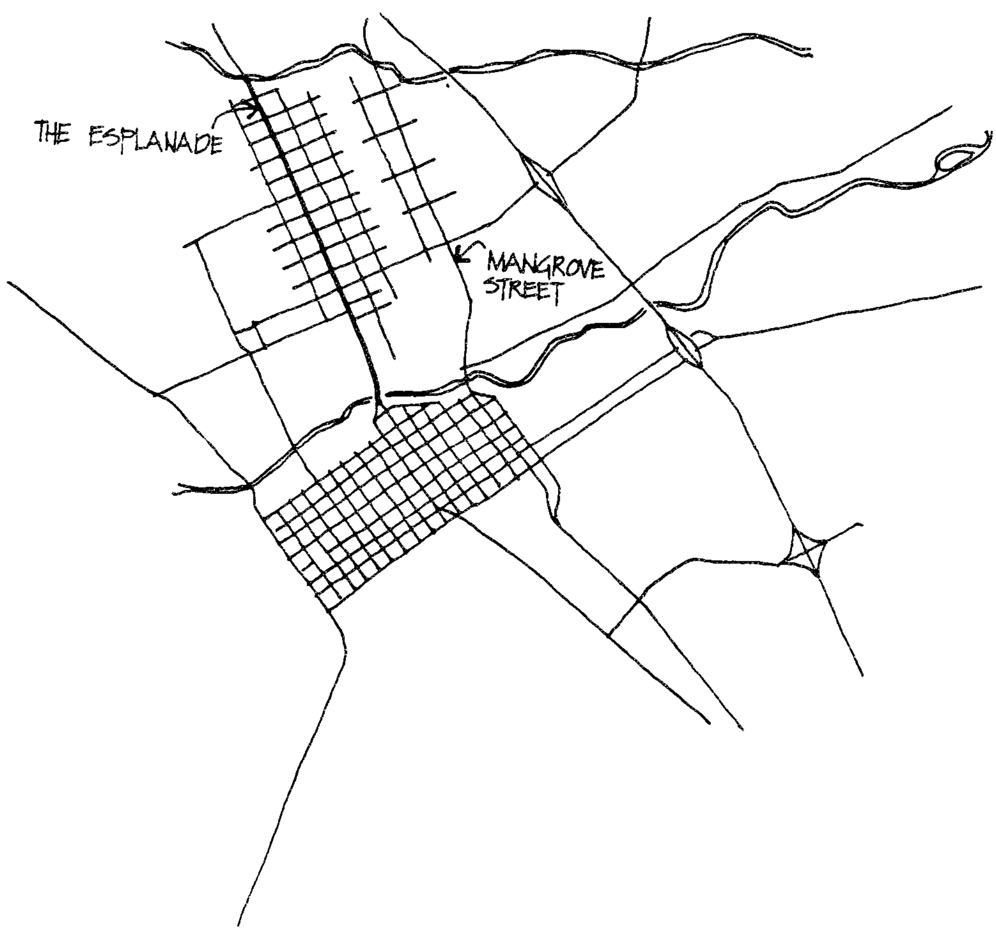

Figure 3.1. Urban Context Map of Chico
Scale: 1:50,000

Control Street

Mangrove Street was selected as the control street. It runs parallel to the Esplanade, five blocks to the east. It carries two lanes of traffic in each direction, plus a left-turn lane, within its 63- to 67-foot-wide roadway. The length observed, near First Avenue, is predominantly a commercial strip. It was selected as a control street primarily because it carries a similar amount of traffic to the Esplanade and most of it is through traffic. The uses along the street are very different than on the Esplanade. No other predominantly residential street in Chico carries nearly the traffic volume of the Esplanade.

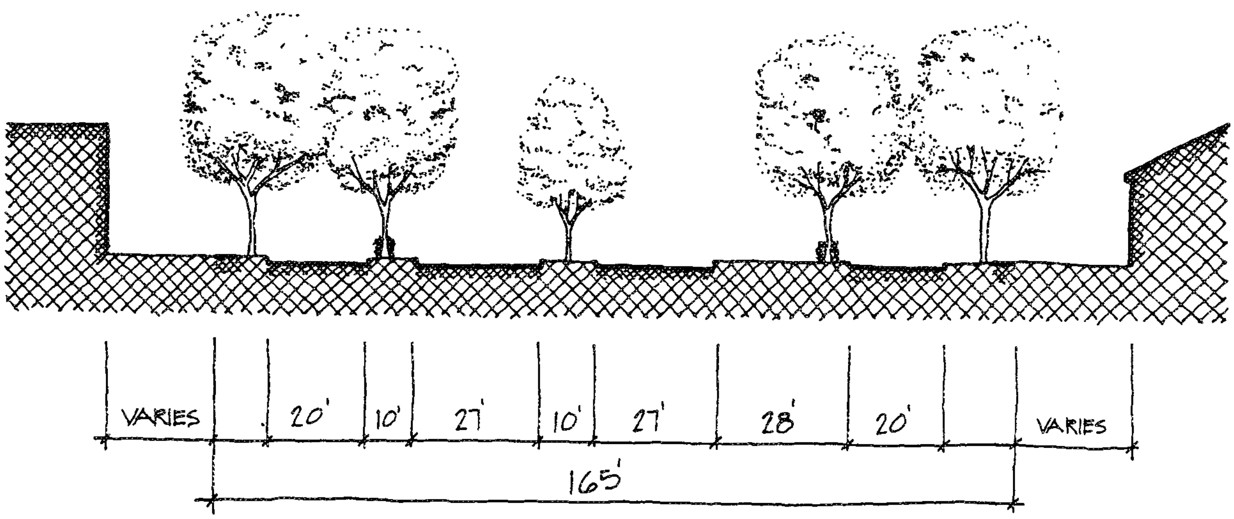

Figure 3.2. The Esplanade: Section
Approximate Scale: 1" = 40' or 1:500

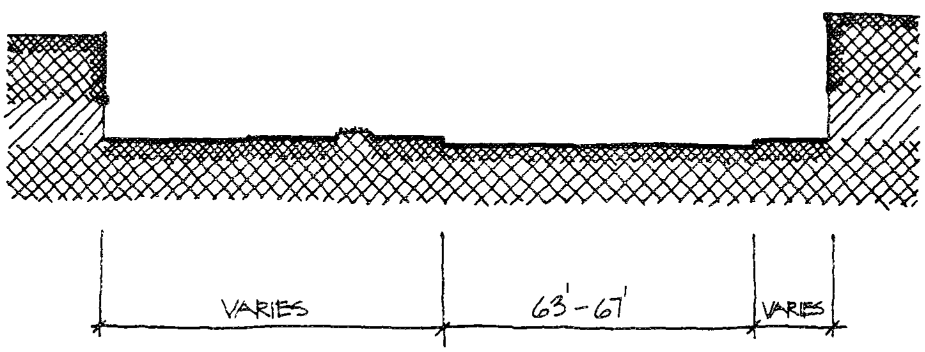

Figure 3.3. Mangrove Street: Section
Approximate Scale: 1" = 40' or 1:500

Boulevard Description

- The street right-of-way is 165 feet.
- Residences are typically set back 25 feet to 30 feet from the curb. Commercial buildings are typically set back approximately 10 feet from the curb, at the sidewalk edge.
- The 64-foot center traffic-way has two lanes in each direction (13.5-foot lanes) with left-turn lanes every other intersection, cut into the 10-foot-wide center median, which is sparsely planted with trees.
- The medians separating the access roads from the center roadway are of different widths. The western one is approximately ten feet wide, while the eastern one is substantially wider, typically 28 feet wide. This median originally carried a railroad track, which has been removed.
- Right-turn lanes are cut into the eastern median at intersections.
- The medians are planted with mature deciduous trees at 30 to 35 feet on-center, intermixed London Planes and Sycamores. The canopies from these trees arch over the access roads, often joining with canopies of similar but less regularly spaced trees in a sidewalk planting strip. Generally, the trees are set back from the intersection from 28 feet to 48 feet, but they are sometimes much closer.
- The marginal access roads on each side are narrow, typically 20 feet, providing one lane of parallel parking and one through lane (10-foot lanes). At some commercial areas, the access road widens to approximately 28 feet for diagonal parking.
- Typically, 10-foot-wide side planting strips separate the sidewalk from the access road, although this is not consistent. Sometimes there is a 4-foot-wide side planting strip and sometimes there is none at all.
- Local bus lines run on the side access roads as well as in the central lanes, but stops are on the access roads.
- Intersection movement between the center and the access roads is not restricted.
- The center and the cross-streets are controlled by signal lights at every second intersection, at First Avenue, Third Avenue, etc. At these intersections, left-hand turns are not allowed from the center. There are no controls at the alternating intersections where left turns are allowed.
- Signal timing is set for 28 m.p.h. in the center.
- The access roads are controlled separately, with a stop sign at every intersection.
- Cross street traffic waits at the median edge.

Behavior and Movement Observations

Intersections Observed

- First Avenue: two-way, high traffic, signalized
- Second Avenue: two-way, low traffic, non-signalized

Observations Taken

- Late afternoon, weekday, summer
  Note: Pedestrian counts were not made because there were very few pedestrians.

Observations

- Almost all the traffic travels in the center. For example, at First Avenue an average northbound volume per hour of 896 was counted in the center and 20 in the access road; an average southbound volume per hour of 844 was counted in the center and 24 in the access road.
- Very little traffic travels along the access roads for more than one block. Only eight northbound and four southbound through vehicles per hour were counted.
- Traffic travels much slower on the access roads then it does in the center: an average speed of 21 m.p.h. was observed on the access roads compared with 31 m.p.h. in the center. Vehicles in the access roads have only one block in which to build up speed, since there are stop signs at every intersection, whereas cars in the center roadway have at least two blocks in which to build up speed, since signals occur only every other intersection.
- The separate controls at intersections permit potential conflicts, but people recognize this and act cautiously at intersections. The main conflict is between drivers on the center roadway making a right-hand turn on a green light and drivers on the access road going straight or making a left-hand turn from the stop sign. In general, the center roadway driver makes the right turn more cautiously when there is a car on the access road at or approaching the intersection. (The driver looks to see what the access road driver is planning to do, slows down, waits.) In general, the access road driver is very cautious about entering the intersection, looking in more directions than when at a normal intersection. The driver must look back over his/her left shoulder to see if there is traffic approaching in the center roadway, especially if the light is green, and must also look to see if a left-hand turn is in process (an unusual direction to look in, across several lanes of traffic).
- On the east side, with the wider median, cars on cross streets pull up to the center roadway to wait for a green-light. When traffic is heavy, more than several cars are waiting and the access road throughway becomes blocked. When this happens, drivers on the access road intending to proceed straight will often give up and turn right instead. Sometimes the drivers of waiting cars notice the situation and back up or pull forward to allow the car on the access road to maneuver through. When traffic is light and only one or two cars back up, access road drivers wishing to go straight simply maneuver around waiting cars. Buses frequently make this maneuver as well.
- In general, there are not many pedestrians on the street.
- Bicycles use the access roads.
- Generally, illegal moves were not observed.
- For pedestrians, there is a strong sense of being in a no-man's-land when crossing a cross-street. Cross-walk markings do not exist, so a specific pedestrian zone is not identified. One feels vulnerable to traffic coming from many directions.

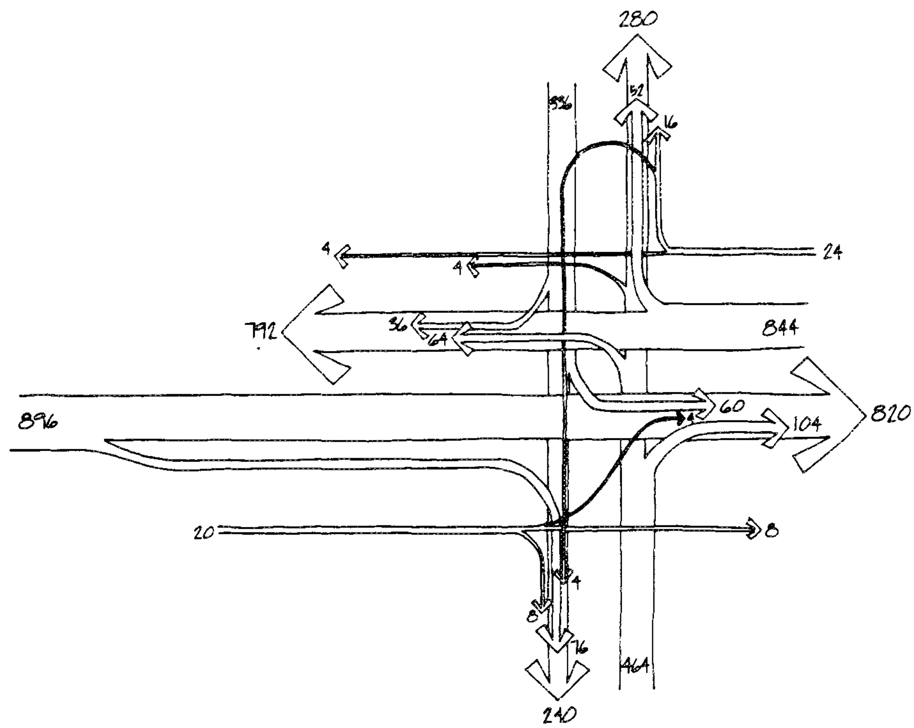

Figure 3.5. The Esplanade at First Avenue: Vehicle Movement Diagram

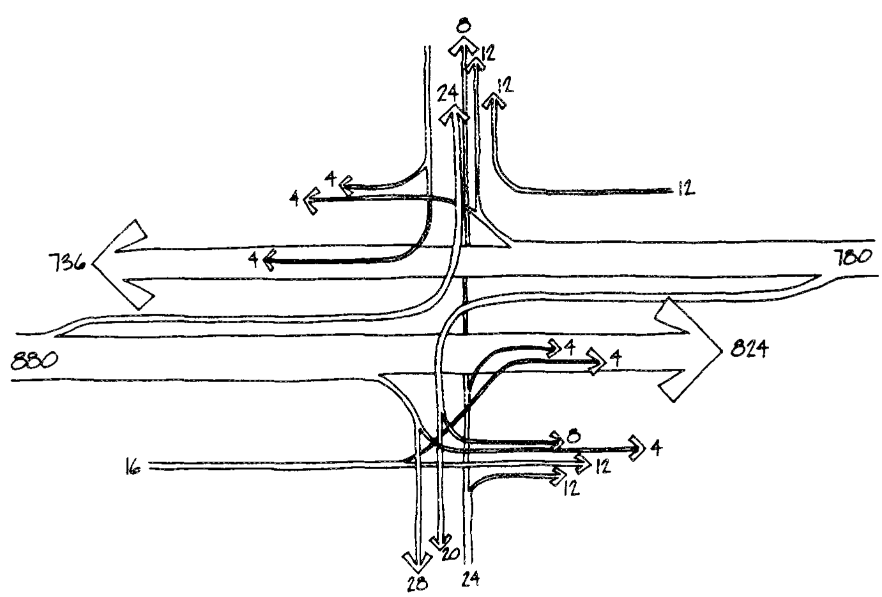

Figure 3.6. The Esplanade at Second Avenue: Vehicle Movement Diagram

Boulevard #2

K STREET, WASHINGTON, D.C.

(medium city, downtown commercial street)

Urban Context

K Street is an important east-west downtown commercial street running several blocks north of the White House. It is a boulevard for 10 or 11 blocks along its central section, that links Mount Vernon Square with Washington Circle. Access roads occur only on one side for several blocks adjacent to Franklin Square and McPherson Square parks, where the park extends to the edge of the center roadway. The street is lined with 8- to 12-story office buildings, with some residential apartments, and has both large and small commercial uses at the ground floor.

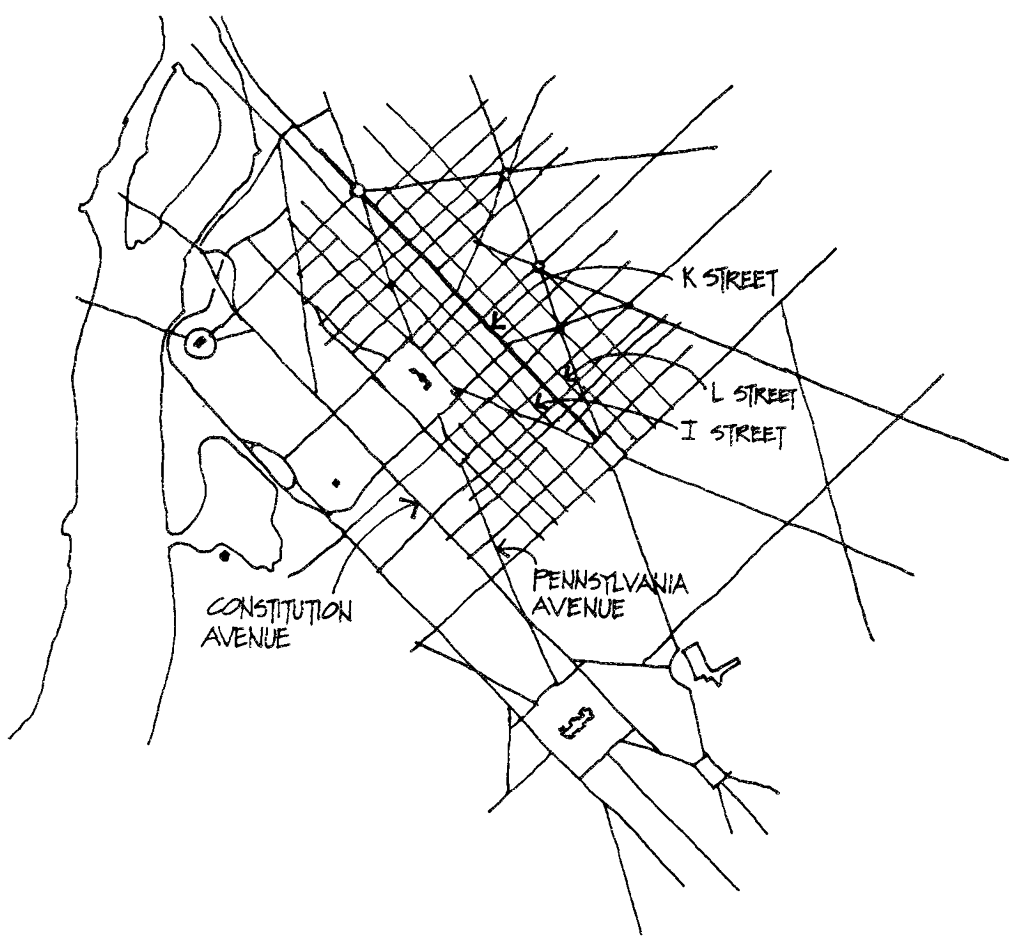

Figure 3.7. Urban Context Map of Washington, D.C.
Approximate Scale: 1:50,000

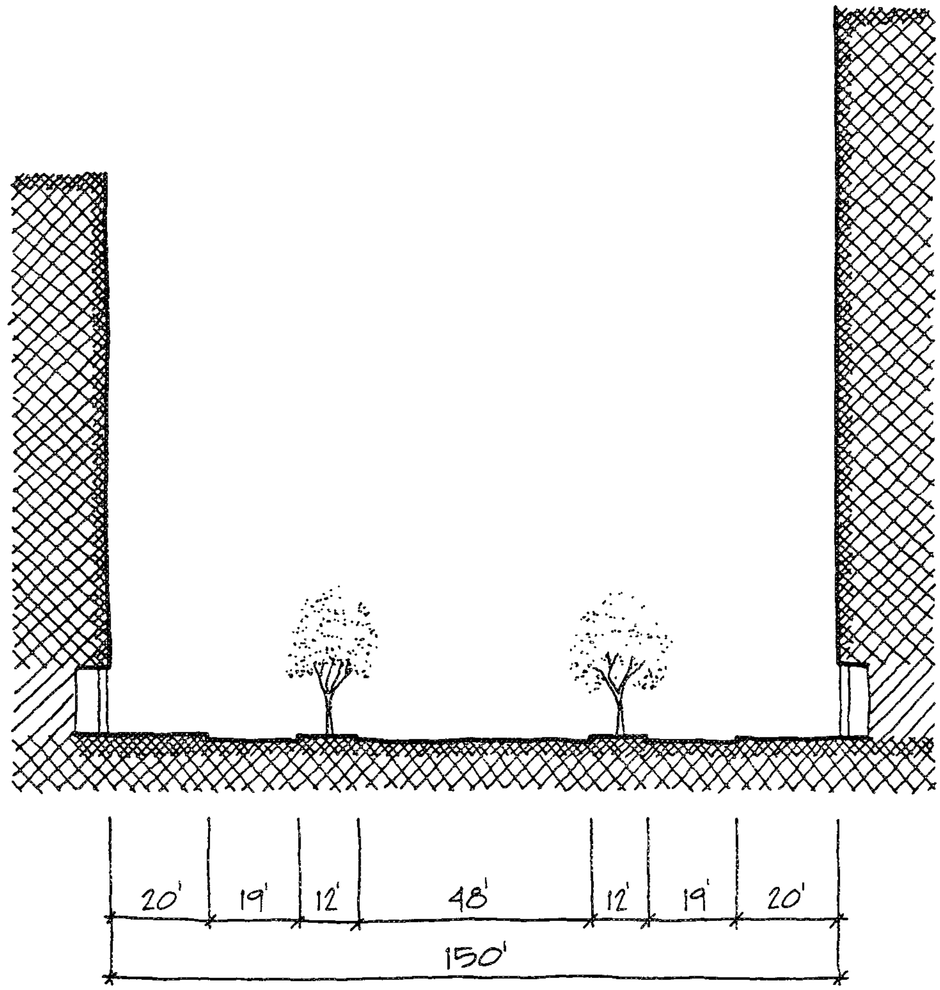

Figure 3.8. K Street: Section
Approximate Scale: 1" = 40' or 1:500

Control Street

Pennsylvania Avenue, Constitution Avenue, L Street, and I Street were all used as control streets for K Street, the first two because they are streets of similar prominence which carry similar amounts of traffic as K Street, and the latter two because they are nearby parallel streets. Physical measurements of the control streets were not undertaken because of time constraints.

Boulevard Description

The street is characterized by its busy commercial nature and sparsely planted medians.

- The street right-of-way is 150 feet, and buildings are generally at the property line.
- Block length varies from 400 feet to 500 feet.
- The center roadway is 48 feet wide and consists of 2 lanes in each direction plus left-turn lanes squeezed in at intersections (9.5-foot to 12-foot-wide lanes).

- The side medians are approximately 12 feet wide and planted sparsely, with a row of trees at 30 feet to 40 feet on-center.
- The access roads are 19 feet, allowing one through lane and one lane of parallel parking (9.5-foot-wide lanes).
- Sidewalks are typically 20 feet wide, with a row of small trees at the curb line.
- Intersection movement is restricted. No right turns are allowed from the center, and vehicles on the access road are not supposed to enter the center.
- Transitions from the center into and from the access road are supposed to occur only at mid-block breaks in the median. These breaks are wide, with a clear passage of 30 feet to 50 feet. Typical blocks contain two breaks, one toward the beginning for vehicles to enter the access road, and another further along for vehicles to exit.

Behavior and Movement Observations

Intersection Observed

- 19th Street: one-way southbound, signalized
- 16th Street: two-way, signalized

Observations Taken

- Mid-morning to early afternoon, weekday, winter, cold

Observations

- The majority of traffic travels in the center, but a considerable amount also travels on the access roads. At eastbound 19th Street, 1,212 per hour were counted in the center, compared to 508 per hour in the access road; westbound, 904 per hour were counted in the center, compared to 312 per hour in the access road.
- Much of the access road traffic seems to be vehicles getting ready to make a right-hand turn, since this movement is restricted from the center. For example, of 508 vehicles per hour traveling along the southern access road, 312 turned at the cross street and only 180 continued through.
- Median breaks, although directionally angled, are often used by vehicles making the opposite movement. For instance, at one location 24 vehicles per hour were observed entering through a break that is supposed to be only an exit. At the same time, 44 vehicles per hour exited through the same break. It is interesting to note that of the latter, 12 made illegal U-turns across the center.
- Pedestrian volumes were quite high: at 19th Street, 2,516 pedestrians per hour were counted walking along the sidewalks and 1,940 pedestrians per hour were counted crossing the boulevard.
- When traffic allowed, many pedestrians crossed to the access road median against the light, and then waited until the light turned to cross the center.

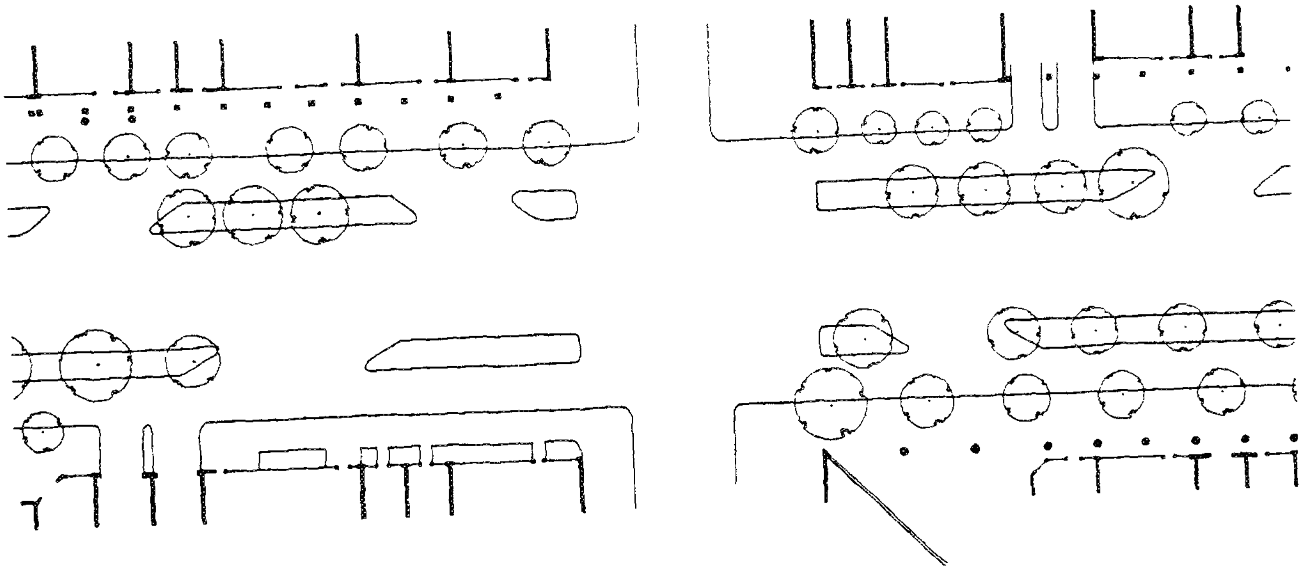

Figure 3.9. K Street at 19th Street: Plan
Approximate Scale: 1"=80' or 1:1,000

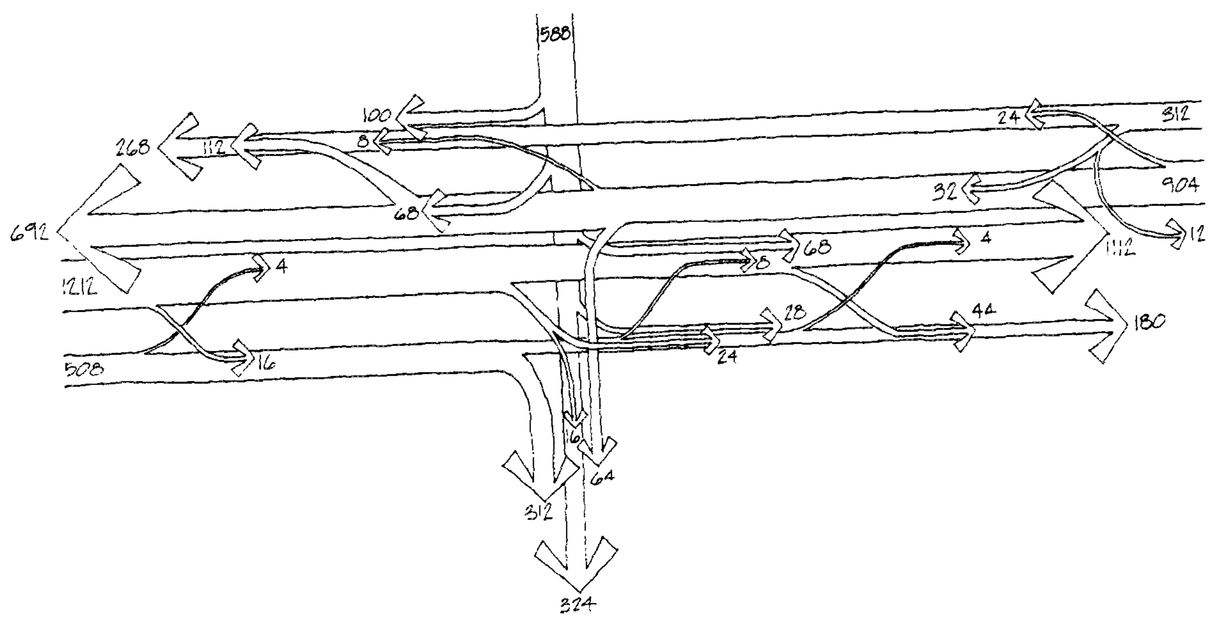

Figure 3.10. K Street: Vehicle Movement Diagram at 19th St.

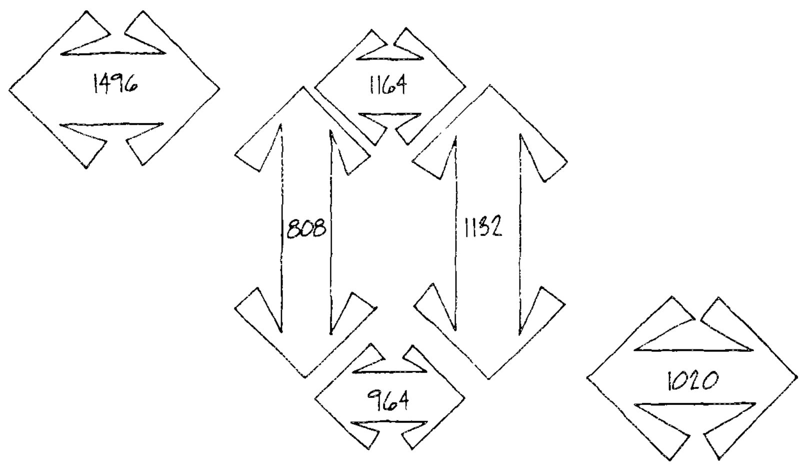

Figure 3.11. K Street: Pedestrian Movement Diagram at 19th St.

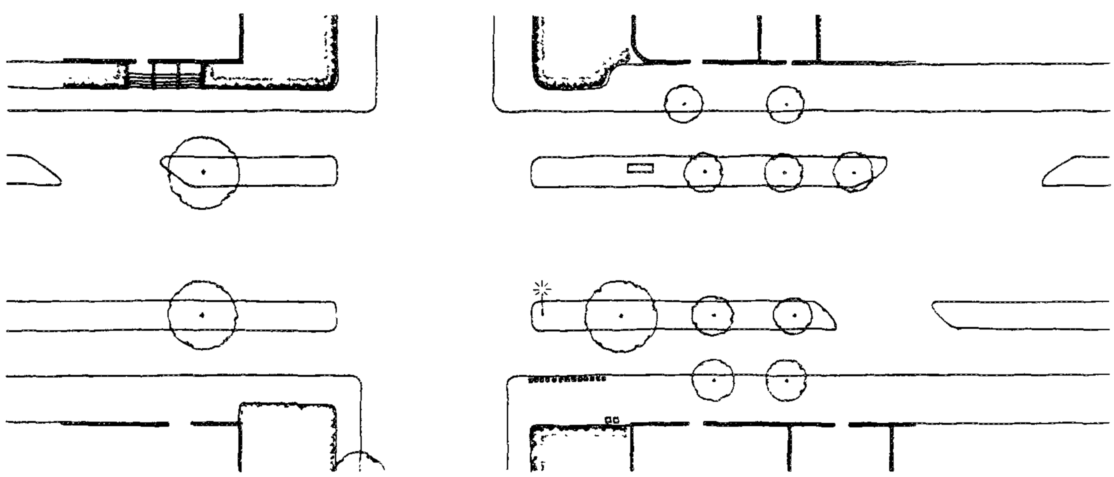

Figure 3.12. K Street at 16th Street: Plan
Approximate Scale: 1"=80' or 1:1,000

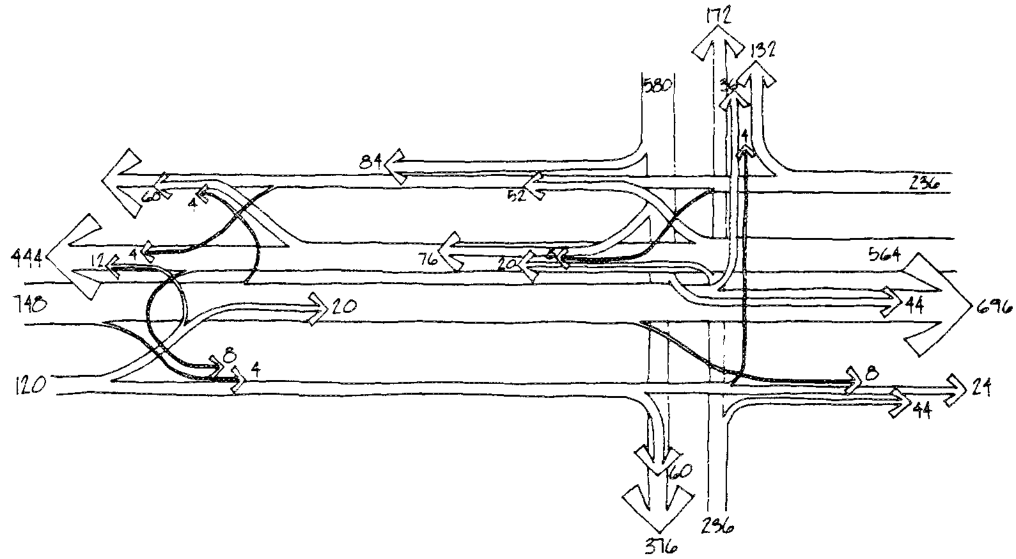

Figure 3.13. K Street at 16th Street: Vehicle Movement Diagram

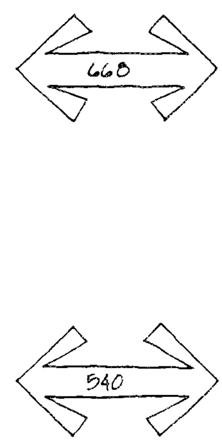

Figure 3.14. K Street at 16th Street: Pedestrian Movement Diagram

New York Boulevards

Field observations were made on all four of the New York City boulevards included in this study: the Grand Concourse in the Bronx, Queens Boulevard in Queens, and Eastern Parkway and Ocean Parkway in Brooklyn. Of these, the Grand Concourse and Queens Boulevard are similar in terms of character, size, and traffic volume, while Ocean Parkway and Eastern Parkway are similar in the same aspects. One of each similar pair — the Grand Concourse and Ocean Parkway — was chosen for detailed illustration here.

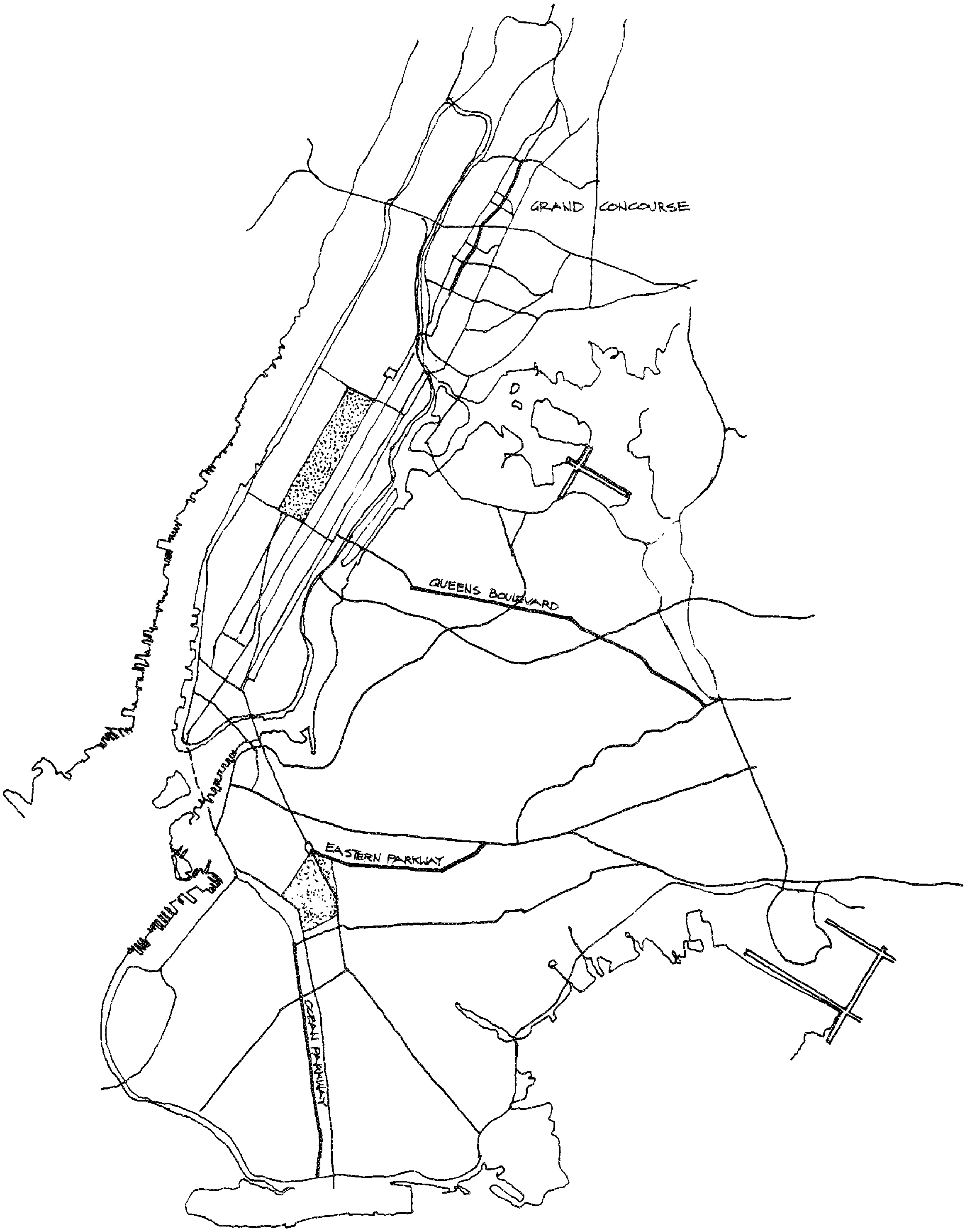

Figure 3.15. Urban Context Map of New York City
Approximate Scale: 1:100,000

Boulevard #3

GRAND CONCOURSE, BRONX, NEW YORK CITY

(big city, major arterial, mainly residential)

Urban Context

The Grand Concourse is a major north-south throughway of the Bronx; it has a boulevard configuration for most of its 4-1/2-mile length. The street is predominantly residential, often lined with five- to six-story apartment buildings, with some shops, usually occurring at the corners. The Bronx Museum is located at 161st Street, and along its southern end the street runs along a major local park. A major subway line runs below the street for a good part of its length. Socio-economically, the area is stable, having declined considerably in its physical maintenance characteristics since the 1950s. Long a middle-class, predominantly Jewish area, most of the surrounding neighborhoods are now occupied by lower-income blacks and Hispanics.

Control Streets

Two nearby streets that carry similar traffic volumes are considered as control streets: Jerome Avenue, which runs parallel several blocks to the west, and Webster Street, which runs parallel several blocks to the east. Although Webster Street was more similar to Grand Concourse in use, buildings on Jerome, in the area that does not have an elevated railway over it, seem to be in a less deteriorated condition than the uses and buildings surrounding Webster. It would have proven difficult to carry out field work on Webster.

Jerome has a mixture of residential and strip commercial development. To the north of 168th Street, an elevated subway runs over the street. Observations were taken at 165th Street, in the section without the overhead, where the street is lined along one side with seven- to eight-story residential buildings and along the other by a park. Within a 60-foot roadway, Jerome Avenue carries two lanes of traffic in each direction and parking lanes on both sides.

Boulevard Description

- The street right-of-way is 175 feet, and buildings are generally built to the property line.
- Block length varies considerably along the street.
- The center roadway is 50 feet wide, accommodating two through lanes in each direction plus a left-turn lane (10-foot lanes).
- The paved medians are 7.5 feet wide, and are generally planted in a random fashion with a variety of large and small trees. Some sections, however, are planted with closely spaced mature London Plan trees, remnants, perhaps, of an earlier planting scheme now lost. Much of the median paving is broken up by large grates covering vents for the subway that runs below the street.

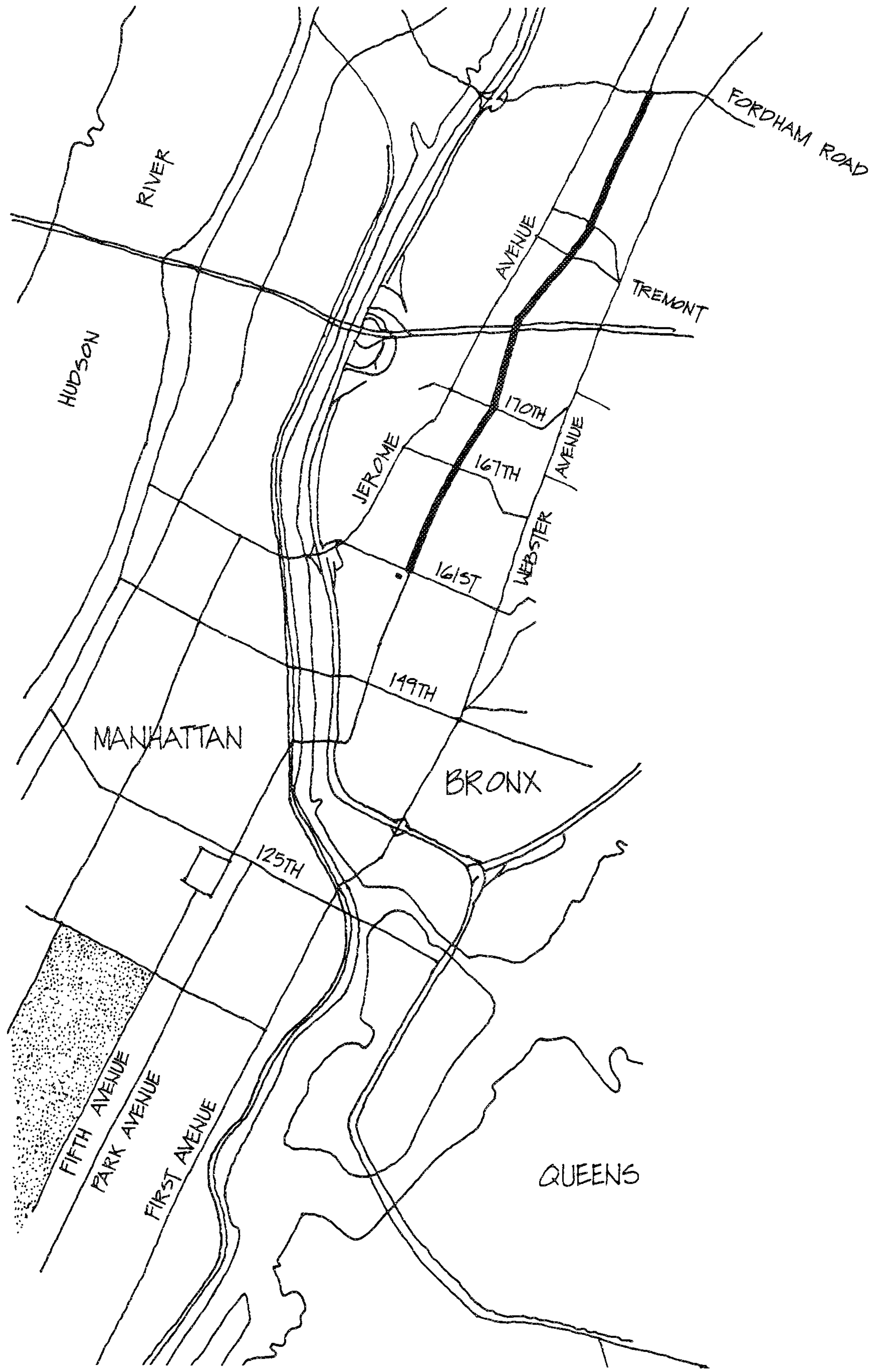

Figure 3.16. Urban Context Map of The Bronx
Approximate Scale: 1:50,000

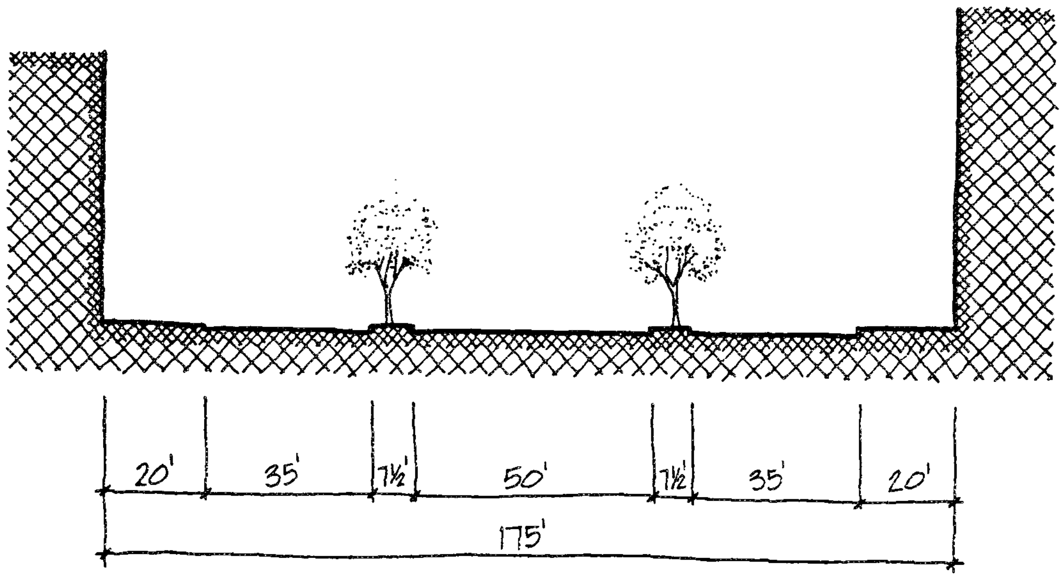

Figure 3.17. Grand Concourse: Section
Approximate Scale: 1"=40' or 1:500

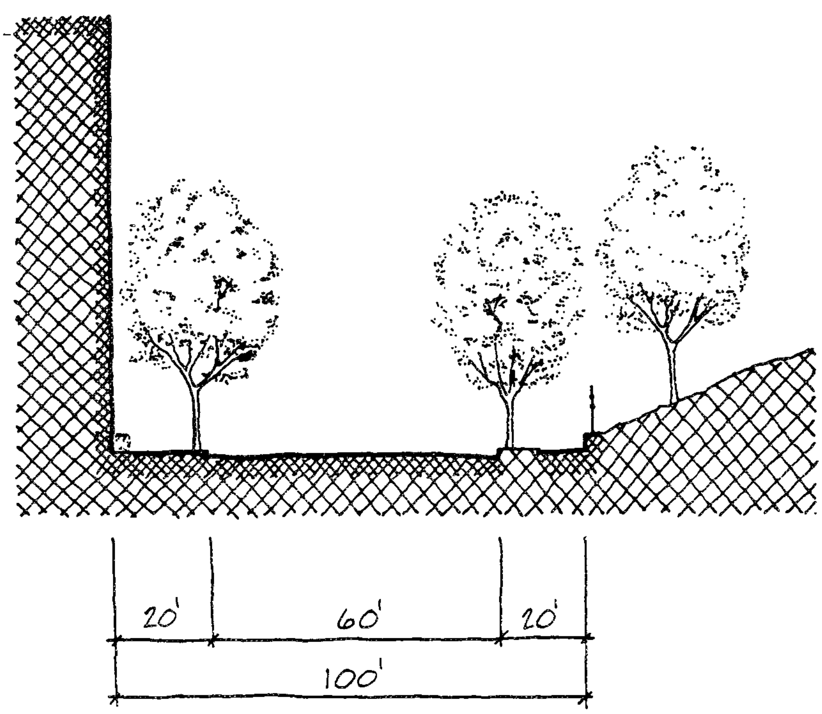

Figure 3.18. Jerome Avenue: Section
Approximate Scale: 1"=40' or 1:500

- The 35-feet-wide access roads allow two lanes of through traffic and one parking lane (11.5-foot-wide lanes; note that this is wider than the center lanes).
- 20-foot sidewalks on either side are planted randomly with an assortment of trees.
- Stair access to the subway occurs at the sidewalk, as do transit stops.
- Most of the street lighting is in the form of tall cobra-heads in the medians, spaced at approximately 100 feet on-center.
- Intersection movement is restricted. Traffic is not allowed to merge from the center into the access roads, or vice versa. Right-hands turns are not allowed from the center, nor are left-hand turns from the access roads. Transitions between the center and the access roads occur at mid-block breaks in the medians.
- At most intersections, the center, the access roads, and the cross-streets are all controlled by signal lights.

Behavior and Movement Observations

Intersection Observed

- 167th Street: two-way, high traffic, signalized

Observations Taken

- Late afternoon, weekday, summer

Behavior Observed

- It appears that almost as much traffic travels on the access roads as in the center. An average north-bound volume per hour of 856 was counted in the center and 792 in the access road. An average southbound volume per hour of 652 was counted in the center and 500 in the access road.
- It appeared that traffic often travels nearly as fast on the access roads as in the center, though no speed measurements were taken. Travel on the access road on a snowy winter day, in a taxi, for at least 20 blocks, was at least as fast as that on the center lanes.
- Intersection movement restrictions are by and large respected by motorists, although some illegal turns were observed.
- Of the cross-street traffic turning onto the Concourse, there were as many or more turns into the access roads as into the center. For example, going eastbound, 60 vehicles turned right into the access road and four turned right into the center, while 52 each made left turns into the center and access road.
- Pedestrian activity is fairly high: crossings of the boulevard at a rate of 864 persons per hour was observed.

- Considerable mid-block jaywalking was observed, possibly linked to the fact that this street has very long blocks.
- Few pedestrians walk along the medians. Their narrowness, and the fact that no activities occur there, such as transit access, mean there is no reason to be there.
- Pedestrians do not treat the access roads any differently then the center roadway. This is a fast-moving realm, clearly meant for cars. The pedestrian realm ends at the sidewalk.
- Many of the vehicles using the access roads are gypsy cabs.
- Despite fast traffic on the access roads, people jaywalk across them whenever they think it safe, to get to the medians.
- Youngsters especially tend to jaywalk.

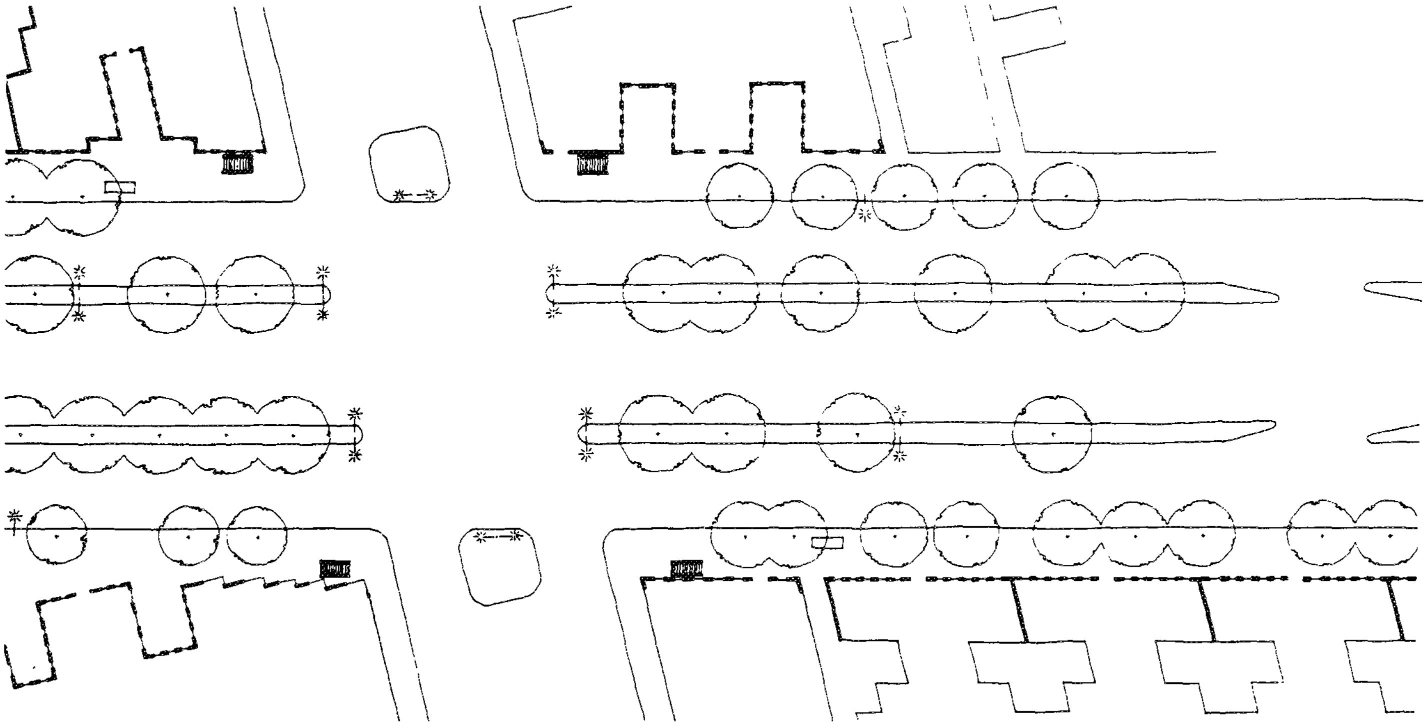

Figure 3.19. Grand Concourse: Plan
Approximate Scale: 1"=80' or 1:1,000

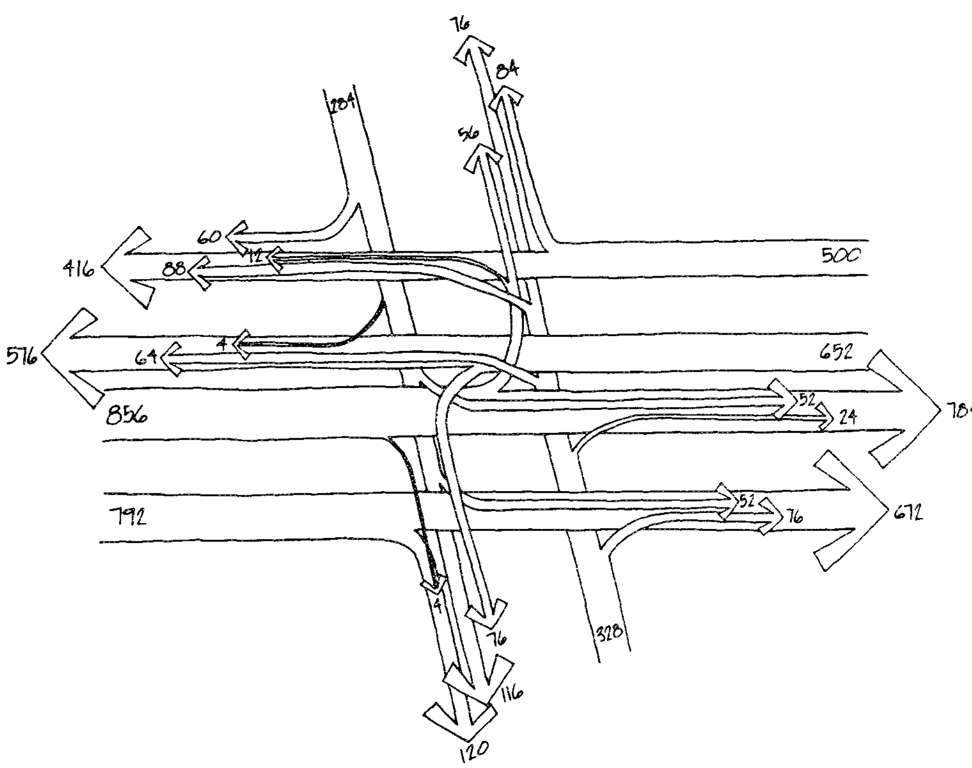

Figure 3.20. Grand Concourse: Vehicle Movement Diagram

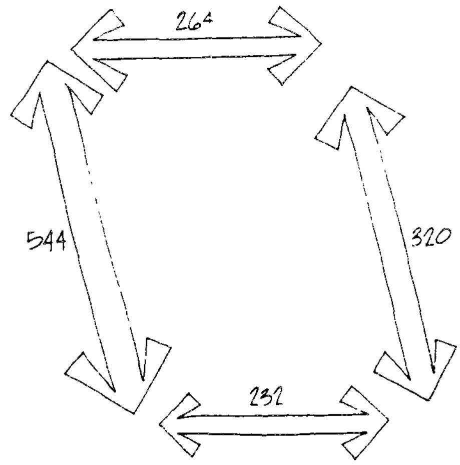

Figure 3.21. Grand Concourse: Pedestrian Movement Diagram

Boulevard #4

OCEAN PARKWAY

(big city, major arterial, residential)

Urban Context

Along with Eastern Parkway, Ocean Parkway is one of two parkways designed by Frederick Law Olmsted which were built in Brooklyn in the 1870s. It was conceived as a "shaded green ribbon" pleasure drive linking Prospect Park with the public beach at Coney Island. Today it serves as a major north/south trafficway, at its northern end turning into the Prospect Expressway which leads to the Queens-Brooklyn Expressway. It has a boulevard configuration for most of its over-four-mile length. The street is primarily residential; the section of the street observed, around Ditmas, is lined with seven- to eight-story apartment buildings.

Control Street

Linden Boulevard was chosen as the control street for Ocean Parkway because it is very similar in use and function. Linden runs perpendicular to Ocean to the northeast. It is a tree-lined street of primarily residential apartment buildings, with some small-scale commercial uses at the corners. Most buildings are uniformly set back from the right of way in a manner similar to Ocean.

Within a 50-foot roadway, Linden carries two lanes of traffic in each direction plus parking on both sides.

Boulevard Description

- The right-of-way is 210 feet, but the street appears wider because buildings are uniformly set back 30 feet on each side.
- Typical block length is 700 to 800 feet.
- The center roadway is 70 feet wide with 3 lanes in each direction plus a left-turn lane (10-foot-wide lanes).
- Medians are 30 feet wide and planted with two rows of mature deciduous trees, at approximately 25 feet on-center, roughly lined up across the street. The trees are a variety of types including maple, oak, sycamore, and elm.
- Generous benches, each 20 feet long, line one side of both medians between the trees.
- The access roads are 25 feet, allowing one through lane and parallel parking along both sides (8.3-foot lanes).
- Sidewalks are typically 15 feet wide and in places have a four-foot planting strip. Large and small trees of various types are planted somewhat randomly along the curbline.

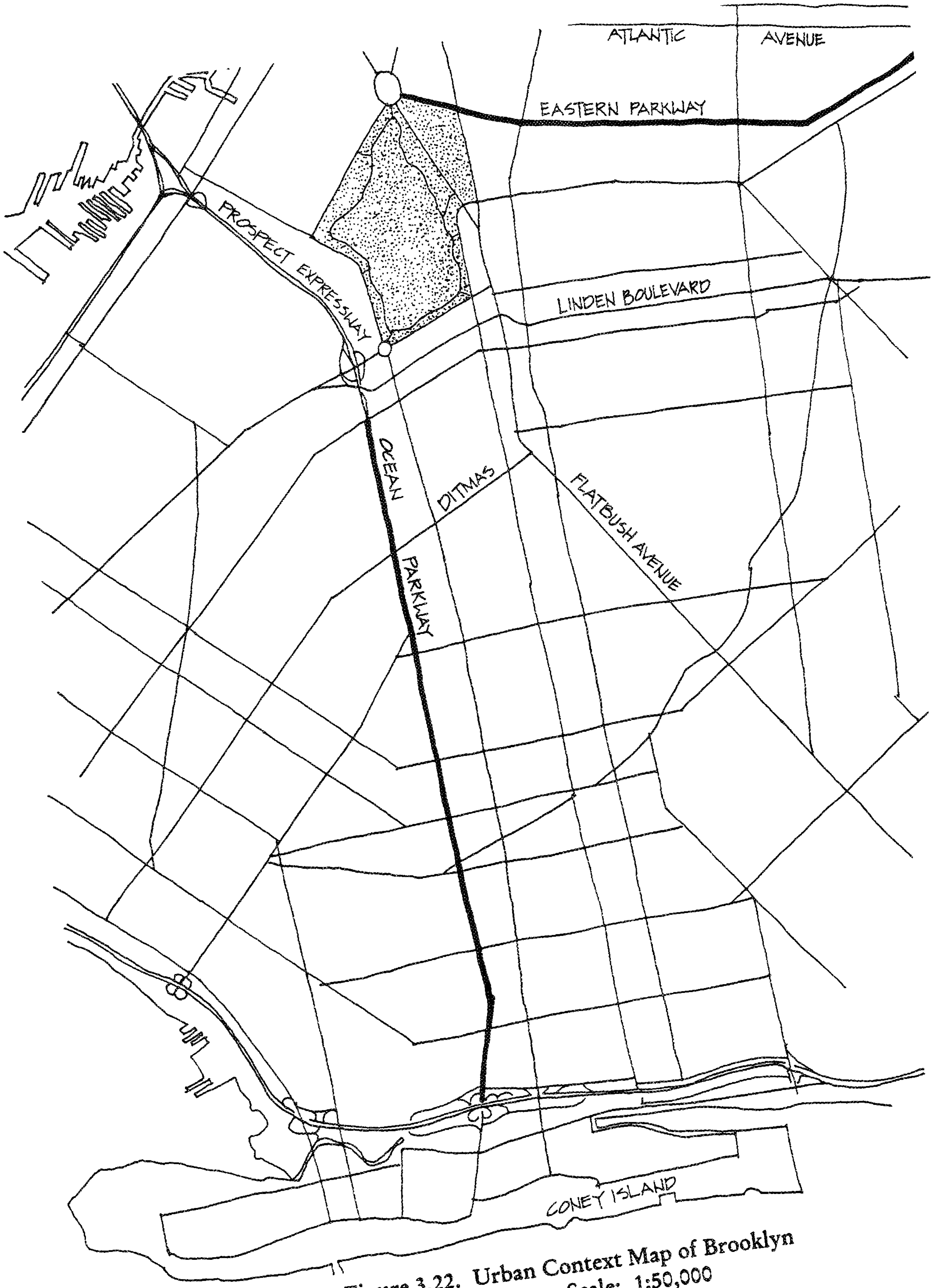

Figure 3.22. Urban Context Map of Brooklyn
Approximate Scale: 1:50,000

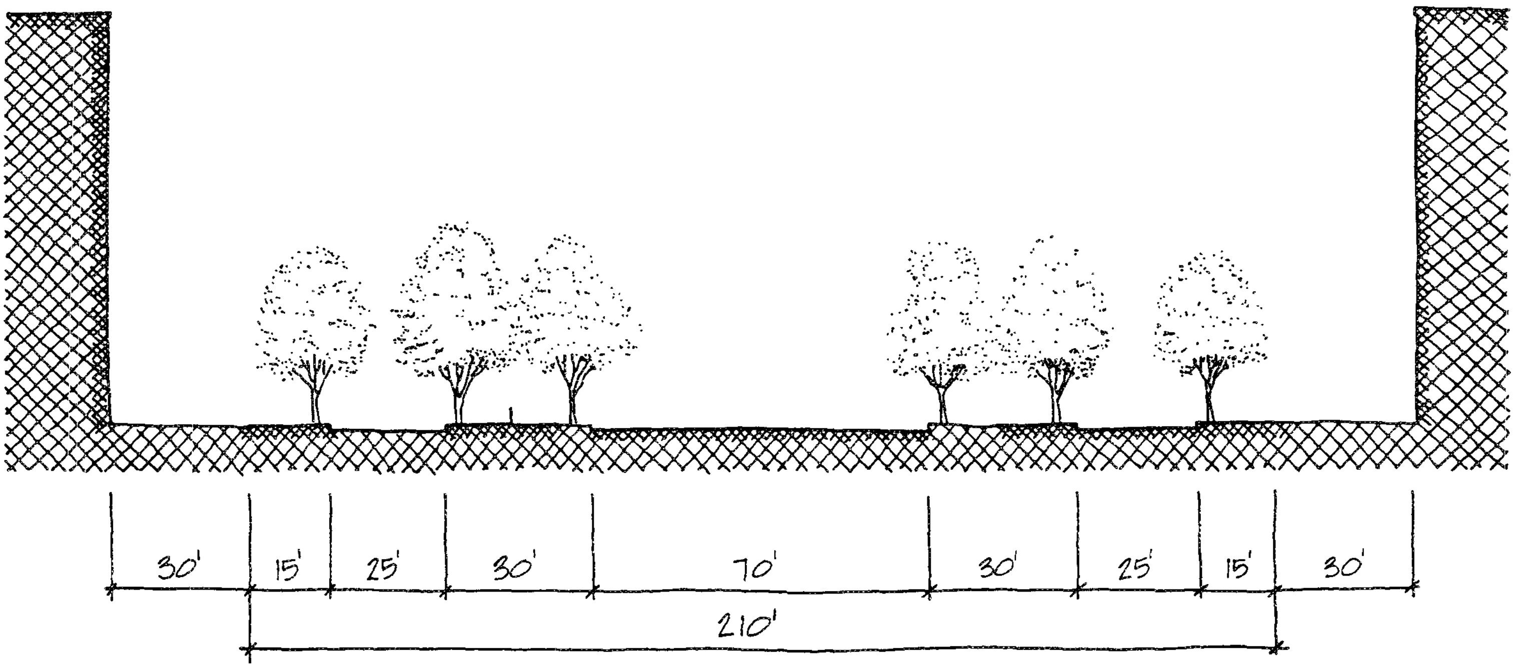

Figure 3.23. Ocean Parkway: Section
Approximate Scale: 1" = 40' or 1:500

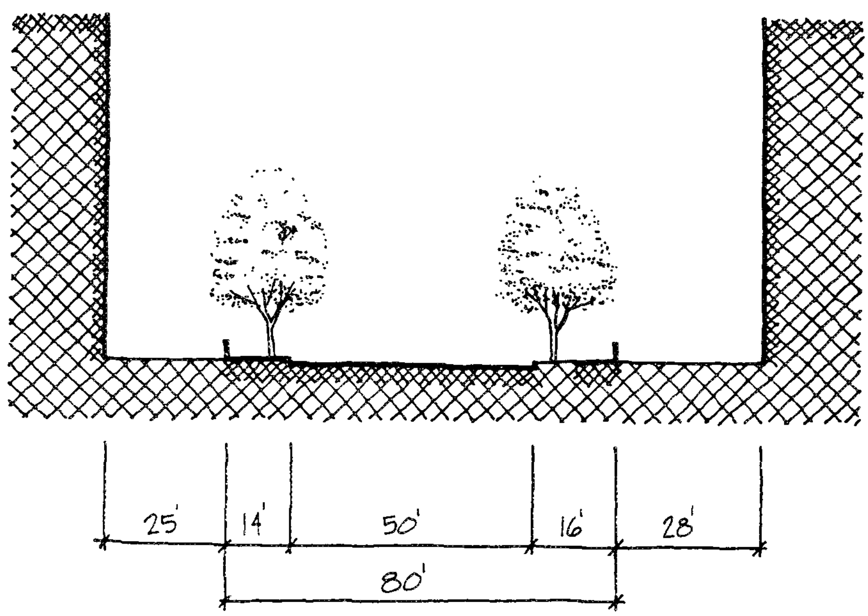

Figure 3.24. Linden Boulevard: Section
Approximate Scale: 1" = 40' or 1:500

- Within the 30-foot set-back, front yards are planted with grass, shrubs, or flowers, and, often, ornamental trees.
- Street lighting comes from somewhat randomly spaced cobra fixtures, some on the medians and some on the sidewalks. There is no pedestrian-scale lighting.
- Transit stops occur on sidewalks, and local buses run on the access roads.
- Movements between the center, the access roads, and the cross-streets are unrestricted. Drivers are allowed to make any turning movement.
- The center and the cross-streets are controlled by signal lights. The access streets are controlled by stop signs.

Behavior and Movement Observations

Boulevard Intersection Observed

- Ditmas Street: two-way, signalized

Observations Taken

- Mid-morning, weekday, summer

Observations

- Observations indicate that Ocean Parkway carries a very high volume of traffic, almost all of which is carried in the center. For example, northbound 1,928 vehicles per hour were counted in the center versus 116 vehicles per hour in the access roads; southbound, 1,420 vehicles per hour were counted in the center versus 128 vehicles per hour in the access road. Both the total numbers of vehicles and the split between access roads and center lanes are markedly different than on the Grand Concourse, all the more so considering that these counts are not in the peak travel hours and that the Grand Concourse counts are.
- Although it was not possible to take actual speed measurements, it was easy to see that traffic moves much slower on the access roads than it does in the center.
- In order to make a left-hand turn out from an access road, drivers pull into the space defined by the median and then wait for the cross-street light to turn green before proceeding. Cross-street traffic waits behind the crosswalk at the sidewalk.
- There is a reasonable amount of pedestrian activity on the street, given its residential nature. 376 pedestrians per hour were counted walking along the sidewalks and medians, and 252 pedestrians per hour were counted crossing the boulevard.
- The medians are used as gathering spots. Many people, particularly older people, sit on benches, usually in groups of two or three, or gather around a table to play cards. Many bicyclists use the medians as bike paths, and there are numbers of people strolling leisurely.

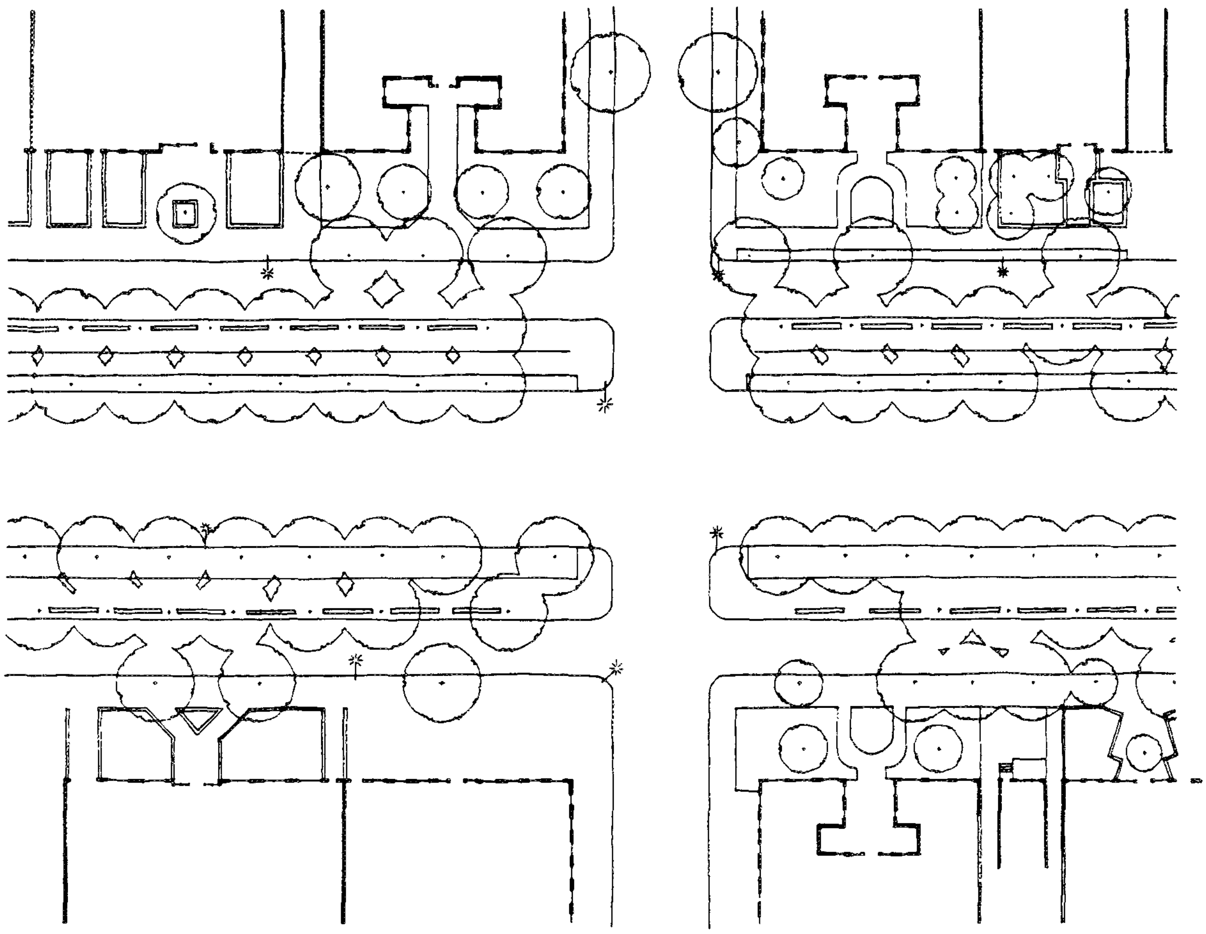

Figure 3.25. Ocean Parkway: Plan
Approximate Scale: 1"=80' or 1:1,000

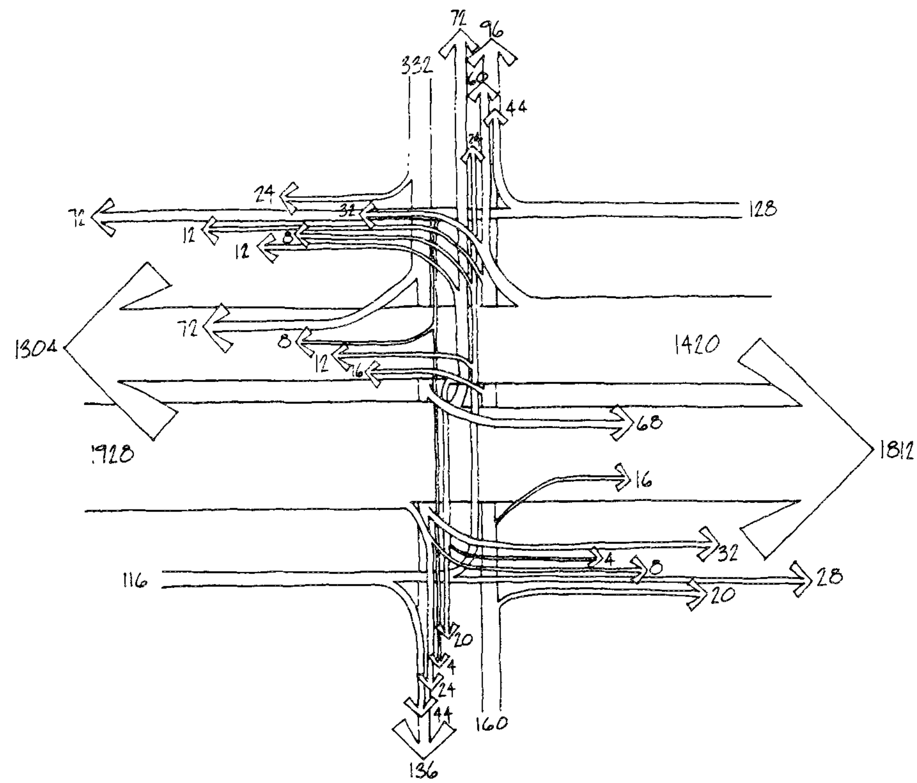

Figure 3.26. Ocean Parkway: Vehicle Movement Diagram

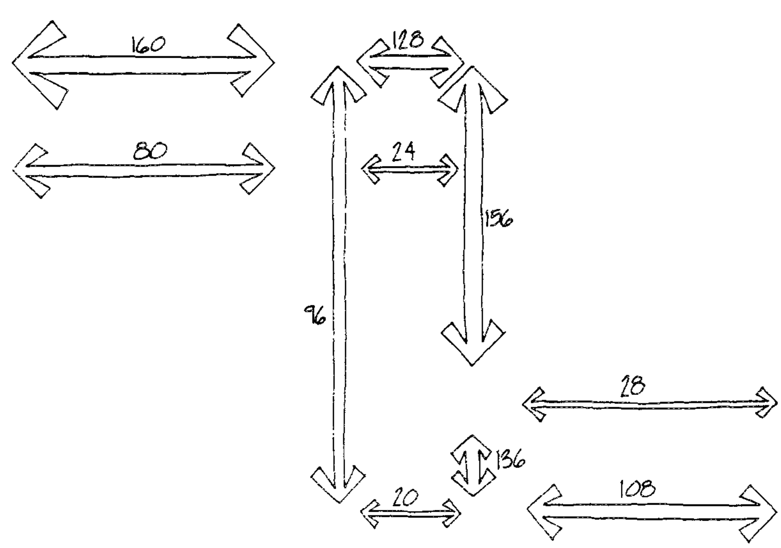

Figure 3.27. Ocean Parkway: Pedestrian Movement Diagram

The Paris Boulevards

Field observations were made on five Parisian boulevards. Of these, the Avenue Montaigne and the Boulevard Courcelles were chosen for detailed illustration, the former because it is representative of most of the Paris boulevards observed and the latter because it has a unique physical form — access roads that re-join the center prior to intersections — which helps to reduce intersection conflict.

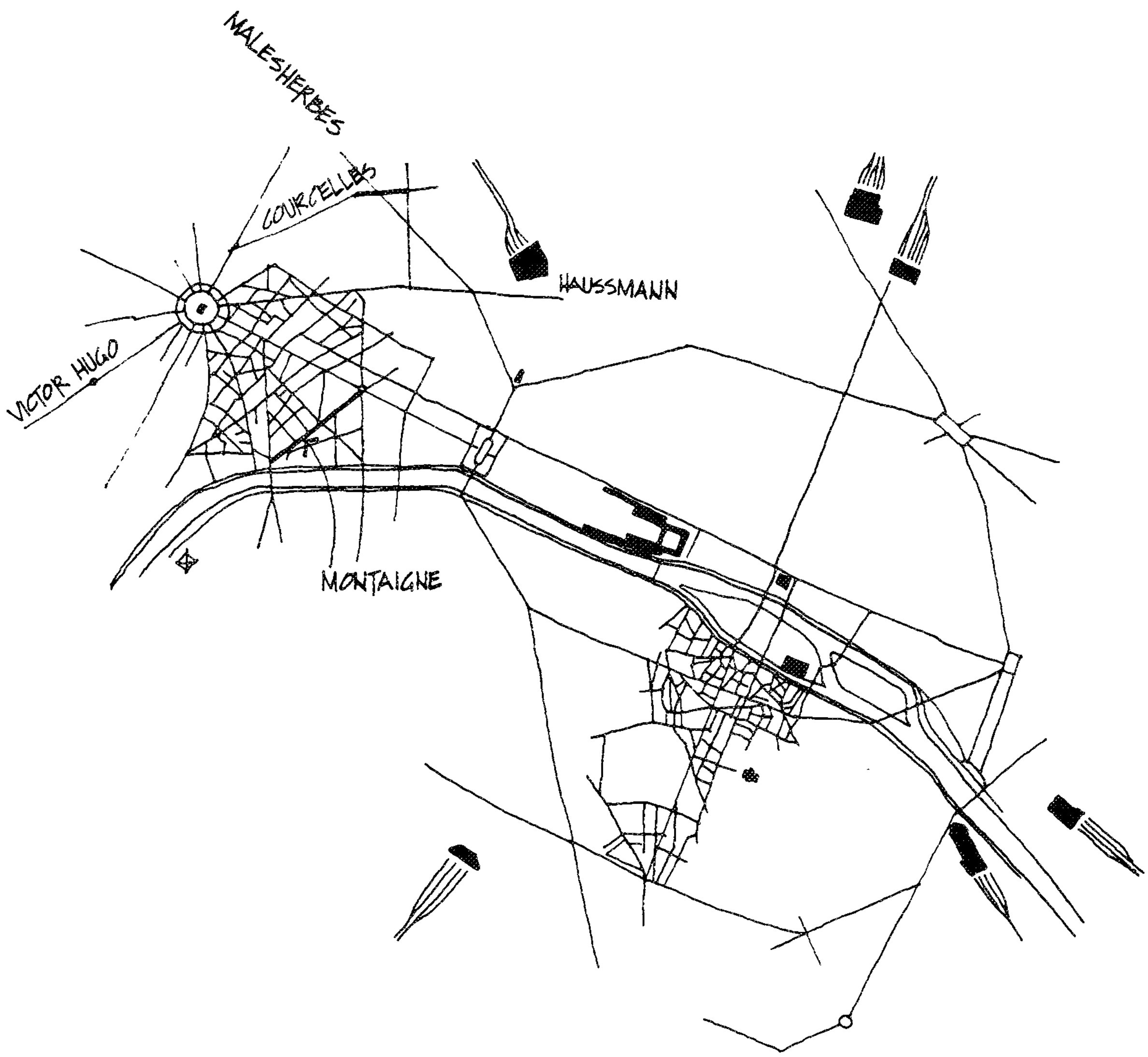

Figure 3.28. Urban Context Map of Paris
Approximate Scale: 1:50,000

Boulevard #5

AVENUE MONTAIGNE, PARIS

(big city, shopping street, mixed-use commercial and residential)

Urban Context

Avenue Montaigne is a fashionable shopping street that runs from the Rond Point on the Champs Elysée southwest toward the River Seine for a length of about five blocks. It is one of six boulevards clustered in this area, radiating from the Champs Elyséée between the Rond Point and the Place Charles de Gaulle. (The others are Avenues Franklin D. Roosevelt, George V, Marceau, d'Iéna, and Kléber.) Avenue Montaigne was selected as representative of these streets, all of which have a similar cross-section but vary in traffic configuration. The Avenue Montaigne is lined with attractive six- and seven-story buildings, with many ground-floor shops, several banks, a major hotel, and an embassy. The upper floors are a mixture of office and residential uses.

Control Street

Avenue Victor Hugo, a street that radiates from the Place Charles de Gaulle, was chosen as the control street because it is similar to Montaigne in use and function and carries a similar amount of traffic. Victor Hugo carries one lane of traffic in each direction plus parking on two sides within a 42-foot roadway.

Boulevard Description

The street is characterized by a narrow cross-section and closely spaced mature trees in the medians.

- The street right-of-way is 126 feet, one of the narrowest of the boulevards included in this study, and buildings are generally built to the property line.
- Block length varies considerably, and there is only one through cross-street. Four other cross-streets form T-intersections.
- The street is predominately one-way; both of the access roads and all of the center lanes except one are for southwest bound travel.
- The center roadway is 42 feet wide and consists of one parking lane and two traffic lanes moving away from the Champs Elysée and one contra-flow lane, reserved for buses and taxis, moving in the opposite direction (10.5-foot-wide lanes). There is no center median.

  The side medians are each approximately seven feet wide and are planted with mature horse chestnut trees at 15 feet to 18 feet on-center, forming a dense screen. The medians also contain bus and taxi stops, and often a few benches. They are paved between generous tree wells of decomposed granite.

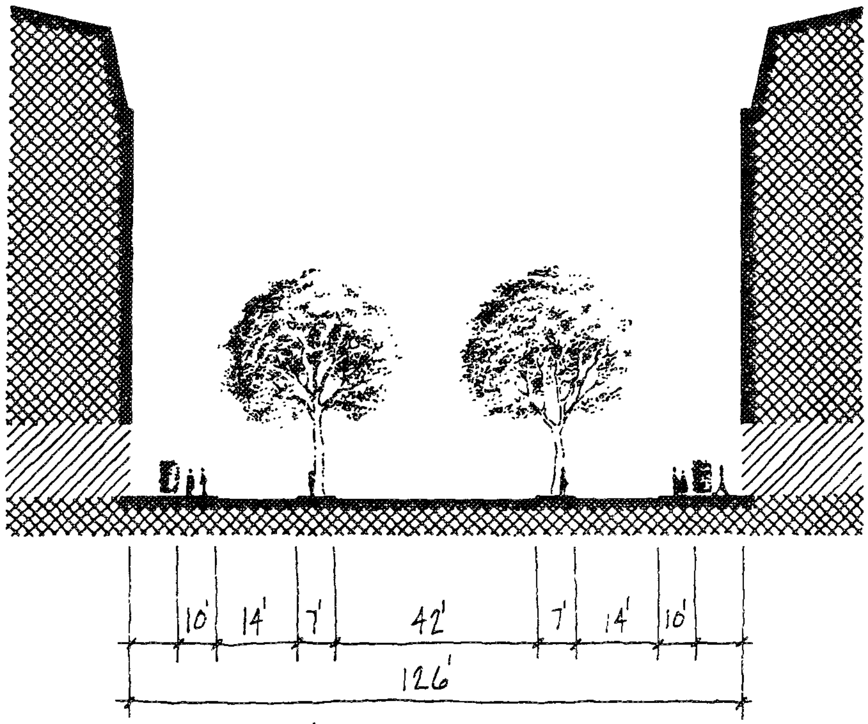

Figure 3.29. Avenue Montaigne: Section
Approximate Scale: 1"=40' or 1:500

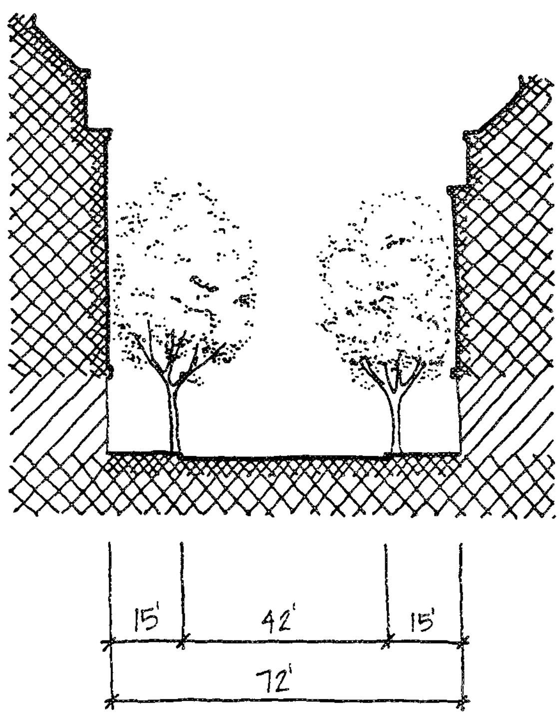

Figure 3.30. Avenue Victor Hugo: Section
Approximate Scale: 1"=40' or 1:500

- On both sides, the width from the edge of the right-of-way to the center side of the median is 35 feet. Within this space, the sidewalk width and access road width varies. At some places, the sidewalk is 21 feet wide, leaving 14 feet for both a traffic lane and a parking lane (seven-foot lanes). In other places, the access road widens to 24 feet and allows parking on both sides (eight-foot lanes).
- Often, the effective sidewalk width is reduced to 10 feet by landscaped areas in front of the shops.
- As is characteristic of most Paris boulevards, the access roads are at a slightly higher grade then the center, with a one-inch elevation break occurring at intersections.
- There are no trees planted at the sidewalk.
- Street lighting is in the form of one-sided cobra fixtures in the medians.
- Ground-floor facades are generally transparent, and have frequent entrances.
- Movement between the access roads, the center, and cross-streets is not restricted.
- Intersections are controlled by signal lights, with the access road having the same signal phase as the center.

Behavior Observations

Intersection Observed

- Rue Francois: one-way, signalized

Observations Taken

- Late morning to early afternoon, weekday, spring

Observations

- The intersection observed has a one-way cross-street, so movements are somewhat simplified.
- The boulevard carries a high volume of traffic, almost all of it in the center: an hourly volume of 852 vehicles was counted in the center, of which 114 were in the contra-flow reserved transit lane, while at the same time only 42 vehicles traveled in the access lanes, 21 on each side.
- A flow of 369 vehicles per hour per lane was counted in the dominant center direction.
- Traffic moves slower in the access roads then in the center because drivers are often looking for parking spaces, or must stop and wait for other vehicles which are stopped to unload or for some other reason. When traffic is flowing, we observed an average speed of 32 kilometers per hour on the access roads versus an average of 48 kilometers per hour in the center.
- The contra-flow transit lane appeared to have the potential to cause problems. Some pedestrians forget to look in that direction before crossing the street, probably because of the infrequency of vehicles.
- There is a high pedestrian volume. The number of pedestrians walking along the sidewalks was 1,328 per hour (988 on the northwest side and 340 on the southeast side), and the number crossing the boulevard was 1,192 per hour (316 on one side and 876 on the other).

- Of cross-street traffic turning onto Montaigne, significantly more turned into the center then into the access roads, a total of 153 per hour into the center versus 15 into the access roads.
- Pedestrians often walk down the access roadway for some distance, and sometimes stop and gather there while carrying on conversations. Mothers pushing baby carriages down the access roadway were observed.
- Some pedestrians walk along the medians to reach the transit stops, but in general they are not used as walkways by most people.
- Benches on the medians are sometimes used, mostly by people waiting for transit vehicles.
- Vehicles slow down upon entering the access roads because of the one-inch elevation change.
- A number of illegal movements were observed, including drivers backing the wrong way into an access road, drivers backing the wrong way out of access roads, drivers parking within the intersection at the ends of the medians. There was not a lot of this activity but there was enough to keep things confused.

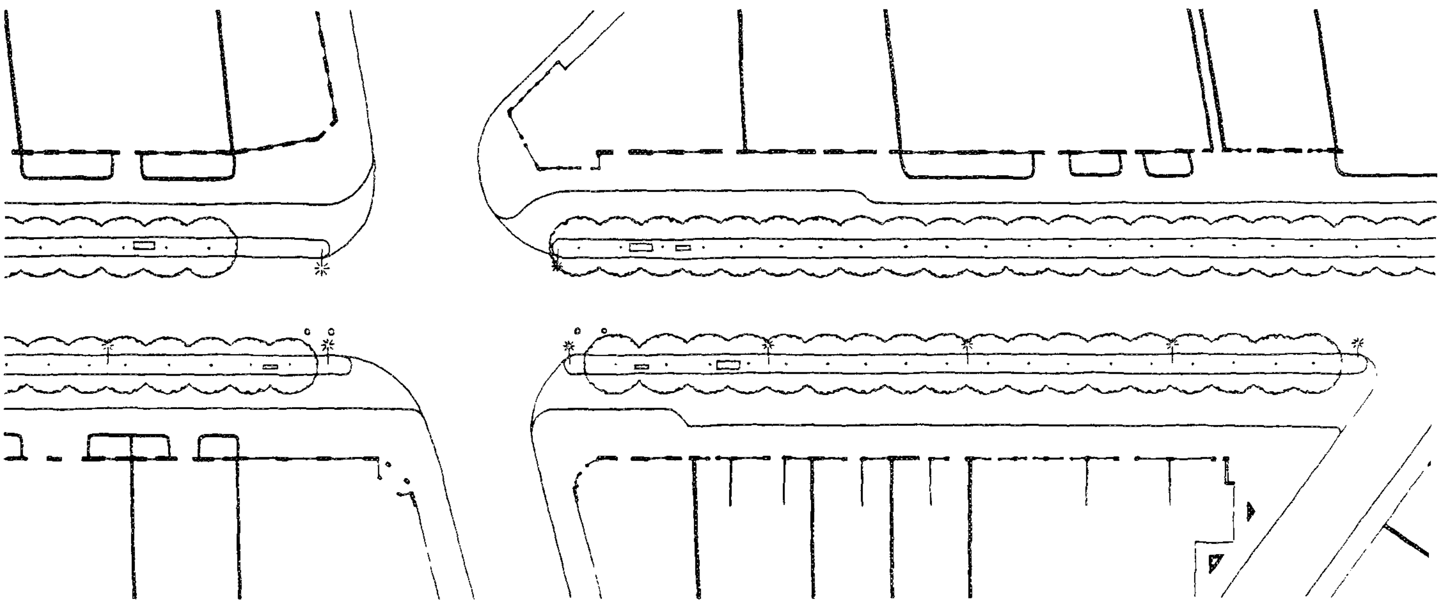

Figure 3.31. Avenue Montaigne: Plan
Approximate Scale: 1"=80' or 1:1,000

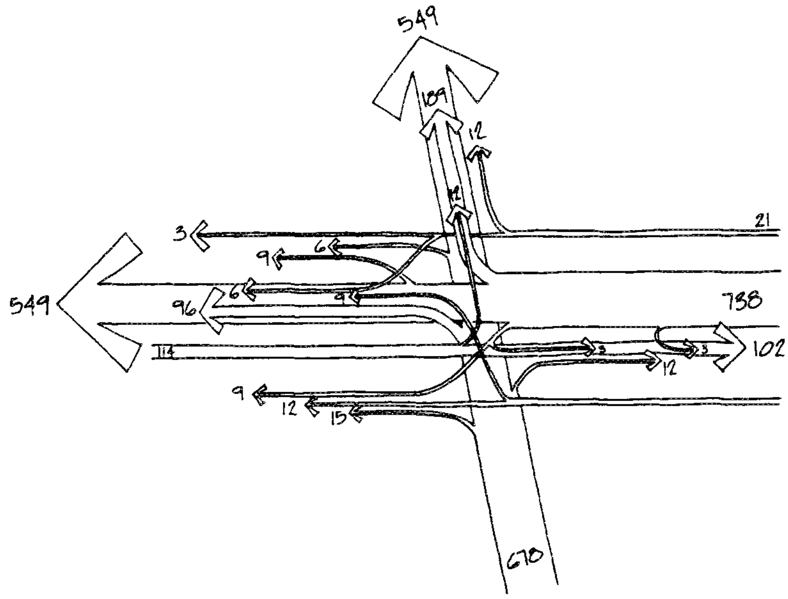

Figure 3.32. Avenue Montaigne: Vehicle Movement Diagram

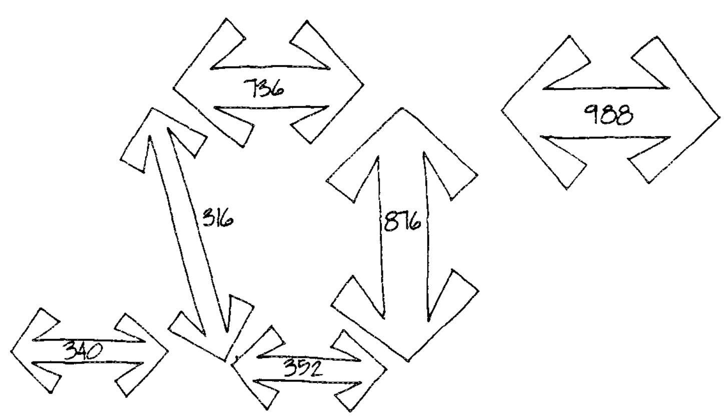

Figure 3.33. Avenue Montaigne: Pedestrian Movement Diagram

Boulevard #6

BOULEVARD DE COURCELLES, PARIS

(big city, major arterial, mixed-use commercial and residential)

Urban Context

The Boulevard de Courcelles runs east-west through a wealthy residential area in the northern part of the city, in an area that during the late 18th century was immediately outside the city walls. It has a classic boulevard configuration for two long blocks, centered around the intersection of Boulevard Malesherbes, a major trafficway. To the east of this section, it takes on a different name and becomes a center-median-type boulevard. The boulevard is one-sided at the block west of Malesherbes, where it runs along the elegant Parc Monceau. Here, the southern access lane space becomes a pedestrian promenade, lined with trees on both sides. The street is lined with six-story residential buildings and many small ground-floor shops.

Control Street

West of the Parc Monceau, Courcelles becomes a normal street. This section was chosen as the control street, because both the nature of the street and the traffic volume remain similar. Here the Courcelles carries two lanes of traffic in each direction in a 48-foot roadway, with a parking lane on each side.

Boulevard Description

The street is characterized by a narrow cross-section and closely spaced mature trees in the medians.

- The street right-of-way is 120 feet, the narrowest included in this study.
- Block length is approximately 650 feet.
- The center roadway is 42 feet wide, which accommodates two lanes of traffic in each direction, and parking on both sides (seven-foot-wide lanes). There is no center median, but at intersections the traffic flows are separated by tall bollards that flank the crosswalks.
- The medians and access roads have different configurations on either side of Malesherbes.
- East of Malesherbes, the width of the side medians is 10 feet on one side and 12 feet on the other. Both are planted with rows of mature London Plane trees at 25 feet-35 feet on-center. They also contain bus and taxi stops and several double-sided wooden benches.
- East of Malesherbes, the width of the access road varies. On one side, 17 feet accommodates one through lane and one parking lane (8.5-foot-wide lanes). On the other side, 23 feet allows a second parking lane (7.6-foot lanes).

  West of Malesherbes, opposite the park, the line of trees continues in what was probably once the median space, but cars are now able to park diagonally between the trees. A total of 27 feet includes the diagonal parking and one through lane.

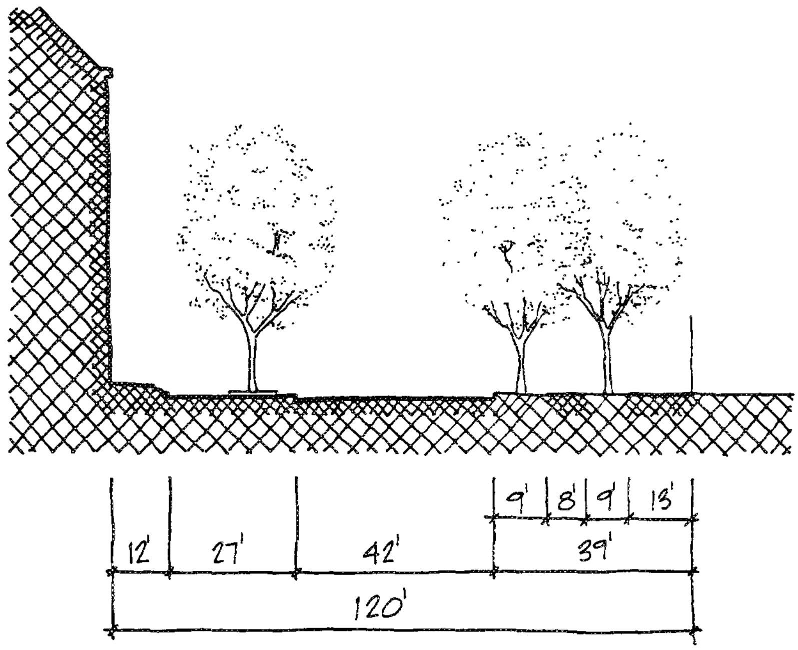

Figure 3.34. Boulevard Courcelles: Section West of Malesherbes
Approximate Scale: 1"=40' or 1:500

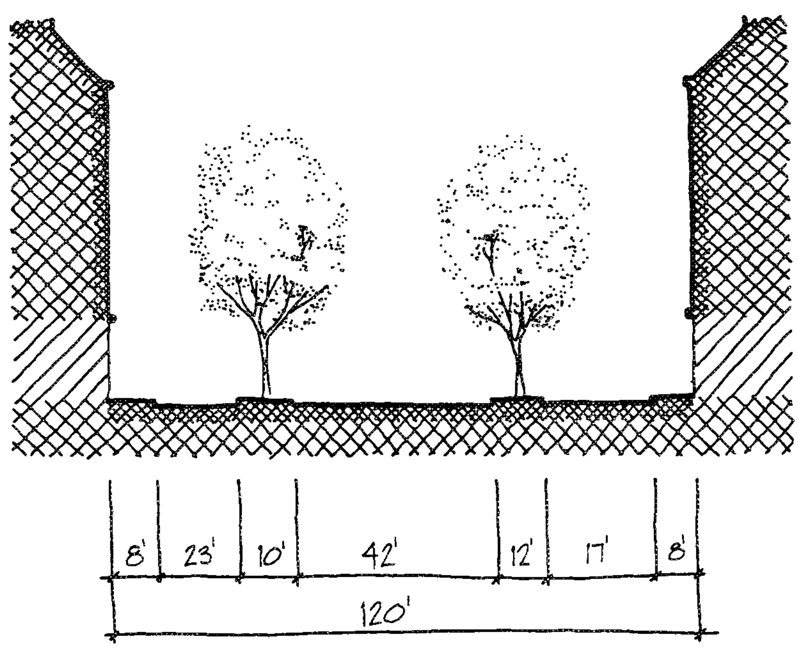

Figure 3.35. Boulevard Courcelles: Section East of Malesherbes
Approximate Scale: 1"=40' or 1:500

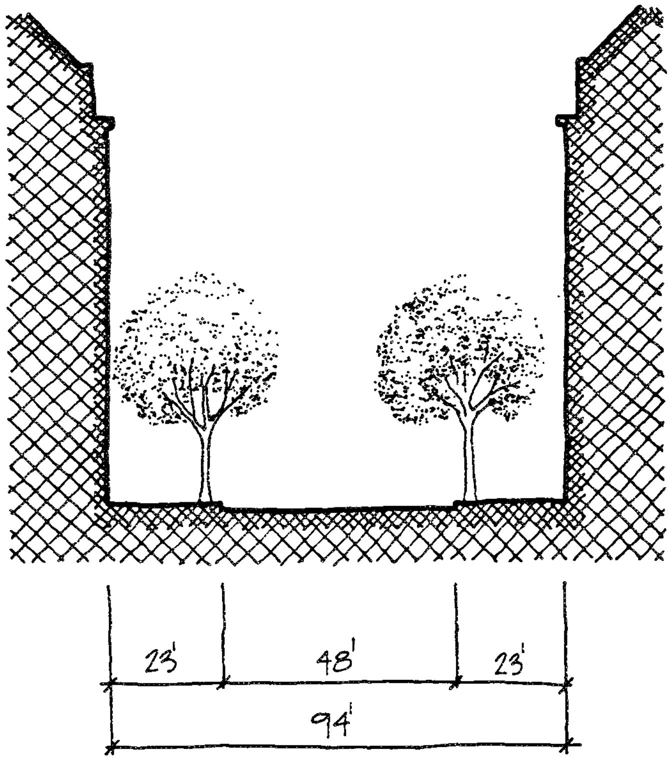

Figure 3.36. Boulevard Courcelles: Section at Control Area
Approximate Scale: 1" = 40' or 1:500

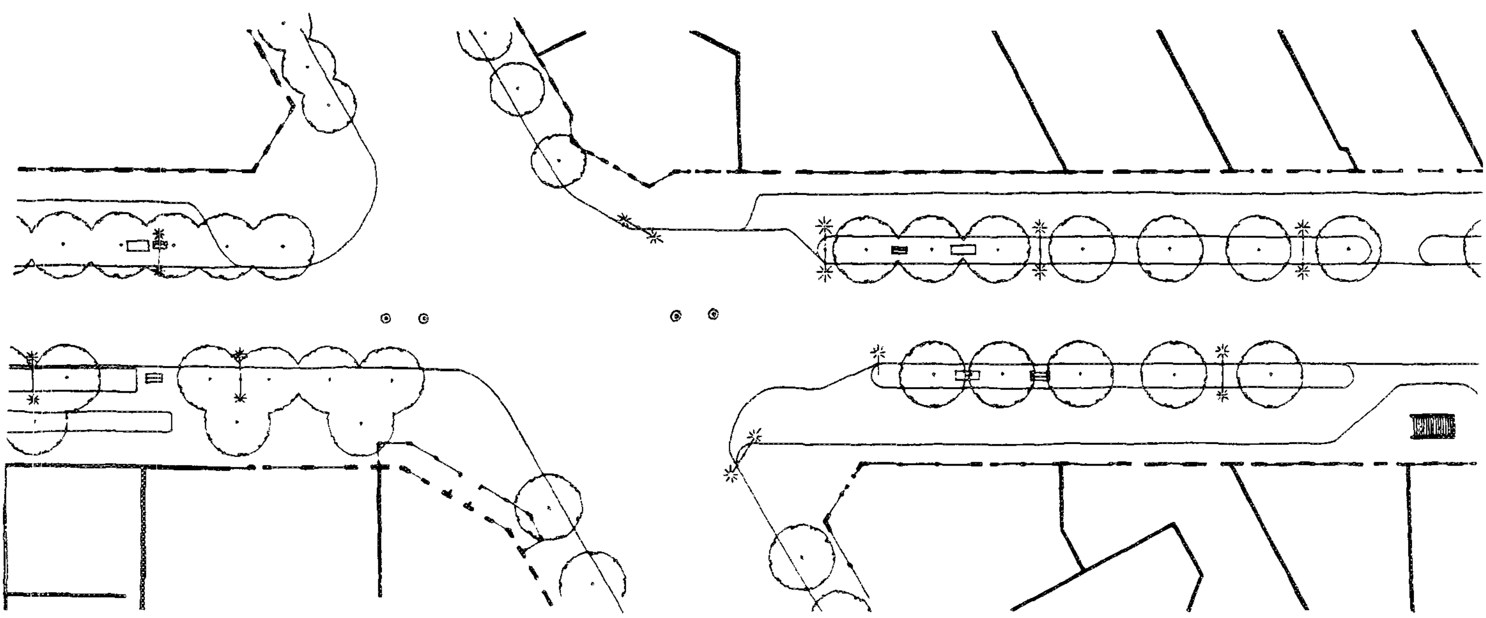

Figure 3.37. Boulevard Courcelles: Plan
Approximate Scale: 1" = 80' or 1:1,000

- The access roads are at a slightly higher grade then the center, with a one-inch break occurring at intersections.
- A mid-block median break occurs within one block, allowing both exit from and entrance to the access road.
- There are no trees planted at the sidewalk except at the ends of the block, where they shift from the median, and along the park.
- Street lighting comes from two-sided cobra fixtures located in the medians at from 80 feet to 140 feet on-center.
- Ground floor facades are generally transparent, and have fairly frequent entrances.
- Movement between the access roads, the center, and cross-streets is not restricted.
- Intersections are controlled by signal lights, with the access road having the same signal phase as the center.

Behavior and Movement Observations

Intersection Observed

- Boulevard Malesherbes: two-way, major trafficway, signalized

Observations Taken

- Late morning to early afternoon, weekday, spring

Observations

- The boulevard carries a high volume of traffic, almost all of it in the center; an hourly volume of 1,944 was counted in the center (1,008 westbound, 936 eastbound), while at the same time only 64 vehicles in total traveled along the access lanes.
- In general, movement along the access roads is much slower then in the center, because often drivers are looking for parking spaces. However, movement does sometimes move fast: average speeds of 52 kilometers per hour were measured in the center, compared to 46 kilometers per hour on the access roads.
- Sometimes, especially adjacent to a busy flower shop on the southeast corner, cars and delivery trucks will stack up in the roadway and along the median while business is transacted.
- Along the south side, near the mid-block median break, the access road provides access to an auto repair shop. A sometimes constant flow in and out of this facility can occur without disrupting the center traffic.
- A moderate pedestrian volume was counted. The number of pedestrians crossing the boulevard was 388 per hour (224 on one side and 164 on the other side), while the number walking along the side-walks was 576 per hour (144 on one side and 432 on the other side).

- Sometimes, especially in the long block opposite the park, the access roads are used by cars and motorcycles to circumvent heavy traffic in the center.
- Some U-turns occur from an access road into the center.
- Vehicles slow down upon entering the access roads because of the one-inch elevation change.

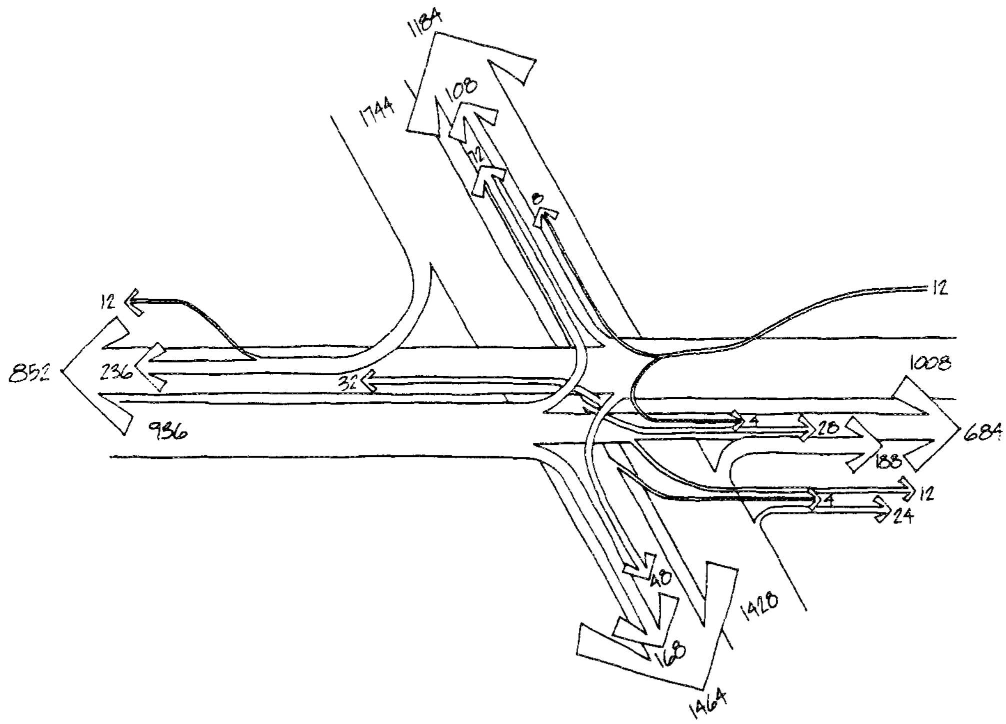

Figure 3.38. Boulevard Courcelles: Vehicle Movement Diagram

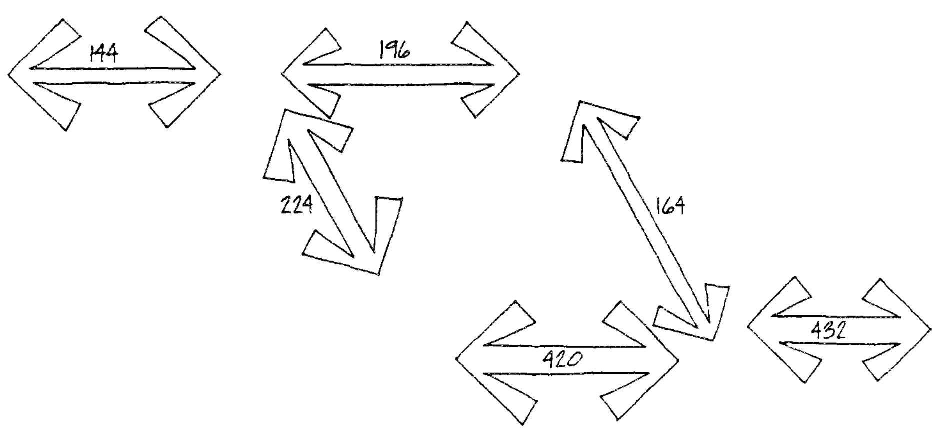

Figure 3.39. Boulevard Courcelles: Pedestrian Movement Diagram

The Barcelona Boulevards

Field observation was undertaken on three Barcelona boulevards: the Paseo de Gràcia, the Diagonal, and the Gran Via. Two of these boulevards were chosen for detailed illustration here: the Paseo, because it is unique, and the Diagonal because it is representative of the latter two, which are similar in terms of character and traffic movement.

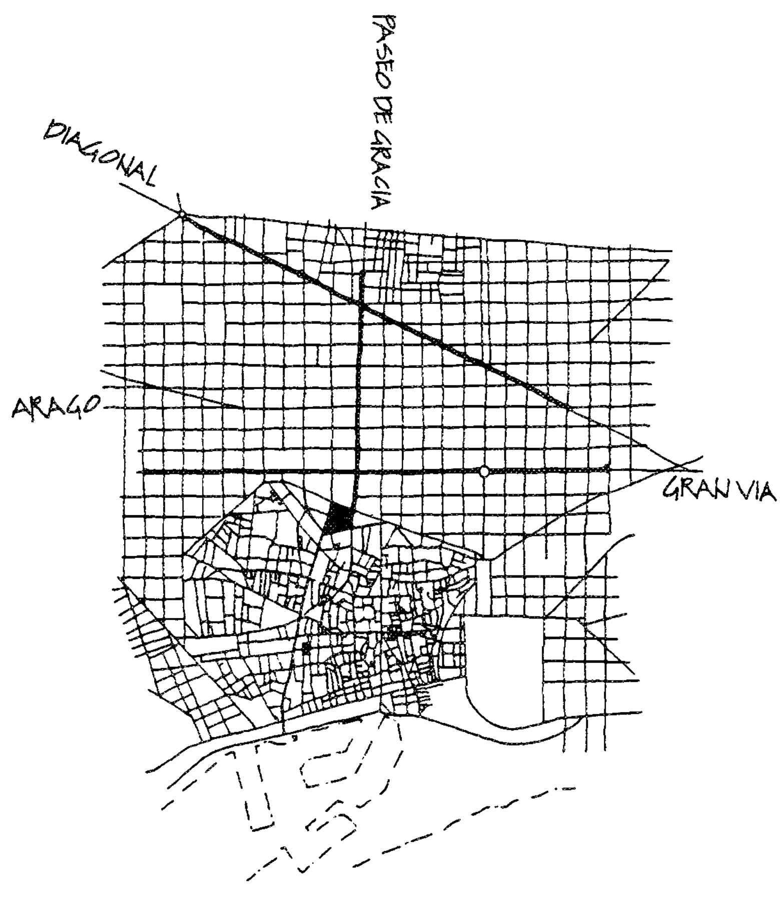

Figure 3.40. Urban Context Map of Barcelona
Approximate Scale: 1:50,000

Boulevard #7

PASEO DE GRÀCIA, BARCELONA

(medium to large city, shopping street, primarily commercial and office use)

Urban Context

The Paseo de Gràcia is the premier shopping street of Barcelona. It is a wide, elegant boulevard, lined with expensive shops and cafes with offices and residential uses on upper floors. Many of the generally five- to eight-story buildings that line it are architecturally interesting; some, like the Casa Mila and the Casa Batlo, designed by Gaudi, are significant. The Paseo has a boulevard configuration for nine blocks where it runs through the Cerda designed part of the city, linking the medieval old city with a residential section to the north, that used to be the village of Gràcia. It is one of only a handful of two-way streets in the central city. A major subway line runs below the Paseo, and there are subterranean parking garages under some sections. A mainline train station occurs beneath the street at the intersection with Aragó.

Boulevard Description

The street is currently characterized by very wide sidewalks, and four rows of closely spaced mature streets. Prior to remodeling in the 1960s, when the subway was installed, it had narrower sidewalks and wider medians.

- The street right-of-way is 200 feet, and buildings are generally built to the property line.
- Typical block length is 360 feet.
- The center roadway is 60 feet wide and has an asymmetrical traffic configuration. Four traffic lanes move away from the old city, and two move the other way (10-foot-wide lanes). In both directions, the lane next to the median is reserved for buses and taxis.
- The paved medians are 26 feet at their widest but narrow to as little as six feet, undulating in and out along their length to accommodate in some places parking, and in other places wide stairways that provide access to the subway running below the street. They also accommodate bus and taxi stops, and several wonderful ceramic tile benches with integral and intricate metal light fixtures designed by Gaudi.
- Four dense rows of mature London Plane trees grace the street. Spread at roughly 25 feet, they occur at the sidewalk edges and in the medians.
- The access roads vary in width from 14 feet to 30 feet, but consistently allow only one through lane of traffic. Wider sections accommodate one or two lanes of parking, sometimes at a diagonal.
- Wide sidewalks on both sides vary from 36 feet to 48 feet, widening even more at the corners where buildings have angled corners. In some blocks, a continuous planting strip, filled with low shrubs, separates the sidewalk from the access road. More typically, however, the paving flows right to the curb.

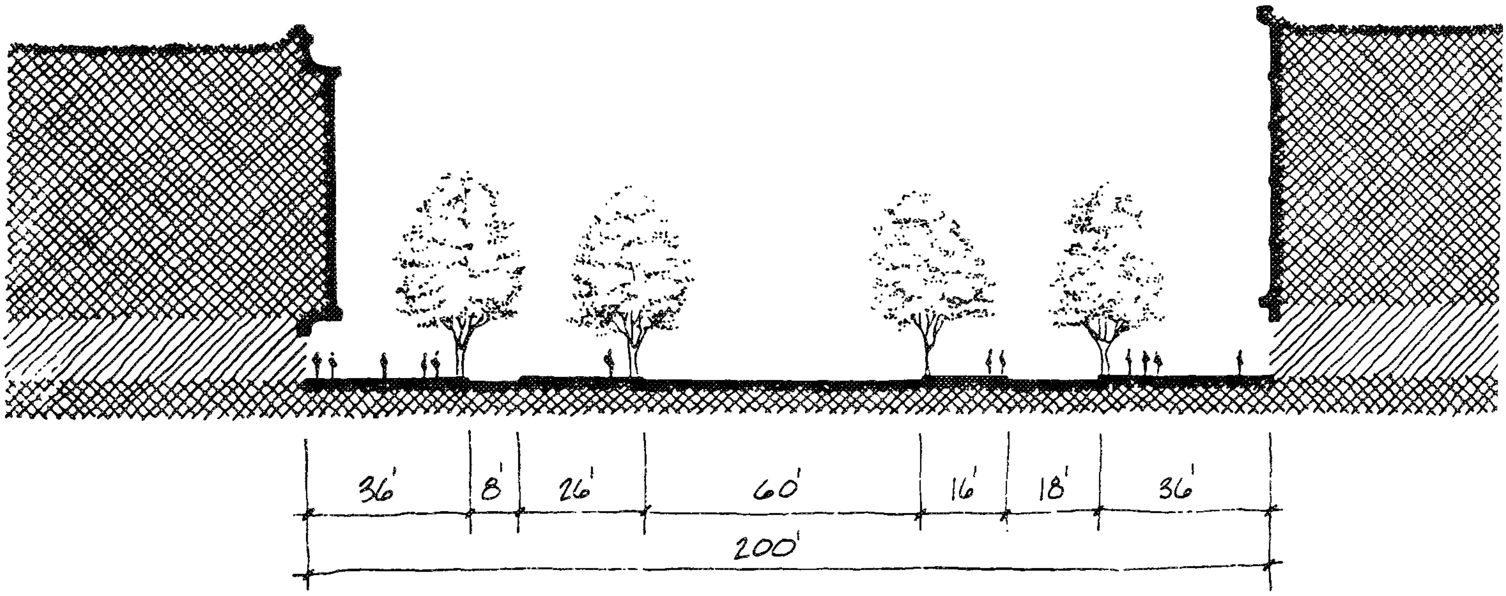

Figure 3.41. Paseo de Gràcia: Section
Approximate Scale: 1" = 40' or 1:500

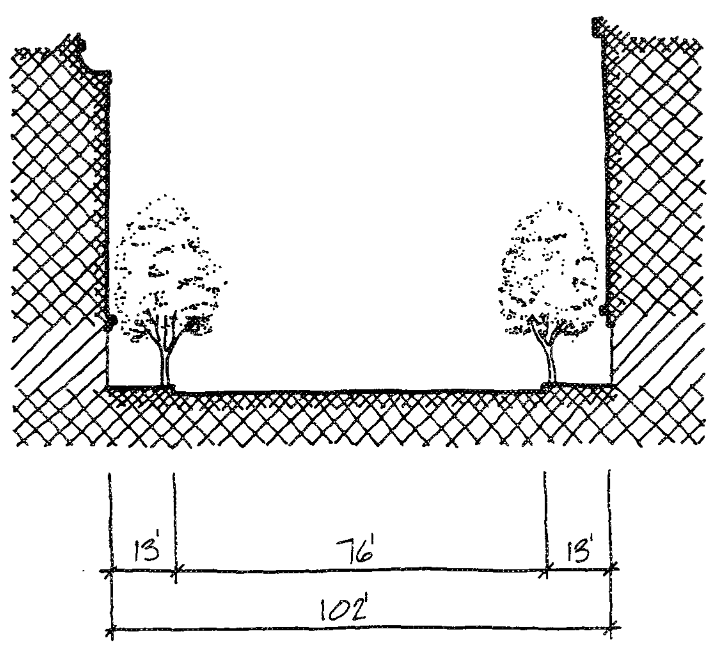

Figure 3.42. Aragó: Section
Approximate Scale: 1" = 40' or 1:500

- The street is well lighted with several types of fixtures: medians have the Gaudi bench lights, two-sided cobras, and ornate pedestrian-scale fixtures at intersections; the sidewalks have pedestrian-scale light fixtures spread at 50 to 60 feet, set within the line of trees
- The sidewalks contain many pedestrian amenities: stair access leading to the parking garage below the street; benches between trees; and numerous kiosks selling lottery tickets, newspapers, and various things to eat. Several cafes offer sidewalk seating, which, where it occurs, may occupy half the sidewalk width.
- Intersections have wide, boldly zebra-striped crosswalks.
- Cross streets are all one way in alternating directions.
- Movement between the center and the access roads is not restricted, but left turns cannot be made from the center.
- The center, the access roads, and the cross-streets are all controlled by synchronized signal lights.
- Traffic on the crossroads waits for the light behind the sidewalk crosswalk, not at the median edge.

Control Street

The cross-street Aragó was selected as a control street. It is a major westbound-traffic street lined with residential buildings and ground-floor commercial that carries eight lanes of traffic in a 76-foot roadway, with no parking allowed. The right-hand curb lane is reserved for transit. A mainline train runs beneath the street. It used to be in the open, which is why the street is so wide.

Behavior Observations

Intersections Observed

- Aragó: one-way westbound, major trafficway, signalized
- Valencia: one-way eastbound, high traffic, signalized

Observations Taken

- Late afternoon, weekday, spring

Observations

- Traffic flows are significantly different in the two directions. In the southbound direction, where the center has only two lanes, significantly more traffic was observed on the access road then in the center. For example, at Aragó, 512 vehicles per hour were counted on the access road versus 88 vehicles per hour in the center. In the predominant northbound direction, somewhat less vehicles use the access road then the center: at Aragó, 512 vehicles per hour were counted in the access road versus 696 vehicles per hour in the center.

In general, cars on the cross-streets seem to make more turns into the access roads than into the center. For instance, at Aragó, 108 vehicles per hour were counted turning left into the southbound access road, while only 24 were counted making a left into the southbound center.

- There is often a steady flow of cars on the access roads, but here traffic moves much more slowly than in the center. An average speed of 31.7 kilometers per hour was observed on the access roads, compared with 52.5 kilometers per hour in the center.
- Cross-streets in general seem to carry more traffic than does the Paseo.
- Very high numbers of pedestrians were counted. For example, at Aragó a total of 3,304 pedestrians per hour were counted walking along the sidewalks (2,232 on one side, 1,072 on the other), while at the same time a total of only 1,808 vehicles were counted.
- A fair amount of jaywalking was observed, mostly associated with mid-block bus stops. People getting off a bus or running to catch a bus are often tempted to jaywalk rather than walk to a corner to cross.
- Pedestrians often mingle with traffic on the access roads, cutting through to parked cars or to the median.
- In order to make left turns out of the access roads, vehicles pull into the space defined by the median, then wait for the cross-street light. Often six or seven cars stack up this way during a signal phase. When the light turns green, they all merge into lanes and lead the pack.
- Pedestrians often use the medians as a haven when crossing the street, waiting there if necessary when the light has changed.

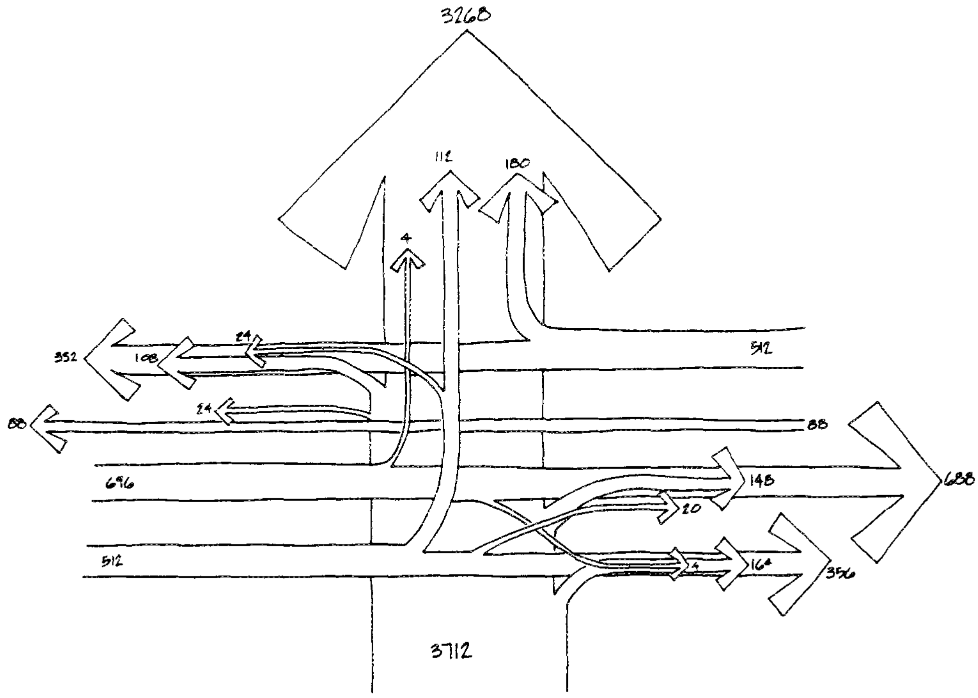

Figure 3.44. Paseo de Gràcia: Vehicle Movement Diagram at Aragó

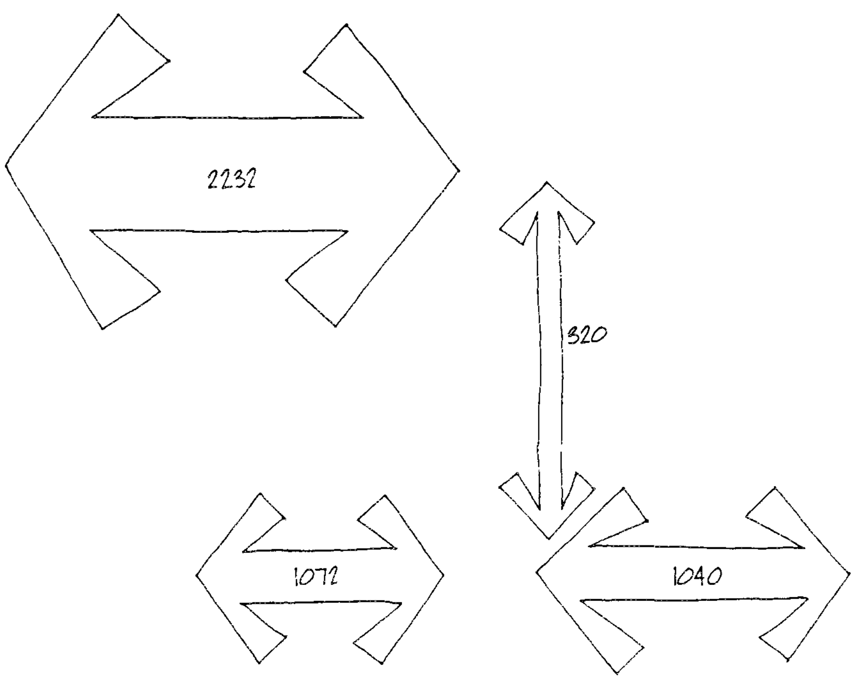

Figure 3.45. Paseo de Gràcia: Pedestrian Movement Diagram at Aragó

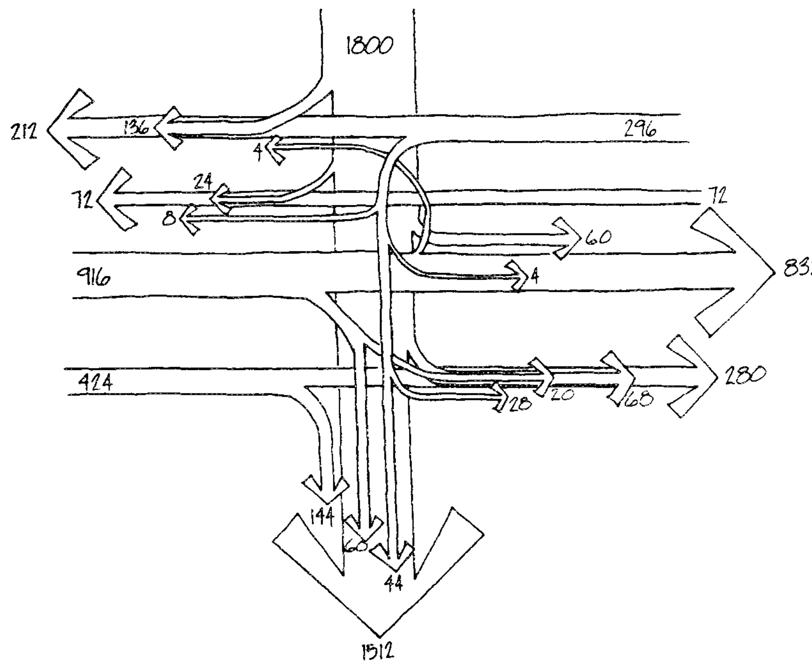

Figure 3.46. Paseo de Gràcia: Vehicle Movement Diagram at València

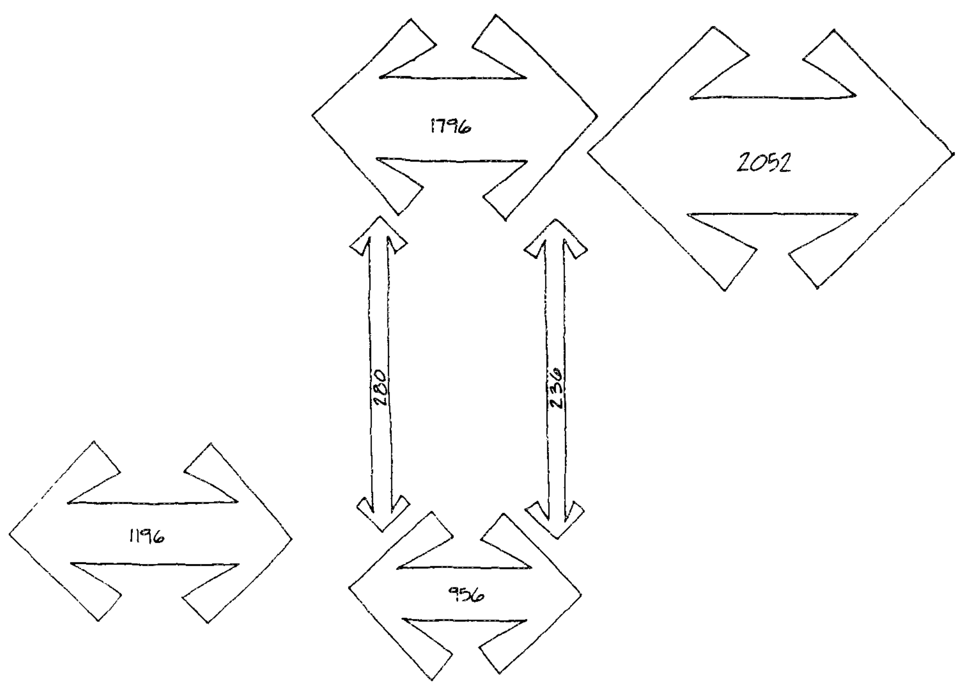

Figure 3.47. Paseo de Gràcia: Pedestrian Movement Diagram at València

Boulevard #8

DIAGONAL, BARCELONA

(medium to large city, major arterial, mixed-use commercial and office)

Urban Context

The Diagonal is a major two-way traffic carrier in central Barcelona. It runs northwest/southeast, cutting diagonally through the central city, intersecting with the northern end of the Paseo de Gràcia. It has a boulevard configuration for approximately 17 blocks, along which it is lined primarily with office buildings, seven floors or higher, many older, some new, and intermittent ground-floor shops, some of a very high quality.

Physical Description

The street is characterized fast-moving traffic, narrow sidewalks, and wide tree-lined medians.

- The street right-of-way is 165 feet, and buildings are generally built to the property line.
- Block length varies but averages about 300 feet.
- The center roadway has six traffic lanes in a 50-foot width, three moving in each direction (8.3-foot-wide lanes). The lanes nearest the medians are reserved for buses and taxis.
- The 30-foot-wide paved medians are planted with two rows of trees. The arrangement is unusual: a staggered pattern of London Plane trees and tall Palms at about 27 feet apart along the length of the median and 20 feet apart across the median. Toward the center roadway side, the trees are contained within a continuous 10-foot-wide raised grass strip. Pedestrian-scale light fixtures occur at every third space between the trees, staggered side to side. Occasional benches are set between the trees, facing into the median. Transit stops occur along the edge near corners.
- The access roads are uniformly 17 feet wide, allowing two lanes of through traffic with no parking permitted (8.5-foot-wide lanes).
- The sidewalks are narrow, only 10-1/2 feet, except where they widen at intersections in front of the diagonal corner buildings, which are the norm in this part of the city.
- Intersections have wide, boldly zebra-striped crosswalks.
- Cross-streets are all one-way in roughly alternating directions.
- At some major intersections, movement between the access roads, the center, and the cross-streets is restricted. For instance, at the intersection studied, vehicles on the access roads are not supposed to turn left into the center or the cross-street, and vehicles traveling on Balmes are only supposed to turn into the center only.
- Intersections are controlled by signal lights, with the access road having the same signal phase as the center.

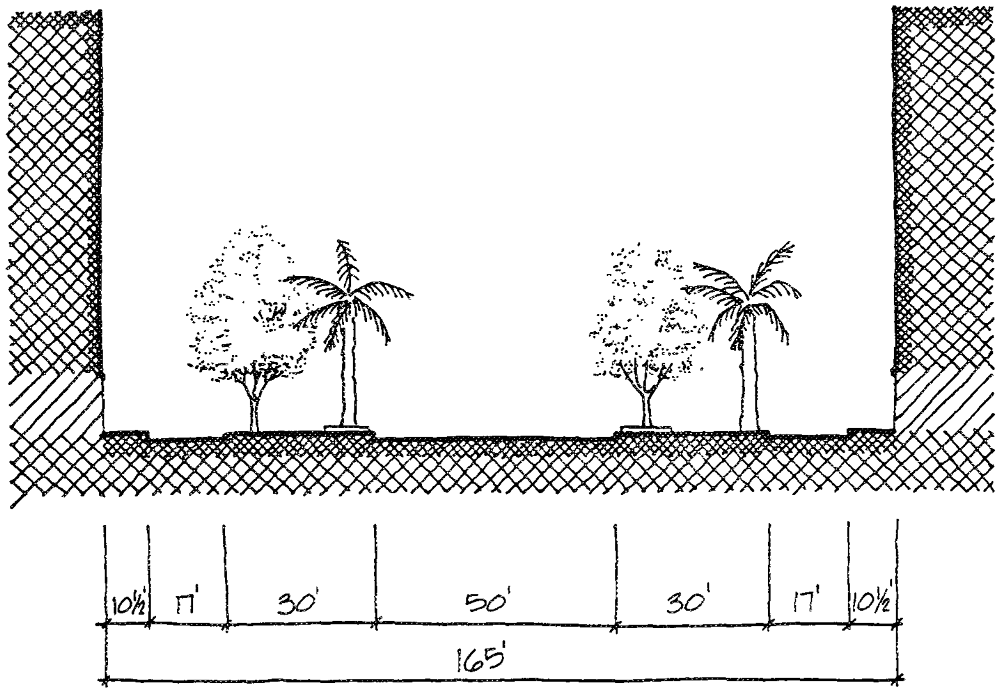

Figure 3.48. Diagonal: Section
Approximate Scale: 1" = 40' or 1:500

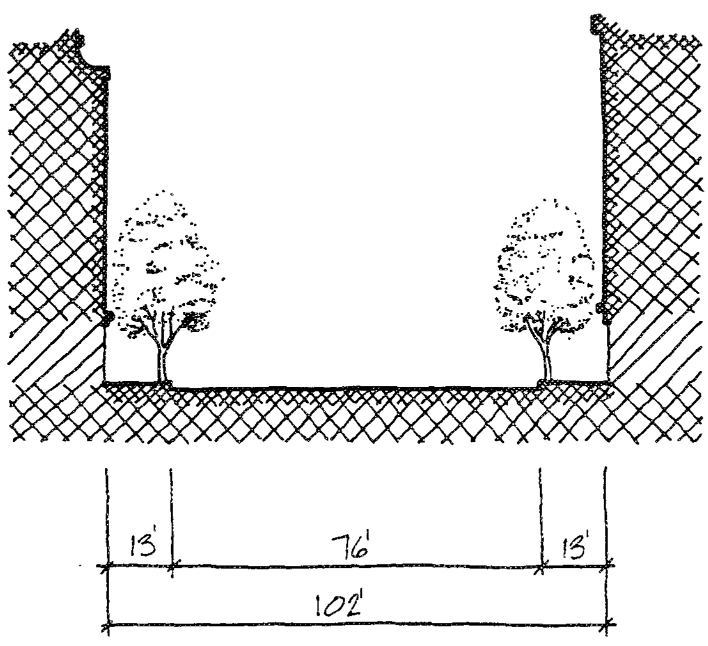

Figure 3.49. Aragó: Section
Approximate Scale: 1" = 40' or 1:500

Control Street

Aragó was used as the control street for the Diagonal.

Behavior and Movement Observations

Intersection Observed

- Balmes: one-way southbound, high traffic, signalized

Observations Taken

- Mid-morning to early afternoon, Saturday, spring

Observations

- Traffic travels almost as fast on the access roads as in the center. Speed measurements, taken when traffic was flowing, were an average speed of 40 kilometers per hour on the access roads, and 52.5 kilometers per hour in the center.
- It appears that significantly more cross-street traffic turns into the access roads than into the center, at least at the one-way intersection observed. One hundred vehicles per hour were counted making right turns into the access road and only 40 vehicles per hour were counted making rights into the center; 32 vehicles per hour were counted turning left into the access road while only 16 vehicles per hour were counted turning left into the center.
- More total traffic travels in the center then on the access roads: 1,512 vehicles per hour in the center (884 westbound, 628 eastbound) versus 824 vehicles per hour on the access roads (400 westbound, 424 eastbound). However, per lane traffic counts are more similar: 295 vehicles per hour per lane in the westbound center and 209 vehicles per hour per lane in the eastbound center versus 200 vehicles per hour per lane on the westbound access road and 212 vehicles per hour per lane on the eastbound access road.
- Several cars were observed parking half on the sidewalk and half in the roadway along the access roads.
- There was only light pedestrian activity on the street. An hourly volume of 144 were counted crossing the boulevard (60 on one side, 84 on the other).
- Of the pedestrians observed, almost as many walked on the medians as on the sidewalks. For example, on the south side, 44 pedestrians per hour walked along the median while 68 per hour walked along the sidewalk. Of those on the median, quite a few continued along its length for more than a block, crossing from median to median at intersections.
- Although wide and heavily planted with mature trees, the medians do not appear to be used as gathering places or as activity spots, other than waiting at transit stops. Some kiosks for newspapers and magazines are located there, but in general they seem underpatronized.

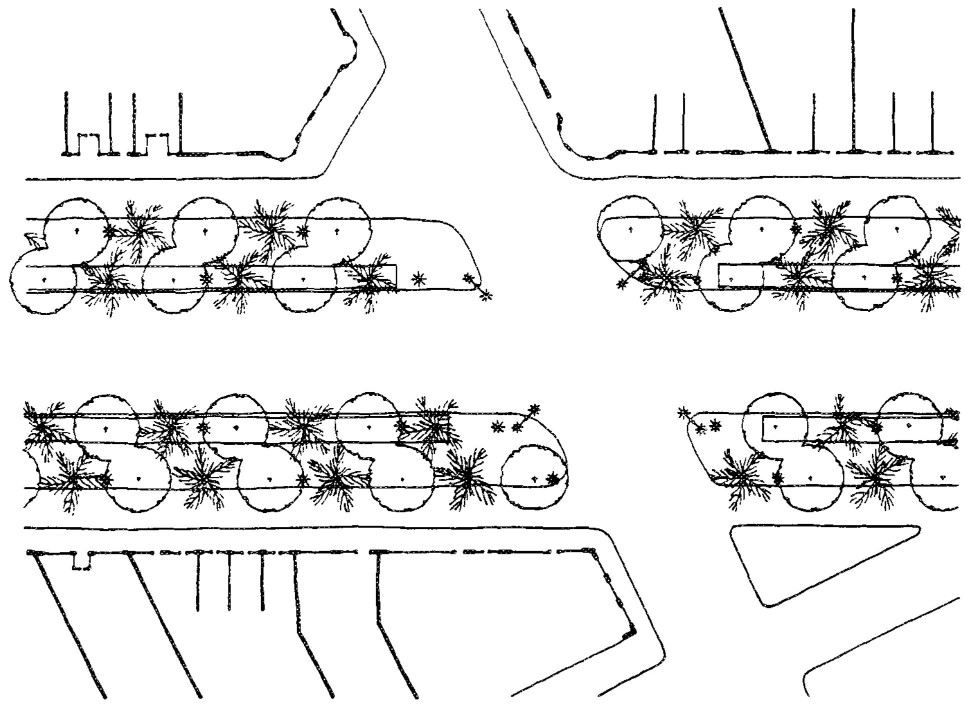

Figure 3.50. Diagonal: Plan
Approximate Scale: 1" = 80' or 1:1,000

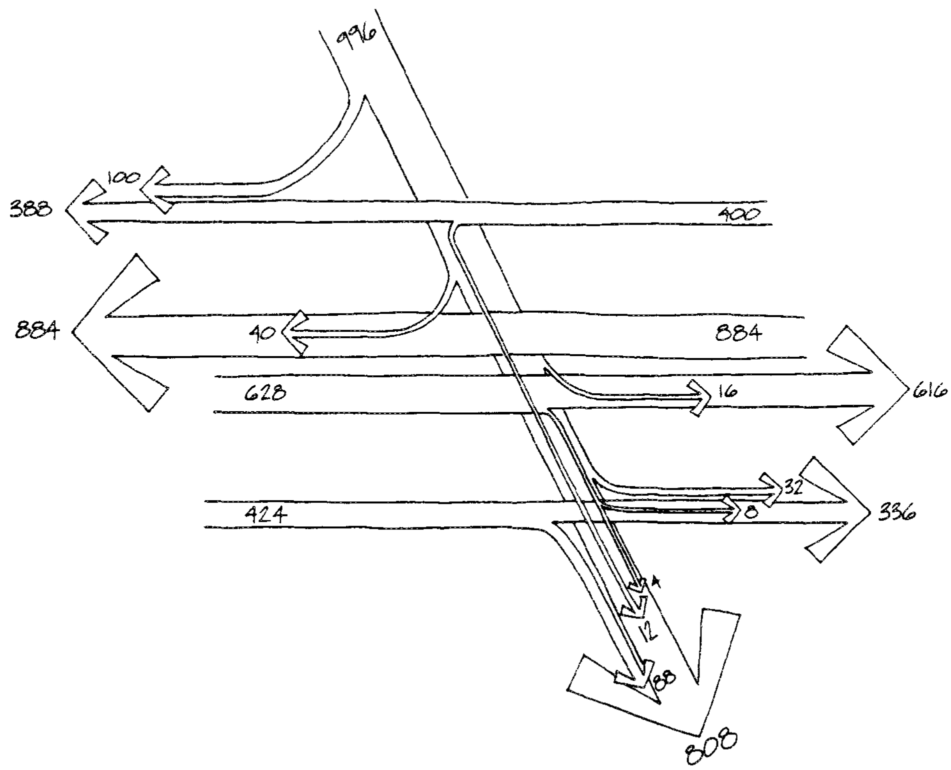

Figure 3.51. Diagonal: Vehicle Movement Diagram

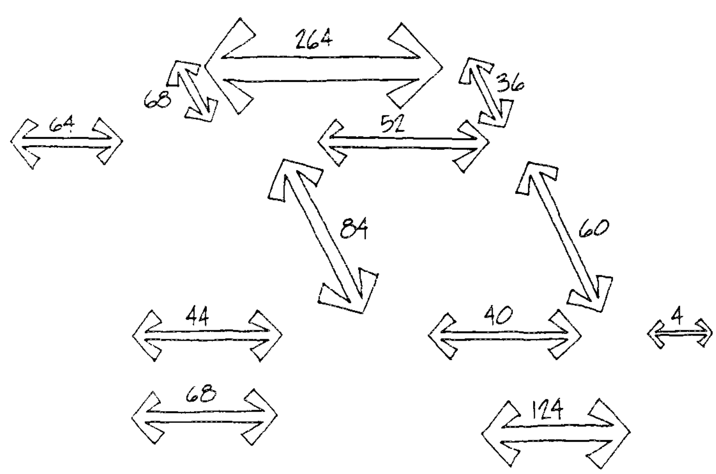

Figure 3.52. Diagonal: Pedestrian Movement Diagram

Comparisons Between Boulevards Based on Field Observations

In general, on most of the streets observed there appears to be adaptation to the boulevard configuration on the part of both drivers and pedestrians, and not much conflict. The boulevards seem to function well and safely while performing their multi-purpose functions. And, although carrying significant amounts of traffic, most are very pleasant places to be. The following are some general observations on and comparisons of the boulevards. Conclusions, based on analysis of both field observations and the accident data presented in the next chapter, will be presented in Chapter Six.

Access Road Configuration and Influence on the Pedestrian Realm

The extent of the pedestrian realm seems to be dependent on the width of the access roads, the number of through traffic lanes on them, and the speed with which traffic moves on them. Observed behavior indicates that five of the boulevards illustrated here — the Esplanade, Ocean Parkway, Avenue Montaigne, Boulevard Courcelles, and the Paseo de Gràcia — have extended pedestrian realms that include the sidewalk, the access roads, and the medians. Each of these streets has only one traffic lane on the access roads, on which traffic generally moves slowly. All of these streets also have medians that are well planted with trees and provided with pedestrian amenities. The extended pedestrian realm was most pronounced on the Avenue Montaigne, where pedestrians often walk down the narrow access roadway; on Ocean Parkway, where the wide tree-lined medians are used as gathering spots; and on the Paseo de Gràcia, where high numbers of pedestrians constantly cross between the sidewalks and the medians all along the block, coming and going from parked cars and transit stops.

K Street also has only one lane of traffic on the access roads, but there behavior indicates that the edge of the pedestrian realm is ambiguous. The access roads and medians seem to be encompassed within the pedestrian realm only at the intersections, where people claim the access roadway enough to cross it against the traffic light. Pedestrians seldom walk on the access roads or along the medians for any length. The reasons for this appear to be the large amount of traffic on the access roads, and the fact that the medians are narrow, sparsely planted, and discontinuous.

Several of the boulevards have access roads that function as through traffic ways. The Grand Concourse, Queens Boulevard, the Gran Via, and the Diagonal are less multi-purpose than the other boulevards because movement rather than access is emphasized on the access roads. They each have two lanes of fast-moving traffic on access roads that feel and function very much like the center. More so than the other boulevards, much of the traffic on these access roads is through traffic. On the Grand Concourse and Queens Boulevard, the pedestrian realm ends at the sidewalk. The wide access roads with fast-moving traffic are difficult to cross except at intersections and with the light, and the narrow median strips, which offer no pedestrian amenities and have fast-moving traffic on both sides, are not pedestrian places. On the Diagonal and the Gran Via, the extent of the pedestrian zone is ambiguous in a way which may be problematic. On these streets, the pedestrian realm on each side is divided into two separate zones. The sidewalks and the wide medians, which are planted with trees and provided with pedestrian amenities such as benches, are both pedestrian realms, but the fast-moving access roadway that separates them definitely is not. Because the medians are so obviously intended to be used by pedestrians, people are often tempted to cross between them mid-block, or against the light, which can be dangerous.

Medians

The presence or lack of trees on the medians has a big impact on how pleasant a boulevard is and how it is used, especially on the wider streets. Even on streets with very high traffic volumes, such as Ocean Parkway, pedestrian behavior suggests that large, closely spaced median trees are an effective buffer between pedestrians and vehicles. Many of the boulevards observed as part of this study have substantial plantings of closely spaced trees in the medians; some also have trees on the sidewalks — two, four, or six rows of trees in total. Streets with less substantial plantings, such as the Grand Concourse, Queens Boulevard, and K Street, are less pleasant to be on than the others and appear to have less extensive pedestrian realms. The narrow, sparsely planted medians on these streets create little separation between the center and the access roads, and it does not help that the medians are frequently interrupted by breaks through which traffic flows in and out between the center and the side.

Wide medians that have amenities such as large trees, benches, and paving may become special pedestrian places, highly used and valued, like those on Ocean Parkway. But if they are not easily accessible and are not comfortable places to be, like on the Diagonal, then mere width and the provision of amenities or pedestrian functions may not be enough. It appears that narrow medians are most likely to be included in the pedestrian realm if they have specific pedestrian functions, such as on Avenue Montaigne and the Boulevard Courcelles, where they contain transit stops.

Movement Restrictions

Unrestricted movements combined with a high traffic volume make the intersections on Ocean Parkway the most complex of any observed in this study, and yet they function smoothly. Intersection conflict between the center and the access roads is reduced because most of the traffic travels in the center. The narrowness of the access roads and the unique separate roadway controls are significant. Most of the traffic on Ocean is through traffic that wants to move fast, and drivers know that the access roads, with a single narrow lane and stop signs at every intersection, are likely to be slower then the center, so they do not drive on them. The same system works on the Esplanade, in Chico. Both of these are residential streets, but unrestricted movements at intersections also work on commercial streets such as the Avenue Montaigne. There, signal lights control both the center and the access roads, but through traffic on the access roads is discouraged and slowed by an extremely narrow roadway and the elevation change at intersections. The unrestricted nature of the intersections on Montaigne is particularly interesting because of the complexity of the traffic pattern. Montaigne is essentially a one-way street, but drivers have to deal with the one lane of contra-flow traffic in the fast-moving center.

Movements are not restricted on the Paseo de Gràcia's intersections, but intersections are simplified because the cross-streets are all one way. Intersections are also simplified on the Boulevard Courcelles, where the access roads re-join the center prior to the intersection.

Some of the other boulevards have intersection movement restrictions that were obviously put in place to minimize actual or perceived conflicts between the center and the access roads. Such restrictions may cut down on conflict, but they may also affect the nature of the access roadway. For instance, on K Street, a downtown commercial street where a fair amount of traffic wants to turn at intersections, the restriction against right-hand turns from the center puts a lot of traffic on the access roads. And so, rather then just performing their special access function the access roads also perform a significant movement function. Because the traffic volumes on K Street are high, the movement function is almost continuous. The result is that even though the traffic on the access roads moves more slowly then in the center, and there is only one lane of it, it is hard for pedestrians to claim the access roadway as part of their realm.

Roadway modifications to cut down on perceived intersection conflicts may be effective but can also cause unanticipated conflicts of their own. K Street provides an example of this. At some time in the past, mid-block breaks were inserted into the medians in order to channel traffic between the center and the access roads. The systems works but also creates some confusion because, even though the breaks are directionally angled, they are so wide that drivers use them for unintended movements.

IV. VEHICLE CAPACITY AND SAFETY ON BOULEVARDS

This chapter examines vehicular traffic volumes and accidents on boulevards and compares them with other major streets that have more "normal" cross-sections. The analysis of the data shows that boulevards carry as much traffic as other comparable arterial streets, and that they are not less safe for drivers and pedestrians than comparable "normal" streets.

In the previous chapter we described the criteria for choosing control streets. Effort was made to choose parallel arterial streets in the same area of the city as the boulevards, assuming that this condition would provide comparable traffic volumes, cross-street movements, and similar land use patterns, thus isolating the physical design as the only different variable. Of course, such streets were not always available, and it can hardly be said that "laboratory conditions" have been achieved. We believe, however, that the choices provide a reasonable comparative base.

1. Sources of Volume and Accident Information

The study relies on statistics of traffic volumes and accidents that could be provided by the cities studied. Although field counts of pedestrian and vehicle volumes were made as part of this research, including counts on some of the control streets, it was not within the resources of this study to perform thorough traffic counts in boulevards and control streets. Cities, it seems, vary in the amount of traffic information they collect. Most cities have automobile-volume data in the form of Average Daily Travel (ADT) over extended periods, but not necessarily for all streets. Pedestrian-volume data, on the other hand, is rarely available, and if so, only at particular locations. Cities also keep records of accidents, although this is usually done by the police and not by transportation departments. It is not always possible to extract data from the accident database by street, or by intersection, as some cities keep this information based on census tract. Nor is the accident data necessarily comparable, city by city.

2. Measure of Safety — Accident Rate

Many different measures of safety on streets are possible.[5] However, because of the varied nature of some of the data available to the study, and because of the absence of first-hand familiarity with some of the data (perhaps a sense of insecurity about it), it was necessary to rely on a measure which could be computed in most cities based on the available data, and which would be as comparable as possible between cities. From the start, it was determined that precisely because of different types of data (based on different local definitions) between cities, the most significant measures of relative safety would be those between boulevards and their control streets in the same city (rather than between different cities). A measure of safety was chosen that reflects the average number of accidents which occurred relative to the probability of accidents occurring based on the sheer number of cars present on a street, as expressed by the Average Daily Travel statistic. In most cases, statistics were calculated for each intersection (accidents between intersections were ascribed to the nearest intersection), and then a mean accident rate for each street was calculated.[6] Thus, our measure of safety is:

$$\text{Mean Accident Rate (per intersection)} = \frac{\text{Mean Accidents per Year}}{\text{Average Daily Travel/1,000}}$$

Accidents per year was computed as a mean of the yearly accidents in 2–3 recent years depending on the availability of data.

Because much of this study is concerned with the safety of these streets for pedestrians (and particularly because two of our chosen boulevards, the Grand Concourse and Queens Boulevard, are considered the worse streets for pedestrian fatalities in New York City), a pedestrian accident rate was also calculated in two ways. The first calculates pedestrian accidents in a similar way to the overall accident rate; that is, pedestrian accidents divided by the ADT/1000. The second seeks to include a weighting for the number of pedestrians on these streets. To do this, the calculated Pedestrian Accident Rate is divided by the number of pedestrians observed in an hour divided by a hundred, as measured at the intersections that were studied.

Thus, the two expressions are:

$$\text{Pedestrian Accident Rate} = \frac{\text{Mean Pedestrian Accidents per Year}}{\text{ADT / 1000}}$$

$$\text{Weighted Ped. Acc. Rate} = \frac{\text{Ped. Acc. Rate}}{\text{number of peds. in an hour / 1000}}$$

3. Results of Comparison

Table 4.1 summarizes the results for all the cities studied in the United States.

A study of the data does indeed show that *boulevards cannot be shown to be less safe than comparable normal streets.*

In New York City, for example, the Grand Concourse in the Bronx, despite being targeted for a special safety study due to its bad fatality record,[7] has an accident rate of 0.36, while Jerome and Webster Avenues, its parallels, which were chosen as "control" streets, have an accident rate of 0.63 and 0.92, respectively. The pedestrian accident rates are roughly similar at 0.08 for the Grand Concourse, 0.09 for Jerome, and 0.07 for Webster. However, the number of pedestrians having to cross the Grand Concourse is much higher, resulting in a weighted pedestrian accident rate of 0.059 for the Grand Concourse, dropping it below Jerome Avenue, on which we have observed very few pedestrians.[8] In another part of New York City, we see that Ocean Parkway, despite having the highest ADT, has a very low accident rate — almost half that of the control street, Linden Blvd. Eastern Parkway, however, has a somewhat higher accident rate and a pedestrian accident rate that is double, so the results are inconclusive.[9] Queens Boulevard turns out to be the least safe of all boulevards, and does not compare well with ordinary streets either; we believe this could be explained by the particular configuration and use of the street, as will be discussed in the following chapters.[10]

Table 4.1: Traffic Volumes and Accidents, Selected Boulevards and Control Streets — U.S.

Streets Studied	Volume (ADT/ 1000)	Accidents (Yearly Mean per Intersection)	Accident Rate (Accident/ Volume)	Pedestrian Accidents (Yearly Mean per Intersection)	Pedestrian Accident Rate (Pedestrian Accident/ Volume)
NYC*					
Grand Concourse	57.950	20.94	0.36	4.88	0.06
Jerome	22.419	14.25	0.63	2.08	0.09
Webster	17.470	16.06	0.92	1.19	0.07
Queens Blvd.	37.654	36.99	0.98	2.14	0.06
Northern Avenue		14.94		0.68	
Eastern Pkwy.	61.000	42.38	0.69	3.65	0.06
Linden Blvd.	27.000	17.54	0.65	1.04	0.04
Ocean Parkway	74.000	27.3	0.37	1.2	0.02
Washington, D.C.**					
K St.	51.850	18.20	0.35		
Penn. Ave	51.822	12.87	0.25		
Const. Ave	58.100	15.33	0.26		
L St.	35.590	11.93	0.34		
I St.	34.600	8.88	0.26		
Louisville***					
Southern Pkwy.	17.211	8.00	0.47		
Third St.	16.503	14.97	0.93		
Chico****					
The Esplanade	24.800	4.83	0.19		
Mangrove Ave.	22.233	3.98	0.18		

*Traffic volume data for New York is from the following sources: for the Grand Concourse and Queens Boulevard: NYC Dept. of Transportation, Grand Concourse Traffic Safety Study, Draft 12/92, and Queens Boulevard Traffic Safety Study (Draft, undated). Volume data for Jerome and Webster Ave. is estimated from traffic counts supplied by NYC Department of Transportation. Volume data for Eastern and Ocean Parkways and Linden Boulevard is estimated from counts performed by us, by assuming a similar pattern of daily traffic in those streets as was apparent in Queens Blvd. and the Grand Concourse for which we had data. Unfortunately we have no volume data for Northern Ave.

Accident information for all streets is from New York State Department of Transportation, Local Accident Surveillance Project. Data is generally from 1/91 to 12/92. In fact, we have been unable to reconcile major differences in number of accidents in this data with NYPD accident date which is included in the Traffic Safety report, and for comparison's sake we have opted to use the Surveillance Project data, which was available for all streets.

**Pedestrian accidents data was not available for Washington, D. C., and Louisville. For Chico, they were so few as to be insignificant.

Data for Washington, D.C., was received from District of Columbia, Dept. of Public Works, Bureau of Traffic Services.

***Traffic and Safety data for Louisville recieved from City of Louisville, Department of Public Works, Engineering and Architecture Division.

****Traffic volume and accident data was received from City of Chico, Central Services Department, Engineering.

As can be seen, boulevards were not safer than ordinary streets in all cases. In Washington, D.C., K Street was compared to Pennsylvania Avenue and Constitution Avenue, because these streets carried roughly comparable volumes, and to I and L Streets, because they are the parallels to K. Only L Street had a similar accident rate to K, with all other streets being significantly safer. Unfortunately, there is no data available on pedestrian accidents in Washington, D.C. There are, however, a few factors that may make K Street a less safe street. First, it begins as a freeway ramp, which means that cars are entering it at a high speed. Some of the alterations that were made to intersections, in order to allow traffic to move between access lanes and center roadway mid-block, were observed to create more possibilities for conflict rather than to eliminate points of conflict.

However, despite these results for K Street, in all other U.S. contexts boulevards are shown to be at least as safe as, if not safer than, ordinary streets of comparable size and function.

Data from Paris and Barcelona was not in a form that made it possible to readily compare between American and European streets. For Paris, a report from the municipality[11] which lists all the locations (either intersections or street segments between intersections) with more than ten accidents between 1/1/90 and 12/31/92 was available. Locations with fewer than ten accidents were not reported. A map with ADT counts for central Paris within the Boulevard Périphérique in 1986, based on counts between 1982 and 1986, was also available. The nature of streets in Paris is very different from American cities. Most major streets are much shorter and end in very complex intersections, usually a square or a circle. Intersections with side streets also tend to be more complex, at angles other than 90 degrees, and often with more than one cross-street.

The Avenue Montaigne, introduced above as one of the best boulevards, has an ADT of 9,300 cars, and had one section of the street in which 11 accidents were reported (a yearly average of 3.67). It happens to be precisely a section of the street where the access lane ends on one side of the street (between Place Astrid and Rue du Boccador). Peculiarly, seven of the 11 accidents are pedestrian accidents. Its control street, Avenue Victor Hugo, carries an average of 15,200 cars per day and had two intersections listed, one with 12 and the other with 11 accidents (an average of 4.00 and 3.67 accidents per year, respectively).

The Boulevard de Courcelles, in the section where it is a full boulevard on both sides (from Place P. Goubaux to Boulevard Malesherbes), carries about 30,000 cars per day. It has two intersections with more than 10 accidents, Rue Miromesnil with 17 and Rue Malesherbes with 14. However, Rue Malesherbes is another major street carrying about 30,000 cars per day, so that there are 64,800 cars per day going through that intersection. In the section of Courcelles which is not a boulevard, used as a control street, the volume drops to 21,000 vehicles per day, yet there is one intersection with 14 accidents. Another comparison is afforded by Boulevard Haussmann (which, despite its name, is configured as a normal street and is therefore used here as a control street), which carries between 30,000 to 40,000 cars per day and yet has six intersections with more than ten accidents. Particularly telling is the intersection with Malesherbes, in which 28 accidents occurred. Two boulevards that were observed, Avenue d'Iéna and Avenue F. D. Roosevelt, were not listed at all in the report, while three others, Avenues Marceau, Kléber, and Hoche, were listed with only one intersection as having more than ten accidents.

Table 4.2 summarizes the findings.

Table 4.2: Locations with More than Ten Accidents in Boulevards and Control Streets in Paris, France, between 1990 and 1992

Streets	Volume (ADT/1000)	Accidents	Pedestrian Accidents
Montaigne — boulevard			
Pl. Astrid-R. du Boccador	9.3	11	7
V. Hugo — control street for Avenue Montaigne			
R. Leroux-Pl Hugo	15.2	12	4
Av. Hugo/R de Presbourg	15.2	11	1
Courcelles — boulevard			
Miromesnil-Malesherbes	28.0	17	4
Courcelles/Malesherbes	64.8	14	1
Courcelles — control street for boulevard part			
Neva-Pl. des Ternes	21.2	14	3
Haussman one-way — control street for Blvd. Courcelles			
Tronchet/Haussmann	66.6	12	2
Haussmann/Italiens	41.5	16	11
Haussmann/Le Peletier	45.4	14	11
Haussman/Halevy	45.4	13	7
Haussman two-way			
Haussman/R. Courcelles	43.1	10	0
Malesherbes	36.8	28	
Other Boulevards:			
F.D. Roosevelt	12.2	Less than 10	
Avenue de Iena	17.3	Less than 10	
Hoche			
Van Dyck-FG Saint Honore	13.6	11	2
Kleber			
Portugais-R. Hamelin	19.9	14	7
Marceau			
R. Newton-R.de Presbourg	29.3	11	8

Only in the case of the Champs Élysées was it possible to reconstruct a similar analysis to those in U.S. cities; since each and every one of the intersections along it had more than ten accidents, all of them are reported. The Champs Élysées has recently been changed, and is no longer a classic boulevard of the type we are studying. Its access lanes have been dismantled and replaced by a wider sidewalk promenade. However, the statistics date from a time when it was still a boulevard. It has an ADT of about 84,000, with an average of 10.67 accidents per year per intersection, for an average accident rate of 0.10. This compares very favorably with most American streets, especially with those New York streets that are the closest to it in terms of carrying capacity.[12] If we further take into consideration that the four highest-ranking accident locations are the plazas, then we see that the average for normal street intersection is lower still. The pedestrian accident rate is 0.03, which compares very favorably with New York streets, especially if we consider that there are many more pedestrians on the Champs Élysées.

Table 4.3 presents the accident statistics for the Champs Élysées.

Table 4.3: Traffic Volumes and Accidents: Champs Élysées, Paris, France

Intersection	Volume (ADT/1000)	Accidents Per Year	Accident Rate (Accident/ Volume)	Pedestrian Accidents Per Year	Pedestrian Accident Rate (Pedestrian Accident/ Volume)
Pl. de la Concorde	123.30	61.33	0.50	11.00	0.09
Ave. Dutuit	186.30	6.33	0.03	4.00	0.02
Pl. Clemanceau	98.60	21.00	0.21	2.67	0.03
Rond Point	101.30	19.33	0.19	5.67	0.06
Ave. Matignon	83.60	4.67	0.06	0.67	0.01
R. Marbeuf	83.60	2.67	0.03	1.67	0.02
Pierre Charron	83.60	9.67	0.12	3.67	0.04
R. Lincoln	83.60	4.33	0.05	3.00	0.04
Rue de Berri	83.60	6.00	0.07	1.67	0.02
Avenue George V	54.10	11.33	0.21	5.33	0.10
R. Bassano	83.60	2.00	0.02	1.67	0.02
R. Galilee	83.60	11.33	0.14	4.33	0.05
R. Arene Houssaye	83.60	5.67	0.07	1.00	0.01
R. de Presbourg	83.60	5.33	0.06	2.67	0.03
Pl. Charles de Gaulle	186.30	21.00	0.11	3.33	0.02
Average	83.46	10.67	0.10	2.91	0.03

Barcelona seems to present a different picture. It seems to show that the boulevards have a higher accident rate than non-boulevard streets. On the other hand, the data available is so general that there is no way of analyzing it to understand whether the anomaly is real, or due to some quirk in the accident-recording system.[13] From the data, it seems that the Paseo de Gràcia and the Gran Via, both boulevards, have significantly higher accident rates than chosen control streets. While this is not surprising for the Gran Via, which has been modified to serve very fast through traffic, it is surprising for the Paseo de Gràcia. Another surprising element is that the Diagonal, although it too is used as an arterial street on both the center lanes and the side access roads, does not exhibit a higher rate of accidents, but is roughly similar to the Aragó, which has a similar volume of cars.

Table 4.4 shows the data for Barcelona. The original data received from the municipal traffic engineering office included only the totals for the whole streets. That number has been divided into the number of intersections in each street, to get an estimate of the mean number of accidents per intersection to enable an easier comparison with American streets, in which the rate is computed per intersection.

It is worth noting that the pedestrian accident rate on the Paseo de Gràcia is significantly higher than on the Diagonal and the control streets. They constitute 25 percent of all accidents, rather than only 15 to 18 percent in other streets. While at first sight this seems to suggest a problem for pedestrians in the

Table 4.4: Volume and Accident Statistics for Streets in Barcelona, Spain

Street	Volume	Accidents	Accidents Per Intersection	Accident Rate	Pedestrian Accidents	Pedestrian Accidents Per Intersection	Pedestrian Accident Rate
Paseo de Gràcia	39,875	172	17.2	0.43	44	4.4	0.11
Diagonal	101,262	317	16.7	0.17	47	2.5	0.02
Gran Via	66,341	367	16.7	0.25	79	3.6	0.05
Aragó	89,157	223	11.7	0.13	31	1.6	0.02
Balmes	52,003	126	11.5	0.22	23	2.1	0.04
Urgell	63,518	88	6.3	0.10	15	1.1	0.02

Paseo de Gràcia, the perspective is changed once we take into account the sheer number of pedestrians on the Paseo. Thus if we compute the weighted pedestrian accident rate at the Paseo, which has a count of 3,270 pedestrians an hour (pph), it is 0.034 against 0.021 for Aragó, which has a count of 970 pedestrians per hour, 0.040 for Balmes, which counts 1,000 pph, and 0.042 for the Diagonal, which has a count of 480 pph.

Although it is not possible, based on the available data, to show a persistent pattern in which boulevards seem safer than "normally" configured streets, it is also not possible to conclude that the contrary is true. *It seems that the claim that boulevards are less safe, specifically because of their complex intersections, is not substantiated by the facts available to this study.*

Indeed, our most "problematic" example, Barcelona, makes one doubt the logic of the "safety" argument even further. The main point of the argument against boulevards is that the complexity of movements in intersections makes them unsafe. And yet in Barcelona, this has been largely resolved by a pattern of traffic organization which relies on alternating one-way streets. The intersections along the Paseo de Gràcia are thus greatly simplified, and the number of conflict points reduced. Consequently one would have expected, in Barcelona, less of a difference between the safety record of boulevards and control streets. However, it seems that the simplification of the intersections has not improved the safety of boulevards, but perhaps made it worse. Interestingly, it is those two places where attempts have been made to "resolve" the complexity of intersections — Barcelona, and K Street in Washington, D.C. — that seemed to fare worse relative to other streets.

On the whole, boulevards carry as much if not more traffic per through lane.

While boulevards come in many configurations and in many local contexts, and their records for carrying through traffic varies to a great degree, in all cases studied boulevards handle the volumes without any delays in traffic. Invariably, because of their width and prominence in the urban fabric, they are used as major arterial streets (with the exception of Paris, in which they exist in varying sizes and sections). Some of the European streets — like the Champs Élysées and the Diagonal, with an ADT of 101,262 — are not matched by any streets studied in the U.S. They manage those volumes with smaller cross-sections than the U.S. streets (165 feet on the Diagonal versus 175 feet on the Grand Concourse, which has an ADT of 57,950; the Diagonal devotes 81 feet to pedestrians against only 55 feet for the Grand Concourse). Nor does giving the side access streets over to local traffic seem to make much of a dent in the capacity of the streets. For instance, Ocean Parkway, on which only 7 percent of the traffic moves on the access lanes, at a very slow pace, carries more traffic than Queens Boulevard, on which the side lanes were used by 31 percent of the passing cars.[14]

Further, intense observation suggests that on urban streets, where abutting uses have direct access to the street, with the constant need for pickup and dropoff, and with deliveries to shops, the disturbance to through traffic caused by single- and double-parking, and by cars pulling in and out of parking, is much greater on normal streets than on boulevards, where it is unobtrusively carried out on the access lanes.

Pedestrian safety is an issue in particular types of boulevards where side access streets are used as through lanes.

Those boulevards with pedestrian safety problems seem to be characterized by two features. One is long length of blocks, which tends to raise the probability of mid-block crossings and is not unique to boulevards. The second is the use, by design or regulation, of the side access roads as fast throughways, rather than as access lanes. This is true for the Grand Concourse and Queens Boulevard, which have the dubious distinction of being the two streets with the highest pedestrian fatality rates in New York City, largely as a result of mid-block crossings and pedestrians being hit on the access roads.[15] It is also probably true on the Diagonal and the Gran Via, where the side streets are used for through traffic, and where the pedestrian accidents occurring mid-block between intersections are about 35 percent of all pedestrian accidents; while in the Paseo de Gràcia, where the side access lanes are slower-moving and narrower, only 20 percent of pedestrian accidents occur at mid-block.

To summarize, we believe we are able to show that boulevards are not less safe than normal streets. Nor do they seem to have a problem in carrying the amount of traffic necessary to make them useful as major urban traffic carriers. In fact, many hours of observing and filming these streets have not suggested serious congestion. "Improving" the intersections, with the intent of streamlining them for less possible conflict points, does not seem to help, but rather, may actually cause these boulevards to be less safe. Finally, improper design or use of the side access lanes for through traffic seems to increase the danger to pedestrians, relatively to other boulevards and normal streets.

V. THE EFFECT OF PRESENT RULES, GUIDELINES, AND NORMS ON BOULEVARD DESIGN

From the outset of this study, it was intended to explore the impacts that current highway design guidelines, standards, and norms would have on the design of boulevards: could a widely acclaimed boulevard (like the Avenue Montaigne), be constructed today, following today's "rules of the road"? We suspected that the answer would be "no!"

More specifically, the initial intent was simply to show how two existing boulevards, Avenue Montaigne and the Paseo de Gràcia, deemed to be exemplary of the type, might have to change using today's American standards, and then to ask if they would remain as fine streets. This exercise within the larger study was to be completed and presented early in the report as a means of highlighting an overreaching problem — how to reconsider the contemporary and future value of this major street-type, which is now in general disrepute. As this part of the study progressed, however, two complicated issues emerged.

First, boulevards do not fit neatly into the prevailing functional categorization of streets as found in manuals of traffic engineering, which we used as a source of standards and norms.[16] So there was a question of which standards or guidelines were applicable to boulevards. Boulevards' prominence in the city, their width as well as their history as major streets, makes it natural to classify them as arterials, or at least as collectors. However, the unlimited access to abutting property, and the local nature of the movement on the side streets, makes one want to classify them as local streets. Which standards should one apply to them? Generally in this study we have used standards for arterials, but for local streets we used criteria based on a design speed of less than 40 mph. Nonetheless, the functional classification issue remains at a larger scale and will be dealt with further in the final chapters.

Second, it became increasingly apparent that any single standard or guideline, while it might be important, may not be critical to the ultimate success or failure of a boulevard. Many combined characteristics account for the best and worst boulevards. Standards tend to deal with elements in isolation. It therefore became necessary to better understand the complexity of boulevards, and how the various elements are related to the roles they play. To simply say that it would not be possible to build Avenue Montaigne today, or that it might be possible to build another fine street, is not enough. A more detailed study of the way boulevards work makes it possible to understand the impacts of the guidelines and norms. For these reasons, this part of the study is being presented later than anticipated, but with much more knowledge in hand.

The Standards and Their Effects

There is no single body of norms and regulations that governs the design of streets in the U.S.A. Practice differs from state to state and from city to city. After reviewing some of the literature on street design guidelines, we chose to use "*Guidelines for Major Urban Streets Design: A Recommended Practice*" (hitherto GMUSD) as a representative of the norms in urban road design. By relating specifically to urban major roads, it was directly applicable to boulevards, and it enabled us to get to the implications of diverse norms and practices without having to make our own interpretations. We supplemented it with reference to AASHTO, 1957; AASHTO, 1990; Homburger and Kell, 1984; and *Traffic Engineering Handbook*, 1982 (see endnote 16).

We will show how the salient physical characteristics are handled on the Avenue Montaigne and the Paseo de Gràcia, what the American recommendations are, and what would be the effect of applying those standards on these two streets.

The following five design issues covered by GMUSD are relevant to boulevard design and may affect them adversely:

1. Lane widths
2. Median width and design
3. Intersection design
4. Sight distance
5. Parking

1. Lane Widths

The following table (Table 5.1) shows the recommended and minimum standards from GMUSD[17] and compares them with the existing widths on the Paseo de Gràcia and the Avenue Montaigne.

Table 5.1: Comparison Between Lane Width Norms and Existing Width in Paseo de Gràcia and Avenue Montaigne.

	American Norms				Existing	
	Design Speed					
	Under 40 mph		Over 40 mph			
Lane Width	Minimum	Desirable	Minimum	Desirable	Paseo de Gràcia	Avenue Montaigne
Curb/ Parking	11'	12'	11'	13'	8'-14' some of it angled parking	6'-7' in access lanes 10' in center roadway
Curb Travel	11'	12'	11'	13'	9'-10'	NA
Inside Lane	10'	12'	11'	12'	9'-10'	7'-9' in access road 10' in center road
Turn Lane	10'	12'	11'	12'	NA	NA

Possible Effect of Lane Width Standards on Boulevards

The Avenue Montaigne includes within its 126-foot right-of-way four and sometimes five parking lanes, two access lanes, and three through-traffic lanes. If rebuilt to American-desirable standards that include the same number of lanes, it would have a right-of-way of 166 feet. If rebuilt to minimum standards, it would need a right-of-way of 154 feet (assuming that the sidewalks and medians stay the same width). Considering only the amount of space devoted to vehicles, the present 80 feet would change to 110 feet using desirable standards, and to 98 feet using minimums. The part of the street that is most affected by lane width standards is the access lanes, which will be expanded from 14 feet to a desirable 24 feet or from a width of 24 feet to a width of 36 feet, an increase of 50 to 70 percent in breadth. The change in the width of the through lanes is relatively small, from 42 feet to a desirable 50 feet, or a minimum of 44 feet (an increase of 5 to 20 percent in the width).

Widening lanes according to American standards does little to increase the capacity of the boulevard, because the center roadway stays roughly the same but expedites faster movement of cars on the access lanes. Observation of the access lanes in the Avenue Montaigne has shown that the pedestrians treat them as part of their realm, and mingle freely with the cars. That is possible only if cars travel very slowly, which they do on the Avenue Montaigne partly because of the extreme narrowness of the access lanes. Another observation consistently made on all boulevards was that pedestrians will cross the access lanes to the median on a red light, to shorten the distance they have to cross when the light changes. By widening the access lanes, and allowing traffic to travel faster, the danger to pedestrians who do so is increased. The balance in the use of the street has shifted to the automobile's needs, rather than the pedestrian's needs and comfort, which is the controlling factor in Avenue Montaigne as it is now.

However, one needs to note that lane width standards alone do not make boulevards impossible to design in the U.S., although they may make it difficult to introduce boulevards where street width is limited. Diagram 5.2 shows that if minimum standards are used, and if the access lanes are limited to a parking lane and one travel lane, and the center roadway is limited to two through lanes only in each direction, a boulevard can be built in a 124-foot right of-way. If the desirable standards are used, and if the center is increased to six through lanes, the required right-of-way width increases to 166 feet. Here again the pedestrian realm is weakened by the wider access lanes, which allow the possibility for faster traffic movement on them.

2. Medians

Following are some of the recommendations in GMUSD:

- Trees over six inches in diameter are not recommended, because they can contribute to fixed-object collision.
- High curbed medians may result in more accidents.
- 8- to 20-ft. landscaped median recommended.

Recommended Median Width (Table 7.1 from GMUSD)

Function	Min. Width (ft)	Desired Width (ft)
Separation of Opposing Traffic	4	10
Pedestrian Refuge and Space for Traffic Control	6	14
Left-Turn Speed Change and Storage	14	20
Crossing/Entering Vehicle Protection	20	40
U-Turns, Inside to Inside Lanes	26	60

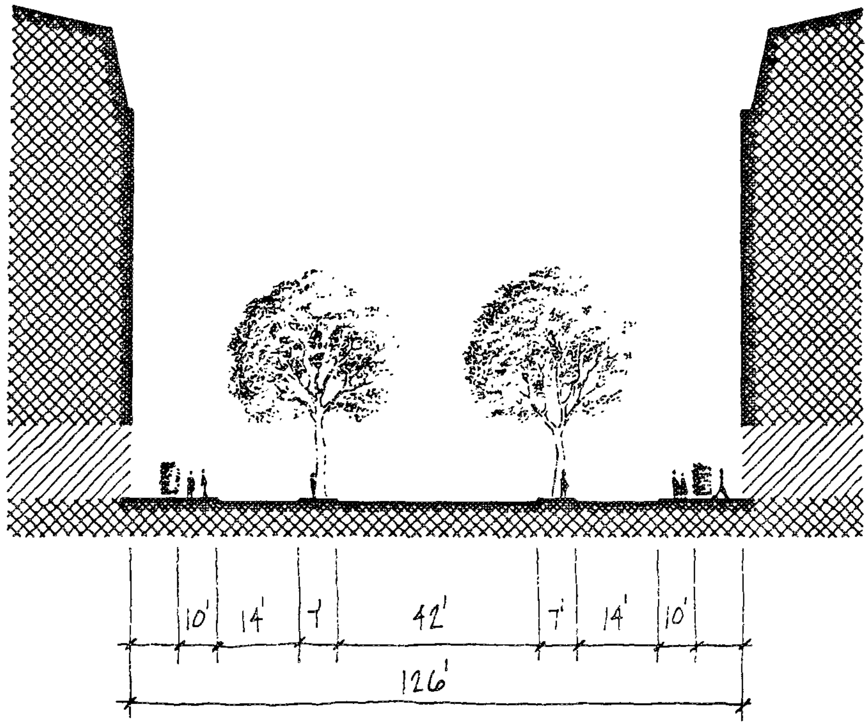

Diagram 5.1a: Avenue Montaigne

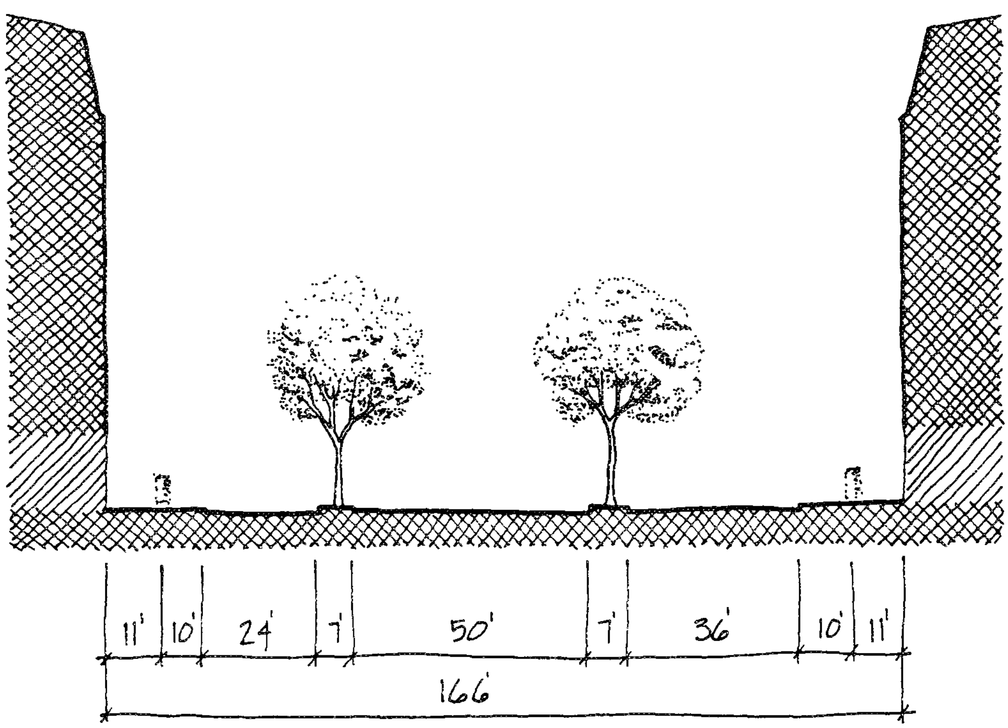

Diagram 5.1b: Hypothetical Reconfiguration if Rebuilt to American Desirable Standards Approximate Scale: 1" = 40' or 1:500

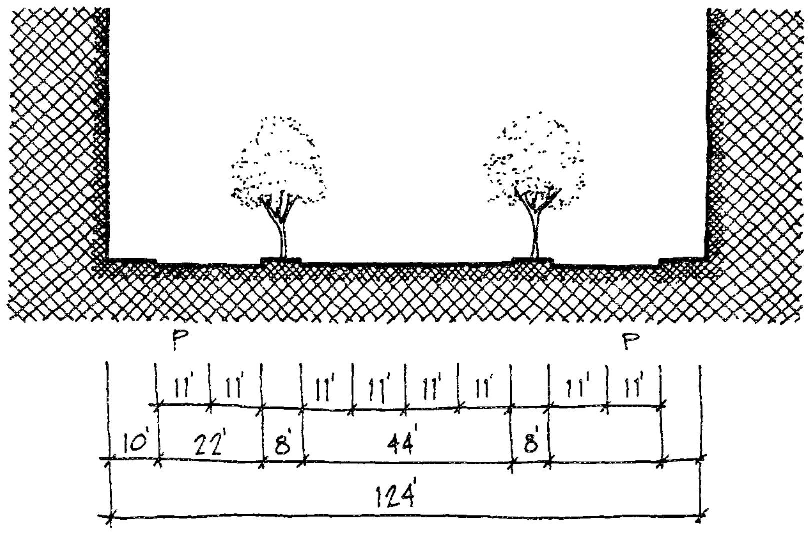

Diagram 5.2a: Minimum Standard Boulevard with Four Center Lanes

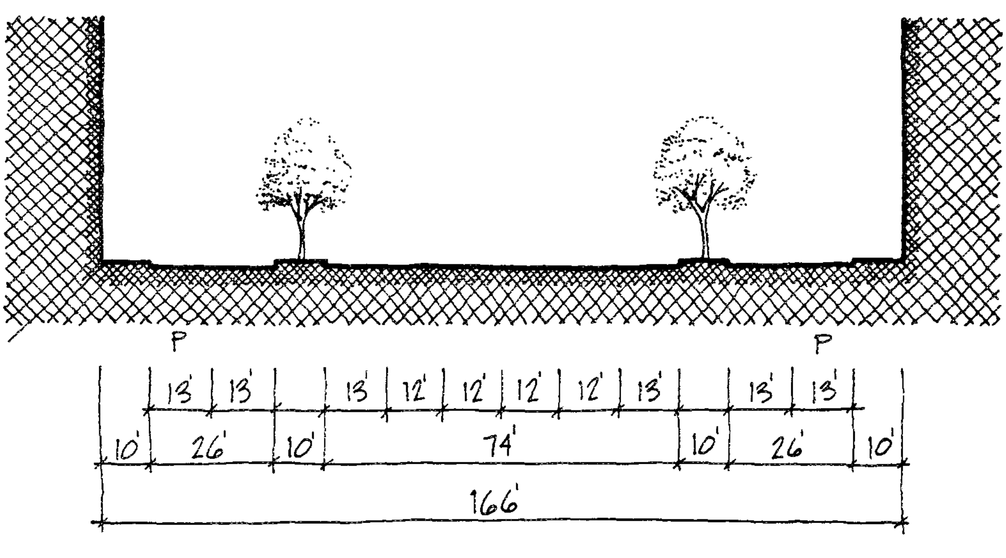

Diagram 5.2b: Desirable Standard Boulevard with Six Center Lanes
Approximate Scale: 1" = 40' or 1:500

Possible Effects of Median Guidelines on Boulevards

The recommendation to limit the size of tree trunks to six inches in diameter would mean that most of the trees on the Paseo de Gràcia and the Avenue Montaigne would have to be replaced. It is hard to imagine these streets without the large trees, separating the various traffic lanes and providing shade for pedestrians in summer, while creating a canopied drive in the center. This norm limits the possible size and effect of trees on a boulevard. The logic of removing large trees, which create a physical and psychological obstacle that improves the sense of safety for pedestrians from cars, because they may contribute to fixed-object accident is questionable. In all, it adds to another weakening of the pedestrian realm.

High-curbed medians provide a sense of safety on an arterial street, especially ones that have heavy traffic. They also provide some obstacle to mid-block crossing. For example on the Diagonal, in Barcelona, the curb towards the center lanes is reinforced by a planter, which creates a high curb towards the driving lanes. On the Boulevard Beaumarchais in Paris, the height difference between the roadway and the sidewalk is equivalent to two step rises, about 12 inches, again providing an increased sense of safety on the sidewalk.

The basis of the recommended median widths are geometric considerations related to the ways medians work to facilitate or hinder traffic movement. The only consideration of pedestrians is as a pedestrian refuge. However, on the Avenue Montaigne and the Paseo de Gràcia, as well as other boulevards, we have observed a much wider array of functions for the medians, first and foremost as locations for transit stops, promenades, kiosks, and newsstands. Avenue Montaigne medians are approximately 7.5 feet wide and accommodate bus stops as well as sitting benches, kiosks and parking ticket machines as well as a public toilet. In the Paseo de Gràcia, medians are between 6 and 22 feet, and accommodate a host of features: splendid benches, which are also bases of street lights; bus stops; and entrances to the underground parking and the subway, which are on the wider portions of the medians. Near intersections at crosswalks, the medians are widened at the expense of the parking lane. This also offers a wider space for cars turning left or making U-turns from the access lanes to wait.

3. Intersection Design (p. 33 in GMUSD)

Following are ten recommended principles for intersection design from GMUSD:

1. Reduce number of conflict points
2. Control relative speeds
3. Coordinate design and traffic controls
4. Consider alternate crossing geometrics
5. Consider alternate turning geometrics
6. Avoid multiple and compound merging and diverging maneuvers
7. Separate conflict points
8. Favor the heaviest and fastest flow
9. Reduce areas of conflict
10. Segregate non-homogeneous flows

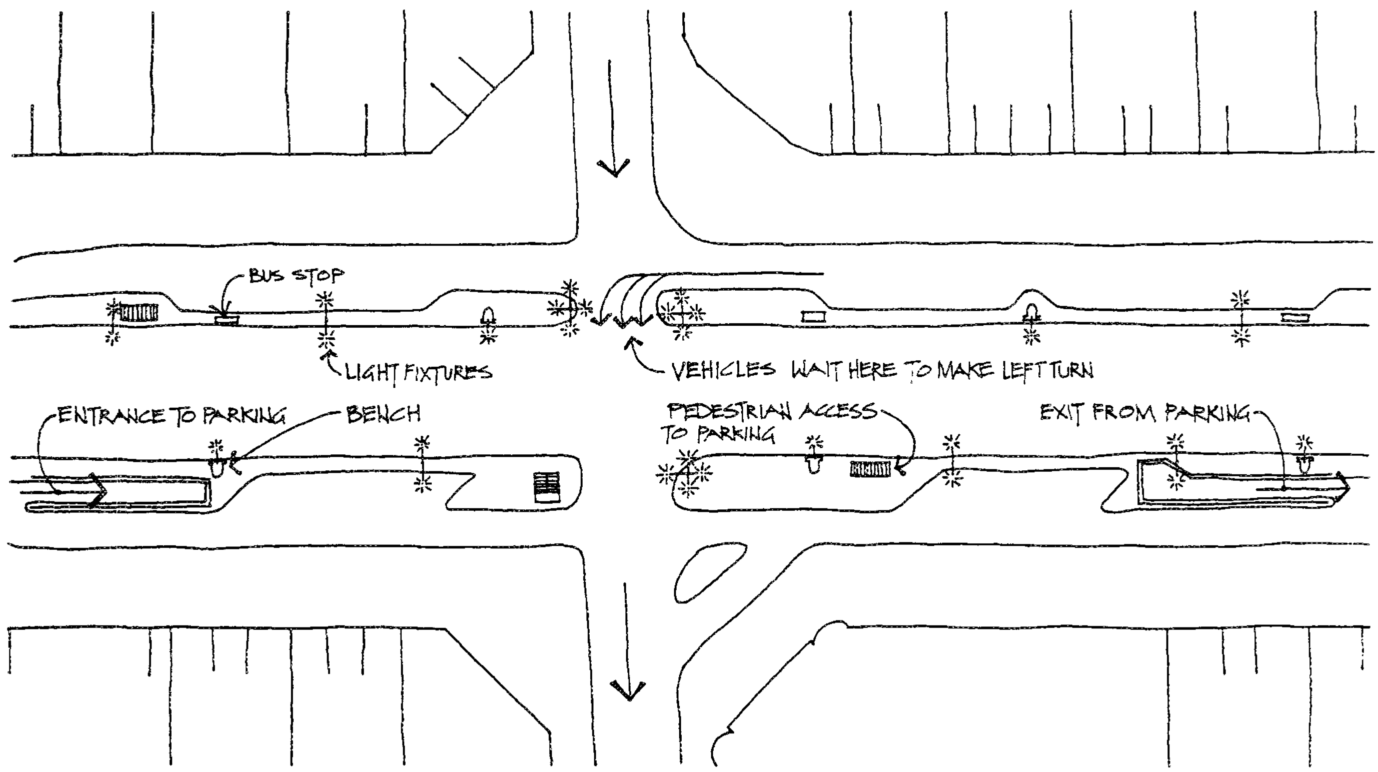

Diagram 5.3: Paseo de Gràcia: Plan Showing Many Functions of the Medians
Approximate Scale: 1" = 40' or 1:500

Possible Effects of Intersection Design Principles on Boulevards

A normal intersection between two two-way streets with one moving lane in each direction has 16 major points of conflict. In the Avenue Montaigne (16) and the Paseo de Gràcia (33), the number of conflict points is kept rather low because the crossing streets are one-way, and in the case of the Avenue Montaigne the boulevard itself is essentially a one-way street, with only public transit going in the opposite direction. It is obvious that points of conflict at boulevard intersections could be reduced without doing away with boulevards, or substantially destroying them. However, even in a worst-case scenario — like the intersection of Ocean Parkway with Ditmas Avenue, which includes all possible movements between a boulevard and a two-way cross-street, and which has 50 points of conflict — it is not at all clear that more conflict points actually cause more accidents to happen. As was seen in the chapter describing the safety performance of boulevards, Ocean Parkway, despite having no limitations on movements at intersections, and despite being the busiest boulevard studied, has the best safety record of all streets studied in New York. The increase in the number of conflict points does not show a corresponding increase in the number of actual accidents.

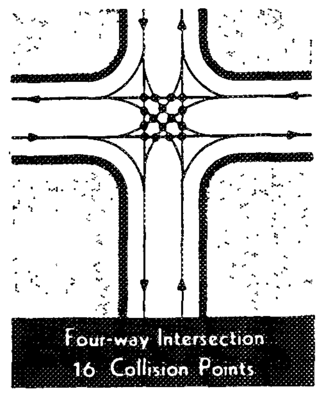

Diagram 5.4. Four-Way Intersection Conflict Points

Principles 2 and 10 are implemented better on Paseo and Avenue Montaigne than in "normal" streets. Relative speeds are controlled, and non-homogeneous flows are separated.

Principles 6, 7, and 9 do not seem to be borne out by our observations as contributing to safety on urban streets. However, it seems impossible to implement them on existing boulevards without destroying them. At K Street in Washington, D.C., attempts to separate some of the conflict points have probably contributed more conflict points on the street, without really reducing those at the intersections.

Regarding principle 8, on the Paseo de Gràcia at Aragó the heaviest flow in terms of sheer number of people is pedestrians at 3,304 per hour versus 1,808 cars per hour. On the Avenue Montaigne, pedestrian flow is 1,328 people per hour versus 1,653 cars per hour. We see that the heaviest is not necessarily the fastest flow, and also that on some streets pedestrian flows are not negligible in terms of people passing through. Even on the Grand Concourse pedestrian crossings at 167th Street there were 864 people per hour relative to total car movement of 2,800 vehicles per hour.

Taken together, the ten principles consider vehicular traffic only, and do not account for the existence of pedestrians and the possible ways that the two modes might interact. They assume an ideal of a single-function street, and ignore the fact that in an urban area this ideal is probably neither attainable nor desirable. The Paseo de Gràcia and the Avenue Montaigne are prime examples of a very different approach to streets, in which pedestrians are recognized and welcomed, and their needs met. Also, they are streets that reach a balance of accommodating both the passing-through traffic and the inevitable local traffic that is created when abutting land uses are accessed from a main street.

It is apparent that the guidelines regarding the complex intersections created by the access roads, or frontage roads as they are sometimes called, have undergone some changes over the years. In the 1957 AASHTO policies, two types of major urban roads that include frontage roads are described: major urban

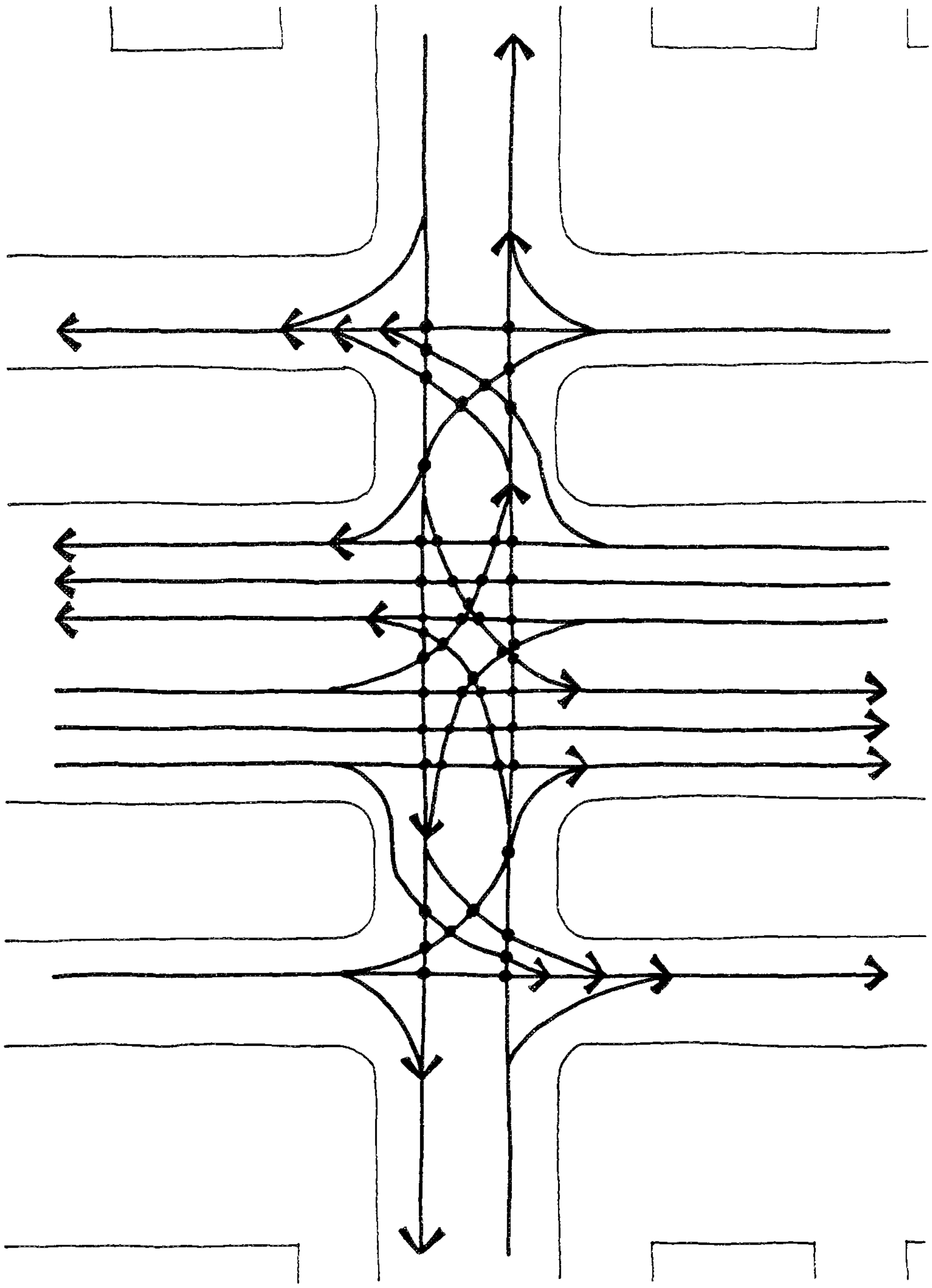

Diagram 5.5. Ocean Parkway Conflict Points
50 Conflict Points

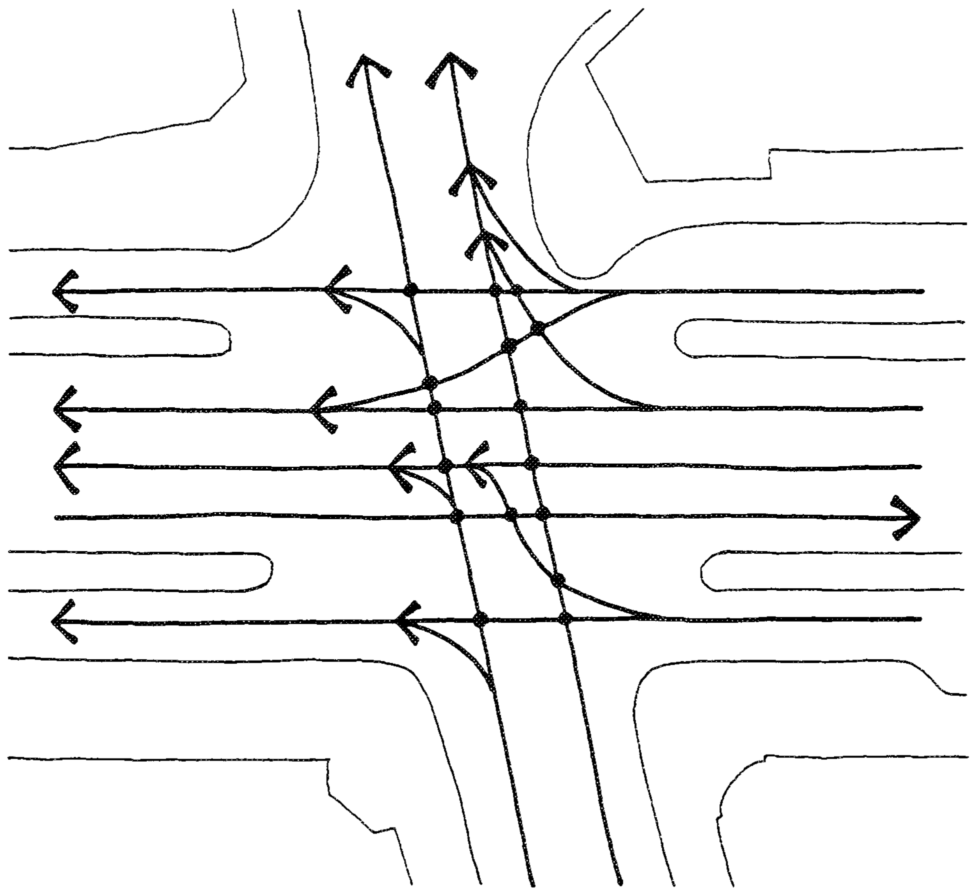

Diagram 5.6. Conflict Points on Avenue Montaigne at Rue Francois
16 Conflict Points

streets and expressways. Lane width requirements and intersection requirements are somewhat different for each type; however, an example of a street with frontage roads is included which has lane width of 11 feet, and it is considered doable. The diagrams show various possibilities for expressways, although it is clear that the desirable one is much too wide to be considered a boulevard, or to function as one.

In the 1990 AASHTO publication, the distinction between major urban streets and expressways has been dropped, and they are all considered as arterials; while the usefulness of frontage roads to facilitate access to adjoining property is acknowledged, it is considered to be offset by complexities at the intersections. It recommends a minimum separation of 150 feet between the right curb of the through lanes and the left curb of the frontage road (pp. 838-839). However, it is allowed that narrower separations are acceptable (down to a minimum of 8 ft.) where frontage road traffic is very light, when it is one-way only, or when some movements are prohibited. Thus, although one can still say that boulevards are allowed or possible under these norms, they are certainly not recommended or encouraged.

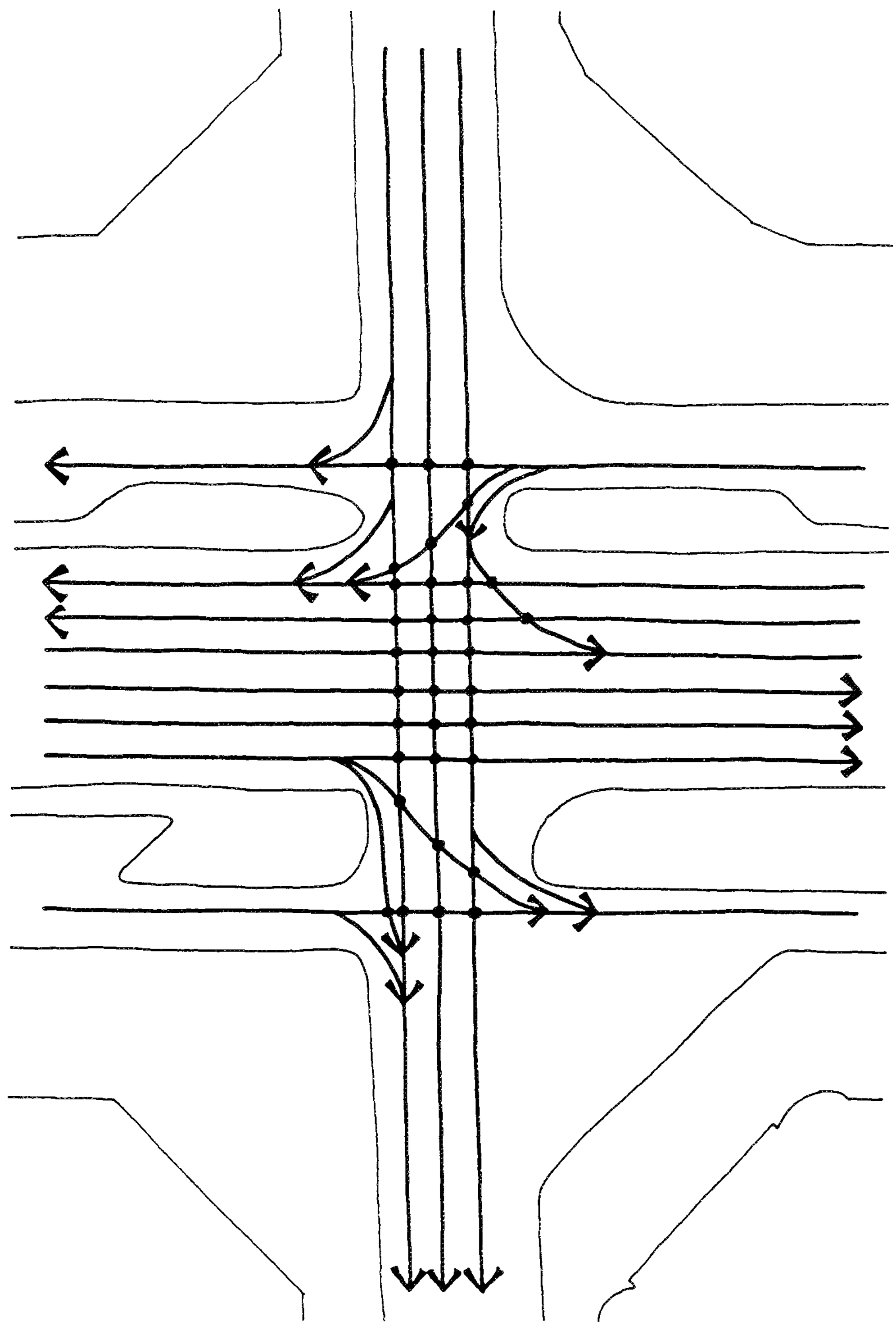

Diagram 5.7. Conflict Points on Paseo de Gràcia at Carrer València
33 Conflict Points

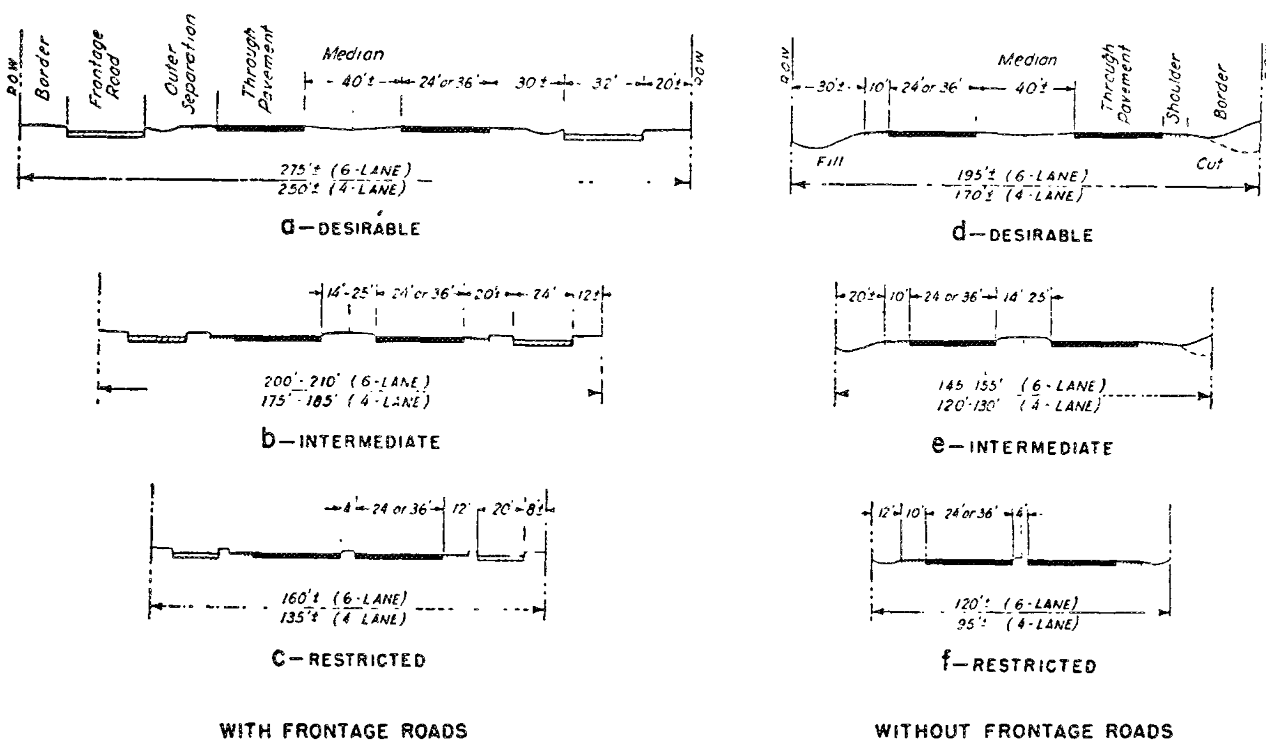

Diagram 5.8: At-Grade Expressways: Right-of-Way Widths (from AASHTO, 1957, p. 264, Figure F-5)

The Paseo de Gràcia and Avenue Montaigne employ two different solutions to the problem of intersection design on boulevards. In the Paseo, the width of the median is increased in the intersections to 26 feet. This is enough for cars wanting to turn left from the access lanes to make a half turn and wait for the light to change on the cross-street, at which point they join that stream of traffic either in going straight to complete the left turn, or to turn left into the center lanes or the opposite access lane of the Paseo to complete a U-turn. We have observed five or six cars waiting in this way without blocking the through movement on the access lane. This is aided by the one-way design of the cross streets, which enables them to stack up along the whole width of the cross-street (see Diagram 5.2). In the Avenue Montaigne, the access lanes are raised slightly and curbed by a one- to two-inch curb, and also are turned slightly inwards. The effect is to make them feel very much like driveways. The result is that the right-of-way for all kinds of turning movements definitely belongs to the cars moving on the center lanes, and the drivers on the access lanes use caution when coming out of the access lanes, similar to the way drivers coming out of driveways will act.

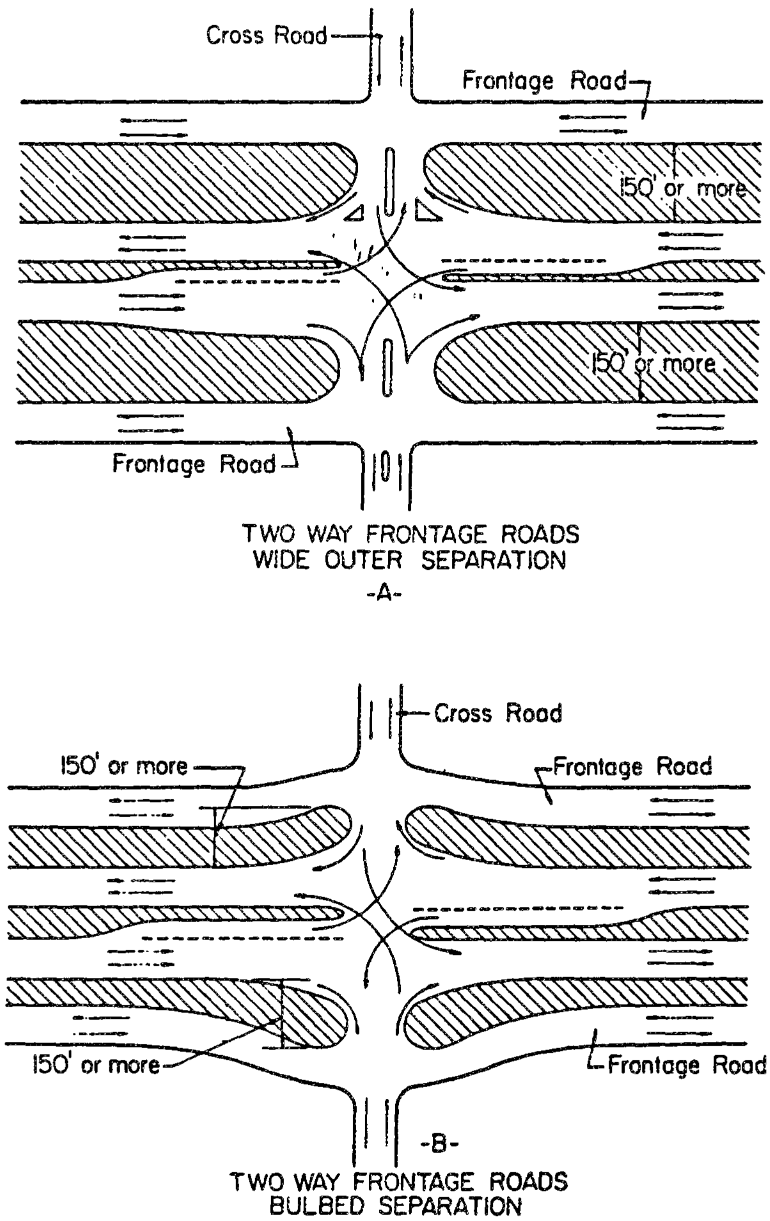

Diagram 5.9: Intersections with Frontage Roads
(from AASHTO, 1990, p. 836, Figure IX-74)

4. Sight Distance (p. 36, Table 92 in GMUSD)

The following table summarizes the sight distance requirements for a typical boulevard.

For 40-mph design speed, six lanes of traffic on the boulevard.

Crossing Vehicle	Sight Distance
Passenger Car	520 ft.
Single-Unit Truck	680 ft.
Large Semi-Trailer	840 ft.

The Effect of Sight Distance Norms on Boulevards

Diagram 5.10 shows that the effect of the application of sight distance to the location of trees on the Paseo de Gràcia would be disastrous (the area that is between the dashed lines would need to be kept free of trees; darkened trees are ones that would remain). A majority of trees around intersections would have to be removed to provide the required sight distance. These boulevards are characterized by the fact that the trees run uninterrupted to the edge of the intersection, making them the strongest element in the definition of the street.

In all our observations, we have not encountered a situation where trees seemed to create a problem for drivers at intersections. Many other temporary or semi-temporary structures that are more obtrusive, like bus stations and kiosks, are bulkier and obstruct sight lines more, yet these have to be located near intersections for functional reasons. Parked and waiting cars obstruct views, but are also a warning to the drivers on the main street to slow down. On American streets, at many intersections one finds newspaper delivery boxes which, when standing side by side, provide a much more formidable barrier to sight for a driver sitting low in a car and for pedestrian movement at an intersection than a row of densely planted trees. The boxes, however, have none of the redeeming functional and aesthetic value of the trees.

5. Parking (p. 47 in GMUSD)

The design guidelines strongly discourage parking on major streets for the following reasons:

- Personal gain for abutting owners at public expense
- Reduction of street capacity
- Consumption of space
- Increased traffic flow by people looking for a place to park
- Seventeen percent of urban accidents involve parking or parked vehicles
- Obstruction of fire-fighting apparatus
- View obstructions

In places where public parking is provided, angled parking is discouraged.

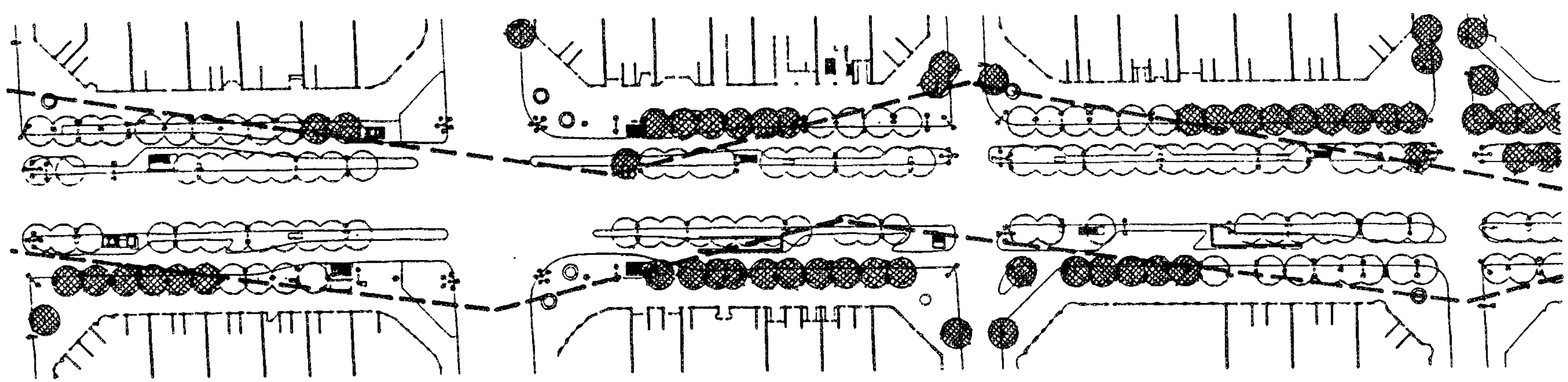

Diagram 5.10. Effect of Applying Sight Distance Norms to the Paseo de Gràcia

The Effect of Parking Guidelines on Boulevards

Parking is an essential function on the Paseo de Gràcia and the Avenue Montaigne. The parked cars help separate moving cars and pedestrians. Cars looking for a place to park or stop slow down traffic on the access lanes. We consistently observed that even on boulevards where parking is forbidden, like the Diagonal and Gran Via des Cortes Catalanes, there were cars parking illegally, with two wheels on the sidewalk.

Parking lanes in Avenue Montaigne are seven or eight feet. The Paseo de Gràcia allows various configuration of parking, in either one or two lanes. It also employs angled parking solutions to increase the use of space.

These streets provide only a limited amount of parking. On the other hand, they are very accessible to public transportation and taxis, which run on special lanes, making them faster than private cars. The result is a balance between cars and pedestrians, and private and public transportation, which is conducive to a lively and pleasant street.

Guidelines, Norms, and the Pedestrian Realm of Boulevards

If we examine a section of the Avenue Montaigne, we can see that the area devoted to pedestrians on the sidewalks and in the medians consists of 44 percent of the total area of the street. For the Paseo de Gràcia, that area is 50 percent of the total area of the street. The lane widths in Avenue Montaigne and the Paseo de Gràcia are all substandard by American norms. Especially so are the side access lanes, 24 feet in Montaigne, in which two lanes of parking and one passing lane are accommodated. The total width of the street including sidewalks and medians is 126 feet. To accommodate as much as it does, under desirable lane width norms in the U.S., a street 166 feet in width would have been needed. Most of the widening occurs at the access lanes, which need to be widened to 36 feet (an increase of 50 percent over their existing width). The land area that is devoted solely to the pedestrian drops from 44 to 34 percent. However, if we consider the way that the Avenue Montaigne really works, where the side access lanes, because of the slow movement of cars, are actually used as a part of an extended pedestrian realm stretching from the buildings to the end of medians, this means that 67 percent of the land in the boulevard is at the pedestrian scale and speed. By widening the access lanes, or limiting parking on them, cars can go faster on them, and will tend to use them more. Thus they cease to operate as an extended pedestrian realm, and become more a part of the motorist realm. As that happens, the medians become less useful to the pedestrians, because they are separated from the sidewalks by fast-moving traffic. In addition, the delineation of the pedestrian realm is further weakened by the removal of any trees near intersections and all large trees within the medians to "improve" sight lines, and by making breaks in the medians to replace turning movements at the intersections. Thus, as a result of the various guidelines and requirements, the area of the street that is devoted to the pedestrian drops from 67 percent of the total street section to 25 per

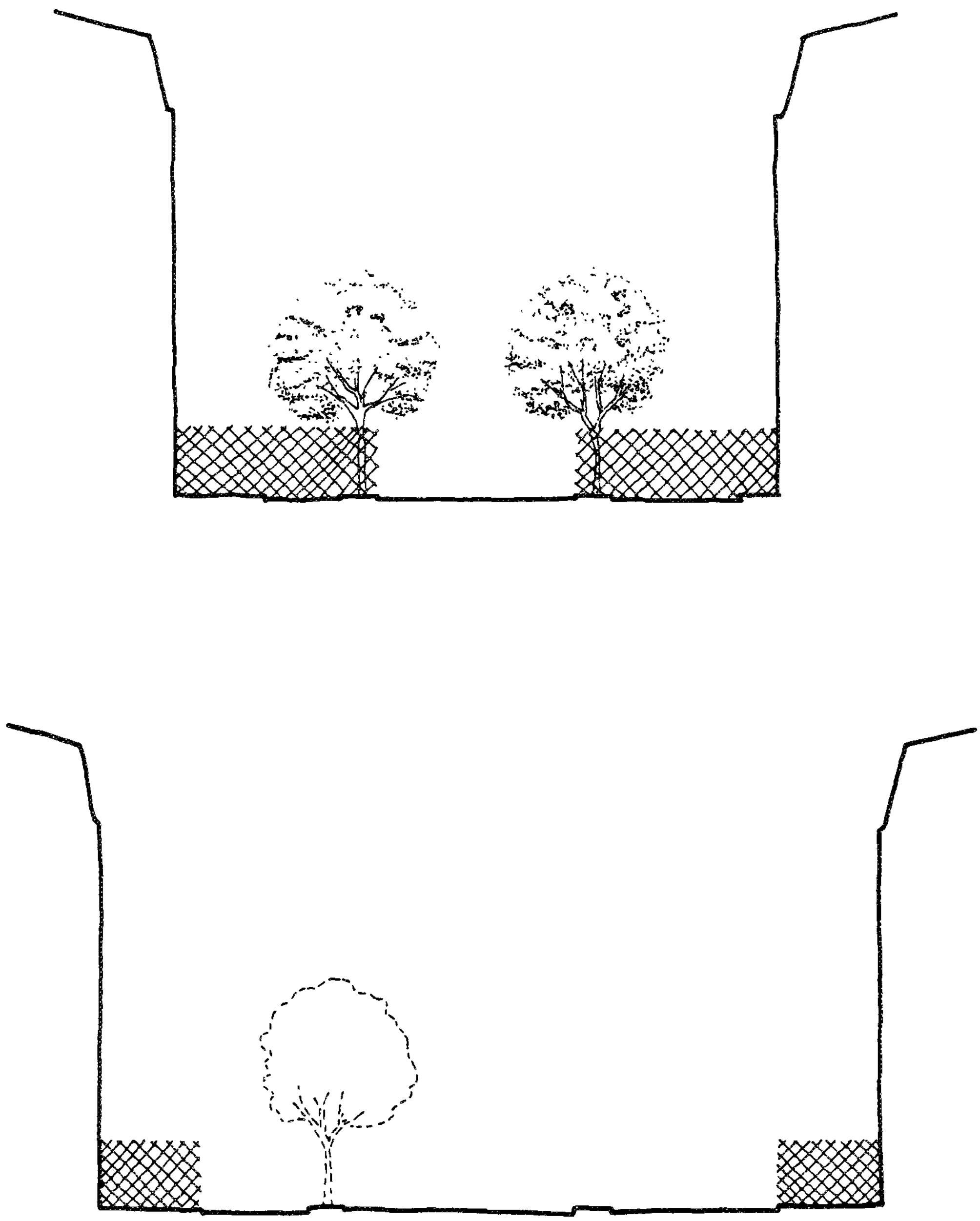

Diagram 5.11. Avenue Montaigne: the Effect of Lane Widening and Tree Removal on the Pedestrian Realm

cent, completely disturbing the balance between pedestrian and vehicular movement, and between local and through traffic.

A Brief Conclusion

This demonstration illustrates the extent of the problem facing the proponents of the continued and expanded use of boulevards. It seems that esteemed and pleasant boulevards like the Paseo de Gràcia and the Avenue Montaigne could not be built in the U.S. today, largely because of the road design guidelines and standards currently in use. It explains, we believe, the deterioration and neglect that many boulevards have suffered. However, no single norm or recommendation actually does the damage on its own. It is the combined force of the various norms together, which are applied in a consistent way under fundamental principles of road design, that make it difficult if not impossible to design and build good boulevards today.

The rationale for the various norms and practices, the essence of the discipline of traffic engineering as it relates to road design, is to design roads and streets that will carry traffic efficiently and safely. We have seen how these norms and practices can destroy existing boulevards, and make new ones nigh impossible to build. In previous chapters, we have seen that boulevards accommodate a great variety of movements and interactions, and that on the whole they do it as safely as other types of streets. Let us now move on to some hypotheses and observations which begin to explain when and where boulevards are needed, and how is it that they work.

VI. WHERE BOULEVARDS WORK AND WHY THEY DO

The focus of this study of boulevards has been on countable data, such as accidents and volumes; on physical measurements of boulevards and their immediate environments, particularly at intersections; and on visually monitoring behavior on boulevards in person and through the use of time-lapse and video photography. All three of these methods used together permit a series of observations about the nature of the type of boulevard that was studied, particularly addressed to why they work and where they do so best. Those are the subjects of this section of this report.

Before moving on, an aside about data and information is appropriate. So-called "hard" data, we have found, is seldom as hard as we might wish. Accident data may be counted differently from city to city and country to country. Different phenomena are counted, precise locations of accidents may or may not be given, and accidents at intersections may be "credited" to one street, thereby raising its accident rate, when perhaps the accident should be counted for the other street. The data is hard to find, all the more so if one is not in the city in question. Once found, it is not always clear what is counted and what are the classification criteria. Traffic volume data may also be less reliable than desired. At times, the volumes are not based on actual counts, but on samples and partial data that is then assigned and expanded via one modeling device or another. In this regard, the actual traffic volumes counted on Avenue Montaigne, for example, do not correspond to the overall Paris data found on volume maps; our field-counted numbers seem higher. The impact would be a lower accident rate. Nor is in-the-field monitoring of behavior without its limitations, even when it includes repeated viewing of film or video taken over time. One always wonders if anything critical is being overlooked. On the whole though, as researchers, we were most surprised by the dubious nature of some of the accident and volume data, both current and past. All the more reason, then, to rely on multiple considerations in assessing the safety and appropriateness of boulevards.

What has been found is that boulevards, in general, are no less safe than other major traffic carriers. To be sure, all boulevards cannot be said to be safe. But that is true of other streets as well — local residential streets, so-called collectors thoroughfares, expressways, and, freeways. Design counts! It makes a difference. This research not only permits a conclusion as to the general safety of boulevards but also observations (the reader may call these hypotheses) that have to do with their design and the relation between design and behavior on them.

A General Observation (Hypothesis) Regarding Behavior on Boulevards: People Follow the Rules

Anomalies may attract our attention, but overwhelmingly motorists and pedestrians follow the rules. Motorists do not generally go through red lights (a general observation for all the streets observed), they do not generally make right turns from central lanes of a boulevard if that is clearly prohibited (K Street, Queens Boulevard, Paseo de Gràcia, Grand Concourse), they use breaks in medians to move between the central lanes and the access lanes (K Street, Queens Boulevard, Grand Concourse), they obey left-turn prohibitions (general observation), and they park where they are supposed to park (general observation). Pedestrians pay attention to lights and cross with them and, generally, are very mindful of vehicles in their behavior.

The Esplanade, in Chico, is a good example of this. It is a boulevard along which a maximum of traffic movements are possible at intersections, yet there is a clear hierarchy of movements established by traffic lights and stop signs: the central boulevard traffic is given top priority for movement, then comes the cross-streets, and finally the slowest-moving across roads, controlled by the most stop signs. People follow the rules all along the route.

However, Motorists and Pedestrians will take Advantage of Opportunities which May Be Against the Rules, if Doing So is Perceived as Safe

This observation is most dramatically exhibited by pedestrians who will regularly cross roads against a traffic light to get to the median, using it as a haven, before crossing the fast-moving central lanes when they are supposed to. This behavior was observed at all boulevards, the ones with fast-moving access lanes (Grand Concourse, Queens Boulevard) as well as those with slow access lanes (Ocean Parkway, Avenue Montaigne). People wishing to cross pause at the first curb to see if a car is coming, they move to the median against the light, and then they wait, having completed a piece of their crossing. The behavior makes sense.

Pedestrians will regularly walk, even stroll, on *narrow* access lanes that are for motorists (Avenue Montaigne, Ocean Parkway, Boulevard Courcelles, Avenue Franklin D. Roosevelt, others).

Motorists provide innumerable examples of rule-breaking that seems safe, for example:

- On K Street, the breaks in the median for access to and from the central lanes are directional, one for entry, one for exit. But the actual design is much more spacious than is needed, and motorists, usually after a pause, will use reentry lanes for exit and vice versa, and they will make illegal U-turns into them. Sometimes this behavior was more frequent than the legal movements.
- Motorists leaving the access lanes on Shattuck Avenue, in Berkeley, regularly cross two lanes of traffic, almost at right angles, to make a left turn at the same intersection where they have left the access lane.
- Motorists will back out of slow-moving or stopped access lanes into intersections if they perceive that will get them moving again without accident (Avenue Montaigne).
- Some motorists move from central lanes to access lanes, or from access lanes to central lanes, at intersections where this is prohibited (K Street much more than on Queens Boulevard or Grand Concourse).
- U-turns are not uncommon whether or not they go against the rules.

It is notable that, generally, people pause before taking advantage of opportunities that may be against the rules. Observed behavior suggests that people see a chance to achieve an objective, understand that the action might not be according to the rules, make an assessment as to whether or not they can do what they want safely and without getting caught, and then do it if the answers are positive. Those mid-block U-turns on K Street, across two lanes of traffic into an exit lane from the access lanes, do not happen when there is continuous traffic moving in the opposite direction. All of which leads to the next observation.

People on Boulevards Adapt their Behavior to Situations, but, when Choices are Many and Complex, People Move with More Caution

For our purposes here, the second half of this observation is the most important, and it is the intersections where we focus. As has been claimed and shown earlier, it is the intersections of boulevards that seem to produce most problems: the diagrams that show all the possible conflict points are impressive. But the travel world does not necessarily work as foreseen in those diagrams, particularly on the best-designed boulevards. Again, we stress the importance of physical design.

On Ocean Parkway, Eastern Parkway, The Esplanade, and Avenue Montaigne, the movement possibilities are especially complex. They are even more so at intersections on Avenue Marceau, in Paris. On the first four of these boulevards, drivers approaching intersections on the access roads, by choice or rule, slow down considerably. Then they proceed cautiously to make one or more of those possible movements. It is as if people are very consciously aware of potential conflict and act accordingly (which usually means slowly) to avoid accidents. True, they may also engage in some outlandish driving behavior — driving the wrong way into an access lane on Avenue Montaigne, parking for a moment at a corner while a driver runs into a store, making a prohibited movement, etc. — but they do so cautiously and generally without consequence.

It should be noted that these streets are characterized by relatively narrow access lanes upon which there is small amounts of traffic in relations to the volumes carried in the central lanes. To a considerable extent, this is a consequence of their designs, but it does not take away the reality of intersections along these streets that are truly complex.

Avenue Marceau, a boulevard leading from the Etoile, is another matter. Here there are some truly complicated intersections, not so much with the access streets, but with cross-streets: at one point, four streets intersect with Avenue Marceau, and Marceau has access streets on both sides. The number of possible movements is staggering, and it seems that all of those are executed. Over two hours of observation reveals that drivers become aware of the complexity of the place they are entering and act with caution. Accident data at this intersection reveals that none of the intersections have more than ten accidents a year, which was the threshold for entry into the report that was provided.

Removing complexity from rather straightforward intersections may not always make them safer. Mangrove Avenue, in Chico, runs parallel to the Esplanade, has significantly fewer intersections, and carries about the same amount of traffic. Major intersections have lights timed to eliminate left-turn conflicts. And yet, Mangrove has a similar accident rate to the Esplanade.

Boulevards with Wide Traffic Lanes and Long Blocks are Associated with Higher Speeds and More Mid-Block Crossings by Pedestrians

Queens Boulevard and the Grand Concourse are considered among the most unsafe streets in New York (Grand Concourse particularly for pedestrians). To stand or drive on either alone is to believe it. Both, however, have particular physical design characteristics that might account for their status. Both of the New York streets have access lanes that are wider than any other of the boulevards studied; 32 feet for Queens Boulevard, and 35 feet for Grand Concourse. The access lanes on Ocean Parkway, Eastern Parkway, Paseo de Gràcia, and Boulevard Courcelles are also wide, but they permit parking against both curbs, thereby narrowing the effective travel width of the access lanes. Indeed, the travel lane widths on Grand Concourse are wider on the access lanes than they are on the center lanes. Both of these streets have traffic volumes on the access lanes that approach those on the central lanes.

Traveling in a taxi on these two streets, the speed regularly is equal to or rivals that in the central lanes. On all of the other boulevards, traffic moved at a significantly slower pace on the access roads than on the central lanes, even discounting the time stopped at the intersections.

To underline the point, no parking is permitted on the access lanes of the Diagonal and the Grand Via in Barcelona, and fast through traffic is encouraged. Both of these streets exhibit a pattern of a higher percentage of mid-block pedestrian accidents than the Paseo de Gràcia, which we associate with pedestrians crossing from the sidewalks to the median in mid block.[18] Certainly the sidewalks along the buildings are unpleasant places to be.

Both Queens Boulevard and Grand Concourse are reputed to experience significant jaywalking between intersections and greater pedestrian-safety problems than other streets. They are rated first and second in New York City in pedestrian fatalities.[19] To observe the streets is to believe the assertion. These boulevards also have grater distances between intersections than other boulevards, or greater distances between designed crossings. In those physical conditions people will, apparently, tend to jaywalk rather than to walk to distant intersections and then double back to destinations across a wide street. For comparison, Eastern Parkway and Ocean Parkway have higher volumes of traffic than Queens Boulevard and the Grand Concourse. Yet, their pedestrian accident rates are 0.02 for Ocean and 0.06 for Eastern, with 0.06 for Queens Boulevard and 0.08 for Grand Concourse.

In General, Street Trees are Less of a Visual Barrier than Other Objects Placed at Street Intersections, and Less of a Barrier than Parked or Stopped Vehicles, whose Existence is Inevitable

Simply put, it is considerably easier to see around a tree trunk , even around a wide one, than it is to see around a parked or stopped car, a transformer box on a light pole, or a battery of newspaper vending machines lined up along the curbs at intersections.

Neither accident data nor observation carried out as part of this study permit a positive correlation between trees, their spacing, or their nearness to corners and safety.

To Work Well, a Boulevard Must Establish an Extended Pedestrian Realm

Put another way, if the access roads of a boulevard are separated strongly from the center roadway and are narrow, and if the medians have closely spaced trees and perhaps benches, have a different paving and a level change, and if there are transit stops or other functions that draw people to the median, pedestrian behavior suggests that people consider the access roads a pedestrian realm. These factors , in turn, modify driver behavior to respect that realm.

On all of the best boulevards, most if not all of these conditions pertain. Trees that form an uninterrupted line and are close together create a traversible yet strong semitransparent picket-fence-like boundary that sets the access lanes apart from the center. Witness all of the boulevards studied except Queens Boulevard, Grand Concourse, and Shattuck Avenue. Grand Via and Diagonal establish extended pedestrian realms, but these are cut in two by fast-moving access roads. Narrow access lanes with parking are associated with slower auto movement (Montaigne, Franklin D. Roosevelt, Esplanade, Ocean and Eastern Parkways), more at a pace with pedestrian movement and with the ideal of local traffic rather than with through traffic.

Not all of the better boulevards have benches, but many do. Generally, they are found along the planted medians, not on sidewalks; witness Avenue Montaigne, Ocean and Eastern Parkways, and on both the medians and the sidewalks of Paseo de Gràcia.

Access lanes of the Parisian boulevards have a further notable feature: their paving is raised above the level of the cross-streets or central lanes by at least one inch, often more. This simple detail alerts drivers that they are entering a different area when they rise over that simple pavement break. For drivers it is a bit like being on a driveway.

Observation, borne out by the films, make it clear that when these design qualities exist pedestrians consider the whole space from buildings to the central lanes as their realm, or at least an area in which they are equal with vehicles. On those boulevards where this pedestrian-paced quality exists, it is common to see autos and pedestrians together on the access roads: Avenue Montaigne, Avenue Franklin D. Roosevelt, Boulevard Beaumarchais, Boulevard Courcelles, Ocean Parkway, Eastern Parkway, The Esplanade. And driver behavior does change; for example, vehicles moving slowly and quietly behind pedestrians who are walking on the street, or a mother feeling safe enough to stroll down the street with

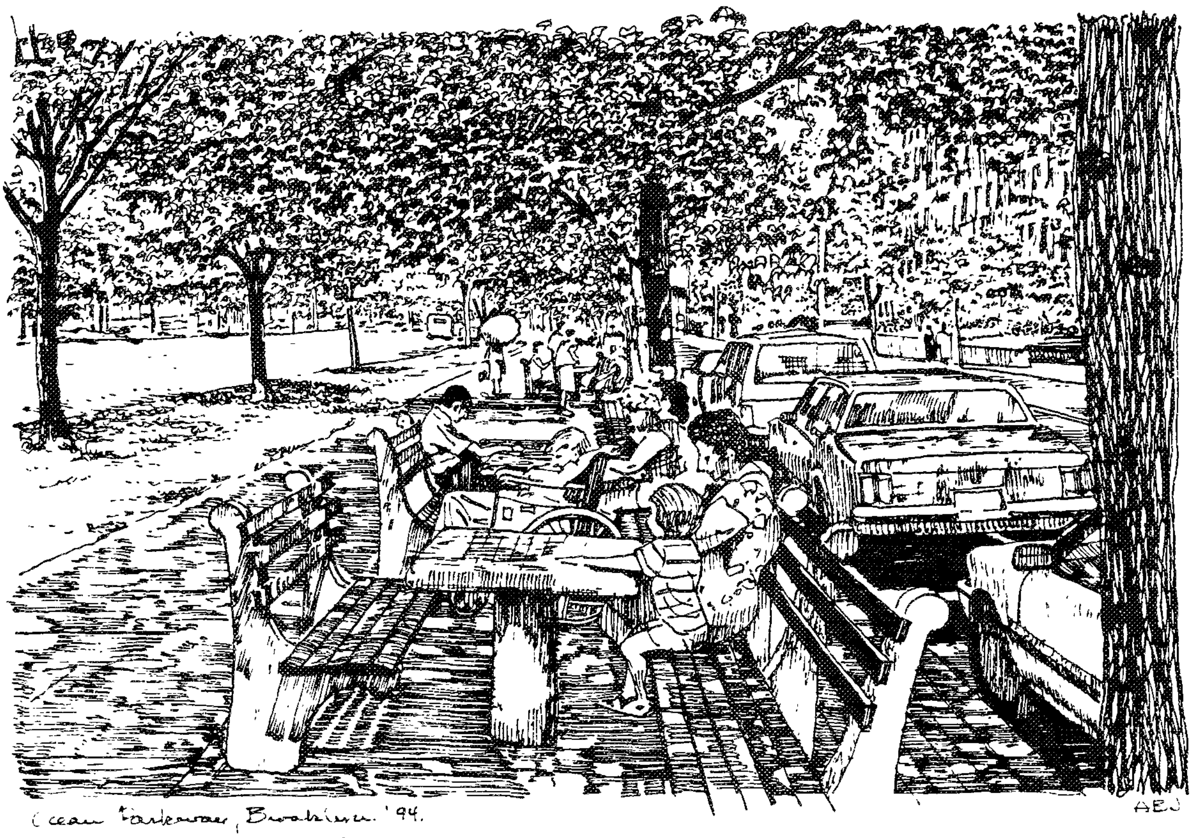

Figure 6.1. Pedestrian Realm on Ocean Parkway

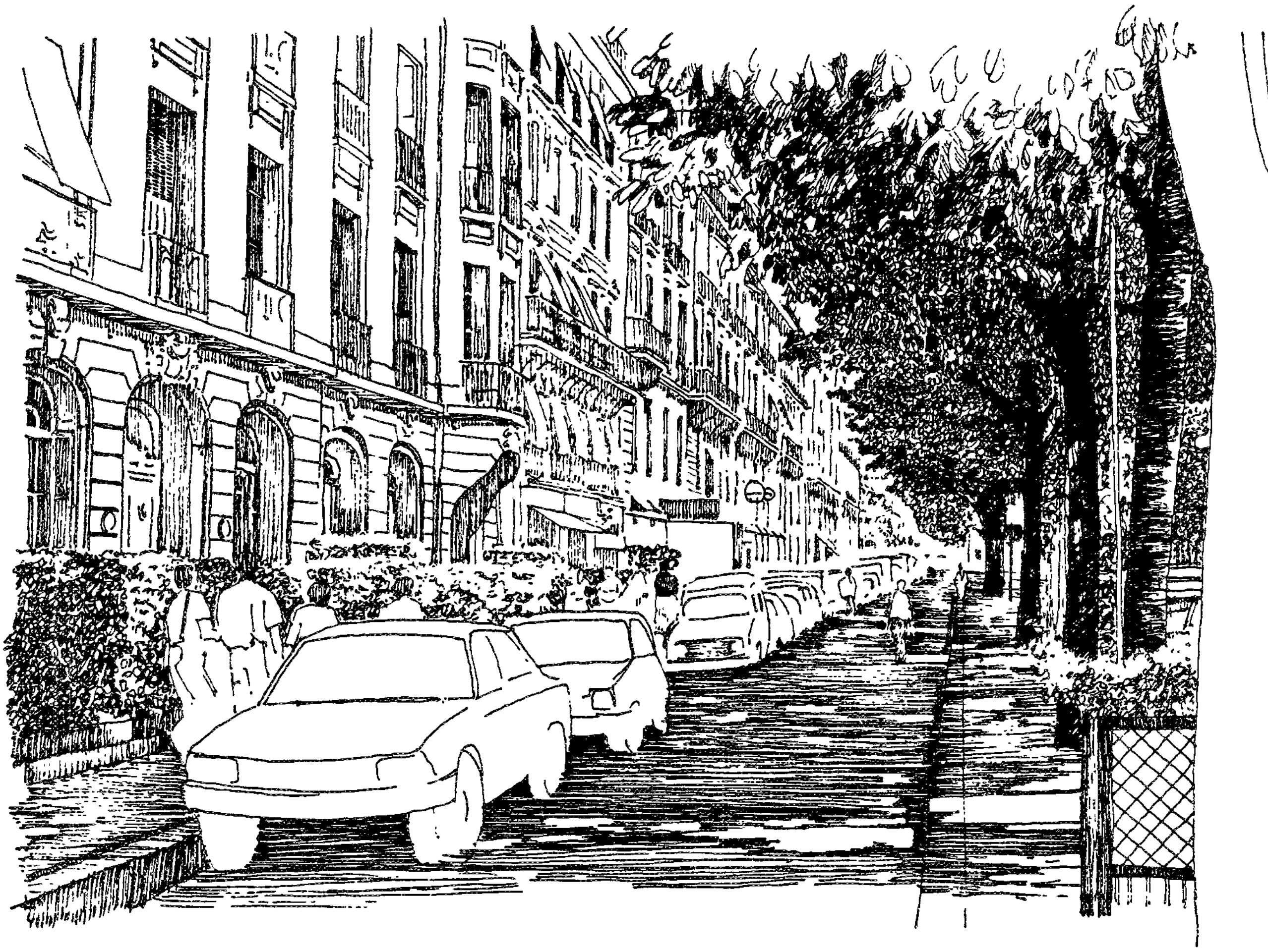

Figure 6.2. Pedestrian Realm on Avenue Montaigne

an infant in a stroller. On K Street, on the other hand, where vehicular movement on the access lanes is paid more attention, the large breaks in the median, for access and egress, seem to compromise the integrity of the pedestrian realm.

Cyclists also seem to feel comfortable in this pedestrian realm. On one of the access roads of the Esplenade, about 60 cyclists per hour were observed regularly. They stayed away from the central lanes. Along Ocean Parkway, half of one of the medians is reserved for cyclists.

A pedestrian realm is not established (or at least does not presently exist) on Queens Boulevard or the Grand Concourse. Nor does it exist on some other boulevards heretofore unmentioned in Paris, like Avenue George V. For sure, at these boulevards, the access lanes are wide, the trees do not help enough to establish separation from the center, and there are few pedestrian amenities.

Those boulevards where this pedestrian quality is strongest seem also to be the safest (perhaps most clearly seen in the relative safety of Ocean Parkway). However, it seems impossible to say that one or two of the noted physical qualities are most crucial to the establishment of a pedestrian realm. They are all important, in that they reinforce each other.

Boulevards Can Work Well for Major Commercial Streets, Residential Parkways, or a Mix of Residential and Commercial Uses. Their Form Allows the Street to Change as the Context of the City Changes Around It

There seems to be no reason, based on reviews of the case studies, why a boulevard cannot work as well for a residential, commercial, or mixed-use environment.

In situations where both through-going traffic and local traffic are heavy, each with different needs, and each conflicting with the other, boulevards seem to be most appropriate as solutions to the needs of both. When a major urban street passes through an area of sufficient residential density, or of intense commercial activity (either of which may include public transit service and stops), or a mix of the two, areas through which pedestrian activity may be significant and in which vehicular access to adjacent properties is relatively constant, safety problems potentially exist in the conflict of those activities with through-going traffic. Boulevards, because they separate the through traffic from the local traffic, and because they can accommodate public transit as well as private vehicles and pedestrians in appropriate sub-realms of the same public right of way, can resolve the inherent conflicts on such corridors. But, to be effective and safe, they must be designed appropriately. The data and observations of this research suggest very strongly that "appropriately" means that a pedestrian realm must be established along the side access roads, and that, within this context, relatively narrower vehicular courtways are essential.

VII. CONCLUSIONS, POSSIBILITIES, AND FURTHER RESEARCH

This report and attendant research, born of experience, started and ends with a positive view of boulevards as efficient, form-giving, urban, status-bestowing, multi-purpose streets for motorists, pedestrians, and cyclists, and for residences, businesses, public service uses, and recreation. At the start, extended observation of some of the most outstanding boulevards suggested that, when well-designed, they were as safe as any other major urban carrier not problematic or unsafe as generally contended by professionals in the field of roadway design. Early field observation suggested that pedestrians and motorists understand the special movement qualities of boulevards. They know when they come to intersections that there are many possibilities, that others are trying to get in when they are trying to get out, that still others are likely to turn when they want to go straight, that a pedestrian is likely to want to cross when they want to turn, that someone will even back up in order to correct a mistake or make an illegal turn, and knowing these things, they act accordingly: they proceed with caution. In short, they adapt. Indeed, traffic engineers have also adapted traffic movements on some of the best boulevards so that they work exactly as originally intended, as gracious multi-purpose streets for local and through motor traffic and for pedestrians.

To be sure, research carried out and data collected as a part of this study cannot be said to prove, unequivocally, our hypotheses, most particularly as regards to safety; but they come close enough.[20] It is the combination of quantitative data and physical observation that makes the argument for well-designed boulevards compelling.

Of course, all boulevards are not as safe as other streets with less complex intersections. Not all freeways are safe, nor are all of the other road types, either. Boulevard safety, as with other streets, depends on many factors, not the least of which are their designs. This research has permitted an integration of traffic volume and accident data with pedestrian volumes, with measured physical characteristics of various boulevards, with land uses, and with pedestrian and motorist behaviors as derived from observation and films. It has permitted discrimination between the physical characteristics of boulevards and determination of what seems to work best. It permits, nay requires, that we say not all boulevards are alike and that some work better than other.

What in fact does work better than others in regards to boulevards may be counterintuitive to some. Essentially, in boulevard design, bigger may not be better, especially in relation to the side access roads. Wide lanes, fast traffic, absence of parking, widely spaced intersections, easy turns, and widely spaced trees — all those standards and norms most associated with contemporary roadway design — may be counter-productive as regards boulevards. In the U.S. we think of the Grand Concourse and Queens Boulevard as sad examples, and of Ocean Parkway, Eastern Parkway, and the Esplanade as compelling models. In Europe, Avenue Montaigne, with its extremely limited sections, remains an excellent example of what to do.

Good boulevard design lies in understanding and accepting the notion of multi-functional roadways, rather than single-purpose streets, and then in designing them accordingly. The side access roads are for local, slow-moving traffic; for pedestrians; for access to public transit; for gaining access to abutting properties; for parking; and maybe for various levels of recreation and cycling. Complex, even crowded designs seem to work best. Tightness of dimensions characterize the best of the boulevard access roads. But it would be difficult to characterize the center lanes of Ocean Parkway, at 70 feet , or the Esplanade central lanes, at 63 feet, as narrow. They are designed for through traffic that moves at a good pace, and they work.

Intersections, it seems, can be complex, more so than we would have imagined at the start of the study. Avenue Montaigne in Paris, and the Esplanade, Eastern Parkway, and Ocean Parkway in the U.S., offer the best examples of the boulevards studied. In the U.S., as in Europe, people adapt to complex environments and, it seems, this is more easily done when physical design constraints require moderately paced movement rather than encouraging speed. Again, the key seems to be accepting multi-function roadways and in designing for the mix, but not in imposing the standards that may be associated with speed on that part of the roadway that is for local, slow, complex movement.

Basically, then, the data together with observations of behavior through a variety of means, and an understanding of the intimate physical environment of boulevards, is extremely encouraging and favorable to boulevards. They are at least not less safe than other streets.

Future Opportunities

There exist considerable numbers of opportunities to design and redesign boulevards, more than one might immediately suspect. It grows less and less likely that central cities will again engage in programs that demolish large lineal swaths of development for the purpose of new road construction, neither for freeways nor expressways nor, for that matter, boulevards. The economic and social costs are too high. The same will be true for existing suburban development. Only in newly developing areas, largely peripheral to existing metropolitan development, may we expect new roads at a significant scale, and these are not likely to be new freeways. At the same time, we may expect increasing efforts at better arrangement and management of the existing framework of roadways, consistent with a higher priority of attention and funding given to public transit, to higher densities, and to revitalization policies and programs in inner-city areas and older suburbs. Just as we look, increasingly, to mixed urban land use areas as both convenient and healthy, so, it seems, we will want to, even must, explore the possibilities of multi-function streets, particularly including boulevards.

Within central cities and older suburbs, there are two notable situations where boulevards can provide solutions to movement and land use problems: the redesign of existing boulevards that for one reason or another do not function well presently, and the redesign of major roadways, usually arterials that either need to be or can be re configured. A significant finding of this study is that a right-of-way of

125 feet, or slightly less, is all that is required. Certainly , as well, there will be many opportunities for new boulevards in newly developing areas.

For now, a significant opportunity and challenge lies in the redesign of existing streets, including boulevards that were mistakenly configured in the first place. That is a reasonable next step for the work started here. To that end, the next phase of this research will focus on the redesign of one or two of the roadways already identified and on an existing urban expressway. We have seen that both the Grand Concourse in the Bronx and Queens Boulevard in Queens are now problem streets, with high accident rates. One or both of them should be redesigned to illustrate how existing problems might be solved using findings in this study. At the same time, Geary Boulevard (really an expressway despite the name) in San Francisco offers an opportunity for a new boulevard, particularly in conjunction with public transit improvements. In both the New York and San Francisco cases, the process will be to redesign the streets as boulevards and then to test the designs with local transportation experts to ascertain values of those in charge with making traffic improvements, and to reconsider existing standards and norms that make boulevards difficult if not impossible to achieve.

Continued Research

Beyond test designs for specific streets, further research will be helpful as regards boulevard streets. Further research can substantiate the hypotheses put forward in the previous Chapter VI. This will involve the gathering of more empirical evidence from more accident and traffic volume data combined with documented behavioral observation, and detailed physical context information as has been started here. Implementation research and design studies are also important. These will deal with costs, land use considerations (including density and mixes of uses) that work best with different configurations, and with alternative designs to show what is possible in alternative rights-of-way in different land use situations. For sure, though, this study strongly suggests that boulevards can be appropriate in many situations.

A Need to Rethink Functional Categorization of Streets and the Concept of Level of Service

In considerable measure, the decline of boulevards as major urban roadways in the U.S. has accompanied the approach to traffic movement centered on a functional classification of streets. As noted earlier, boulevards do not fit neatly into prevailing functional categories: arterials, collectors, local streets, and so on. What standards should apply to them? A recent edition of the AASHTO manual[21] does not offer much insight into the problem. They refer to boulevards as historic and substandard arterials, and as such give U.S. minimum standards but do not differentiate between the center driveway and the side access lanes. Neither does the Institute of Transportation Engineers (ITE) publication *Guidelines for Major Urban Street Design*.[22] In relation to the functional categorization of streets, boulevards are perceived as a historical aberration, predating sound traffic engineering principles, which could be tolerated, but should be modified to comply with design guidelines for arterials streets as soon as possible.

Boulevards, however, are a solution to the problem of the growing disparity in speeds between thoroughgoing and local and pedestrian traffic. This problem began to make its mark on cities with the prevalent use of horse-drawn carriages and streetcars in the middle of the nineteenth century, and became more acute with the advent of the automobile in the twentieth century. This is the same problem that the functional categorization of streets attempts to resolve. But while the functional categorization of streets attacks the problem by changing the very nature of streets, and breaking them down into their functional components as either traffic corridors or destinations, the boulevard can resolve the problem by differentiating between different modes of travel within the same space, while retaining the wholeness of the street as both a traffic corridor and a destination at the same time.

Another feature of boulevards and their designs is that they originate from a time when pedestrian movement was still the predominant way of moving about in the city. They are thus as oriented towards pedestrians as much as they are towards vehicles. Modern design standards have been predominantly influenced by the needs of the automobile, even where by function the pedestrian and property access were central, as in residential street standards.[23] Good boulevards have a balance between pedestrian and vehicular realms that the application of American guidelines tend to disturb.

Another fundamental concept of traffic engineering has contributed to the demise of boulevards, directly by compromising this balance between the pedestrian and vehicular modes of travel. This is the concept of "Level of Service." This concept is defined as the freedom of a driver to choose the speed at which he will travel.[24] As one ascends the level of streets in the functional categorization from local to arterial to freeway, a higher level of service is expected. Boulevards, which have usually been categorized as arterials, were thus expected to provide a high level of service for cars. The result has been a push to increase the number of through lanes at the expense of the access lanes, in order to improve the level of the service of a roadway with the growth in the number of vehicles. This has led to instances where the side access lanes are treated as through lanes (Diagonal and Grand Via in Barcelona, and Queens Boulevard and the Grand Concourse in New York City). The end result of this action is an erosion of the pedestrian realm completely, a realm which as previously demonstrated is essential for the safety of pedestrians on these streets.

* * *

For what seems like a long time, but is only about 150 years, urbanites have been delighted with boulevards, with the prospect of strolling along tree-lined streets in dappled light, meeting friends, shopping, stopping at a bench or a cafe, isolated from fast-moving traffic in the center by parked cars along a side road and by rows of closely spaced trees. The best of them that remain offer all of these experiences still. Boulevards deserve a second look!

ENDNOTES

[1]Francois Loyer, *Paris Nineteenth Century: Architecture and Urbanism*, trans. Charles L. Clark, New York: Abbeville Press, 1988, 121.

[2]See Mark H. Rose, *Interstate: Express Highway Politics 1941-1956*, Lawrence, Kansas: The Regents Press of Kansas, 1979, 85-94. Also John B. Rae, *The Road and the Car in American Life*. Cambridge, Mass.: MIT Press, 1971, 170-194, for a discussion of various modes of freeway development as toll roads, and through state taxes (in California), which preceded the Federal Highway Act of 1956 in their emphasis on freeway construction.

[3]See Allan Jacobs, *Great Streets*, Cambridge, Mass.: MIT Press, 1993, for justification of the stature of these streets, and for a more detailed description of their attributes.

[4]ITE, *Guidelines for Urban Major Street Design, A Recommended Practice*, Washington, D.C.: ITE, 1984. See also AASHTO (1965) and AASHTO (1990). Wolf Homburger, *A Handbook of Transportation Engineering*.

[5]See Edmund J. Cantilli, "Transportation Safety," in *Transportation and Traffic Engineering Handbook*, Homburger, Keefer, and McGrath, eds., 2nd edition, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1982.

[6]Many would argue, and quite rightly, that the probability of accidents rises with the number of cars on the cross-streets, the average speed of travel, the signaling of intersections, and a host of other factors. Unfortunately, the data readily available in transportation and police departments in most cities is not sufficiently detailed in most cases to allow one to examine these hypotheses. By choosing parallel streets as control streets, it was hoped that at least the cross-traffic would be of the same magnitude. Speed measurements are not readily available; however, speeds on the center lanes of boulevards will tend to be higher than on normally configured streets, while on access lanes it would tend to be slower. As for conflict points, this study tries to show that boulevards are not less safe, even though they have typically more conflict points per intersection. Since boulevards on the whole have many more conflict points per intersection, a similar accident rate based on traffic volume would mean that, per conflict points, they are safer, but it also means that reducing the number of conflict points usually may not make a street any safer.

[7]New York City Department of Transportation, Grand Concourse Traffic Safety Study (E. 161 St. - Mosholu Parkway), Draft 12/92.

[8]We were not able to obtain pedestrian counts for Webster Avenue.

[9]One should note, however, that the blocks on most of Linden Boulevard are much shorter than on either Eastern Parkway or Ocean Parkway. The accident rate on the part of Linden Boulevard that has long blocks is 1.18, and the pedestrian accident rate is 0.09. Thus it can be seen that by eliminating the effect of the shorter blocks on the number of accidents per intersection, and isolating the effect of the boulevard configuration, Eastern and Ocean Parkway are both safer than Linden Boulevard.

[10]It is also possible that the estimate of traffic volume which is based on the NYC Dept. of Transportation draft safety report is somewhat low, contributing to a high accident rate.

[11]Mairie de Paris, Direction de la Voirie, Centre de Recherches et d'études techniques, Observatoirre des déplacements, *Statistiques des Accidents Corporels Survenus sur la Voie Publique. 1990-1991-1992*, December 1993. This report includes only accidents in which injury to persons was sustained.

[12]One must be aware, however, that we may be confounded here by different definitions of what is a reportable accident.

[13]The main unresolved problem about the data for Barcelona, which concerns the ascribing of accidents to intersections. is that it is unclear whether an accident occurring on the corner of Paseo de Gracia and Career d'Arago, for example, is ascribed to one or the other or both. It is hoped that it was ascribed to both, otherwise the statistics shown below are misleading.

[14]And incidentally it is much safer even if we count the simple mean accidents per intersection, without taking into consideration the traffic volume. It is 27.3 for Ocean Pkwy., against 36.99 for Queens Blvd.

[15]See New York City Dept. of Transportation, Grand Concourse Traffic Safety Study, draft 12/92 and New York City Dept. of Transportation, Queens Boulevard Traffic Safety Study (Draft).

[16]Our major source for guidelines was the ITE publication: ITE Technical Council Committee 5-5, *Guidelines for Urban Major Street Design: A Recommended Practice*, Washington, D.C.: Institute of Transportation Engineering, 1984 (GMUSD). In some matters which were not explicitly considered by GMUSD, we have looked at two policy publications of the American Association of State Highway and Transportation Officials (AASHTO); the first of these is *A Policy on Arterial Highways in Urban Areas,* Washington, D.C.: AASHTO, 1957 (hitherto AASHTO, 1957), and the second is *A Policy on Geometric Design of Highways and Streets*, Washington, D.C.: AASHTO, 1990 (AASHTO, 1990). We have also used Wolfgang S. Homburger and James H. Kell, *Fundamentals of Traffic Engineering*, Berkeley, Calif.: Institute of Transportation Studies, 1984, and *Transportation and Traffic Engineering Handbook*, 2nd Edition, Wolfgang H. Homburger, L. E. Keefer, and W. R. McGrath, eds., Englewood Cliffs, NJ: Prentice-Hall, 1982, as valuable sources.

[17]Table 2.1 in GUMSD.

[18]Of a total of 79 pedestrian accidents on the Grand Via and 47 pedestrian accidents on the Diagonal, 27 and 15 occurred between intersections, which accounts for 34 percent and 32 percent respectively. This compares with only 9 pedestrian accidents between intersections out of a total of 44 on the Paseo de Gracia (20 percent). We hypothesize that the higher rate reflects pedestrians being hit mid-block by through traffic as they cross the access streets. We observed few mid-block crossings of the central lanes.

[19]NYC Dept. of Transportation, Queens Boulevard Traffic Safety Report, undated draft.

[20]Indeed, one of the major findings of this study has been the difficulty of obtaining usable up-to-date information on accidents that could be used to test safety-related hypotheses. At the outset of our studies we were told over and over again that yes, accident data was available, just ask so-and-so in a particular city, " I know it exists," or, "I've seen it." Well, often it does not exist, or exists only for a particular street of interest on a city, or does not permit an understanding of the nature of accidents, or does not exist comprehensively, permitting comparisons between streets, or exists by census tract or some other area designation rather than by street, or exists only in the form of individual accident reports in police files. While this caused us some problems, it raised an even larger question: if we were having problems gathering data in 1993-94, what were the bases of supposedly safety-generated standards and norms that have dictated against boulevards for so long? If it is difficult to get good data now, what was the accident data like much earlier? What objective research was the basis for various street design standards and guidelines that have been the foundations for the physical layouts of streets of many types? To be sure, Institute of Transportation Engineering Guidelines contains a disclaimer: "Few of the dimensions used in major street design have been precisely determined by research. Instead, they represent a consensus based on operating experience" (ITE, *Guidelines for Urban Major Street Design: A Recommended Practice*, Washington, D.C.: ITE, 1984). We are left to wonder just what that experience is and to what extent generations of road designs are influenced more by notions such as functional classification of streets and by generally accepted "Guidelines" than by actual testing.

[21]AASHTO, *Policy on Arterial Highways and Streets*, Washington, D.C.: AASHTO, 1990.

[22]ITE Technical Committee 5-5, *Guidelines for Urban Major Street Design: A Recommended Practice*, Washington, D.C.: ITE, 1984.

[23]Michael Southworth and Eran Ben-Yosef, *Regulated Streets: The Evolution of Standards for Suburban Residential Streets*. Working Paper No. 625, Berkeley: Institute of Urban and Regional Development, University of California.

[24]See Wolfgang S. Homburger, *Fundamentals of Traffic Engineering*, Berkeley, Calif: Institute of Transportation Studies, 1984, 8.1-8.2.

Appendix 1
UCTC Boulevards Study

Behavior and Physical Features Observation Task Schedule
The Esplanade, Chico
12 February 1993

Task	Location	Researcher	Start Time	Duration	Equipment
Street Orientation • Determine which intersections to observe. Choose one with traffic signal, one without. • First Street heaviest cross traffic. • First and Eight Streets highest accident rates		Jacobs Macdonald			
Car Movements and Volumes • Two observers work as a team, one observing cars going one direction, the other observing cars going the opposite direction. Do this for the boulevard and for the cross-street. • Prior to starting count, draw all probable movements of cars in a particular lane on plan diagram. • Count the number of cars making each movement and note on diagram.				40 minutes total 2 counts: 20 minutes each, one on boulevard, one on cross-street	• 2 watches • 2 clipboards • 2 counters • Plan diagrams
Pedestrian Volume Count • Two observers work as a teaml • One stands on sidewalk and counts pedestrians passing on that side of the street. • The other makes two simultaneous counts, one of pedes-trians crossing the boulevard and one of pedestrians crossing the side street. • Do this first on one side of the street, then on the other side.				20 minutes total 2 counts: 10 minutes each side of street	• 2 watches • 2 clipboards • 2 counters • Plan diagrams
Pedestrian Movement Observation • Two observers work as a team. • Each stands at a different intersection. • Select a person at random and map what she/he does at the intersection. • Map as many people as possible on one diagram, then start on a new sheet, etc. • Make notes about what each person does: stopping, talking, sitting, pace of movement, etc.				1 count 30 minutes	• 2 watches • 2 clipboards • Plan diagrams

Task	Location	Researcher	Start Time	Duration	Equipment

Lapse Photography of Right-Hand Turn From Center
• Purpose is to show the conflict between a car turning right from the center where controlled by a light and a car on the access road where controlled by a stop sign.
• Possibly film from two positions:
  • Back from access road intersection (i.e. from access road perspective)
  • From across street
					• Film Camera
					• Battery pack
					• Extra batteries
					• Tripod
					• Film

Stop-Lapse Photography of Through Movement on Access Road • Position camera to get best view of how cars in access road maneuver around cross traffic that blocks intersection while waiting for a light/at stop sign.					• Video camera • Video cassette tape • Battery pack • Tripod
Stop Lapse Photography of Illegal Movements • Observe street first to see what, if any, illegal movements are typically made. • Position camera to view this behavior.					
Video of Traffic Speed • Set up camera to get best mid-block view that shows traffic in both center roadway and access road					• Video camera • Video cassette tape • Battery pack • Tripod
Video of Tree Locations and Spacing, and Visual Barriers • Shoot video from drivers side while driving along access road. • Shoot video from passengers side while driving along center roadway.					
Video of Street Widthsl • Straight shot down access road showing parked cars and moving cars. • Straight shot and pan across entire roadway to show overall width.					

Note: Don't show observers in any of the filming, it's too distracting.

Appendix 2

Street Descriptions -- Streets Observed but Not Included in Detailed Illustrations.

Shattuck Avenue, Berkeley

Center Roadway
- 2 lanes each direction plus left turns in center median
- signals each intersection

Access Roadway
- 1 lane plus diagonal parking
- through traffic not allowed, traffic can only enter after an intersection and is forced back into center traffic before the next intersection

Cross-Street observed (Bancroft)
- one-way westbound
- 2 lanes plus parking both sides

Boulevard direction
- runs north/south
- direction/side: #1 north, #2 south, #3 west, #4 east

Eastern Parkway, Brooklyn, New York City

Center Roadway
- 3 lanes each direction plus left turn lanes inserted at intersections
- no center median
- controlled by signal every intersection
- left turns/u-turns allowed every intersection
- right hand turns allowed every intersection

Access Roadway
- 1 lane plus parallel parking both sides
- controlled by stop sign each intersection
- through traffic allowed
- left turns allowed

Cross-Street observed (Bedford)
- two-way
- 1 lane each direction plus parking each side

Boulevard direction
- runs east/west
- direction/side: #1 east, #2 west, #3 north, #4 south

Queens Boulevard, Queens, New York City

Center Roadway
- 3 lanes each direction plus left-turn lane
- center median
- controlled by signal every intersection
- left turns/u-turns allowed every intersection
- right hand turns allowed every intersection

Access Roadway
- 2 lanes plus parking both sides
- controlled by stop sign each intersection
- through traffic allowed
- left turns not allowed

Cross-Street observed (71st Ave/108th Street)
- two-way
- 1 lane each direction plus parking each side

Boulevard direction
- runs east/west
- direction/side: #1 east, #2 west, #3 north, #4 south

Gran Via Des Cortes Catalanes, Barcelona

Center Roadway
- one-way, 5 lanes westbound
- 1 curb lane transit only

Access Roadway
- 2 lanes, no parking

Cross-Street observed (Paseo de Gracia)
- two-way

Boulevard direction
- runs east/west
- direction/side: #1 east, #2 west, #3 north, #4 south

Avenue Franklin Roosevelt, Paris

Center Roadway
- 3 lanes southbound, curb lane transit only
- 1 transit only lane northbound
- no center median

Access Roadway
- Occurs on west side only
- 1 through lane plus parking both sides

Cross-Street observed (Jean Goujan))
- one-way

Boulevard direction
- runs north/south
- direction/side: #1 north, #2 south, #3 west, #4 east

Avenue Hoche, Paris

Center Roadway
- 2 lanes each direction
- parking each side
- no center median

Access Roadways
- 1 through lane plus parking one side

Cross-Street observed (Rue Fauborg St. Honore)

Boulevard direction
- runs north/south
- direction/side: #1 north, #2 south, #3 west, 4 east

Avenue Kleber, Paris

Center Roadway
- 3 lanes southbound, curb lane transit only
- 1 transit only lane northbound
- no center median

Access Roadway
- 1 through lane plus parking one side

Area observed (between Etoile and Rue Paul Valery)

Boulevard direction
- runs north/south
- direction/side: #1 north, #2 south, #3 west, #4 east

Avenue Marceau, Paris

Center Roadway
- 2 lanes each direction plus parking both sides
- no center median

Access Roadway
- 1 through lane plus parking both sides

Intersection observed (Rue Newton/Rue Galilee)
- cross-streets converge
- uncontrolled movements
- no stop signs or signals

Boulevard direction
- runs north/south
- direction/side: #1 north, #2 south, #3 west, #4 east

Appendix 3
Physical Features Summary —

U.S. Streets Observed but not Included in Detailed Illustrations.

PHYSICAL FEATURES (units in feet)	Berkeley: Shattuck at Bancroft	New York: Eastern Parkway at Bedford	New York: Queens Blvd. at 108th
Right-of-way	156	210	200
Typical building-to-building	156	260	200
Curb-to-curb	130	170	170
Center roadway total	65	60	86
roadway direction #1	25	30	42
roadway direction #2	25	30	30
center median	15	0	14
Access roadways	29	25	32
Side-median side #3	3.5	30	10
Side-median side #4	3.5	30	10
Typical sidewalk width	13	15	15
Typical block length curb-to-curb	290	788	-
Typical side-median tree spacing	(none)	35	(sparse)
Cross-street width	40	36	-
Mean center speed (m.p.h.)	-		-
Mean access speed (m.p.h.)	-		-

European Streets Observed but not Included in Detailed Illustrations.

PHYSICAL FEATURES (units in feet)	Paris: Franklin Roosevelt at Jean Gougan	Paris: Hoche at Fauborg St. Honore	Paris: Kleber at Etoile	Paris: Marceau at Galilee	Barcelona: Gran Via
right-of-way	116	109	112	132	162
Typical building-to-building	-	109	112	132	162
Curb-to-curb	71	87	88	109	141
Center roadway total	42	41	40	46	50
roadway direction #1	10.5	20.5	20	23	-
roadway direction #2	31.5	20.5	20	23	50
center median	-	-	-	-	-
Access roadways	22	15	15	23	16
Side-median side #3	7	8	9	8	28
Side-median side #4	11	8	9	9	31
Typical sidewalk width	13	11	12	11 or 12	10 or 11
Typical block length curb-to-curb	-	-	-	-	-
Typical side-median tree spacing	15	-	-	35	-
Cross-street width	-	-	-	-	-
Mean center speed (m.p.h.)	-	-	-	45	-
Mean access speed (m.p.h.)	-	-	-	-	-

Appendix 4
Detailed Volume and Accident Data for U.S. Streets

Grand Concourse, Bronx, N.Y.C.

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
E192nd St.	46.360	21.00	0.45	4.00	0.09
E 184	49.671	15.50	0.31	3.75	0.08
E 183	52.983	17.50	0.33	6.50	0.12
E Burnside	56.294	22.00	0.39	2.50	0.04
E Tremont	59.606	30.00	0.50	6.00	0.10
Mount Eden	62.917	24.00	0.38	4.50	0.07
E 170	66.229	29.50	0.45	3.75	0.06
E 167	69.540	8.00	0.12	5.00	0.07
Avg.	**57.950**	**20.94**	**0.37**	**4.50**	**0.08**

Jerome Avenue, Bronx, N.Y.C.

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
W192nd St.	17.930	7.50	0.42	2.00	0.11
E 184/W 184	19.211	11.50	0.60	1.50	0.08
E 183/ W 183	20.492	11.50	0.56	3.00	0.15
Burnside	21.773	20.50	0.94	0.50	0.02
Tremont	23.053	23.00	1.00	1.00	0.04
Mount Eden	24.334	14.00	0.58	1.00	0.04
E 170	25.665	15.50	0.60	1.00	0.04
Shakespeare	26.896	10.50	0.39	6.50	0.24
Avg.	**22.419**	**14.2 5**	**0.64**	**2.06**	**0.09**

Webster Avenue, Bronx, N.Y.C.

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
E 193	13.976	10.50	0.75	1.00	0.07
E 184	14.974	8.00	0.53	0.50	0.03
E 183	15.973	11.50	0.72	2.50	0.16
E 179	16.971	7.00	0.41	1.00	0.06
E Tremont	17.969	32.50	1.81	2.50	0.14
E 173	18.967	15.00	0.79	1.00	0.05
Claremont	19.966	30.00	1.50	0.50	0.03
E 167	20.964	14.00	0.67	0.50	0.02
Avg.	**17.470**	**16.06**	**0.90**	**1.19**	**0.07**

Washington, D.C., K Street — Boulevard

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
12th	38.100	9.67	0.25		
13th	42.800	14.33	0.33		
14th	54.400	29.67	0.55		
15th	41.500	12.67	0.31		
16th	55.500	18.67	0.34		
17th	55.800	16.00	0.29		
18th	57.800	22.67	0.39		
19th	57.200	17.67	0.31		
20th	57.600	21.33	0.37		
21st	57.800	19.33	0 .33		
Avg.	**51.850**	**18.20**	**0.35**		

Washington, D.C., Constitution Avenue — Control

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
10th	39.200	8.00	0.20		
12th	61.700	19.00	0.31		
14th	79.200	29.00	0.37		
15th	59.900	16.33	0.27		
18th	50.500	4.33	0.09		
Avg.	**58.100**	**15.33**	**0.25**		

Washington, D.C., Pennsylvania Avenue — Control

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
9th	65.6	14.33	0.22		
10th	51.5	7.00	0.14		
11th & D	51.1	8.67	0.17		
12th	62.6	8.00	0.13		
13th	45.5	9.33	0.21		
14th	75.900	21.33	0.28		
15th & E	63.300	15.33	0.24		
15th & NY	59.000	19.00	0.32		
17th	53.800	21.67	0.40		
18th & H	46.000	10.00	0.22		
19th & H	52.300	20.00	0.38		
20th & I	55.700	12.67	0.23		
21st & I	50.500	7.67	0.15		
22nd	46.200	5.00	0.11		
24th	31.600	12.67	0.40		
25th	44.700	12.33	0.28		
26th	36.900	12.67	0.34		
29th & M	40.600	14.00	0.34		
Avg.	**51.822**	**12.87**	**0.25**		

Washington, D.C., L Street — Control

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
12th	31.600	9.67	0.31		
13th	31.400	18.67	0.59		
14th	43.400	15.00	0.35		
15th	35.900	10.33	0.29		
16th	39.500	15.33	0.39		
17th	37.100	9.00	0.24		
18th	36.200	14.67	0.41		
19th	34.300	11.00	0.32		
20th	34.000	8.00	0.24		
21st	32.500	7.67	0.24		
Avg.	**35.590**	**11.93**	**0.34**		

Washington, D.C., I Street — Control

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
13th	27.900	8.67	0.31		
14th	38.000	12.00	0.32		
15th	26.700	8.00	0.30		
17th	35.500	12.67	0.36		
18th	25.200	5.67	0.22		
19th	17.300	3.67	0.21		
20th	55.700	12.67	0.23		
21st	50.500	7.67	0.15		

Louisville, Kentucky, Southern Parkway — Boulevard

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
Whitney	10.939	5.50	0.50		
Florence	17.834	7.67	0.43		
Southern Hts.	16.700	7.33	0.44		
Ashland	14.989	5.17	0.34		
Woodlawn	17.111	10.67	0.62		
New Cut/Taylor	25.691	11.67	0.45		
Avg.	**17.211**	**8.00**	**0.47**		

Louisville, Kentucky, Third Street — Control

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
Whitney	12.185	11.83	0.97		
Florence	20.252	9.00	0.44		
Southern Hts	18.533	14.00	0.76		
Wellington	16.433	8.83	0.54		
Woodlawn	16.330	31.67	1.94		
Tenny	15.282	14.50	0.95		
Avg.	**16.503**	**14.97**	**0.93**		

Chico, The Esplanade — Boulevard

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
Memorial	26.900	4.70	0.17		
W 1st	24.200	6.30	0.26		
E 3rd	24.200	1.70	0.07		
E 5th	24.500	7.30	0.30		
E 7th	24.500	5.30	0.22		
E 9th	24.500	3.70	0.15		
Avg.	**24.800**	**4.83**	**0.19**		

Chico, Mangrove Avenue — Control

Intersections	Volume & Accident Data: Volume ADT/1000	Accidents	Accident Rate #Accident/ Volume	Accidents, pedestrian only	Ped.Acc. Rate, Ped. Acc/Vol.
Vallenprpsa	18.900	6.30	0.33		
W 1st	22.5001	0.30	0.46		
E 3rd	22.250	3.30	0.15		
E 5th	22.000	2.30	0.10		
E 7th	23.250	1.00	0.04		
E 9th	24.500	0.67	0.03		
Avg.	**22.233**	**3.98**	**0.18**		

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