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I am submitting herewith a dissertation written by Paul Allen Bielicki entitled “The Influence of Confluence and Resolution on Architectural and Structural Frameworks”. I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Masters of Architecture, with a major in Architecture.

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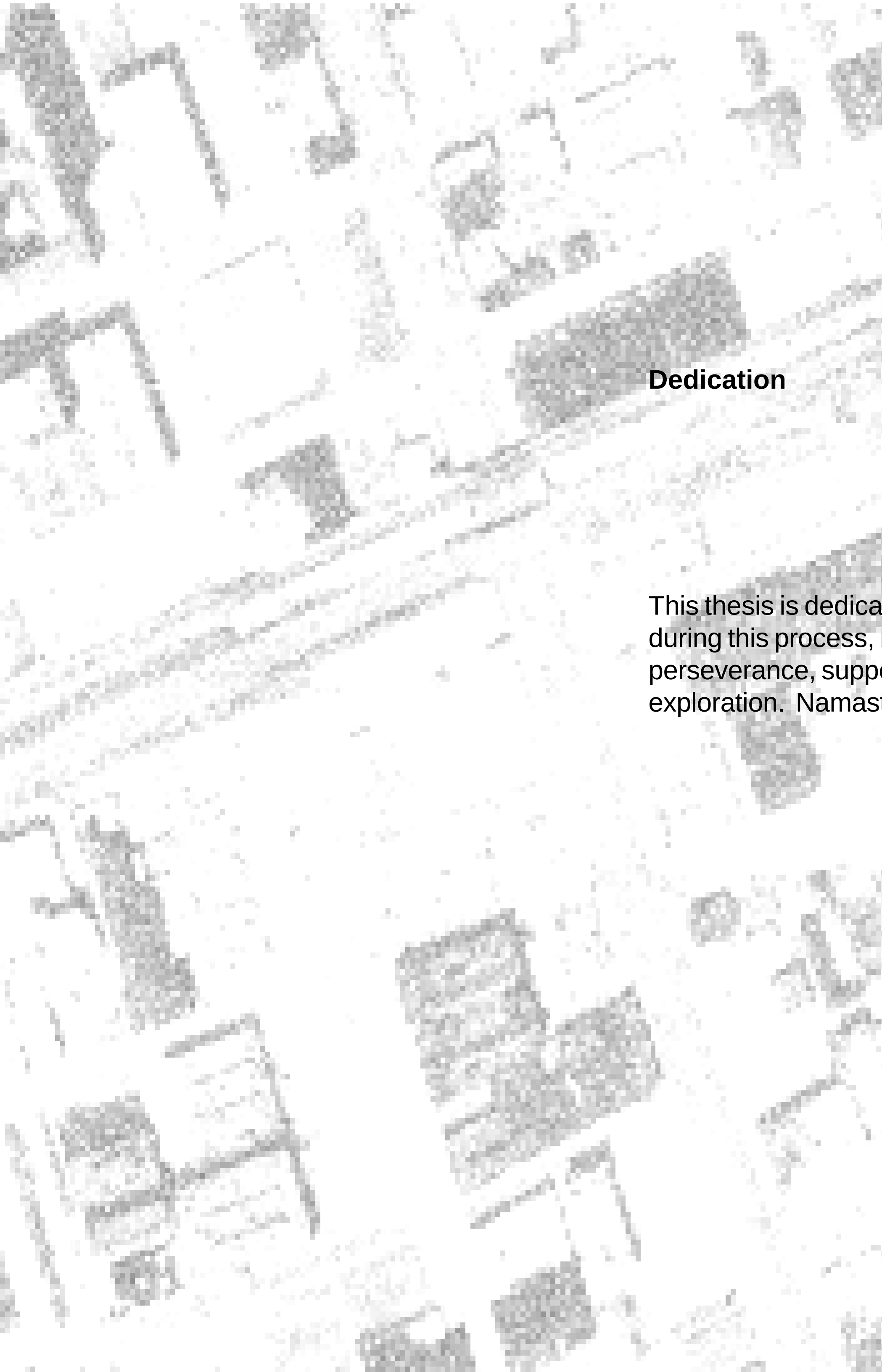
The Influence of Confluence and Resolution on Architectural and Structural Frameworks

A Thesis
Presented for the
Master of Architecture Degree
The University of Tennessee, Knoxville

Paul A. Bielicki
August, 2000



Dedication

This thesis is dedicated to my wife, Linda. Thank you for not only tolerating me during this process, but equally tolerating the absence of me. If not for your perseverance, support and love, I may not have realized the culmination of this exploration. Namaste.

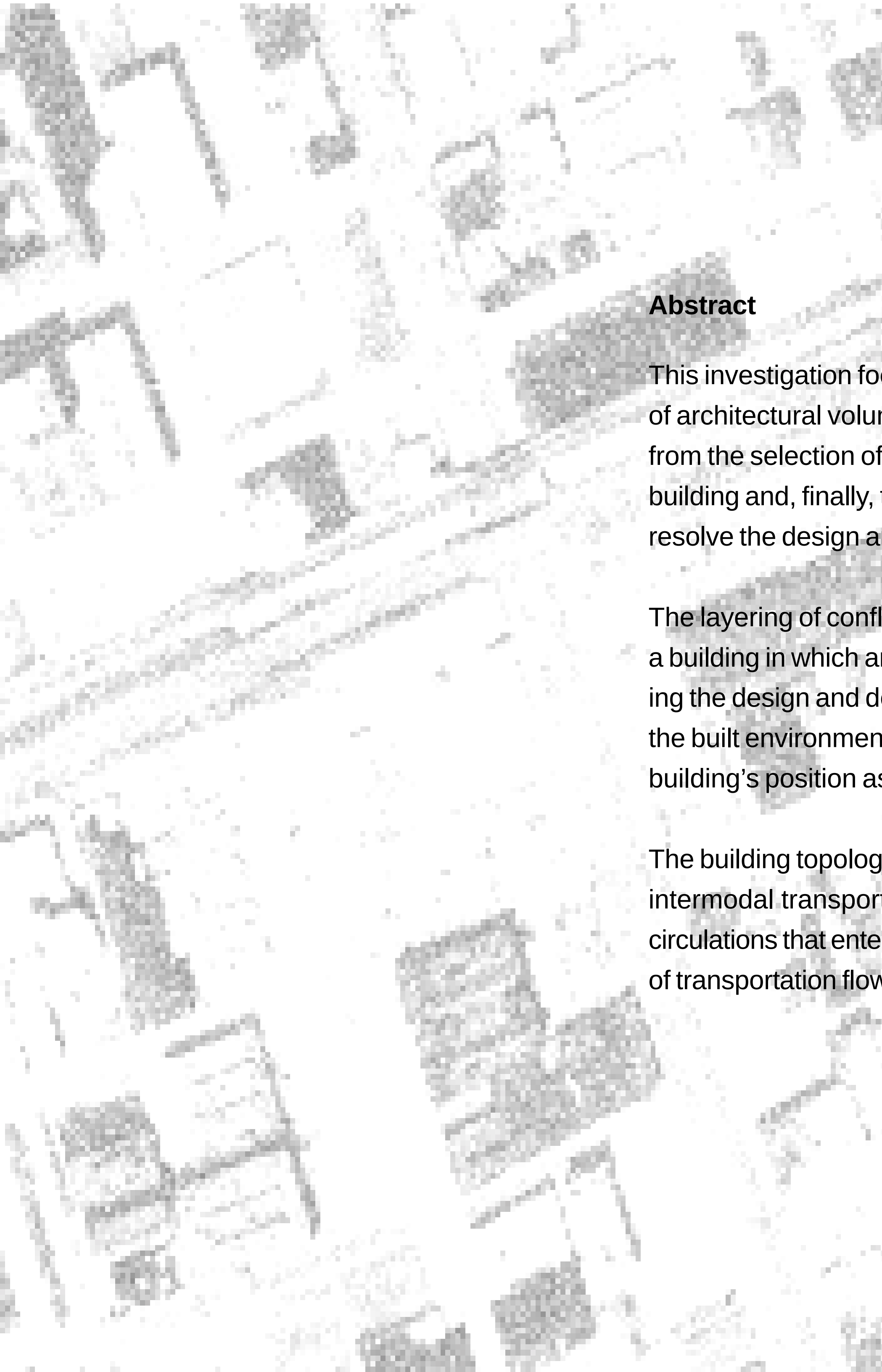
Acknowledgements

I would like to take this opportunity to thank the many people who have helped and inspired me through this thesis process. First, thank you to my thesis committee – J. Stanley Rabun, Tracy Moir-McClean and Jon Coddington. Your insight and opinions greatly affected the outcome of this thesis.

Thanks also go to my fellow students who began this adventure with me. I learned a great deal about subjects, in addition to architecture, due to your diversity.

I would also like to thank my mother-in-law and father-in-law for their unquestioning generosity to their daughter and me.

Lastly, I would like to recognize my parents, who have provided a great deal of unwavering emotional support, encouragement and love. I would especially like to thank my grandfather and grandmother for their encouragement to all their grandchildren to continue their education. I am sorry my grandfather did not live to see this process to its completion.



Abstract

This investigation focuses on the ideas of confluence and resolution as generators of architectural volume. This focus is applied as the driving design idea extending from the selection of the city, to the selection of the site, to the organization of the building and, finally, to the architectural development of the details, all of which help resolve the design and construction of the building.

The layering of confluent conditions, from the site to the detail, is intended to create a building in which an occupant may begin to understand the relationships influencing the design and development of the building, and by extension, development of the built environment. One can even begin to recognize the importance of a building's position as a confluence of events within a city.

The building topology used to express these ideas of confluence and resolution is an intermodal transportation station in the City of Detroit. The multiple transportation circulations that enter an intermodal station explicitly define the station as a confluence of transportation flows within the city.

Foreword

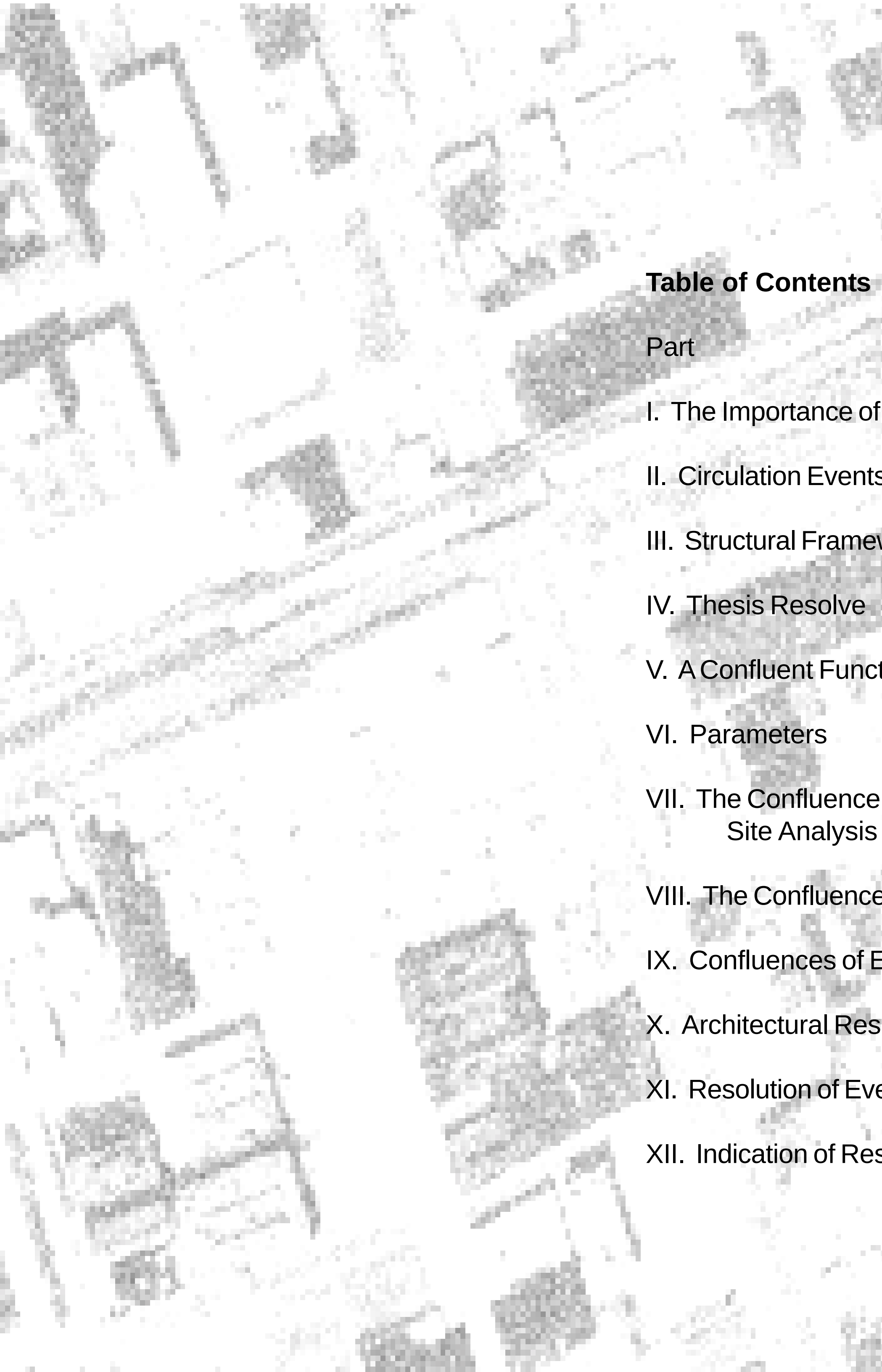
con-flu-ence (n): **1. a flowing together of two or more streams, rivers, etc. 2. their place of junction.** 3. a body of water formed by confluence. **4. a coming together of people or things; concourse. 5. a crowd or throng; assemblage.** (Webster's, 285)

con-flu-ent: **1. flowing or running together; blending into one: *confluent rivers; confluent ideas*.** 2. characterized by confluent efflorescences: *confluent smallpox*. -- (n) 3. a confluent stream. 4. a tributary stream. (Webster's, 285)

Initially, this thesis was to recognize a potential in structural frameworks extending beyond the conditions of a three-dimensional grid, physical building support and economic efficiency, which are often strong considerations in the design of structural frames. From the search for this potential, recognition was made of the importance of connection, especially the connection between a column and a beam. Extending the pragmatics of the frame and its grid allowed for connections to the city and its grid, as well as the numerous types of spatial connections the frame allows. Connections are the places where several forces may flow together and change direc-

tion. The structural connection between a column and a beam allows the flow of forces within the beam to be resolved through the column and into the ground. In that sense, a connection could be considered a three-dimensional representation of the resolution of a confluence of forces. The condition of resolving confluences in a connection holds the continuity of the frame together.

One may also speak of a confluent nature of space, traffic, pedestrians, ideas, or perceptions and the resolutions that help avoid conflict between the flows. Because of their broad range of implications the concept of confluence and its resolution has on construction and space in the service of social needs, the ideas of confluence and resolution became the focus of this thesis.



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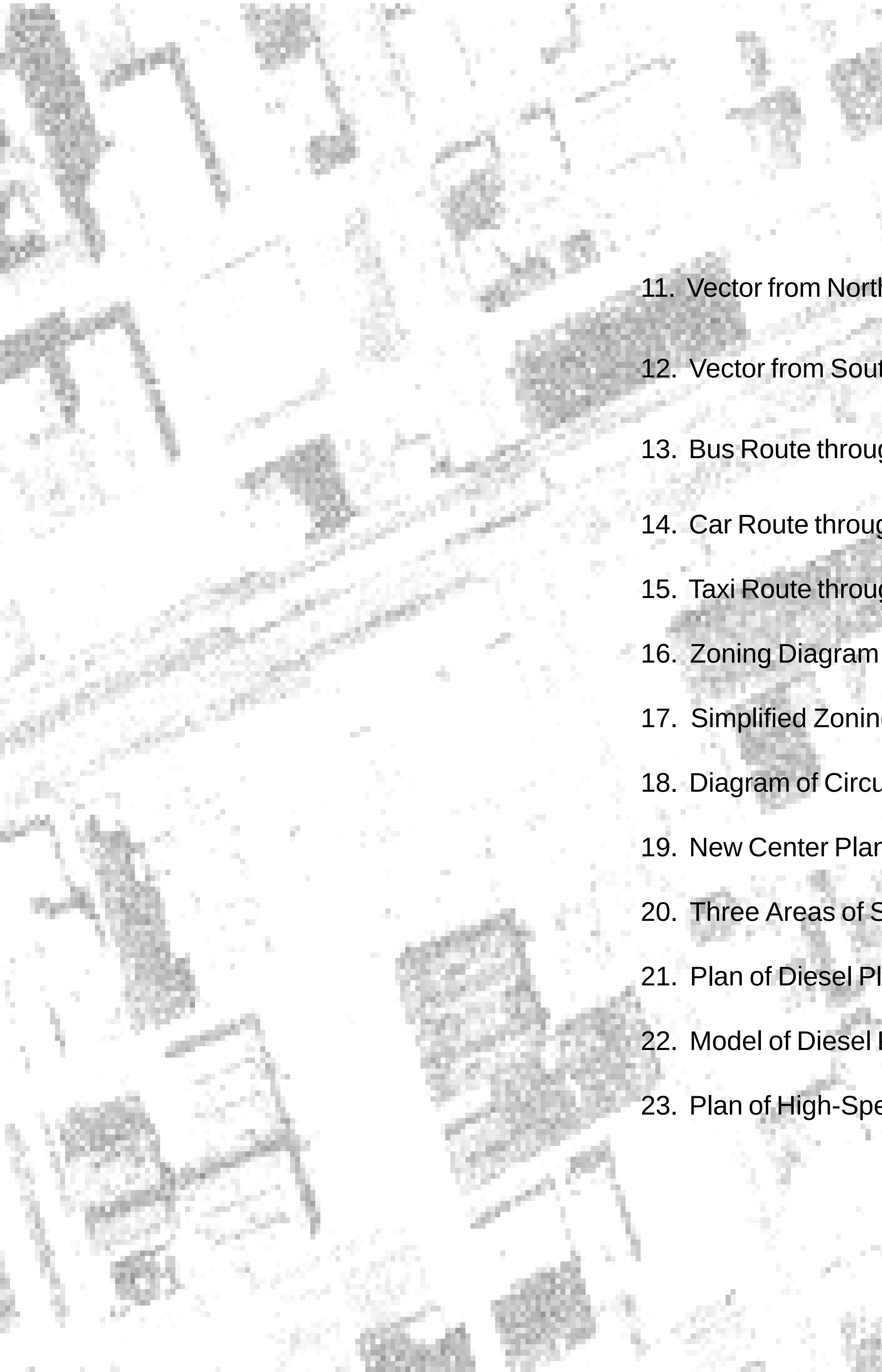

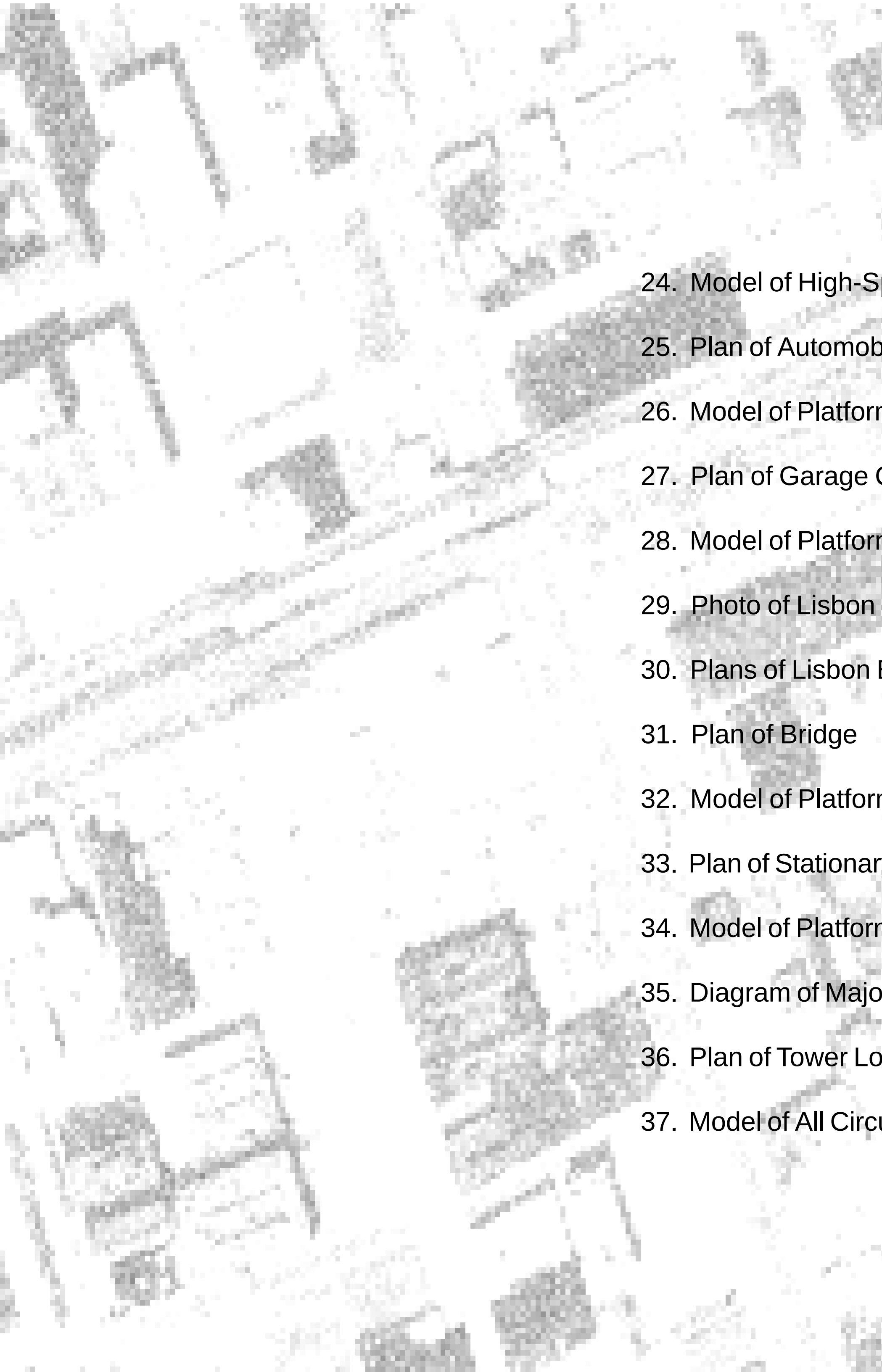

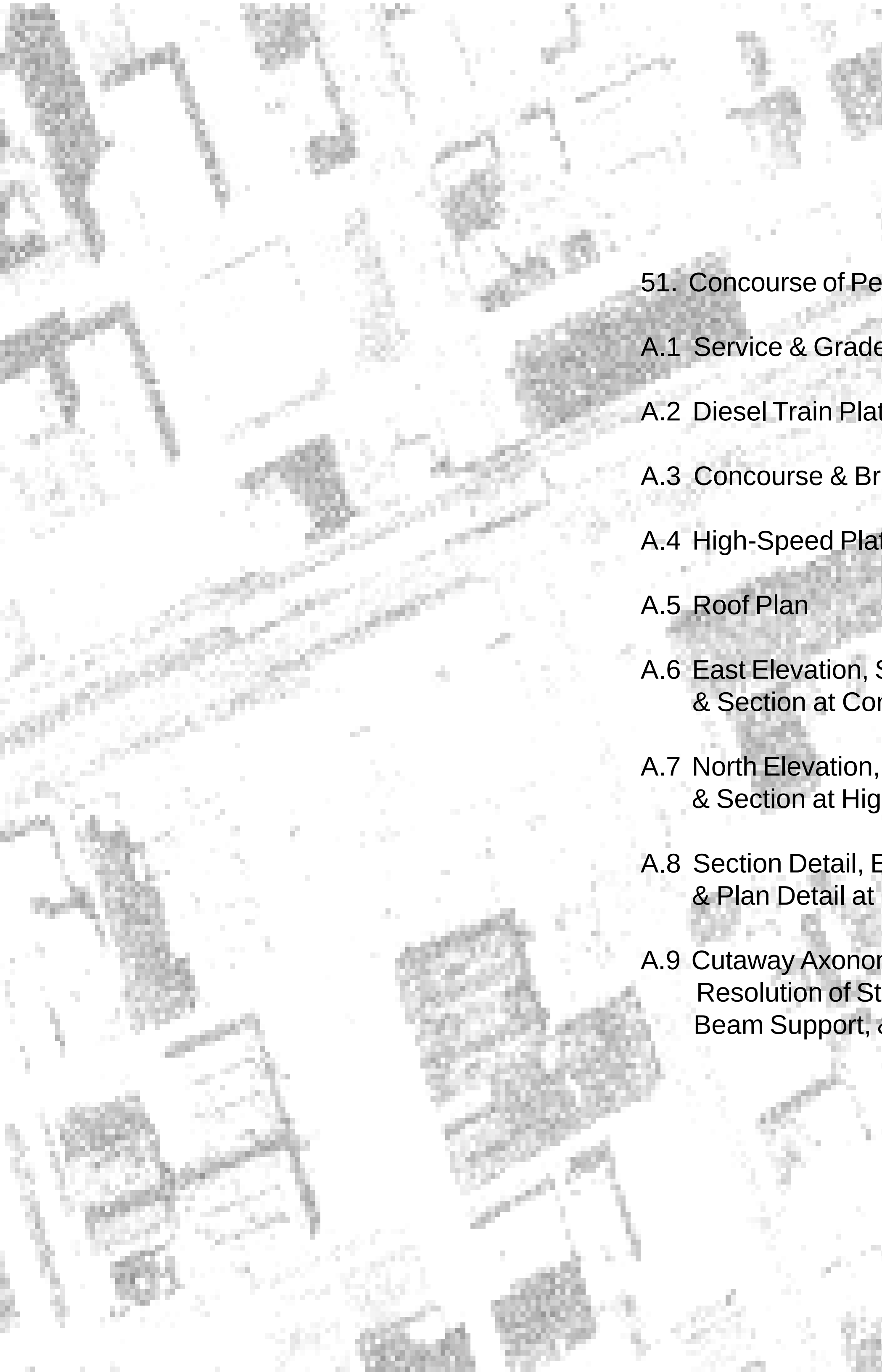

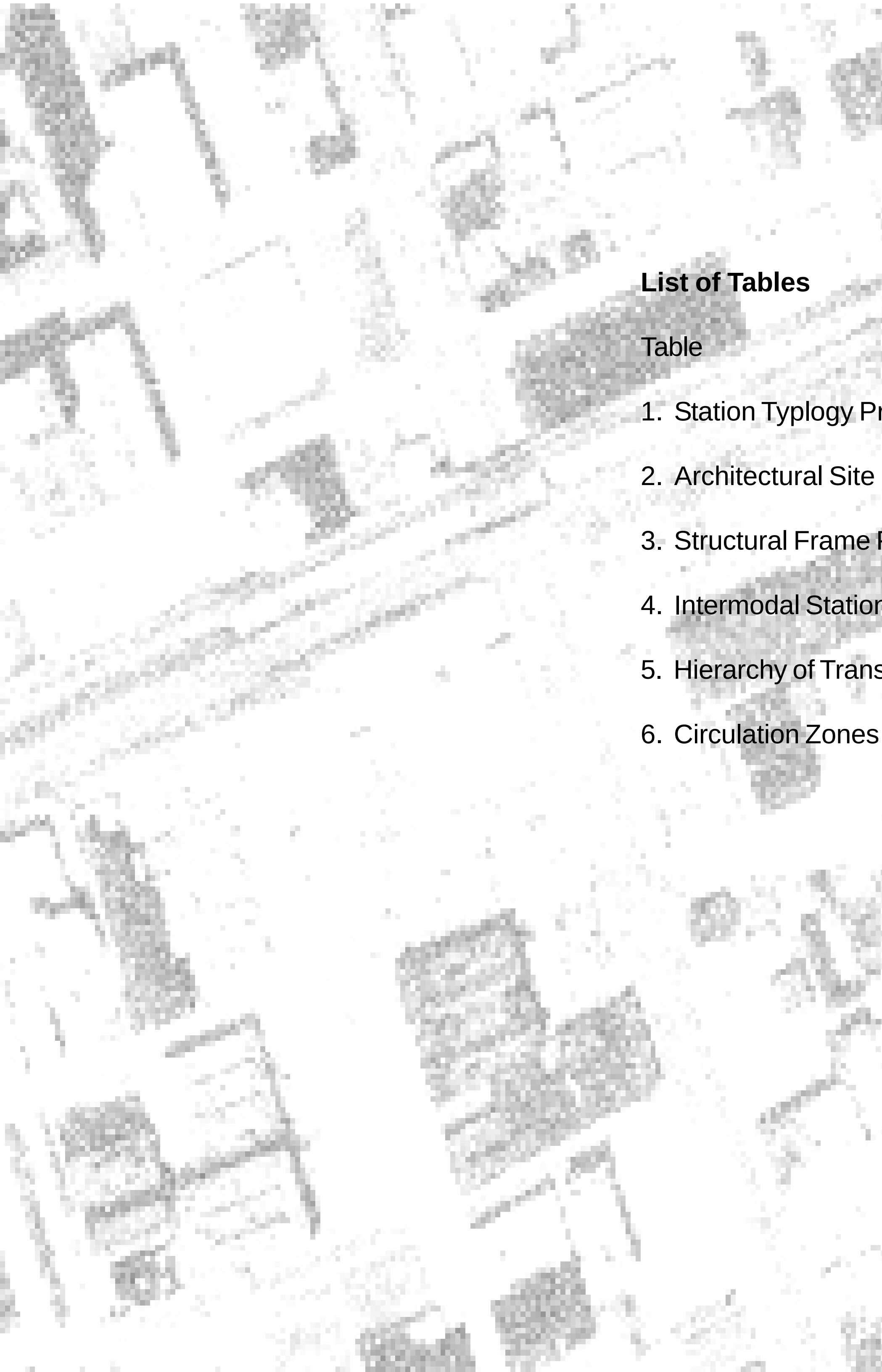

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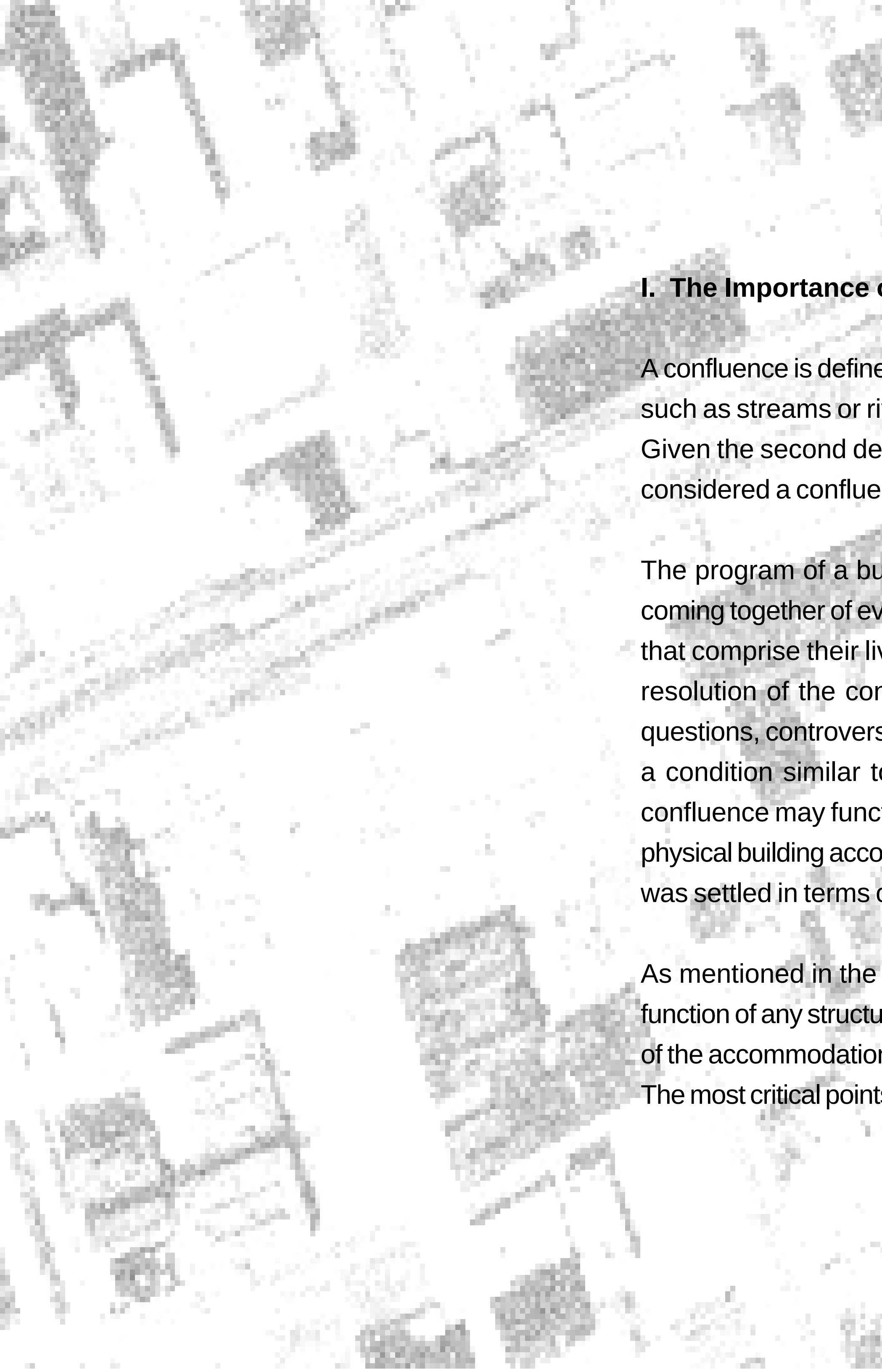


I. The Importance of Confluence and Resolution

A confluence is defined as a flowing together of two or more fluent or flowing conditions, such as streams or rivers. It is also defined as a coming together of people or things. Given the second definition, for this investigation, the program for a building may be considered a confluence.

The program of a building is a plan to accommodate different types of events or a coming together of events. Most often, the events are people and the daily happenings that comprise their lives. The accommodation of these events is considered to be a resolution of the confluent events. A resolution is defined as the way in which a questions, controversy, etc., is dealt with or settled. A confluence of events is just such a condition similar to questions or controversy requiring a resolution, so that the confluence may function with the intended efficiency of the owner, designer, etc. The physical building accommodating the confluent events is the way in which the confluence was settled in terms of space, form, and construction.

As mentioned in the preface, the point of connection is an important element in the function of any structural frame. A structural frame is a three-dimensional representation of the accommodation of confluent loading and resisting forces exerted upon the frame. The most critical points in any structural frame are the connections because the individual confluences of forces are resolved in the connections (Fig. 1). A structural connection is thus a resolution of confluent forces.

A design condition of larger focus, in which the idea of confluence plays a pivotal role, is in the layout of a modern city (Fig. 2). A modern city can be viewed as being composed of overlaid frameworks of roads, circulation paths allowing the flow of traffic. Where confluences between the different frameworks occur, a resolution must be provided. The confluences of the flows of traffic become very critical elements within the system. These critical elements are the intersections, on/off ramps and overpasses where the flows of traffic change direction or accommodate one another (Fig. 3). Kevin Lynch, in his book *The Image of the City*, felt that traffic confluences were important enough to designate them as an element within the image of a city. Lynch states, “The concept of node is related to the concept of path, since junctions are typically the convergence of paths, events on the journey.” (Lynch, 48) Nodes or confluences are important to a city and “in certain cases may be [a] dominant feature.” (Lynch, 48)

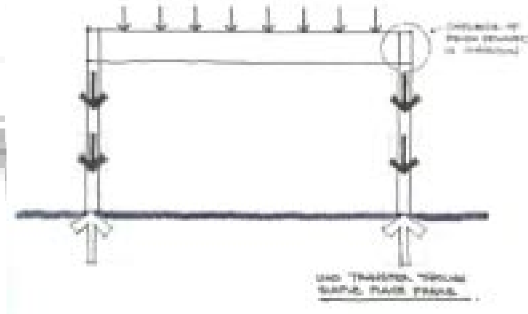


Fig. 1 Confluence at connection
Source: Author

Fig. 2 Map of downtown Detroit
Source: U.S.G.S.

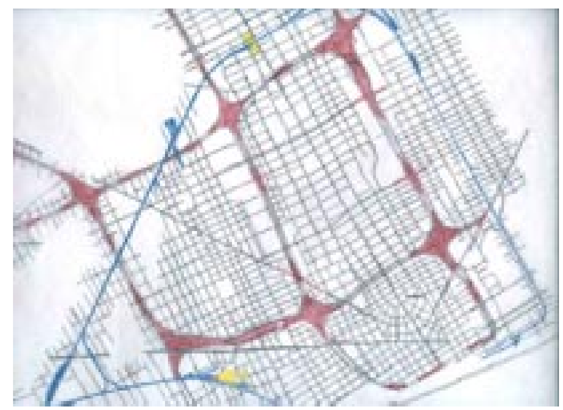
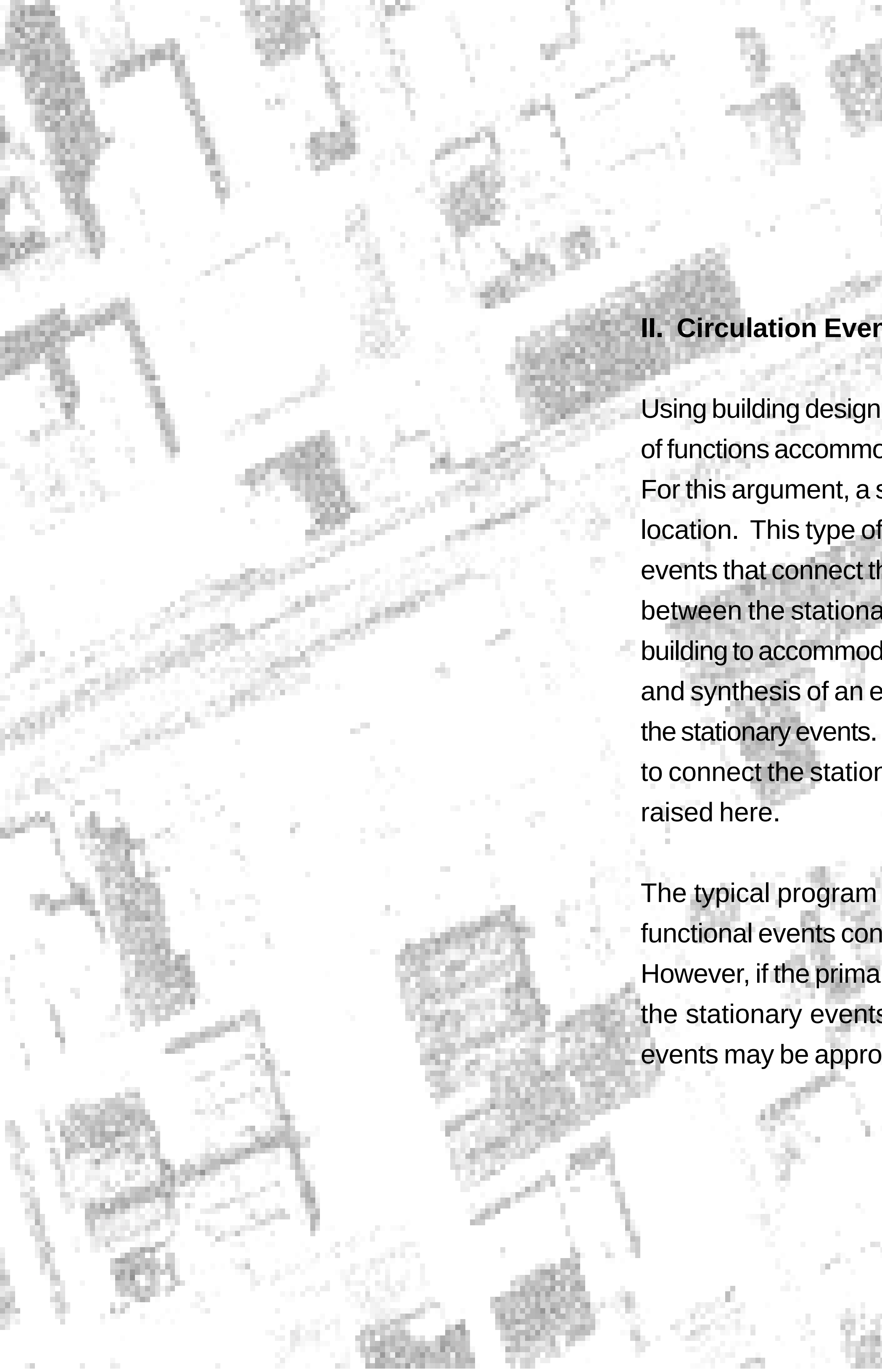


Fig. 3 Sketch indicating intersection confluences
Source: Author



II. Circulation Events and Confluence

Using building design as a resolution of confluent events, the events can be any number of functions accommodated by a building, or they can be stationary events or circulation. For this argument, a stationary event is any event that is accommodated in a specified location. This type of event is opposed to circulation events, which typically are those events that connect the locations of the stationary events and allow occupants to travel between the stationary events. Given these conditions, the architectural design of a building to accommodate mostly stationary events follows a process of repeated analysis and synthesis of an established, functional program for the building, in order to locate the stationary events. Volumes accommodating the circulation events are then designed to connect the stationary events as necessary. The question of functional program is raised here.

The typical program of a building is comprised of the accommodation of stationary, functional events connected by circulation, which is in the service of stationary events. However, if the primary events of a building's program consist of circulation events and the stationary events are in service of the circulation, the accommodation of these events may be approached differently.

Bernard Tshumi's questioning of the traditional relationships between event and program, and between program and sequence, serve as a catalyst for a different perspective regarding the organization of space in order to accommodate events. A programmatic flow of circulation, when observed as a single event, does not have a sequence, unless the beginning and end of the flow or individual pedestrian movements, hand, foot, etc., are considered. A sequence indicates the following of one thing after another. Unless fixed points of, perhaps, structure or event occurs along the flow, then no sequence exists, except for the beginning and end of the flow. That is unless the programmatic flow of circulation meets an obstacle, as in another programmatic flow of circulation.

Photo of expressway interchange
Source: JRR Enterprises, Inc.

Circulation events are quite similar to the flows of automotive traffic over the circulation frameworks of a city or forces within a structural frame. All of these conditions have a direction and magnitude and may be considered as vectors. In the case of pedestrian circulation, the magnitude would be the relative quantity of occupants within the circulation space. If the circulation events are considered vectors, confluences between the circulation vectors will develop and need to be resolved architecturally. The relative volume of the resolution would depend upon the magnitude of the involved circulation vectors. In a building with several different types of circulation events, these events may be overlaid upon each other with each circulation type satisfying its programmed magnitude and direction. Confluences arise, similar to the confluences occurring in the overlaid frameworks of a city, and resolutions would be required. The resolutions

have the potential to be significant spatial locations within the finished building; similar to the nodes within a city that become significant landmarks.

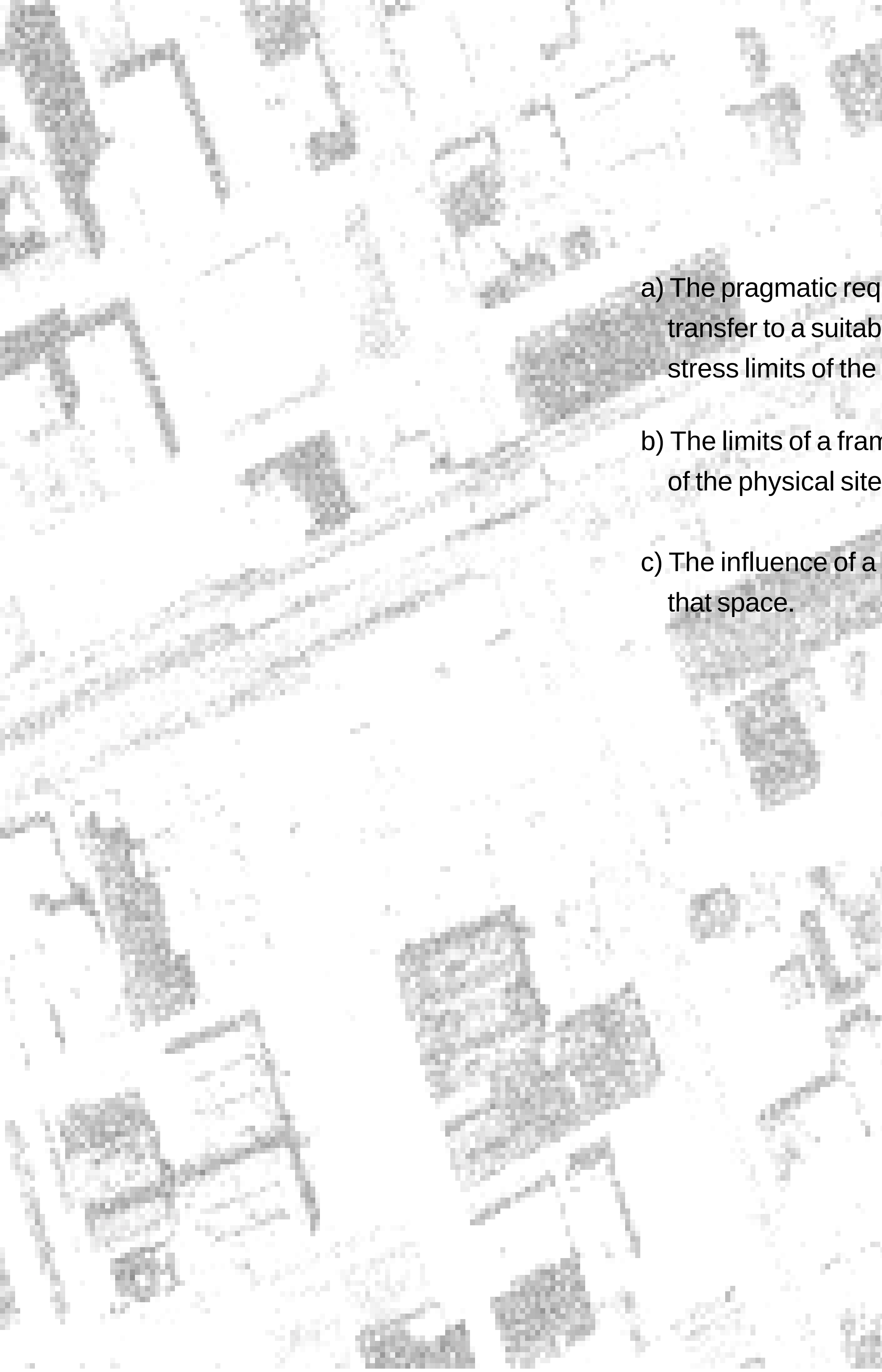
III. Structural Frameworks and Confluence

Because the stability of a structural frame also relies upon the idea of confluence and resolution, the frame is used as the primary structural system in this project. The structural frame is also considered to be the initial, defining element of a volume accommodating an event and, therefore, also accommodates the event. Further, the physical flexibility of the structural frame is beneficial in accommodating and defining the architectural resolutions of event confluences.

For example, in a condition where a structural framework accommodating a circulation event may conflict with a spatial volume accommodating another event, the flexibility of a frame allows the spanning of the conflicted event without drastically affecting the organization of the structural frame. The columns and beams in the immediate area may be forced to a larger size, but this change may be viewed (and possibly celebrated) as a physical manifestation of the confluence between two events.

While this investigation is a search to resolve architectural confluences as they are linked to a structural framework and its flexibility, it is recognized that, to insure a cohesive project, the design must still consider:

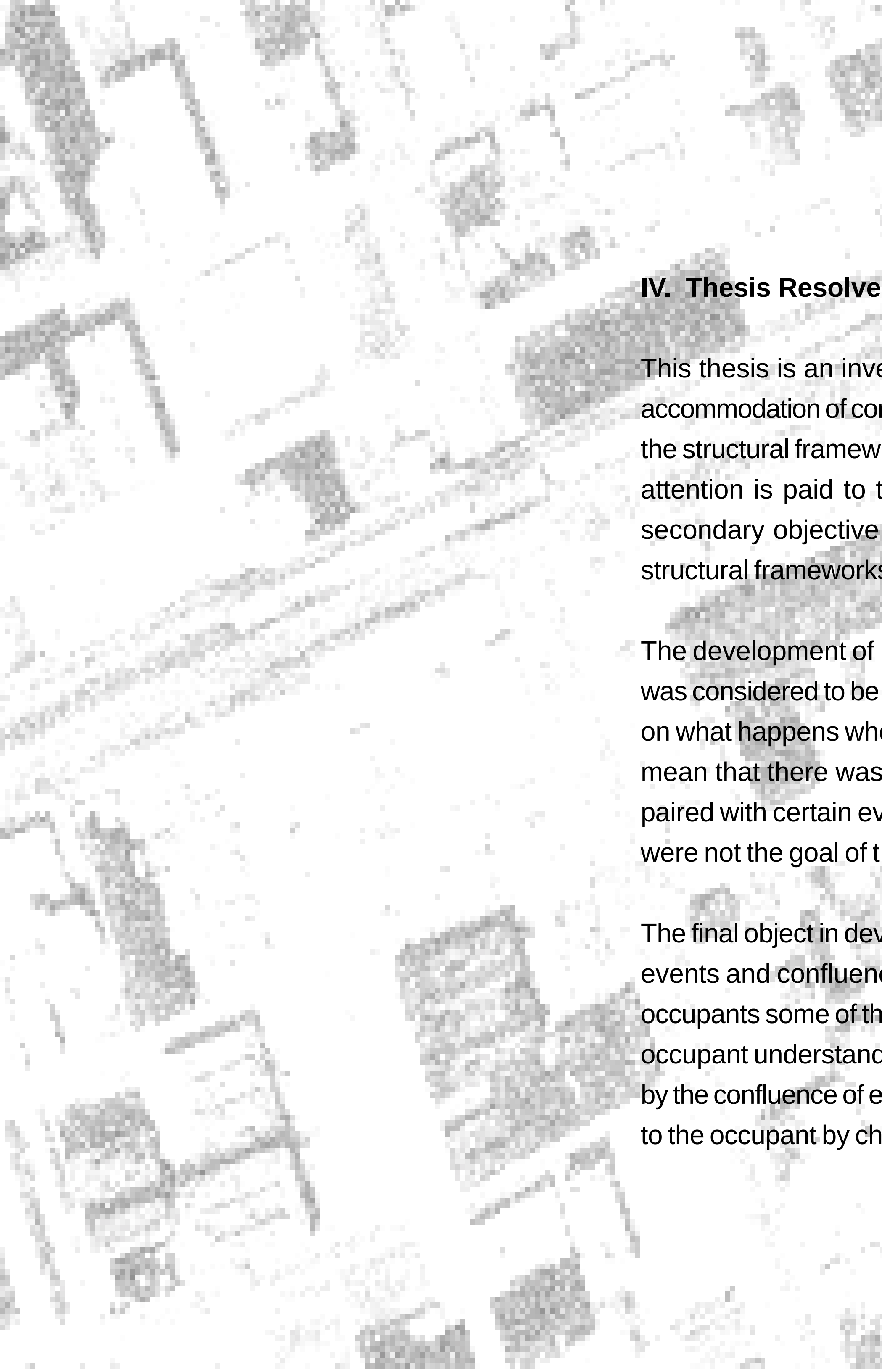
(see next page)



a) The pragmatic requirements of a structural frame, including continuity of stress transfer to a suitable foundation, adherence to the laws of statics, and internal stress limits of the materials being used;

b) The limits of a frame as defined by the specifics of the project, including the limits of the physical site and the limits imposed by the building's intended use;

c) The influence of a frame upon a space as it accommodates the intended use of that space.

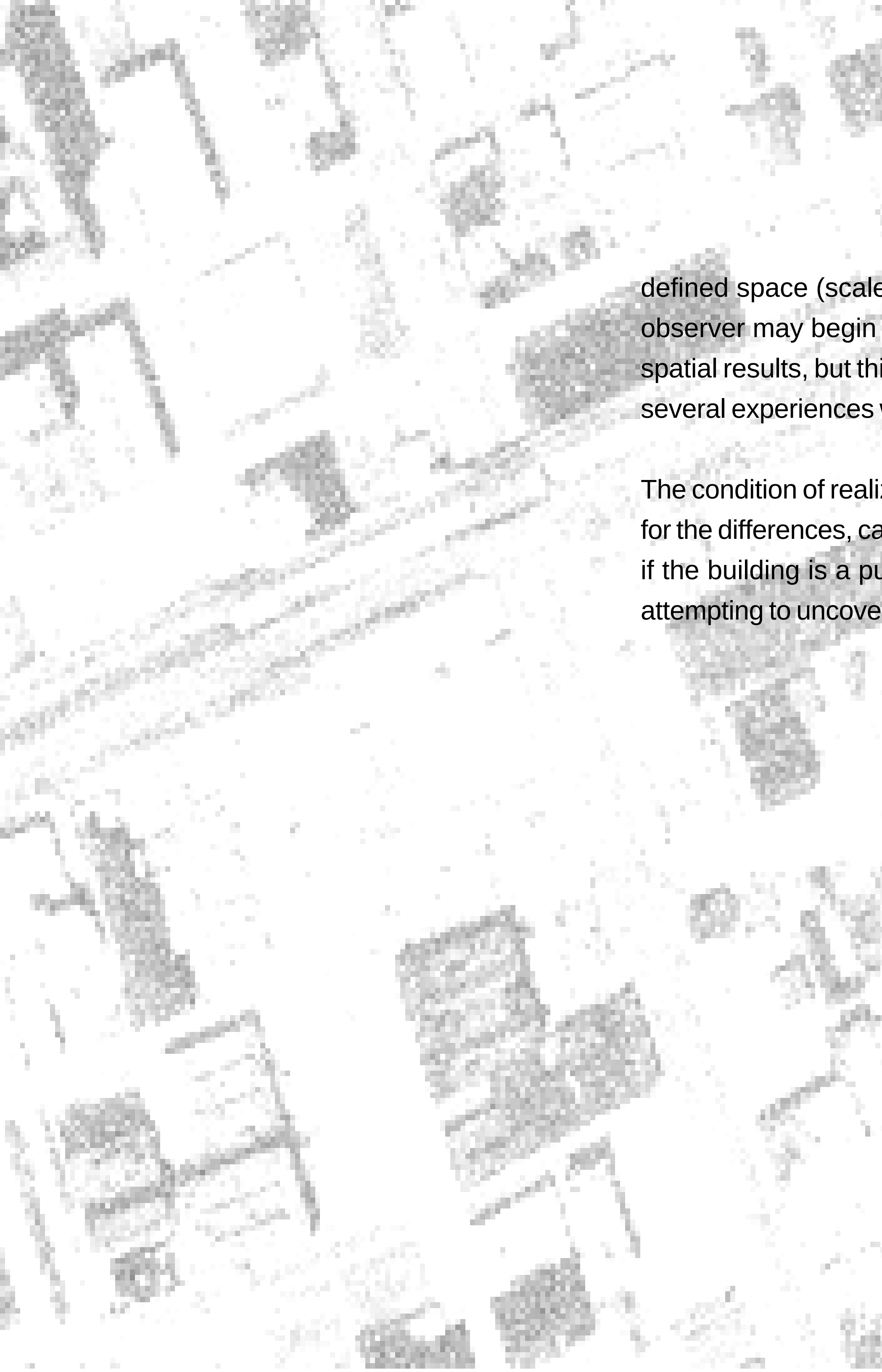


IV. Thesis Resolve

This thesis is an investigation of confluence and resolution in the organization and accommodation of confluent events. As events interact within the architectural resolution, the structural frameworks accommodating the events interact with each other. Special attention is paid to the interaction or confluence of the structural frameworks. A secondary objective of this thesis is the implicit or indirect reinvigoration of planar structural frameworks in architectural design.

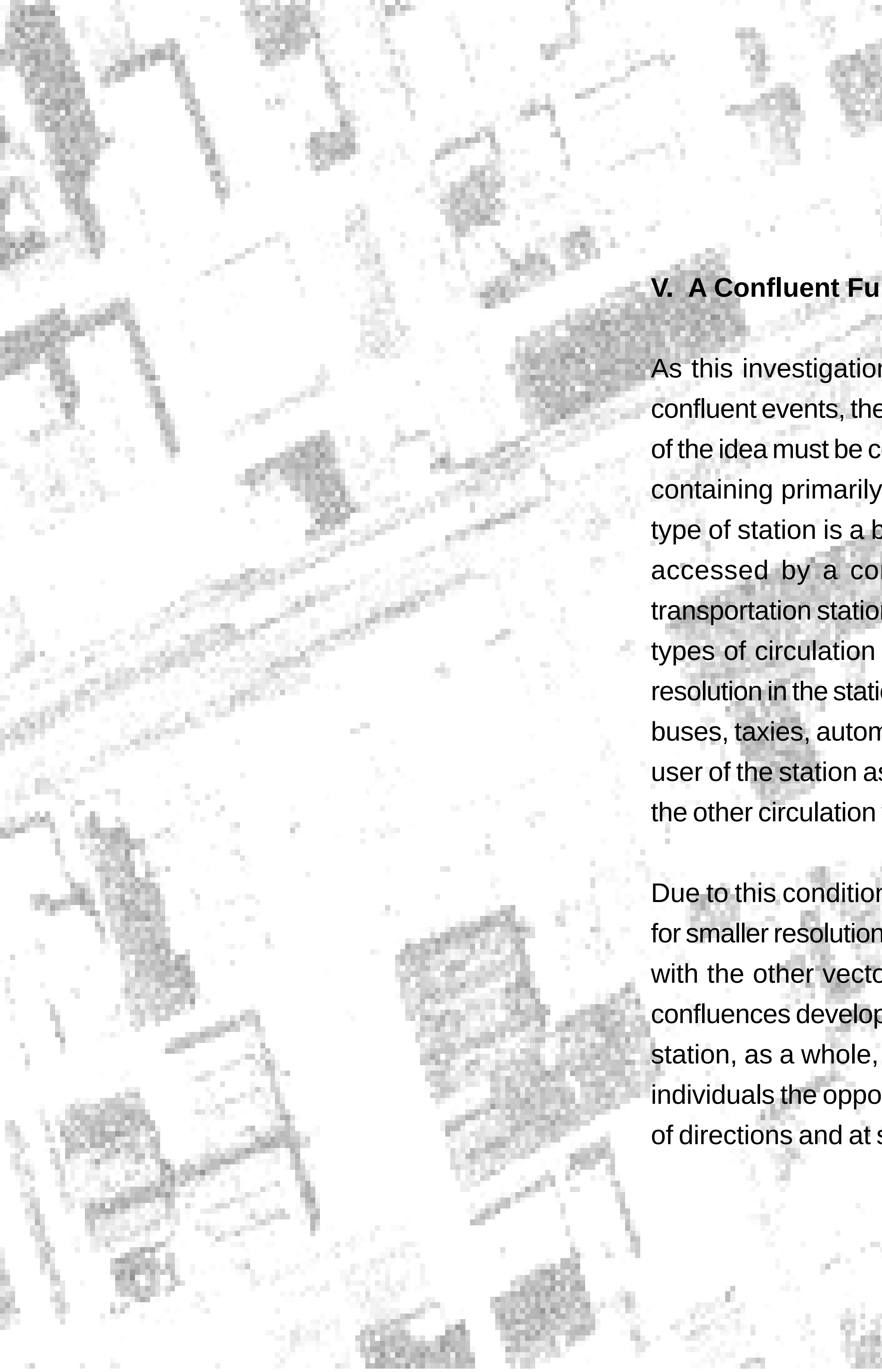
The development of ideal structural frameworks to define spatial volumes for events was considered to be outside the scope of this investigation. The scope here is focused on what happens when different frameworks interact with one another. This does not mean that there was no consideration given to specific structural frameworks were paired with certain events. Rather, this only means that “ideal” structural frameworks were not the goal of the project.

The final object in developing a building, where the structural framework is informed by events and confluences taking place within the building, is to offer awareness to the occupants some of the intents influencing the design of the building. It is hoped that an occupant understands that a change from one spatial volume to another is influenced by the confluence of events within these volumes. This confluence of events is indicated to the occupant by changed characteristics in the structural frame and the consequent



defined space (scale, rhythm, material size, and proportion). Over time, an astute observer may begin to deduce relationships between the confluent events and the spatial results, but this may only happen over a considerable period of time and upon several experiences with the building.

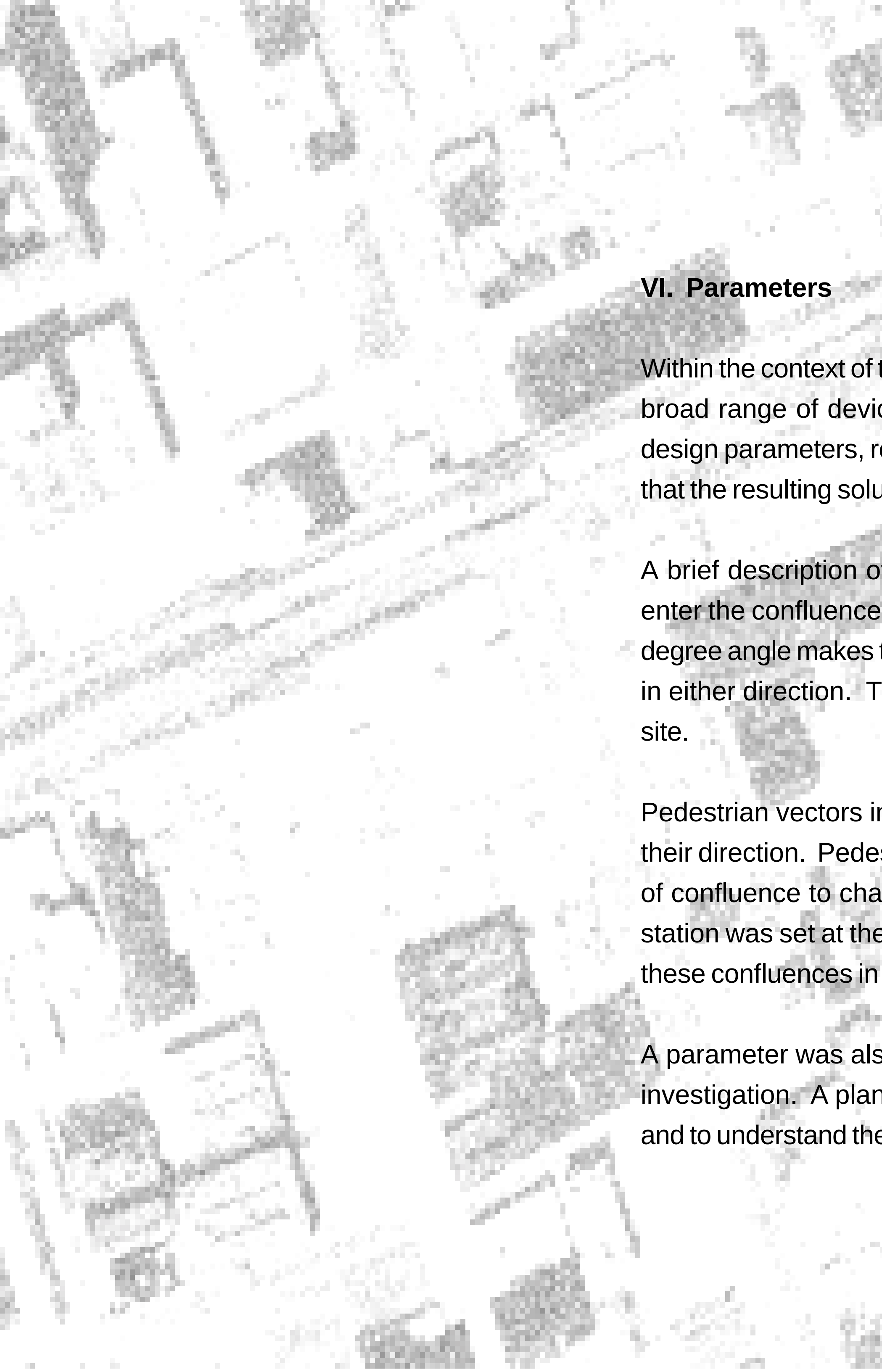
The condition of realizing differences, but not immediately understanding the reasons for the differences, can potentially add levels of interest to the building's design. It is as if the building is a puzzle that the occupant may navigate across the pieces, while attempting to uncover the underlying organization of the building.



V. A Confluent Functional Typology

As this investigation focuses on confluence and resolution in the organization of confluent events, the functional use of the building designed as the physical resolution of the idea must be composed of primarily circulation events. An architectural typology containing primarily circulation event is an intermodal transportation station. This type of station is a building where several different modes of transportation can be accessed by a commuter or traveller. This exploration uses an intermodal transportation station as the programmatic function to illustrate the idea. Six different types of circulation are used as the circulative vectors coming to confluence and resolution in the station. These circulations are high-speed trains, steel-on-steel trains, buses, taxies, automobiles and pedestrians. Recognition is made that in all cases, a user of the station assumes the role of pedestrian before journeying onto any one of the other circulation vectors.

Due to this condition of being a pedestrian between circulation types, opportunities for smaller resolutions of confluence occur as the pedestrian vectors become confluent with the other vectors. Recognition is also made within the station when several confluences develop between the circulation types. At the social level, the intermodal station, as a whole, may be seen as a confluence of transportation types, allowing individuals the opportunity to connect with circulation vectors traveling in a multitude of directions and at several different rates.



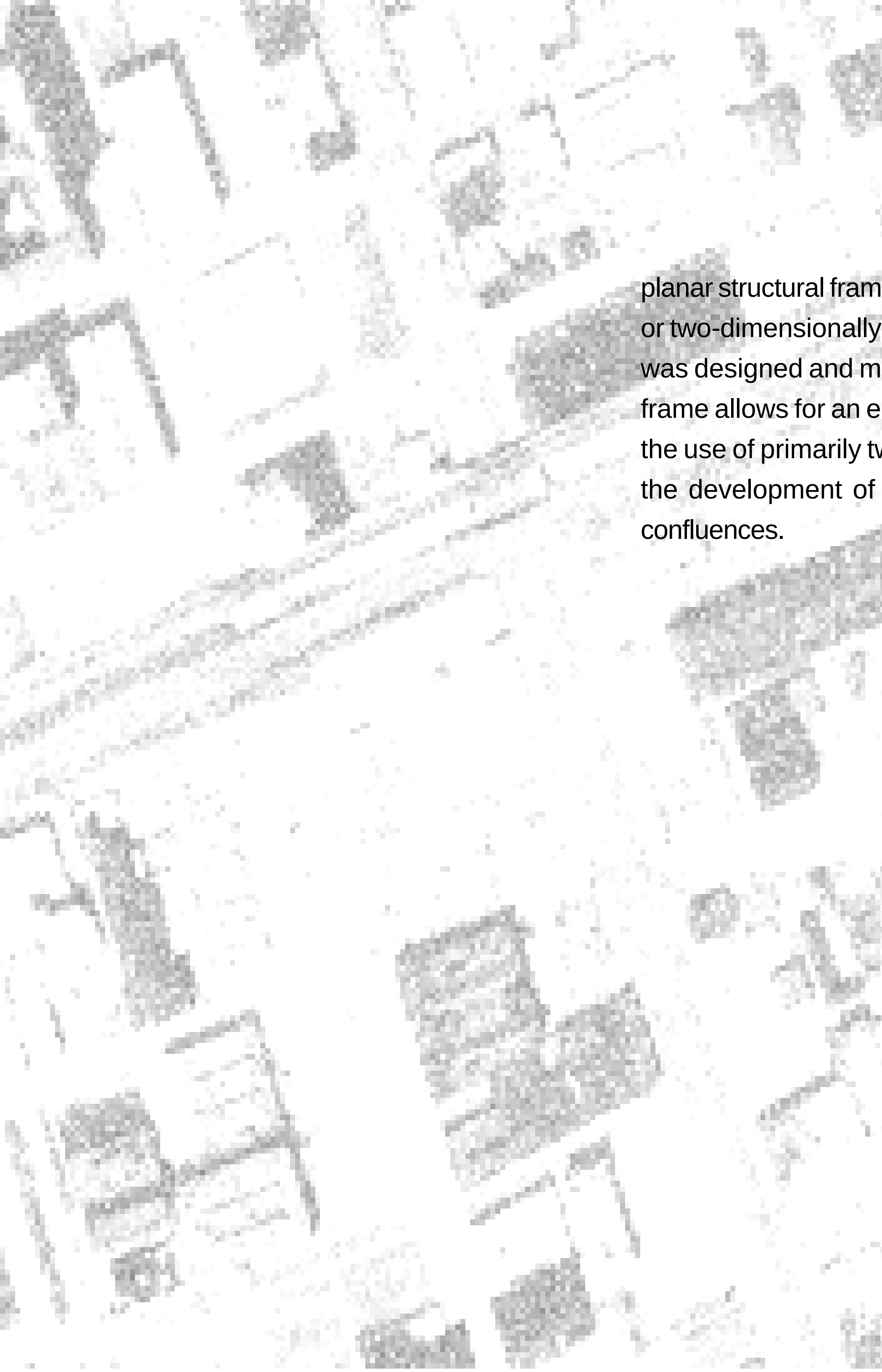
VI. Parameters

Within the context of this thesis, confluence and resolution may be exhibited through a broad range of devices pertaining to architecture. For this reason, some specific design parameters, regarding functional program and structural program, were set so that the resulting solution would be feasible.

A brief description of automobile traffic indicates that two-way street traffic should enter the confluence of the building at a ninety-degree angle to the street. A ninety-degree angle makes the change in vector direction the same for flow of vehicular traffic in either direction. This ninety-degree entrance is a set condition around the entire site.

Pedestrian vectors in the city, on the other hand, do not have a similar logic behind their direction. Pedestrian vectors slide past the site on sidewalks. The logical place of confluence to change direction and bring pedestrians into the confluence of the station was set at the existing confluences of the city. More detail is given regarding these confluences in the site analysis section of this document.

A parameter was also placed upon the type of structural frame used for the design investigation. A planar structural frame is used in order to keep the analysis simple and to understand the flows, confluences, and resolutions of forces within the frame. A



planar structural frame is one where the transfer of forces can be understood “in-plane” or two-dimensionally. This condition allowed for an understanding of the system as it was designed and modified around the flows of events. Just as the planar structural frame allows for an easily understood analysis of load vectors and their confluences, the use of primarily two-dimensional drawing techniques (plan, section, elevation) in the development of the design, allows one to understand and resolve the event confluences.

VII. The Confluence of the Site

Fig. 4 Regional location of Detroit, Michigan
Source: State Farm Road Atlas, 3

The city of Detroit is located in the southeast corner of Michigan (Fig. 4). It has been called the “Automotive Capital of the World” because it is home to the “Big 3” automobile manufacturers (Ford, General Motors and Chrysler). It also has a prominent position as a confluence of automobile circulation frameworks. Despite Detroit’s location in the corner of the state, it has two major interstate routes running through the downtown area; I-75 running north to south from Sault Ste. Marie, Ontario, Canada to Fort Myers, Florida and I-94 running east to west from Port Huron, Michigan to Billings, Montana, going through Chicago, Illinois.

Detroit has also been listed as a stop along a high-speed train corridor intended to run from Montreal, Quebec, Canada to St. Louis, Missouri (Fig. 5). It is also a current stop along diesel train railroads that extend in several directions.

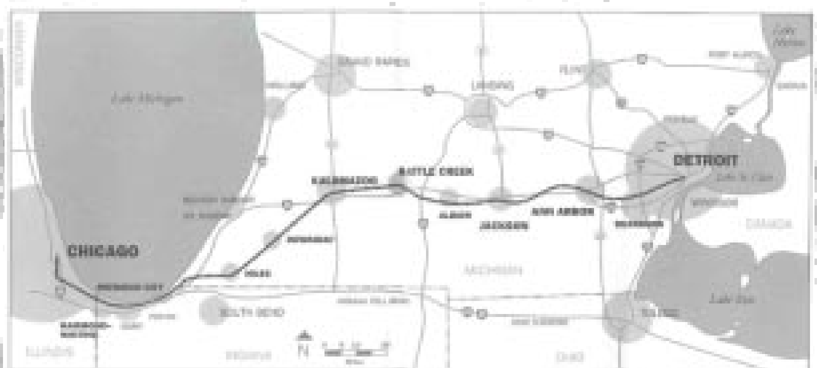


Fig. 5 High-speed corridor from Detroit to Chicago Source:URS Consultants, ii-iii

Due to its confluent nature with these major transportation systems, Detroit is an ideal urban location for this investigation.

The urban area of Detroit, while not having all of its vehicular circulation routes meet in one location, does have a central focus to it (Fig. 6). Detroit was originally based upon a radial-plan, but then, as the city grew, switched to a gridded system. The major vehicular

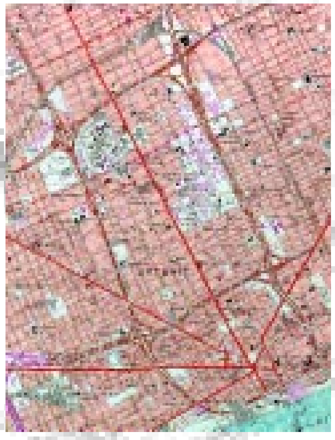


Fig. 6 Map of Detroit
Source: U.S.G.S.

circulation flow or vector travels out of the downtown area along Woodward Avenue. Two expressway systems parallel Woodward Avenue, I-75 and M-10, giving more focus to the central nature of Woodward Avenue and defining a central urban strip. Further, two expressway systems cross the central strip of the urban area, I-75 as it turns to avoid the Detroit River and I-94, dividing it into areas which may be considered Uptown, Midtown and Downtown (Fig. 7).

A significant diesel train circulation vector passes through the Uptown area of the city and is confluent with Woodward Avenue at a ninety-degree angle (Fig. 8). This confluence of major circulation vectors made the location a significant place in the city at which a building resolving circulation confluences may be placed. The location also has a relatively significant history in the city, having been the location of the first Union Railroad Station in Detroit. It was also the location of the first Cadillac manufacturing plant and is the current location of a small railroad station servicing the city (Fig. 9).

Fig. 8 Confluence of tracks & Woodward Ave.
Source: U.S.G.S. & author

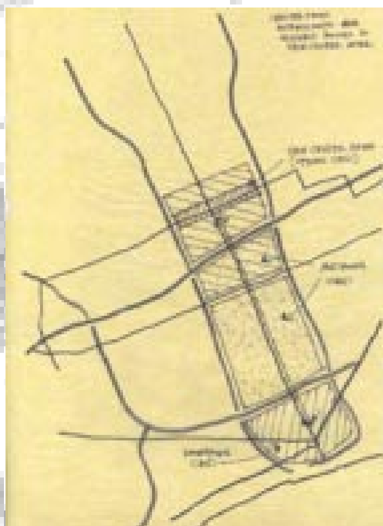


Fig. 7 Locations of Uptown, Midtown, & Downtown Source: Author

Fig. 9 Photo of existing station
Source: Author

Due to its Uptown location along Woodward Avenue and its significant history, city officials would like to see this location develop as a stopping point for the many travelers that may use the several different types of transportation expected in an intermodal transportation station.

The streets which define the boundaries of the site are as follows: to the north – Baltimore Avenue; south – Amsterdam; east – Woodward Avenue; and west – Cass Avenue (Fig. 10).

As the train platforms were expected to be longer than the site is wide, an allowance is made for the platform portions of the building to extend to the west along the railroad right-of-way beyond the building's boundary.

Fig. 10 Location of site
Source: U.S.G.S. & author

Arial Photo of Detroit with site outlined
Source: JRR Enterprises, Inc.

South area of site
Source: Author

Railroad bridge over Cass Avenue
Source: Author

Site north of project site
Source: Author

Railroad bridge over Woodward Avenue
Source: Author

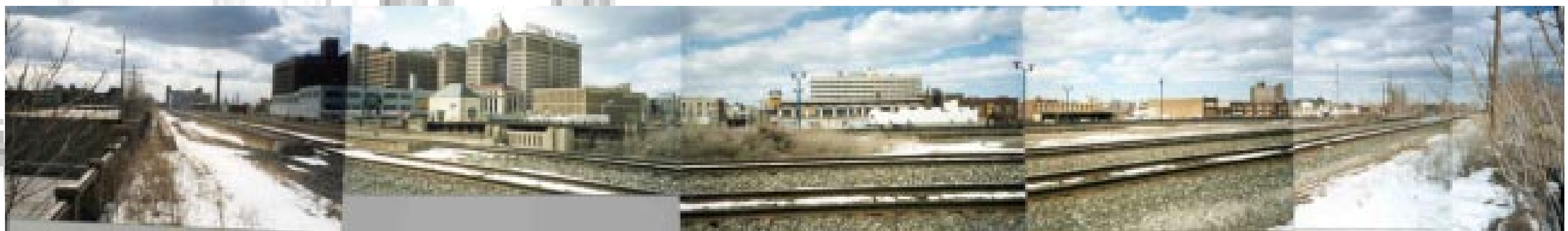
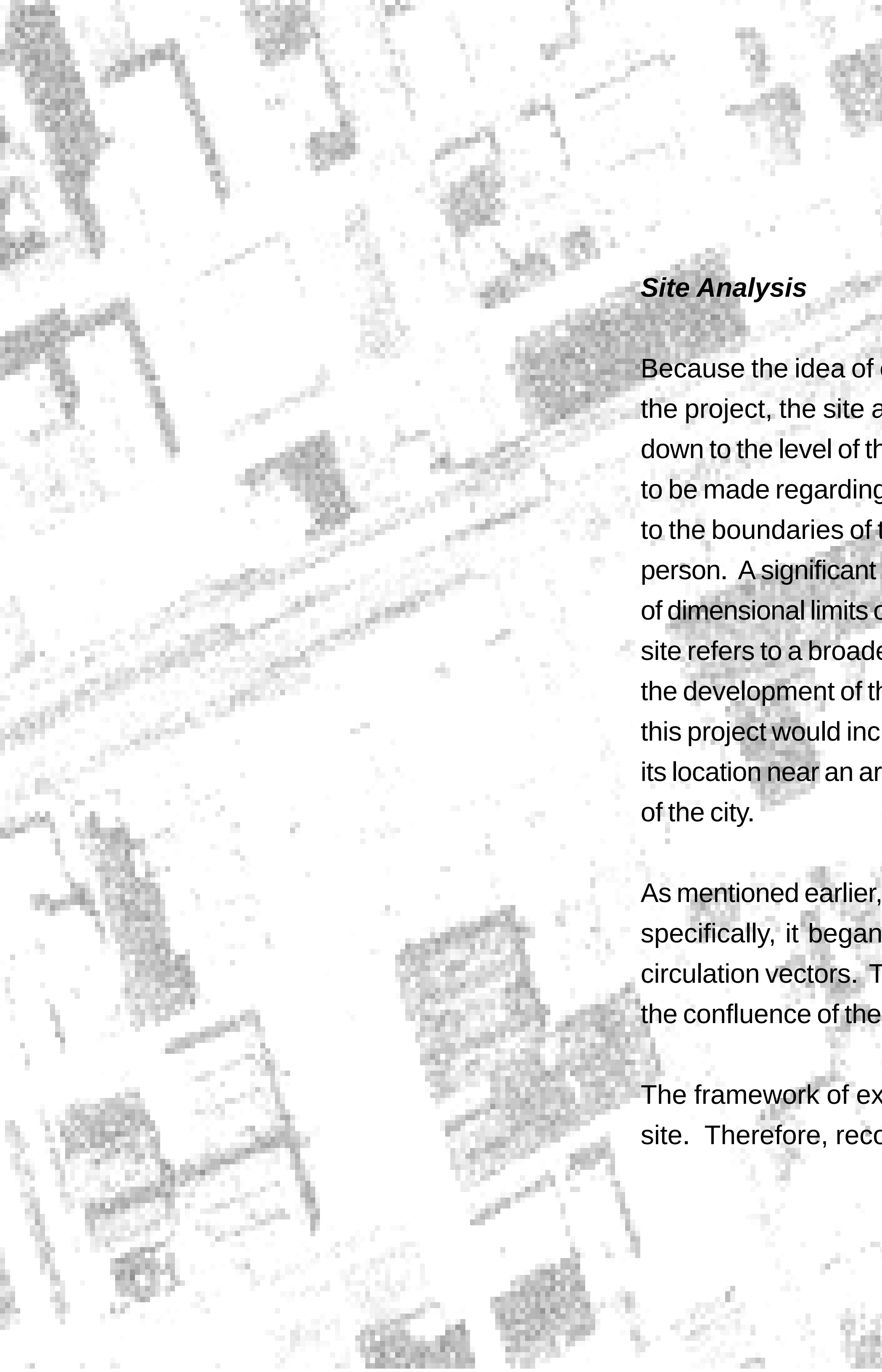


Photo of railroad at Woodward Avenue
Source: Author

Photo of railroad tracks west of site
Source: Author

Photo of building proposed for residential lofts
Source: Author

Photo of Amtrak train on Cass Ave. bridge
Source: Author



Site Analysis

Because the idea of confluence had the potential to exist on many different levels of the project, the site analysis started at a very broad scale and progressed in stages down to the level of the physical site and the station. At this point, a clarification needs to be made regarding the extents of the site. For this thesis, the physical site pertains to the boundaries of the site, as they would relate to the definition of land owned by a person. A significant impact of the physical site, upon the building design, is the setting of dimensional limits on the footprint of the building. On the other hand, the architectural site refers to a broader definition of site that includes the specifics of location affecting the development of the architecture. Conditions pertaining to the architectural site for this project would include the location in southeast Michigan, in the city of Detroit, and its location near an area defined as the New Center Area located in the Uptown portion of the city.

As mentioned earlier, the site analysis began at the level of the architectural site. More specifically, it began with the identification of Detroit as a confluence of vehicular circulation vectors. The analysis proceeded to the identification of the physical site at the confluence of the existing railroad tracks and Woodward Avenue.

The framework of expressway systems in Detroit has no direct confluence with the site. Therefore, recognition was given to the most likely vehicular vectors from the

Fig. 11 Vector from north I-75
Source: Author

Fig. 12 Vector from south M-10
Source: Author

expressways to the site. These vectors were assumed to travel from the closest expressway confluence with the city street framework and, following the direction of traffic for each particular street, arriving at the south end of the site (Fig. 11,12). The reasons for this location on the site are addressed later in a discussion regarding New Center Area Economic Development Plan ("New Center Plan").

Analyses were also done regarding bus circulation, an assumed taxi route around the site, and a framework for a pedestrian path (Fig. 13-15). A study of the existing and proposed zoning provided some magnitude to the pedestrian circulation (Fig. 16,17).

The layering of the circulation frameworks, coupled with the existing and proposed zoning studies, indicated that the intersections of Baltimore Avenue with Cass and Woodward Avenues are major concentrations of circulation events and, are considered major, city-level confluences (Fig. 18). The intersections of Amsterdam Street with Cass and Woodward Avenues have fewer pedestrians, primarily coming from proposed office parks and residential lofts south of the site. These intersections are considered minor, city-level confluences.

The city has developed the New Center Plan for this area affecting the manner in which some vehicular confluences are resolved. The New Center Plan calls for all new buildings to have their vehicular entrances into a site come from the east/west streets allowing the north/south facades to be uninterrupted by driveway connections.

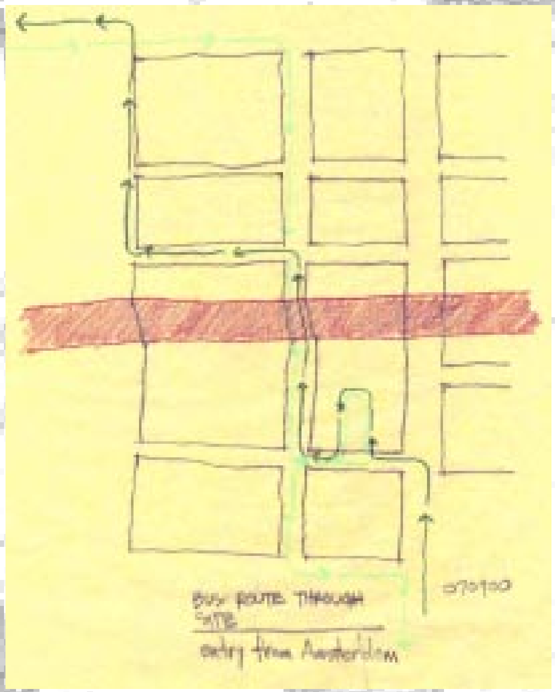


FIg. 13 Bus route through site
Source: Author

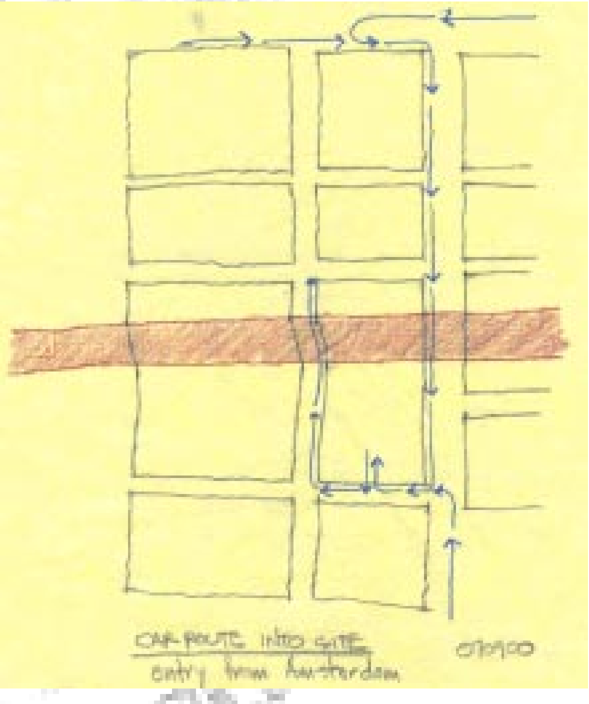


Fig. 14 Car route through site
Source: Author

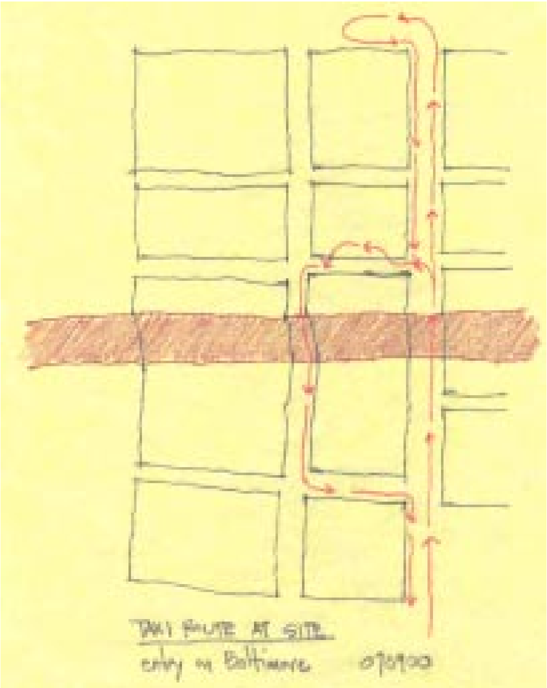


Fig. 15 Taxi route through site
Source: Author

Fig. 16 Zoning diagram
Source: City of Detroit & author

Fig. 17 Simplified zoning areas
Source: Author

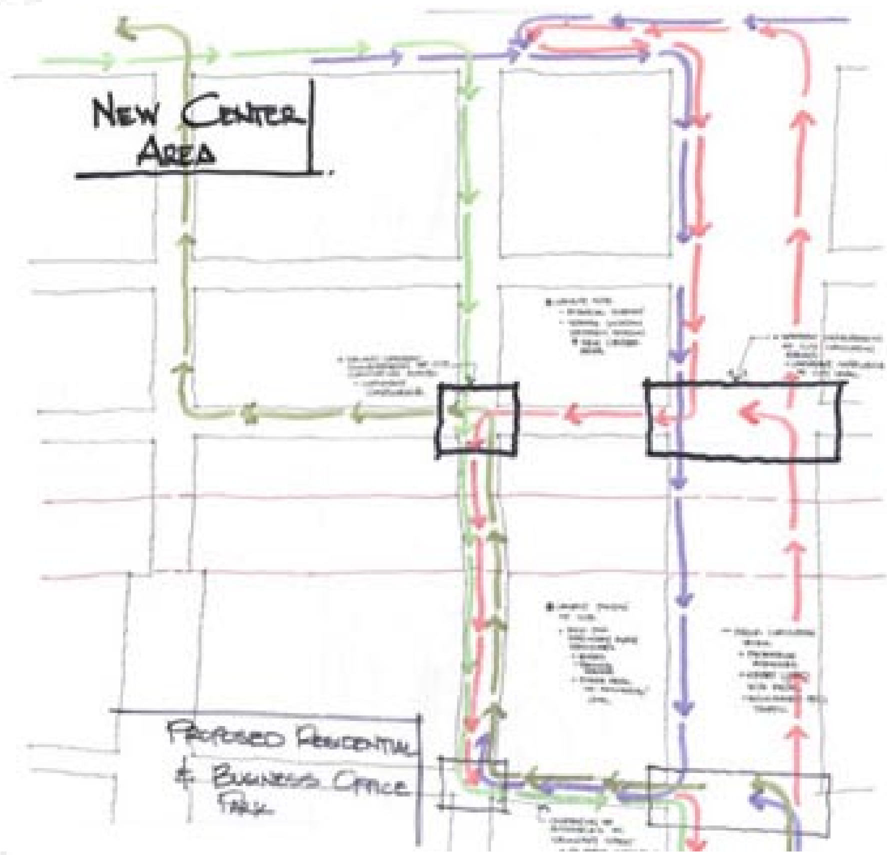


Fig. 18 Diagram of circulation confluences around site
Source: Author

The New Center Plan also calls for a conference center to be built within close proximity to the new intermodal transportation station (Fig. 19). The conference center location, with respect to such a highly traveled building, will help draw visitors to the urban Detroit area. For this investigation, the conference center is given a location with respect to the station because the center may be considered an anchor for a pedestrian vector within the station. However, the actual design of the conference center is beyond the scope of this thesis.

Fig. 19 New Center Plan
Source: New Center Area Council

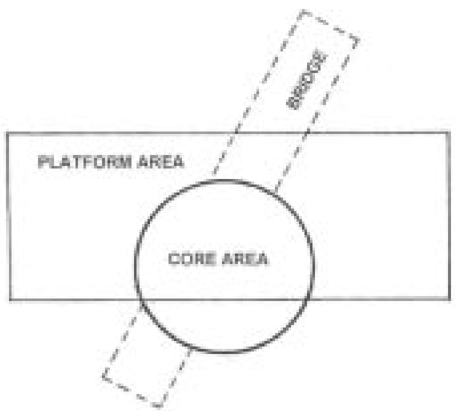


Fig. 20 Three areas of station
Source: Edwards,76

VIII. The Confluence of the Program

The simplest possible definition of a train station program is given in a book called *The Modern Station* by Brian Edwards. Edwards describes a train station as consisting of three basic areas (Fig. 20). The most significant area being the platform area where the pedestrian boards the train. The other two areas are the bridge and the core area. The bridge allows the pedestrian access to all of the platforms in the platform area. The core area is considered to be the center of the station (Edwards, 76) and for Edwards, the core area is an architectural element that is designed into the building. For this project, the core area is considered to be the confluence of bridge and platform areas. The location and volume of the core area is derived from this confluence.

In this investigation, the approach to programming to understand the confluences of events and their relationship to the architectural and structural resolutions which would help in directing the development of the building. The events are organized into a framework format to remain consistent with the project ideals. The programming frameworks are referred to as matrices throughout this document.

The organization of the individual matrices was divided into three sets of issues. First were issues relating to events use or function of the programmed element. Included in the event set of issues were the activities and relationships considered intrinsic to the particular programmed element.

The second set of issues considered in the matrices is volume. The word “volume” was used in place of the word “space” in order to specify that these issues were concerned with the three-dimensional accommodation of events. The word space was considered to have too many possible definitions. This set of issues is related to volumetric environments, qualities and surroundings. A program considering volumetric issues could have been done for each and every volume accommodating some event. For this project, though, the issues in this section pertain to all volumes within the building.

The third and final set of programmatic issues included in the matrices is relating to occupancy. This set may seem redundant since volumes accommodating events must be occupied, but the inclusion of occupancy, as a matrix element, is an attempt to understand a progression through time associated with most of the events. It was also an attempt to consider relative magnitudes associated with the circulation vectors.

The overall program is divided into three program matrices and each was programmed separate from the other. The first two matrices developed were the program for the station typology and the architectural site (Tables 1 & 2). These are developed first because they are typical programming considerations in any architectural design and usually cannot be separated. The matrix for the architectural site includes the specific condition of the physical site.

Table 1 Station typology program

Confluence of events

STATION TYPOLOGY PROGRAM	
Station is an integration or a confluence of transportational events.	Use/Function/Event
5 levels of event "rhythms of motion" exist within the composite volume of station (bus, car, pedestrian, train, vertical).	
Events possess their own, unique organizational frameworks.	
Non-circulation, stationary events will be considered additional program available to infill the volumes defined around transportational frameworks. Locations will be influenced by the frameworks of transportational events.	
Interior of station may be viewed as a "visual joint of event frameworks"	Volume
Spatially defining events dictate the vertical dimensions of a volume and indirectly dictate the vertical height of volume defining structural frameworks.	
Volume is defined to accommodate event	
Defined volumes are informed by an event's organizational frameworks.	
Event spaces will, by necessity, have further definition provided by walls and roof. The transparency of these partitions and their connections to structural frameworks may be informed by the event.	
Non-transportational events will be considered additional program available to infill the volumes defined around transportational frameworks. Locations will be influenced by the frameworks of transportational events.	
Events and space interact (positively, negatively or neutrally) upon intersection.	
Building is activated by the presence of people.	Occupancy
Occupancy is a product of the accommodation of events within space.	
An opportunity for different events to occupy the same volume but at different positions in time may alter the sense of intended occupancy about that volume.	

Table 2 Architectural site program

Location - existing volume/space
Boundary conditions - limits

ARCHITECTURAL SITE PROGRAM	
Architectural site is a territory within the city containing the physical site. Arch. site provides the context for the volume of the physical site.	**Event**
Physical site provides a volume inside of which further volumes may be defined to accommodate specific events.	(activities, relationships, people/users)
A confluence within the physical site (within the building) may also be a confluence within the architectural site. This allows the opportunity for a confluence between typological event frameworks and the cities' frameworks.	
An analogy exists between the site volume defined by city frameworks and architectural volumes defined by structural frameworks.	**Volume**
Existing condition of site is bisected by the railroad grade. Grade exists as a condition applied through the site volume and over the street volumes.	(spatial environment, spatial qualities, spatial surroundings)
Structural framework anchors its defined space to the physical site.	
Volume / space of site is traveled through.	
Volume / space of site is traveled through by occupants. (movement)	**Occupancy**
Physical site imparts a specific location (time & distance) to defined spaces and to the occupants within the defined spaces.	(time/motion, relative quantities, progression through time)

After the site and station programs were analyzed separately, these programs were then studied in combination for points of confluence. When confluent programming issues are identified, these issues are incorporated into both matrices. These confluent program issues were potential locations of resolution between the station and the architectural site, and are highlighted on the matrices.

A third program matrix is developed for the structural frame (Table 3). Since the structural frame is used to resolve the confluences between volumes accommodating events, it also needed studying. This matrix was initially developed as if the structural frame existed separate from the project, in order to identify those conditions that belong to the structural frame, as a generic element. The three matrices were then studied in combination for confluences between all three programs.

When confluences are identified, they are included on all of the matrices that are affected, and have been highlighted. The entire program consists of all three matrices tied together by confluent issues with potential to be significant points of resolution.

The programming phase also included spatial allocation (Table 4). Spatial allocation may be considered to be part of the station typology matrix. Once events within the building are identified, required square footage estimates are determined for each event. The square footages expected for the circulation events are simply determined as required widths, since the circulations are considered to be continuous between

Table 3 Structural frame program

Definition of event accommodation.

STRUCTURAL FRAME PROGRAM	
Structural framework is a "cooperation between the column and beam".	Use/Function/Event
Provides physical / elemental support.	
Station typology influences / informs the structural framework with a dialog dictating frame element locations.	
Ordering systems for structural frameworks may reflect the transportational events occupying the volumes defined by the structural frameworks.	
Structural frame is an initial definienta of space.	Volume
Structural frame is an anchor for space at the foundations of the frame.	
Organizational frameworks may inform structural frameworks.	
An indirect confluence exists between the structural frame within the volumes defined by the frame.	
Confluences of events indicate a volumetric confluence defined by structural frameworks which is in turn influenced by the confluence of events.	
Spatial and structural confluences exist in the transfer of occupants between transportation events. The three-dimensional flexibility of the structural frame can be used to resolve confluences between itself and events.	
The opportunity to redefine events within volumes defined by a structural frame is an innate quality of the frame (definition of modern space & design).	Occupancy
Movement, sensed by occupants primarily through vision, is pronounced when moving past regularly spaced objects implying that structural frameworks may reinforce the perception of movement through defined volumes.	
Occupancy within the interior of the station may impart a dynamic appearance within a static presence whether witnessed from the interior or exterior of the station.	

Table 4 Intermodal station spatial allocation

Intermodal Station Spatial Allocation

Spatial Use	Floor Area Req.	Volume Recommended
Arrival platforms	20'-25' x max. train length + 39'-4"	20' higher than height of train min.
Departure platforms	20'-25' x max. train length + 39'-4"	20' higher than height of train min.
Ticket sales area	5-8 windows 10 people	8' ceiling behind counter / 10'-15' at waiting area
Restrooms		
Mens	for 1000 ped. per level	min. 8' ceiling
Womens	for 1000 ped. per level	min. 8' ceiling
Administrative offices	to accommodate 40 people	min. 8' ceiling
Concourse area	30' wide pedestrian circulation min. / concourse is at confluence of bridge and platforms. Floor area will develop from confluence.	half the longest plan dimension min.
Leasable space (possible combination with other spaces or movable vending areas)	2000 s.f. avg. (spaces will develop out of void space in structural frame)	15' to bot. of deck above
Bus arrival area (including space for luggage unloading)	space for 12 buses incl. both city buses and long dist. buses	20' higher than bus to dissipate exhaust
Bus depot office	to accommodate 10 people	can be as low as 8' ceiling height
Taxi arrival area (including space for luggage unloading)	arrival area/drop off for 8 taxis	

confluences. Platform requirements are determined from suggested widths given in *The Modern Station*. With the program focus on circulation events, some square footages are not easily determined. The square footages required for resolutions of confluences were unclear at the beginning of the project. Therefore, early in the process, resolution square footages were decided to be the results of two or more circulation widths when the widths crossed each other or were confluent.

Most recommendations for square footages within the station came from references to European rail stations. Rail is a more popular form of transportation in Europe, which suggests why more references are written on rail stations in Europe than in the United States. Nevertheless, these references are considered to be qualified references for this study. Functional uses, such as the ticket sales area, the leasable spaces, administrative offices and the bus depot office are listed in these references as necessary to the development of a station. For this project, functional uses are considered to be stationary events and are not significantly influential events in comparison to the circulation events. However, during design, their support functions were recognized and were included in the list of required spaces, with simple suggestions as to the square footage required in each space.

In addition to the matrices, the programming process included a hierarchical ordering of the circulation vectors incorporated into the building (Table 5). The ordering is based upon the relative amounts of flexibility or amounts of accommodation each circulation

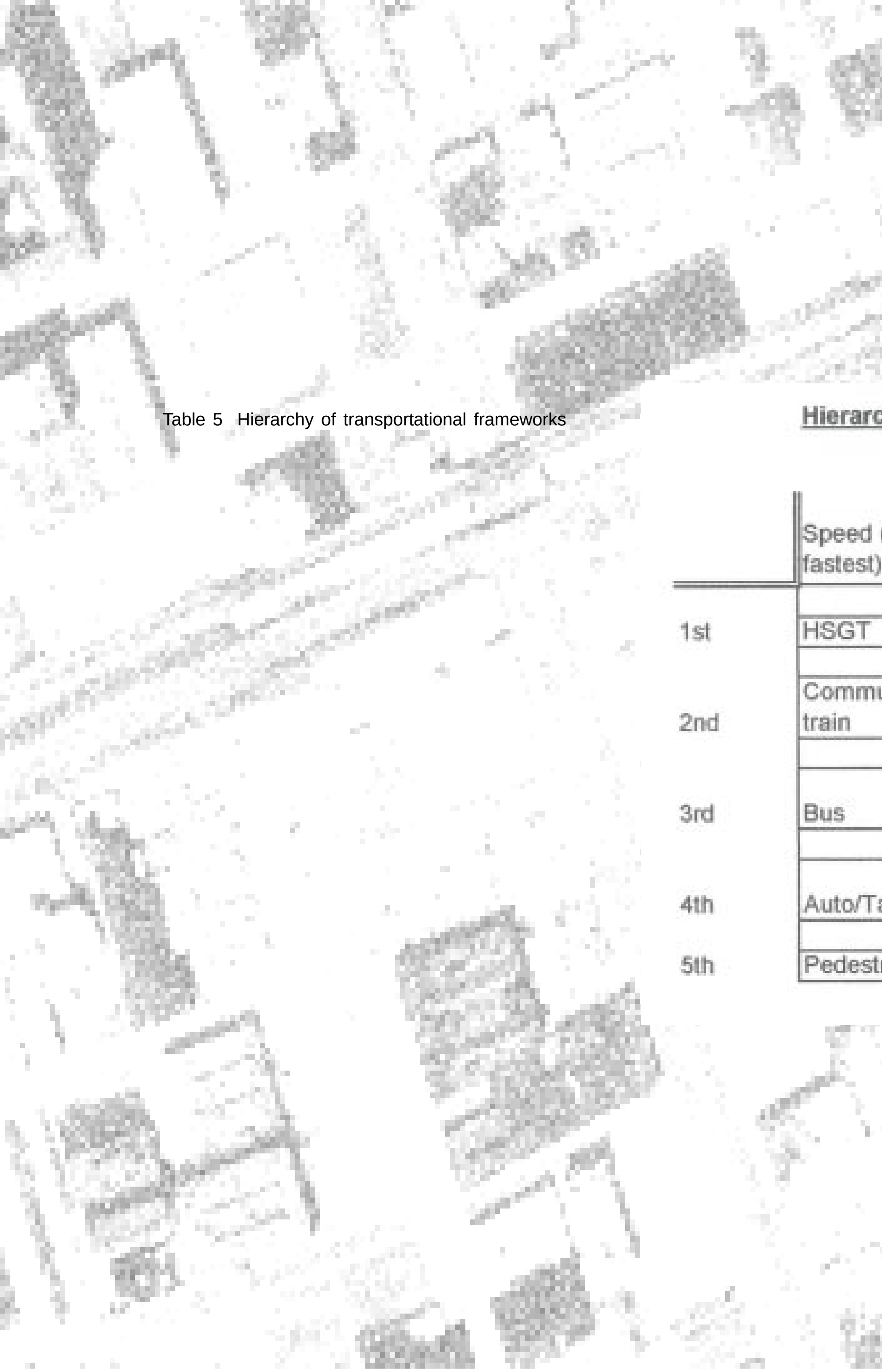


Table 5 Hierarchy of transportational frameworks

Hierarchy of Transportational Frameworks

	Speed (1st - fastest)	Isolated Direction (1st - most isolated)	Size (1st - largest)	Frequency of event (1st - most frequent)
1st	HSGT	HSGT	HSGT	Pedestrian
2nd	Commuter train	Commuter train	Commuter train	Auto/Taxi
3rd	Bus	Bus	Bus	Bus/Commuter train
4th	Auto/Taxi	Auto/Taxi	Auto/Taxi	Commuter train/Bus
5th	Pedestrian	Pedestrian	Pedestrian	HSGT

event could have when confluent with the other circulation events. Referring to the hierarchy matrix, the trains are the least flexible events with the pedestrian events being the most flexible. While the result is predicable, this information is, nevertheless, behind the organizational layout of the circulation frameworks.

Some support function events intrinsic to an intermodal transportation station exist within certain zones of the station without belonging specifically to the definitions of stationary or circulation events. These events are listed in *The Modern Station* as belonging to the Core or Confluence Area, the Platform area or within a “circulation zone”. A matrix containing these additional support events was developed; ordering the events with respect to the direction of the pedestrian vector (in or out of the station) on which they are encountered (Table 6). The additional support events listed in this matrix are not specifically identified on the final documentation of the project, because it was felt that their locations were flexible within their designated zones. Because they are listed as support for the station, though, recognition of their relative locations is needed in the programming phase.

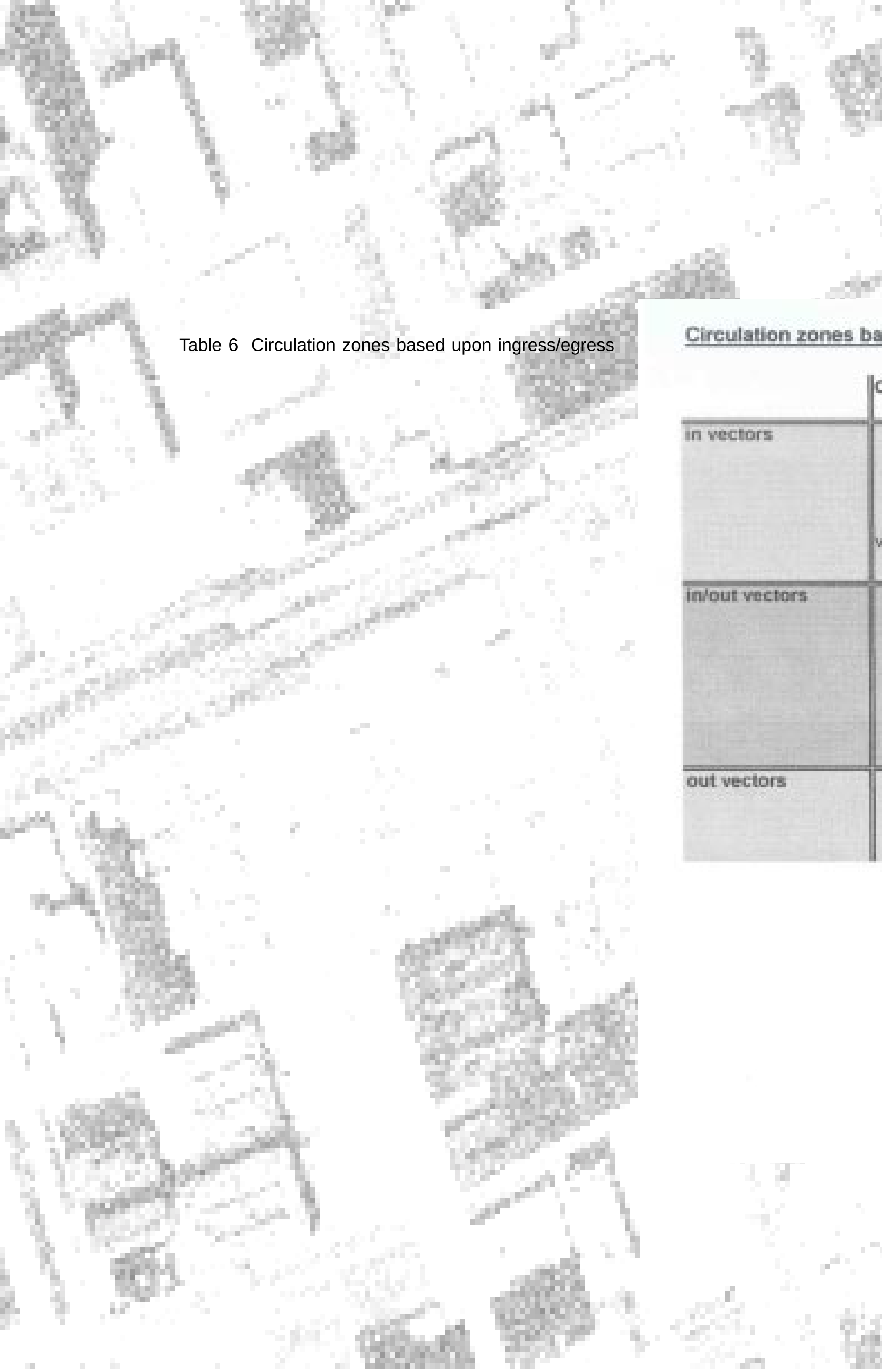


Table 6 Circulation zones based upon ingress/egress

Circulation zones based upon Ingress/Egress

	Core or Confluent Area Events	Circulation Zones (from *The Modern Station*, pg. 61-62)	Platform Area Events
in vectors	tickets	dwell areas for intending passengers (platform)	ticket control
	timetables (departures)	ticket info. areas (confluence)	train info. (arrivals)
	vending machines	toilets (confluence)	direction signage
in/out vectors	offices	cafes, bars, shops & bookstall (confluence)	shelters
	phones	telephone & office facilities (confluence)	litter bins
	bookshop/stores		seats
	toilets		
out vectors	travel info.	waiting areas (for meeting passengers (platform)	parcels point (pick up)
	timetables (arrivals)	tourist info. stands (confluence)	train info. (departures)

bridge

Events taking place on the bridge.

- ***pedestrian travel***
- ***conversing***
- ***train watching***
- ***eating & drinking (fast food)***
- ***impromptu & arranged meetings***
- ***reunions***

IX. Confluences of Events in the Organization of the Station

While the programming of this project may seem complex from the multitude of confluent ideas, the initial organization of the building is straightforward. Simply put, the zones of circulation requiring accommodation are located on the physical site with structural frameworks providing the volumes for each of the circulation events. The locations of confluence between the events are then resolved with the structural frame providing the flexibility of span that allows the confluences of event and structure to be resolved.

This section of the thesis describes the project in the same order as listed above. First, the pieces of the project accommodating events are described. The reasoning behind their locations is also discussed. The confluences and resolutions between the pieces are described next, in a progressive fashion, as a pedestrian would enter the confluence of the station from the city. Finally, one portion of the platform area is selected as an example of confluence and resolution in the structural frame. The specifics of the confluences and resolutions in the structural frameworks and in the required enclosure are described in this section of the document. This last discussion shows how the idea of confluence and its resolution is carried from the level of the city, to the station, and finally to the level of the building details.

The first decision regarding the location of events around the station was to locate the proposed conference center. The New Center Plan proposed that the convention center

Fig.21 Plan of diesel platform zone
Source: Author

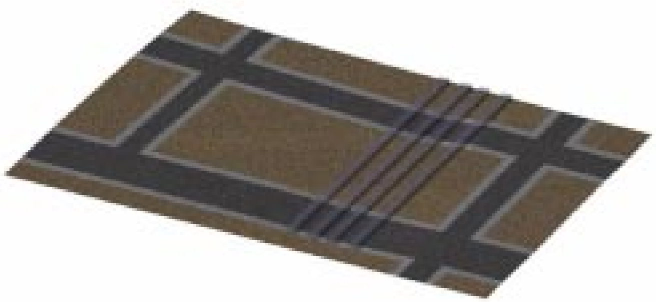


Fig. 22 Model of diesel platform zone
Source: Author

and the train station be part of the same building (Fig. 19). Because this project views the intermodal transportation station to be a significant resolution of confluence among the transportation frameworks of the city, it was felt that the station should be an independent resolution within the city. However, the idea that the station maintains a direct relationship to the conference center is retained. The intermodal transportation center is not only a confluence of transportation frameworks, but also a confluence of pedestrians, entering the station and the city from many locations across North America. For this reason, maintaining a social confluence with an event, such as a conference center, can only be beneficial.

As shown in the diagram, the tracks for diesel locomotives are located in the same position that they currently run on the site (Fig. 21, 22). A more central location on the site may have been optimal, but it was considered to be an excessive decision to move the tracks and their embankment such a small amount. The diesel locomotive vectors are expected to travel in both directions along the tracks, away from the site. Therefore, the zone of the required platforms is centered over the width of the site crossing the confluence of the station.

The diesel locomotive vector is the least flexible circulation framework in the programming phase, and is left at its existing location. The high-speed train vector is considered to be the second least flexible vector in the programming

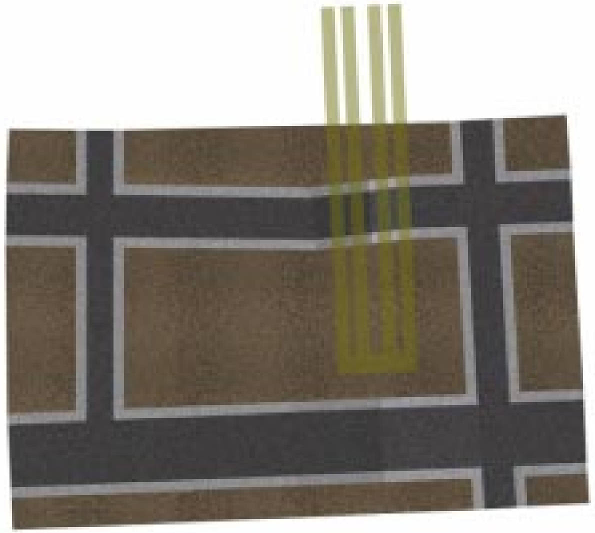


Fig. 23 Plan of high-speed platform zone Source: Author

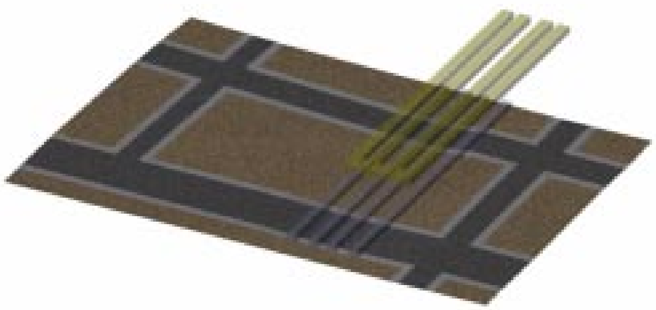


Fig. 24 Model of diesel & high-speed platform zones Source: Author

phase. If the high-speed platforms are located adjacent to the diesel train platforms, a considerable width would have been required across several sites, in addition to the project site, as the high-speed train vector traveled through the city parallel to the diesel train vector. The vertical flexibility of the high-speed train vector is exploited (Fig. 23,24) by locating it directly over the diesel train vector. According to the plan for the high-speed corridor, the high-speed train vector is expected to enter the station from the west and leave the station in the same direction. Therefore, the zone of the required high-speed platforms is positioned with one end at the center of the site and the confluences of the station, and extending it to the west.

The existing railroad grade separates the site into northern and southern sections, with the southern section considerably larger than the northern section. The separated impression is even more pronounced with the two train vectors stacked vertically. The size of the southern section makes it an ideal location for stationary events of substantial size. It is also an ideal location for the automotive and bus garages. The stationary events are discussed later.

The bus vector is the next least flexible vector. The bus garage is located on the southern section of the site and is an event that is both a circulation event

Fig. 25 Plan of automotive garage Source: Author

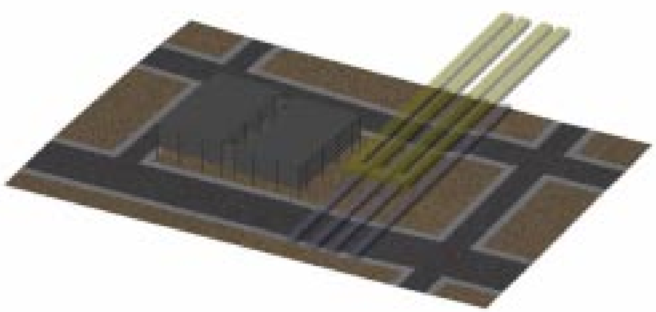


Fig. 26 Model of platform zones & garage Source: Author

and a stationary event. The travel of a bus is a circulation event, yet the parking or garaging of the bus is a stationary event. To satisfy both conditions, the garage is located as a stationary event, but is designed as a U-shaped circulation vector. The New Center Plan dictates that vehicular access come off Amsterdam Street. Therefore, the entrance is off Amsterdam and the vector loops back before it reaches the tracks. The exit is also onto Amsterdam Street. The vector deviates only slightly from the level of the street, due to its relative inflexibility.

The automotive garage is also located on the southern section of the site (Fig. 25, 26). Similar to the bus garage, the automotive garage is both a circulation event and a stationary event. It is located as a stationary event but designed as rotating circulation vector, allowing an entrance and exit on Amsterdam Street. The rotating vector spirals around a center core (Fig. 27, 28). The core is used as a vertical circulation vector and confluence between the bus garage and the automotive garage. This confluence is the focal point for the bridge event.

Fig. 27 Plan of garage core Source: Author

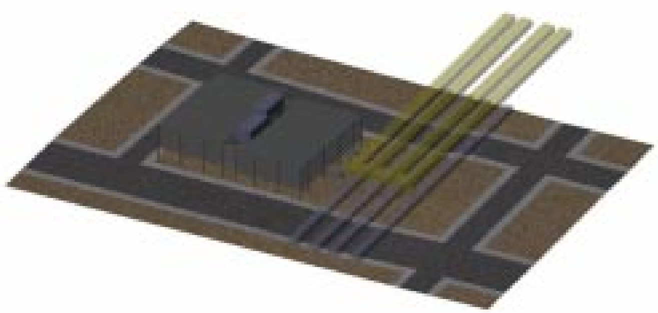


Fig. 28 Model of platform zones, garage, & core Source: Author

The side-by-side layout of the garages and the tracks was influenced by the Lisbon Expo 98 station designed by Santiago Calatrava. Here (Fig. 29, 30), the bus garage is at the level of the street and the automobile garage is located below. Pedestrians from both of these events proceed along a vector perpendicular to the tracks and up to a concourse or confluent area just below the tracks. From there, the pedestrians then proceed up to the platform level.

For the Lisbon project, Calatrava had a site approximately one hundred feet wider than the Detroit site, with no allowance for events along the adjacent street facades. In this project, due to the far narrower garage, the automobile and bus vectors spiral around the center core in order to orient the pedestrian. The pedestrian then uses the core as both a vertical circulation vector and a confluence. This confluence is between the parking garage and an extension of the bridge event, which is noted later.

The bridge event is a pedestrian event placing it in a hierarchical category of being one of the most flexible events (Table 5). However, it is also one of the three main elements listed in *The Modern Station* as crucial to the program of a station, so the bridge location, with respect to the other events, is crucial to the project.

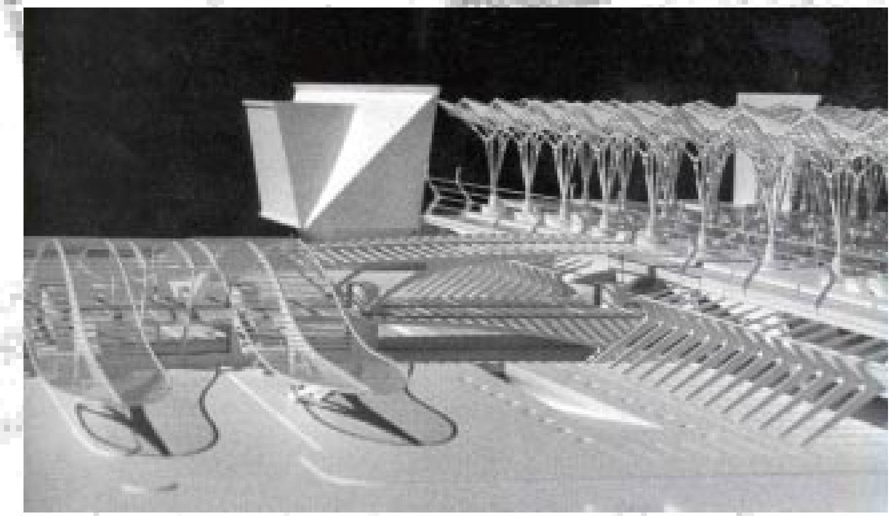


Fig. 29 Photo of Lisbon Expo 98 site model
Source: Binney, 88

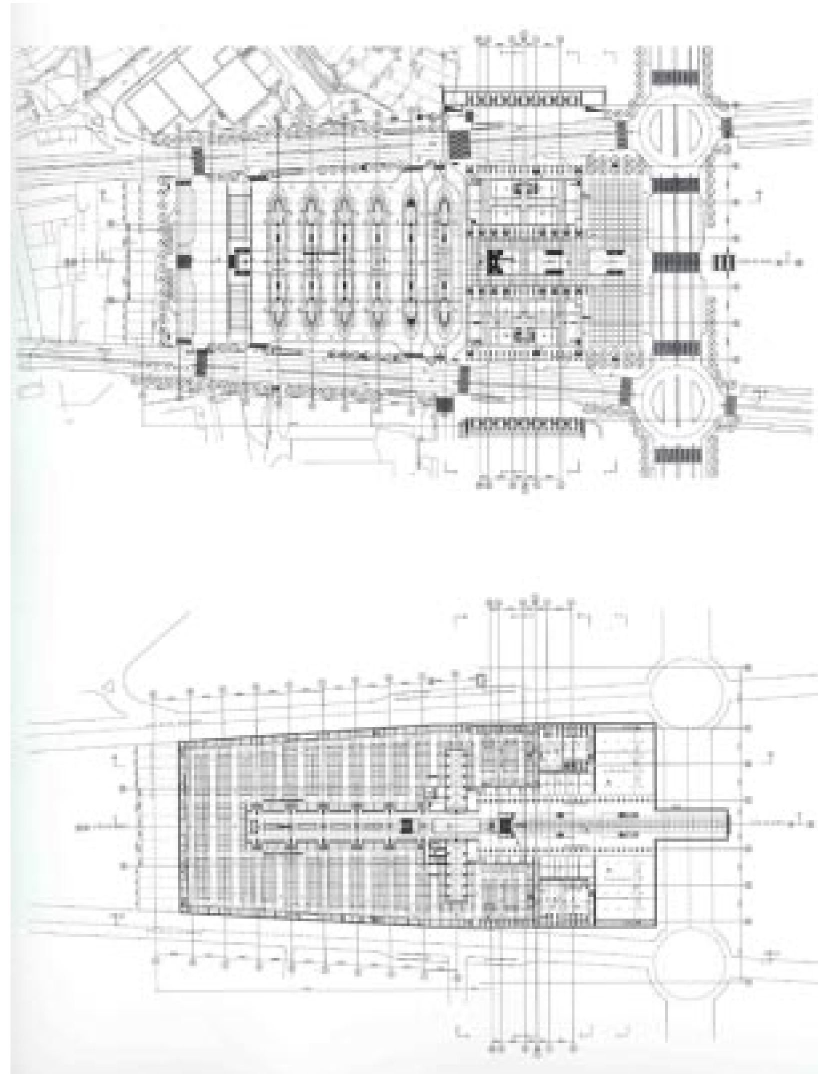


Fig. 30 Plans of Lisbon Expo 98 bus platform level & car parking level
Source: Binney, 90

Fig. 31 Plan of bridge zone Source: Author

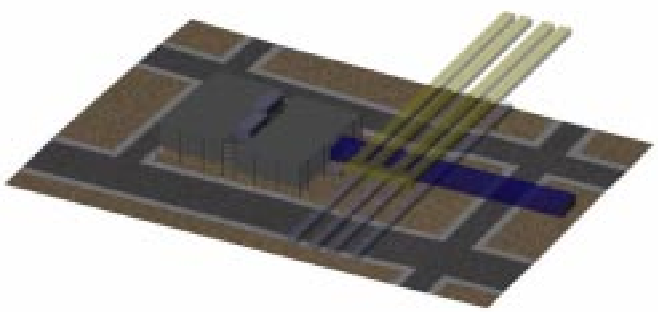


Fig. 32 Model of platform zones, garage, core, & bridge Source: Author

The bridge is the point at which the pedestrian crosses the train circulation event from events on one side of the tracks to events on the other. In this case, the events at either end of the bridge are the overlapped frameworks of the automobile and bus on the south side, and the proposed convention center on the vacant lot north of the station. The bridge is located between the centers of the conference center site and the center of the tracks on the physical site, ending at the face of the automobile garage (Fig. 31, 32). Extensions of the bridge then continue down into the garage and end at the garage's confluent core, creating a pedestrian vector from the conference center to the garage.

As mentioned earlier, some stationary events are considered in the layout of the station confluence on the south side of the site. Recognition was given to a proposal for developing residential lofts and an office park to the southwest of the station site (Fig.18). To address this proposal, and keep the station confluent with its support of travel, a nine-story hotel is proposed for the southwest corner of the site (Fig. 33, 34). The actual design of this hotel is beyond the scope of the thesis. However, the form is diagrammed on the architectural drawings and the hotel is expected to be confluent with pedestrian vectors, not only from Cass Avenue, but also from the automobile and bus garages. These are located directly behind the hotel.

Fig. 33 Plan of stationary event zones Source: Author

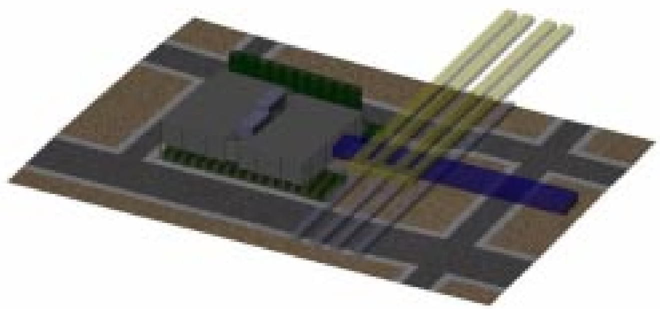


Fig. 34 Model of platform zones, garage, core, bridge, & stationary event zones Source: Author

The other stationary event, located on the south side of the physical site, is a strip of retail use along Woodward Avenue (Fig. 33, 34). The actual design of this strip is also beyond the scope of the thesis. However, it was felt that a portion of the site supporting the station remain confluent with the planned zoning of the area (Fig. 16) promoting the pedestrian vector along the Woodward façade of the station.

To summarize the basic layout of the circulation frameworks on the site, the train vectors and their respective zones of pedestrian platforms are directly above each other, in the location of the current train vector passing through the site. The automobile and bus frameworks are adjacent to the tracks and the south side of the site with entrances and exits on Amsterdam Street. The garages are flanked by the stationary events of a hotel to the west and a retail strip to the east, making the site development confluent with the proposed context. The pedestrian bridge spans across the train framework from the confluent core of the garages to the proposed conference center north of the station (Fig. 34).

Because the station is composed of horizontal layers of circulation, there is a need for vertical circulation vectors for pedestrians between the layers. Towers, similar to large elevator shafts, are used to designate these points of vertical circulation. Because the vertical circulation vectors connect

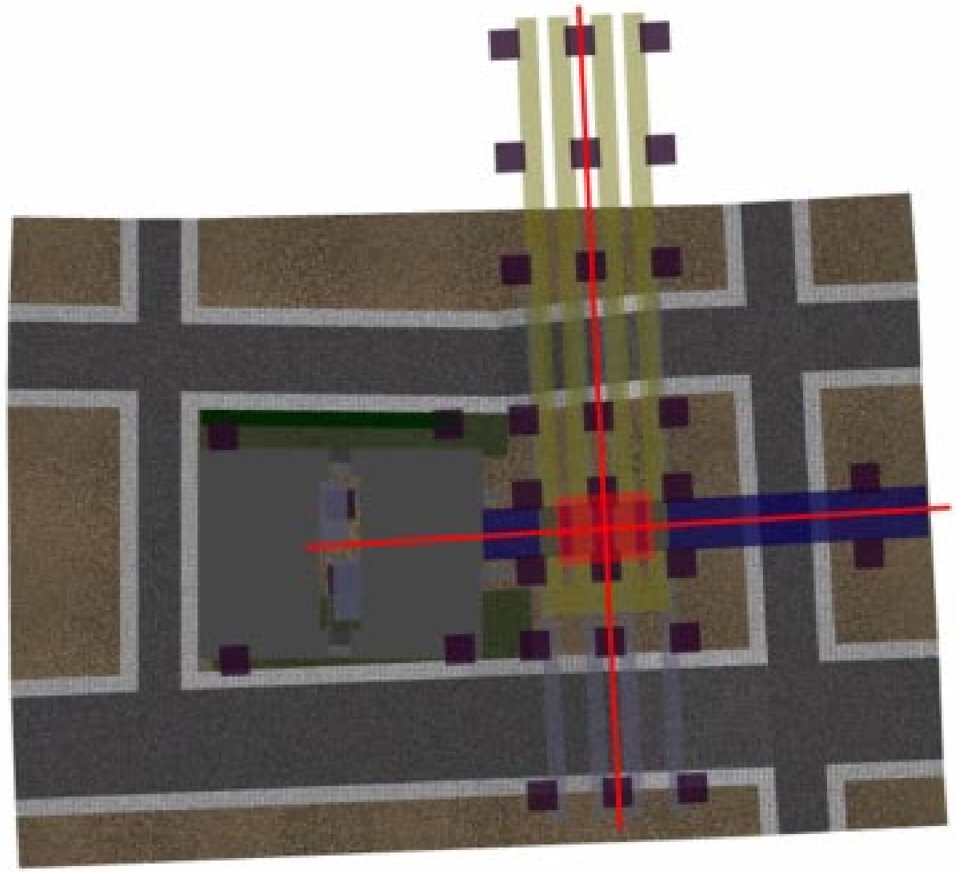


Fig. 35 Diagram of major circulation vectors & location of confluence
Source: Author

different layers or levels of circulation frameworks, they can also be considered points of confluence between the levels (Fig. 36).

The locations of the towers are based upon a regular, square grid placed over the site. The spacing of the grid and the actual locations of the towers are set after a process of trial and error . Because the towers are intended to be confluent between several different horizontal layers of circulation frameworks, their locations had to resolve the track location, the garage core, and egress requirements to the streets for the garages and the station. Basing the locations of the towers on a regular grid is intended to bring some confluence to the unrelated frameworks of the automobile, bus, trains and pedestrians using one ordering system. An additional intent is to make the towers landmarks within the station and the city (Fig. 37).

The idea of using regularly spaced vertical circulation towers was inspired by the Lille-Europe station. Jean-Marie Duthilleul used evenly spaced escalators, elevators and staircases to allow pedestrians access to the platforms close to their respective coaches. The elevator towers are shown in the left side of the photo (Fig. 38).

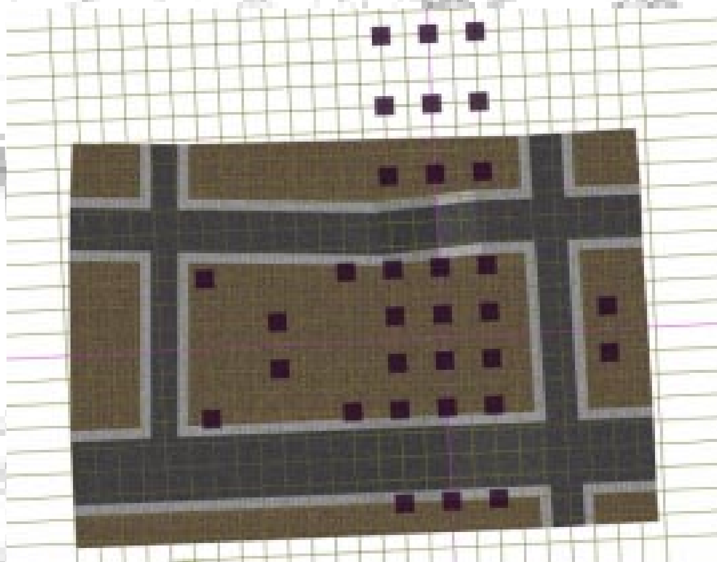


Fig. 36 Plan of tower locations Source: Author

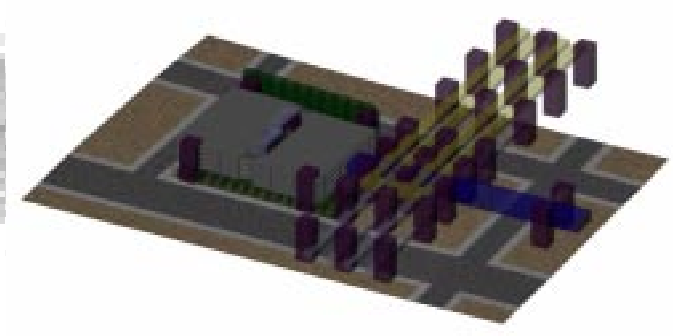


Fig. 37 Model of all circulation event zones Source: Author

Rem Koolhaas uses an elevator tower as a type of landmark or anchor in his design for the Espace Piranesien at the entrance to the Lille-Europe station (Fig. 39).

Fig. 38 Photo of Lille-Europe concourse & elevator towers
Source: Binney, 30

Fig. 39 Photo of elevator tower in Espace-Piranesien
Source: Binney, 28

X. Architectural Resolution of Event Confluences

In order to understand the flow of events in the station and the series of confluences encountered as a pedestrian enters the station, the procession of events is described next, beginning at the existing event confluences in the city and then progressing to the center of the station. Egress from the station would be along the same vectors, but in opposite directions. The inward progression of the pedestrian leads the discussion from the scale of the city down to the architectural detail.

The progression can start from any one of the several modes of circulation. Because the bus and automobile lead to the same confluence at the garage core, the description begins there.

Once a traveler has arrived at either garage, he then takes either of the central confluence towers or the northern most garage towers to a lobby area suspended in the garage. This lobby area is considered a resolution to the minor confluences of pedestrians entering the southern end of the station (Fig. A.1--see Appendix).

The pedestrians on the sidewalks also arrive at the lobby confluence area. A resolution is made between the city confluences of the corners of Amsterdam Street and the vertical circulation towers adjacent to these corners. The sidewalk pedestrians proceed

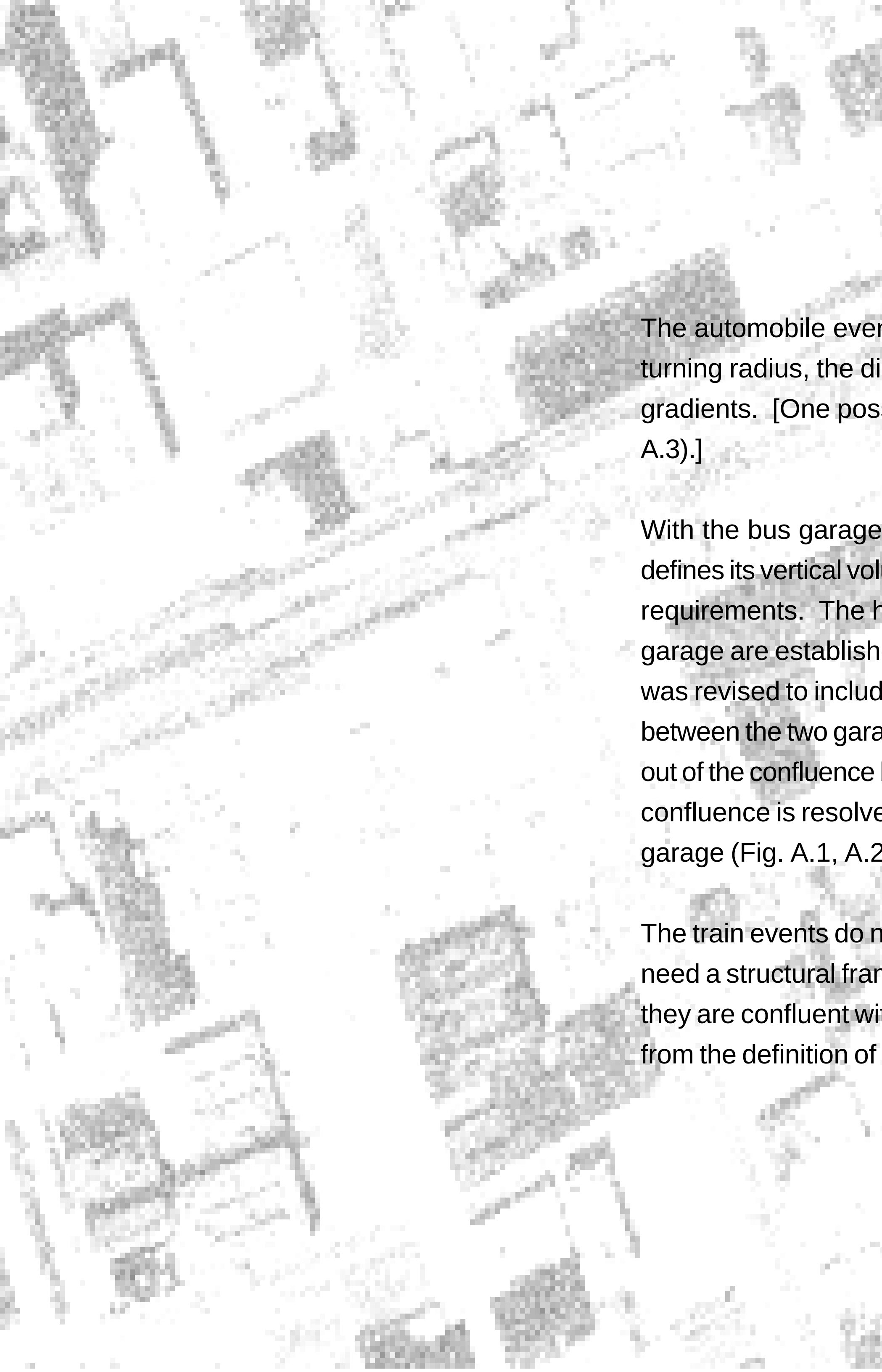
from the towers up an elevator or escalator to suspended walkways over the bus garage and arrive at the lobby confluence area (Fig. A.2).

From the northern end of the site, a resolution is made with the city confluences indicated at the corners of Baltimore Avenue. These confluences proceed up escalators to the vertical circulation towers adjacent to the bridge. For elevator access, the towers are open (to the elevators) at the bottom (Fig. A.1).

The taxi vector wraps around these two towers for access to the vertical condition and to the conference center.

Once the pedestrians are at the lobby confluence on the south side of the station, or at the bridge confluence with the towers on the north side of the station, they proceed along the same line to the major confluence of the station, where the bridge becomes confluent with the train frameworks. The line of progression is diagrammed in Fig. 35 and the architectural floorplans are shown in Fig. A.1 though Fig. A.4.

The volumetric conditions for each circulation event is established so that the confluences could be resolved architecturally. The structural frameworks which support the events define the volumes selected. They are not meant to be perfectly accommodating volumes. The only expectation is that the volumes accommodate the events and are defined by planar structural frameworks.



The automobile event volumes are based upon the requirements of an automobile turning radius, the dimensional requirements for parking spaces and limits on ramp gradients. [One possible result is the parking garage designed for this project (Fig. A.3).]

With the bus garage located below the automobile garage, the automobile garage defines its vertical volumetric limit. The width is defined by bus turning radii and parking requirements. The height of the bus garage and the lower levels of the automobile garage are established in order to adequately ventilate the bus exhaust. The height was revised to include clearances for the enclosed pedestrian walkways suspended between the two garages. The spacing of the structure in the bus garage is developed out of the confluence between the bus event and the automobile garage structure. This confluence is resolved with transfer beams along the column lines of the automobile garage (Fig. A.1, A.2).

The train events do not actually require a defined volume in which to “park”. They do need a structural framework as physical support, but only require a defined volume if they are confluent with a pedestrian event in the station. This defined volume comes from the definition of the adjacent pedestrian platforms in this project.

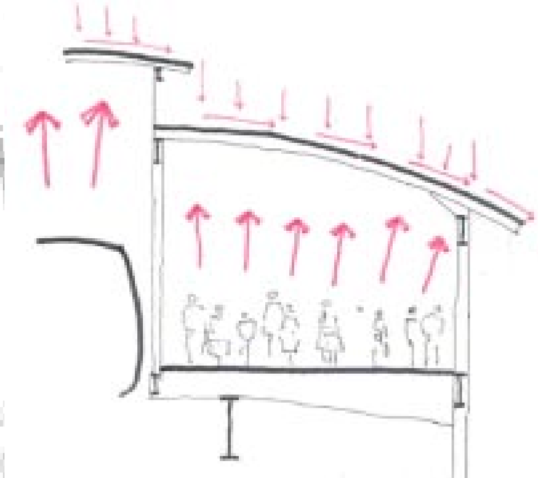


Fig. 40 Diagram of implied forces on barrel vault
Source: Author

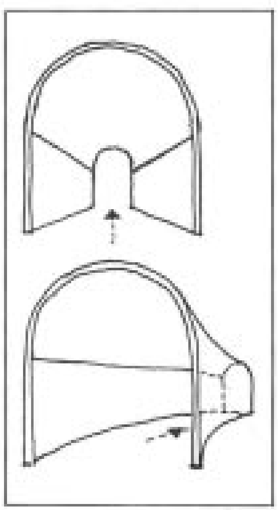


Fig. 41 Expression of movement under barrel vault Source: Thiis-Evensen, 328

The widths of the pedestrian event volumes were described previously in the programming section of this document. The longitudinal spacing of the structural framework for these volumes is the same for all of the pedestrian events and was intended to relate to a pedestrian scale. At 20 feet, the spacing is probably closer than is typical for the types of events being supported, but some relation to a pedestrian scale is necessary for this investigation. The closer spacing also reduces the relative member sizes down to a pedestrian scale. As mentioned earlier, the structural frameworks defined for this project are not intended to be perfect.

The top of the pedestrian volume, or the roof volume, is defined by a barrel vault. This form was selected to shed water and to express the “pressure” from the pedestrians inside the volume (Fig. 40) and as an archetype. Thiis-Evenson describes the archetype as expressing an image of forward movement (Thiis-Evenson, 329) (Fig. 41). For the archetypical reason of expressing forward movement, the barrel vault was retained for all pedestrian volumes, including the bridge and the escalator enclosures.

The two platform structural frameworks have different starting points for their progression of spacing. The high-speed train framework spacing starts at the eastern most set of vertical circulation towers that lead to the high-speed platforms. They are not centered between the limits of the site, since the high-speed train is not centered on the site. The diesel train platform and its structural framework are centered between the limits of the site, since the diesel train passes through the site. This causes the structural frameworks of the platforms to be shifted off of each other longitudinally. The resolution of the structural confluence arising from the shift is described later.

The structural framework of the bridge is centered on the confluence of the bridge and the train vector. Since the bridge is not specifically anchored by an event at either end, the structural framework of the bridge is centered at the confluence.

The defined volume for the vertical circulation towers requires a description. As a shaft, the entire volume is a definition of a vertical confluence between the platform levels. However, the shaft is not a tube, but a framework of four L-shaped columns (Fig. A.9). Separated in this way, the tower is a framework of columns defining a volume, similar to the horizontal circulation volumes being defined by the planar frameworks. The framework of columns can seen as a series of small columns or as a larger single “tower” column anchoring the many frameworks of the station.

The confluences between events and, consequently, the confluences between the volume-defining structural frameworks are resolved through manipulation of one or more of the structural frameworks involved in the confluence. The manipulations used are simple: a structural member can be removed to create necessary square footage, the frame may be reordered to span the event, or a substitution of a structural member in one framework may be made for a member in another confluent framework. The last manipulation occurs primarily at the towers where the tower takes the place of one or more columns in confluent frameworks.

The towers resolve most confluences between pedestrian events, as the pedestrian vectors pass between platforms. However, a major pedestrian confluence exists at the intersection of the bridge with the entire train circulation framework. This confluence is resolved as if there are only two circulation vectors involved: one along the direction of the bridge and the other along the direction of the trains (Fig. 35). In this case, the barrel vault bridge collides with the high-speed platforms and encompasses all the events in the confluence. Therefore, the bridge barrel vault volumetrically resolves the confluence.

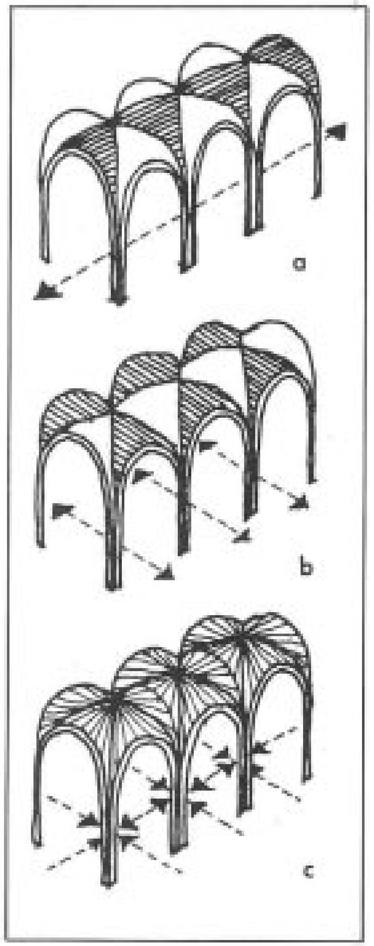
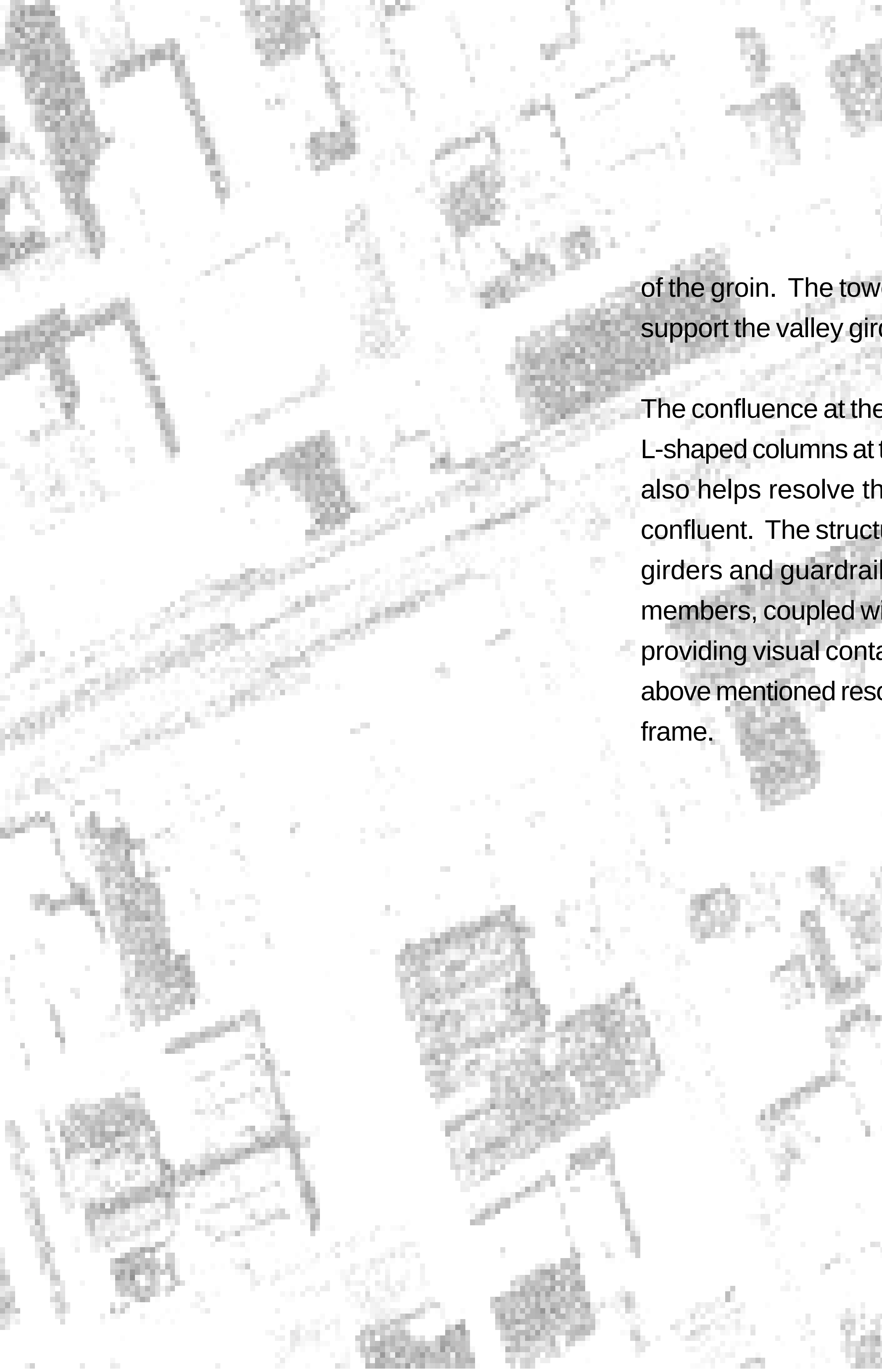


Fig. 42 Bi-directional & focusing intentions of groin vault
Source: Thiis-Evensen, 332

However, leaving the resolution this way would have created the impression that the bridge event had a hierarchical superiority over the train and platform events. This location is the one point of the project where an element is added that is not specifically influenced by one event. This element is the barrel vault with its axis parallel to the platforms (Fig. A.6, A.7). This additional barrel vault is intended to address all the events of the trains and the platforms. It also emphasizes the confluence at the center of the station by developing a groin vault between the two roofs. Thiis-Evensen notes that the groin vault is an architectural element that emphasizes the intention of a space to be bi-directional and centering at the same time (Thiis-Evensen, 332) (Fig. 42). The groin vault is resolved structurally by two girders with shallow radii along the valleys



of the groin. The towers, acting as columns at the four corners of the groin vault, then support the valley girders.

The confluence at the station's center is additionally emphasized by the removal of the L-shaped columns at the center of the confluence (Fig. A.3). The removal of the columns also helps resolve the additional volume required when pedestrian events become confluent. The structural frameworks of the high-speed platforms are reduced to plate girders and guardrails at the main confluence (Fig. A.6). The reduction of structural members, coupled with the openings cut into the floors in the center of the confluence, providing visual contact with all of the events flowing into this one volume. Each of the above mentioned resolutions are realized through manipulations of the flexible structural frame.

XI. Resolution of Event/Structure Confluences

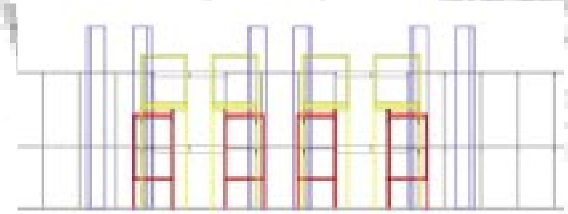


Fig. 43 Superimposed planar platform frameworks
Source: Author

Fig. 44 Model of platform framework resolution Source: Author

This thesis is intended to be a study of confluences and their resolutions in architectural and structural design using an intermodal transportation station as the means for the investigation. The project investigation allows for design analysis to be applied to transportation frameworks down to the architectural details. In this case, since the structural frame is the element being used to define the limits of architectural volumes. The architectural details are the members and connections of the structural framework. For this investigation, the circulation and structural frameworks of the platforms are used as an example of the resolution of confluence between a structural framework and an event framework and also an example of the resolution of confluent forces in the structural frame.

Beginning with the resolution between the structural and event frameworks, the design of the platforms started with the two platforms being supported by separate, simple planar frameworks of columns and beams (Fig. 43). Since the trains are stacked one above the other, the platform frameworks are superimposed on top of each other. A consequence of the superimposition is a conflict between the volumes defined for the platform events and the structural framework for the other platform. Resolutions of the confluences are derived through manipulations of the individual frameworks (Fig. 44). These manipulations also produce additional confluences of forces in the structural frameworks, in addition to those apparent in the simple column and beam frame. The internal, force confluences of the structural frameworks are discussed later.

Starting at the top of the station, with the high-speed platform, and following the flow of forces to the ground, the inner most column of the high-speed platform would normally be in confluence with the events below it. Removal of the column and the use of a cantilevered beam to support the column (Fig. A.8) achieve a resolution of the confluence. Also apparent in the section (Fig. A.8) is the support for the cantilevered beam. As shown in the section through the high-speed platforms (Fig. A.7), this column is part of the framework when no events are programmed below the high-speed platform. However, this row of columns does become confluent with the concourse event. This confluence is resolved with a transfer girder (Fig. A.8). The towers, again acting as columns and shown in the Concourse Level plan (Fig. A.3), support the girders.

A confluence between the platform frameworks also exists longitudinally due to the shift in the two column spacings. The confluence is apparent in the section and elevation details (Fig. A.8) and is resolved through a system of three transfer beams that become confluent again with the columns of the diesel train platform.

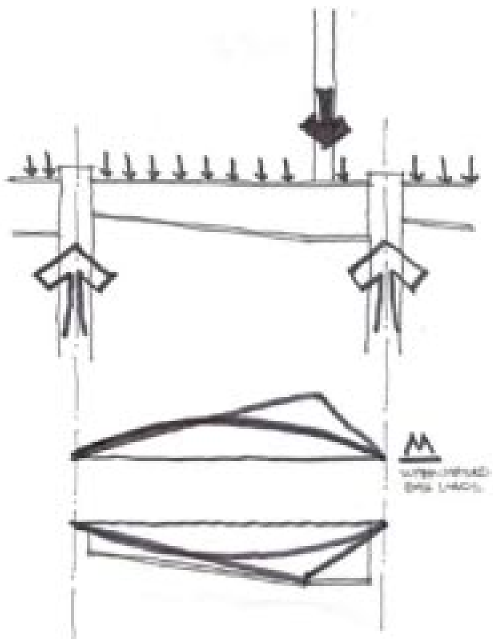


Fig. 45 Resolution of force confluence within high-speed platform transfer beam
Source: Author

XII. Indication of Resolutions within Structural Frameworks

A secondary objective in this investigation was that an occupant be able to recognize locations of confluence and the subsequent resolutions, not only in the organization of the station, but also within the structural frame. For this reason, some resolutions were designed to make their influencing forces and resolutions apparent.

An example of the attempt to make the design of the resolution apparent shows in the support of the outside columns of the high-speed platforms (Fig. A.9). As mentioned earlier, these columns are supported by transfer beams. In most typical conditions, transfer beams are simply selected as a straight, rolled steel beam. In this case, however, the transfer beam, as part of the resolution, is built up and tapered to express the result of the eccentric column loading. As shown in the diagram, the intent is to follow the resulting internal stresses due to the confluence of forces (Fig. 45). The connection of this beam to another transfer beam attached to the column is also intended to express the results of the confluence. The gusset plate is shaped to reflect the expected flow of forces and to fit all three beam conditions entering into it. Further, the flanges of each longitudinal transfer beam are slotted onto the gusset plate to express their integration with the connection.

Another example of resolution of a confluence of forces within the structural framework is the transfer beam over the service entrance (Fig. A.8). Here, the beam itself acts as the resolution rather than the resolution coming from a connection. The column for the diesel train platform framework is confluent with the center of the service event. The confluence is resolved through the use of a transfer beam. With the column confluent with the center of the beam, the resolution is actually within the beam itself. This transfer beam is also intended to express the resolution of the internal stresses due to the confluence of the loads of the column and floor above the beam and the reactions of the columns at the ends of the beams (Fig. 46).

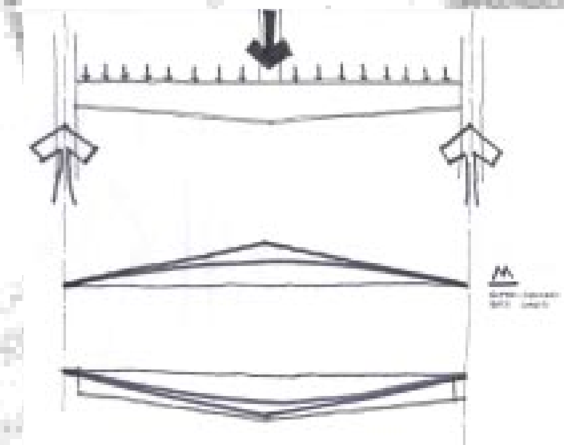


Fig. 46 Resolution of force confluence in service entrance transfer beam
Source: Author

The resolution of the confluence between the structural frameworks and the ground is a resolution that is not fully considered in this investigation. The focus is primarily on confluences within the frameworks. The resolution to the ground could potentially have an infinite number of possibilities depending upon the soil, the structural material, potential events on either side of the confluence, etc. The resolution on this project was simply to make the confluence apparent. The structural material changes from steel to concrete as the frame reaches the ground (Fig. A.8). The structural members are encased in the concrete to give the appearance of the structural frameworks being “socketed” or “fixed” to the ground. The concrete foundations, when viewed over the entire station, give the appearance of a base or plinth upon which the station rests (Fig. A.7).

XIII. Additional Conditions of Confluence and Resolution within the Station

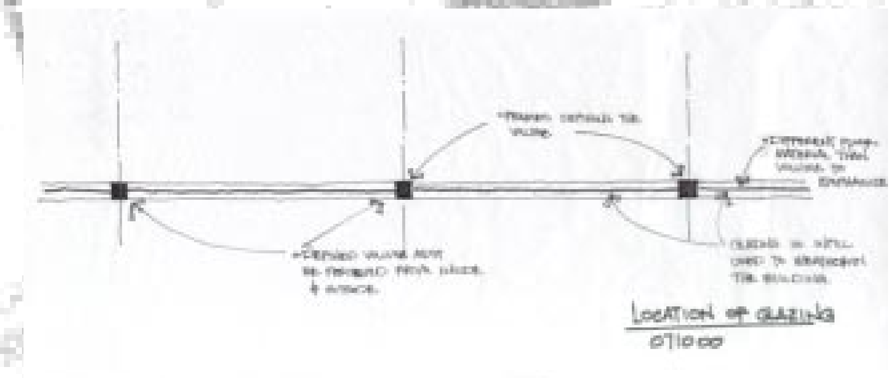


Fig. 47 Glazing location
Source: Author

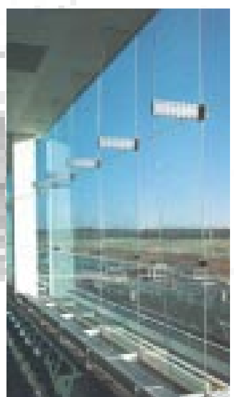


Fig 48 Photo of structural glass system
Source: Pilkington Glass Limited

Enclosing the station with some type of skin was not an initial consideration in this thesis. However, enclosure is necessary in architecture. The selected skin for the station needs to retain the appearance that the volume definition and resolution of confluence come from the structural frame and not the skin.

When defining any volume, the definition of that volume is apparent from both the inside and the outside of the volume. In order to prevent the appearance of the skin being the defining element, from either the inside or the outside of the volume, the skin must be placed on the centerline of the structural frame (Fig. 47, A.8) allowing the structural frameworks to appear as the more dominant architectural element.

Initially, the skin material was intended to be any type of infill material, as long as it was located on the centerline of the structural framework. To support the idea that the station is a confluence of transportational events within the city, the appearance of the events from outside the station is considered necessary. The selected skin for the station is a structural glass system supported by structural glass mullions (Fig. 48). Using an all-glass system allows the skin to dissolve visually, and celebrates the activity of the interior events and the importance of the structural frameworks.

Fig. 49 S. Pancras Station platforms
Source: Fletcher, 1125

Fig. 50 Santa Justa Station platforms
Source: Binney, 98

The details of the structural glass system were intended to follow the same idea of confluence and resolution as does the frame system. There is no architectural ceiling within the station where the head connection of the glass can be hidden. Hiding this connection is a typical detail at the head of the system. To resolve the confluence between the mullions and the beam at the head of the glass system, a gusset plate is used (Fig. A.9). The gusset plate is shaped to follow the expected flow of wind load forces from the mullion to the beam. A similar detail is used at the jamb with a gusset plate at an angle. The sill detail is not as apparent in its resolution of confluent forces, due to the necessity of a floor system under the mullion. To compensate, no horizontal glass frame or support is used along the bottom of the glass system. This emphasizes the structural framework at the sill.

An argument may be made for a building's confluence with its typological history. Regarding a building's imagery throughout history, a person's impression or memory of the appearance of a building, as influenced by its history, may also make the historical, memory confluence a cultural one. Many modern stations retain imagery from older stations (FIg. 49, 50). There may be a personal comfort for occupants when a building resembles its cultural history.

The facades under the ends of the barrel vault, aligned with the platforms, are completely

Fig. 51 Concourse of Pennsylvania Station
Source: Copplestone, 312

left open to glass (Fig. A.6). The large window, illuminating the central space of a train station, is similar to some of the concourses in historical stations such as Pennsylvania Station in New York (Fig. 51). Allowing light in to the central confluence or concourse of a station makes manifest the confluence of activity. It also indicates a visual confluence with the environment outside the station.

The ends of the station are also glass, letting light stream in the ends of the platforms and suggesting a confluence between the occupant and his destination at the other end of the rail.

“Light, especially natural light, has the benefit of focusing attention on important spaces, such as booking halls, or of leading passengers towards platforms and entrances.” (Edwards, 98)

The station expresses a societal confluence in the emphasis of the central confluence of events. The station, as a building, is the resolution of the confluence of the major transportation circulation frameworks in the City of Detroit. The groin vault is the emphasis, as one major volume, where pedestrians from all walks of life come together in the city and then disperse. This cultural confluence of the station could be an active and vibrant social space within the city.

Afterword

With an investigation of this size, reflection upon the completed project is clearer than during the process. A couple of significant questions arose regarding the approach used to investigate the idea.

One significant question pertained to the exclusive use of only circulation events to organize the building. People tend to circulate between specific places or locations. Without designing specific locations, as anchors, within the station, circulations occur between circulations. This approach works fine when circulations cross and a definite confluence is present. However, when the circulation vectors are directionally parallel, the area of confluence is not clear. The platforms are actually events that are both circulation and stationary allowing for confluence and its resolution to occur dynamically.

At the beginning of this investigation, additional square footage was expected to be gained from areas between the circulation volumes that were expected to develop as the seemingly different circulation frameworks were superimposed on the site. This expectation lead to questioning the basic approach of the investigation. That question refers to the regularity or possible need for irregularity in the circulation frameworks.

Most of the circulation frameworks within the building respond to the city's transportation frameworks, which are rather regular and rectilinear around the area of the site. The

result is a regular and rectilinear organization of the station, allowing for the formation of the structural frame. If the circulation frameworks within the station were organized around a more irregular system or site, confluences between the frameworks may have become more apparent.

The impression of the towers acting as a unifying confluence between the unrelated circulation frameworks may also have been more apparent had the circulation frameworks been more irregular and the tower organization remained on a regular grid.

An additional study of structural frameworks and their relationship to event volumes may be a worthwhile investigation. In the station, most of the structural frameworks are ordered loosely around pedestrian movement, with all of these frameworks possessing the same rhythm. The result is that the only difference between the structural frameworks is relative height, direction and starting point of the framework's spacing. A study of relationship between the event, requiring accommodation, and the specifics at the structural frame defining the volume for the event, may have resulted in very different frameworks for each of the pedestrian events in the station. With this result, an occupant of the station may actually begin to witness different locations in the station possessing different volume definitions. As a consequence, the confluences and subsequent resolutions between these forces may have become even more apparent and a more dynamic experience.

Finally, as mentioned in the thesis resolve, a secondary objective of this investigation is the implicit or indirect reinvigoration of planar structural frameworks in architectural design. This objective is only beginning to be met by this project. The flexibility of the structural frame may also become more apparent in the resolutions of the confluences expressed above. When used to resolve complex confluences, the abilities and resolutions of the structural frame may be utilized and hence reinvigorated as a way of creating an understanding a vibrant, dynamic architectural design.

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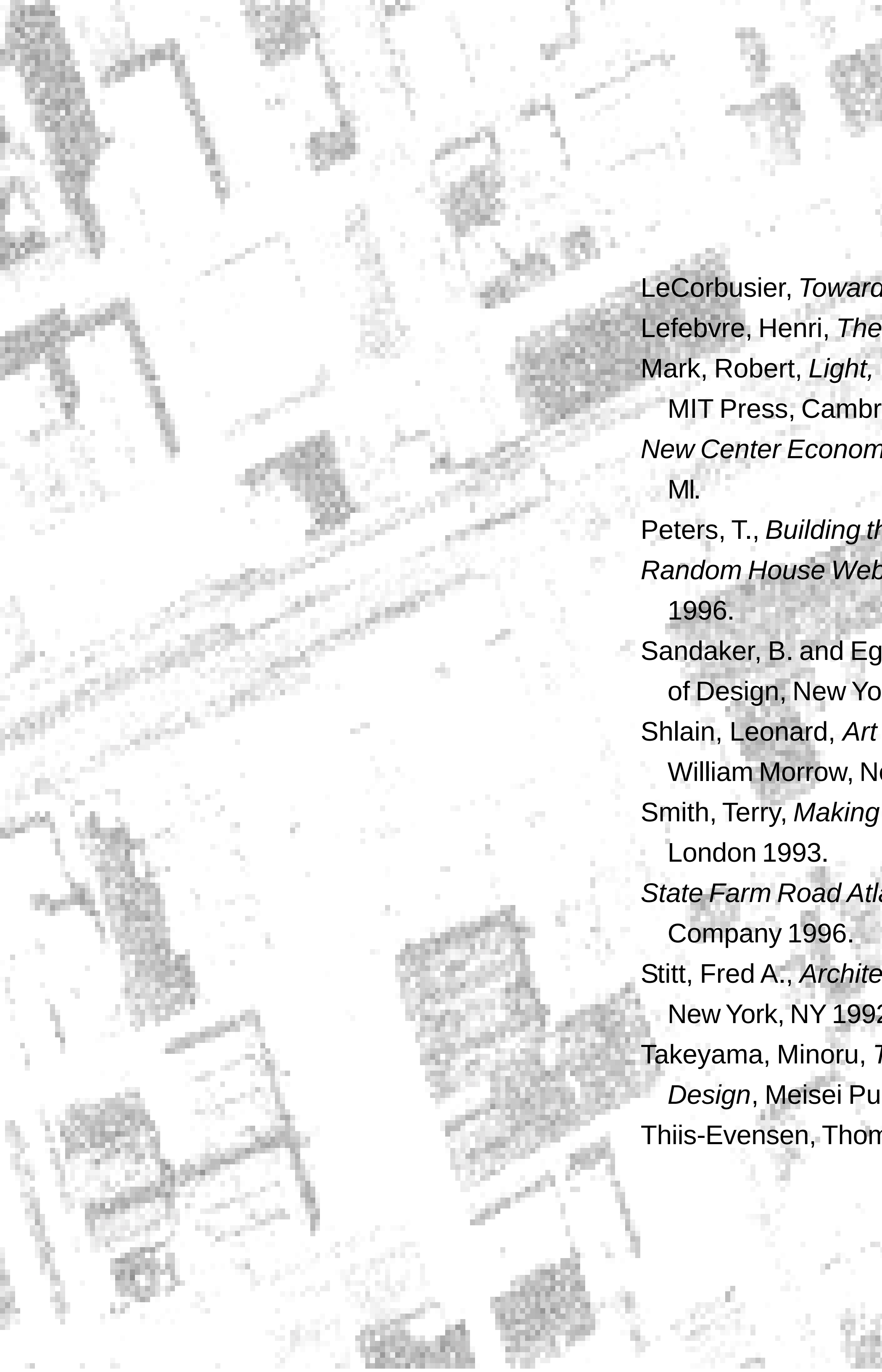

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Appendix

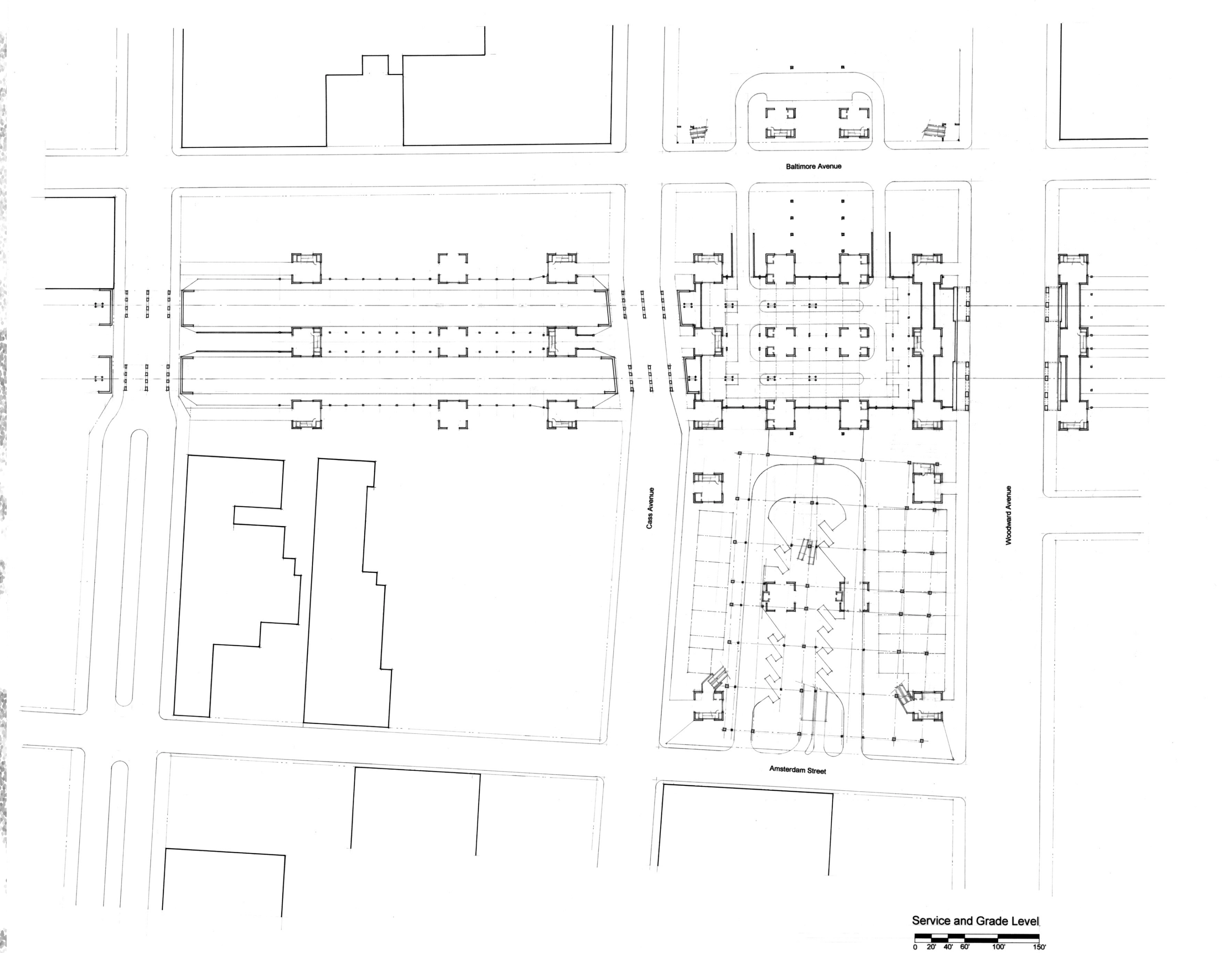


Fig. A.1 Service & grade level

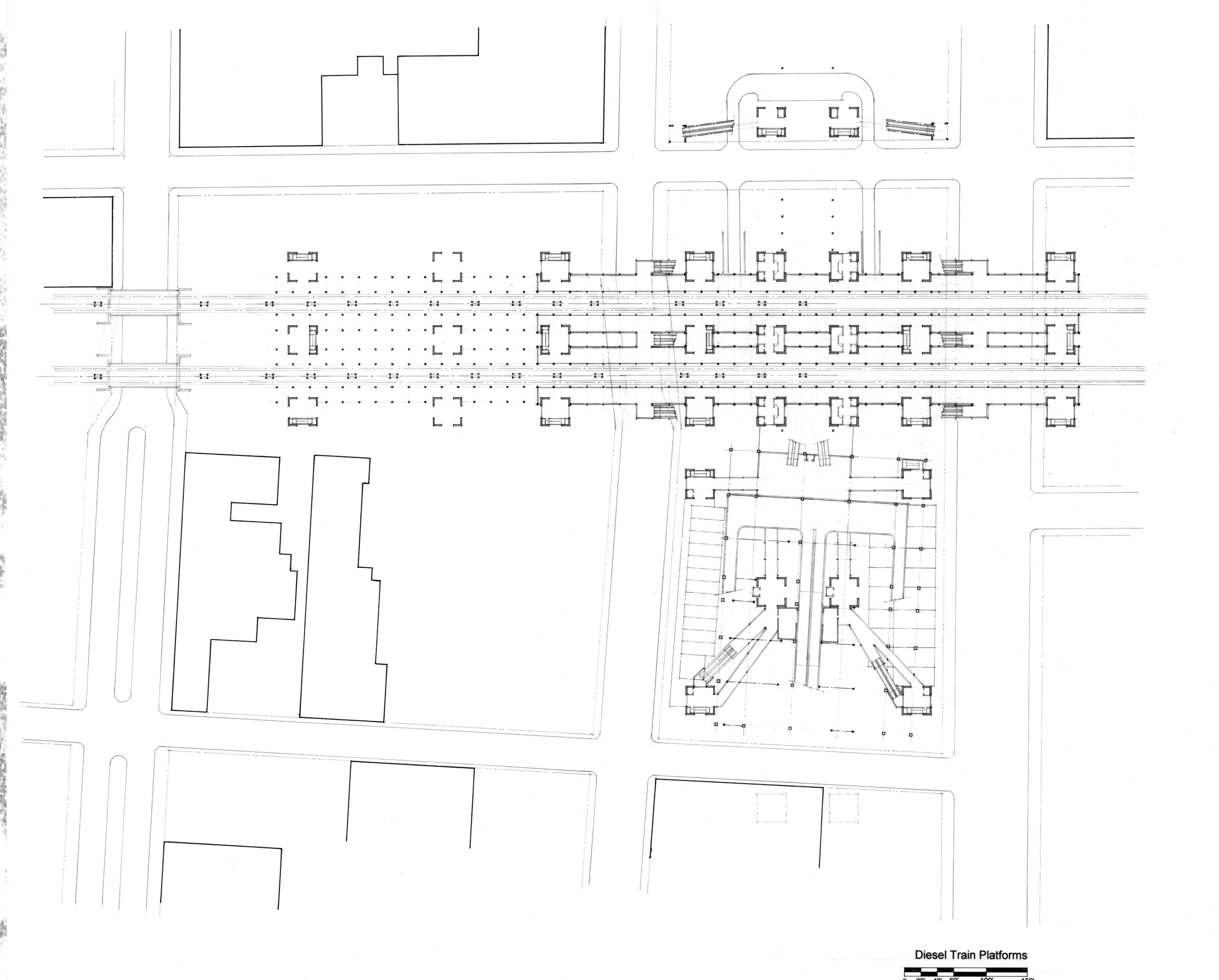


Fig. A.2 Diesel Train Platforms

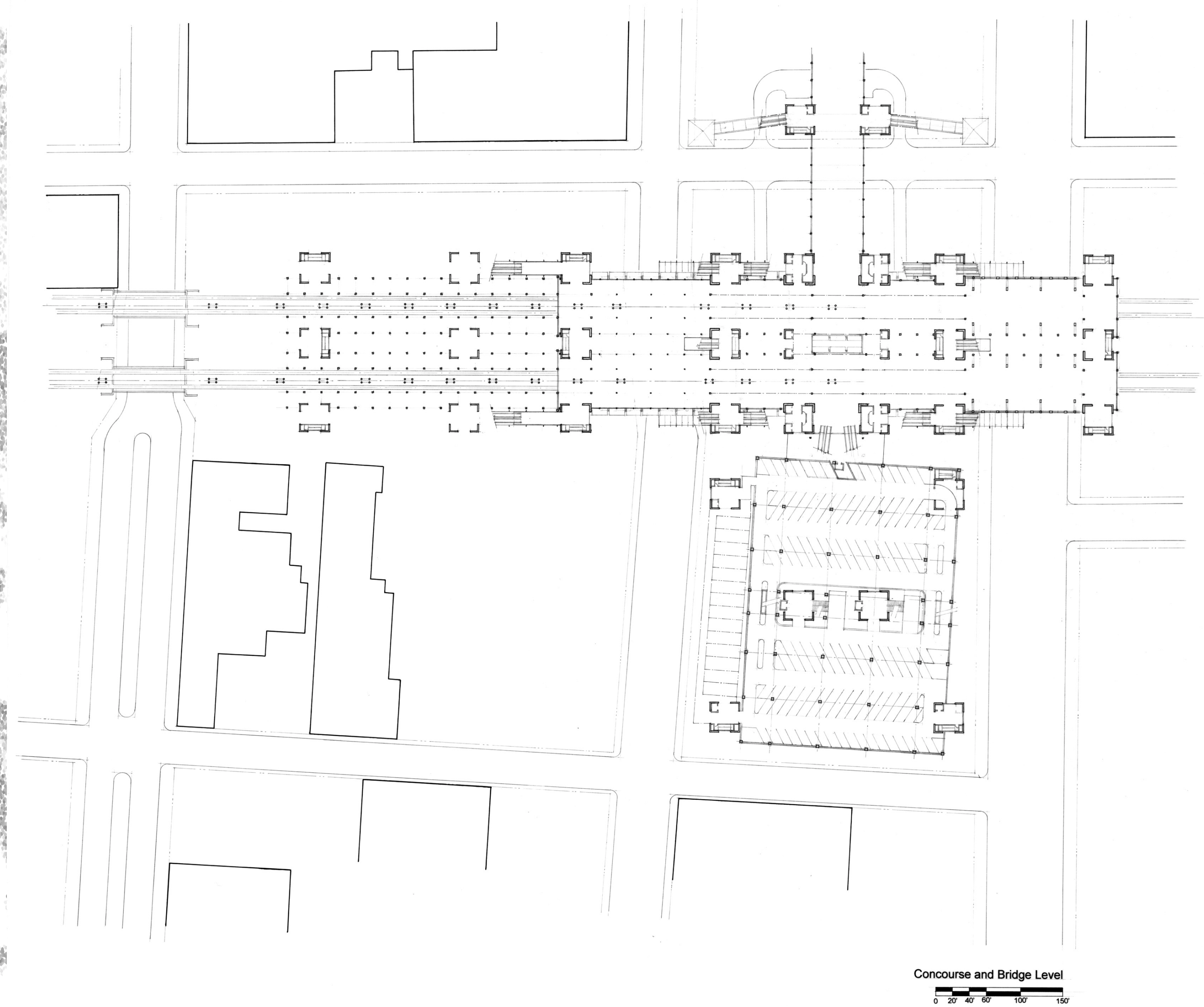


Fig. A.3 Concourse & Bridge Level

Fig. A.4 High-Speed Platforms

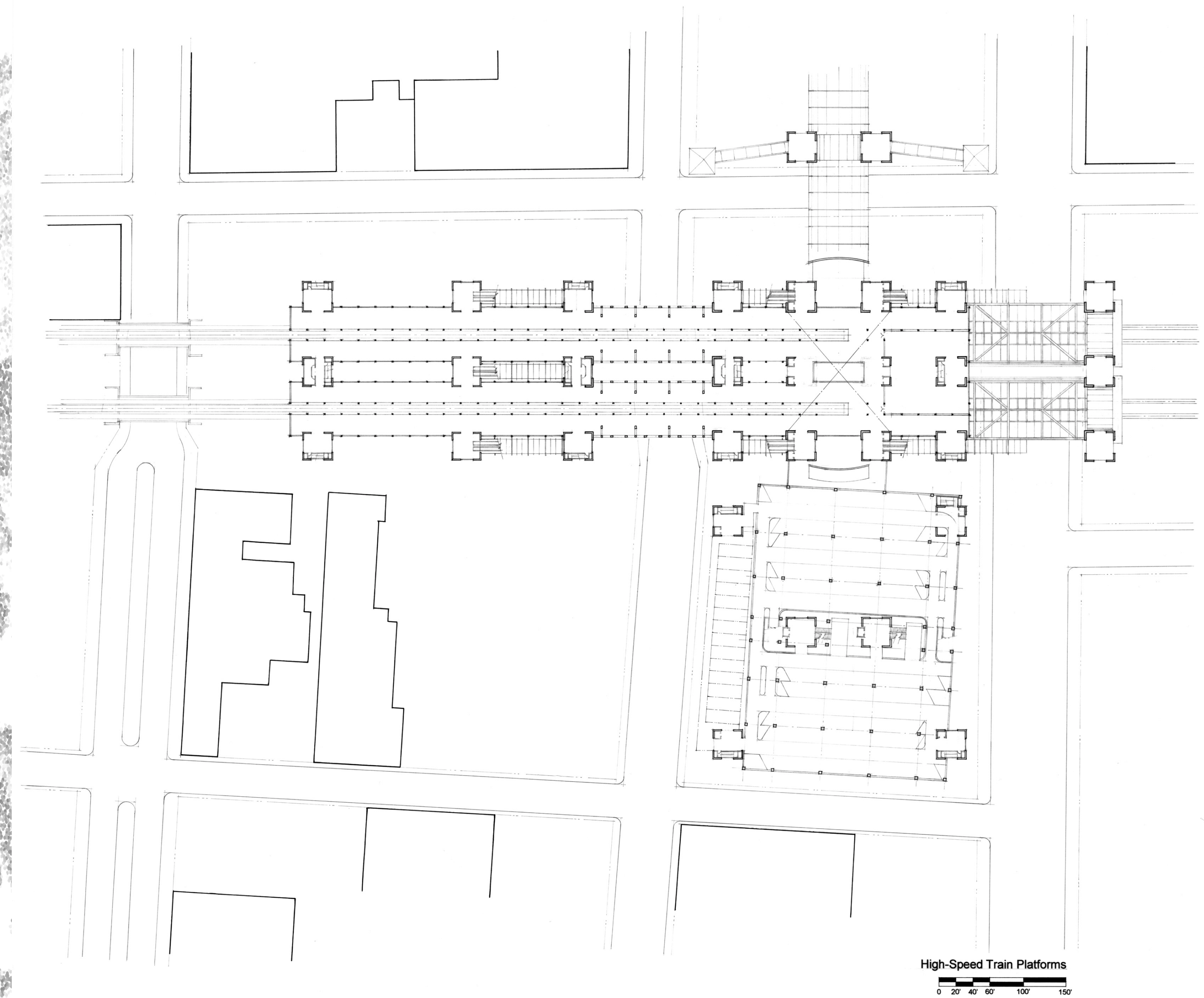
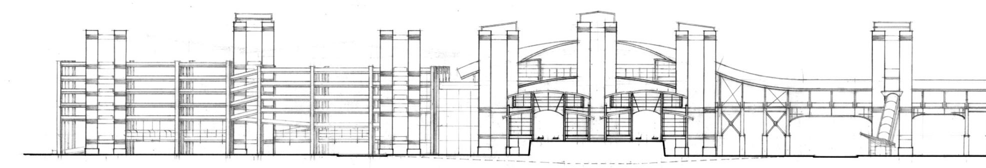
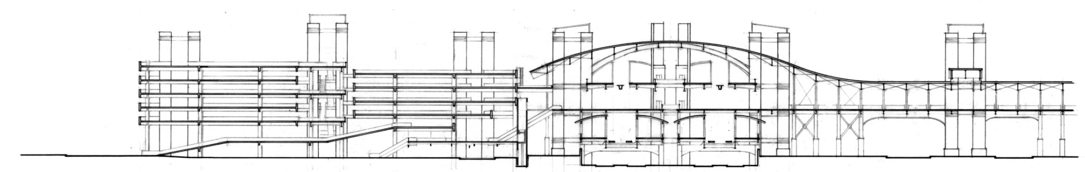


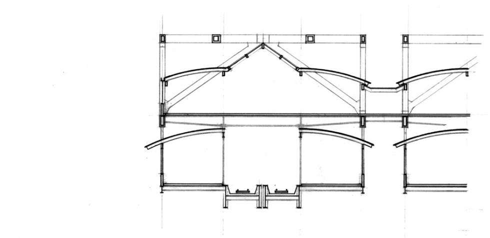
Fig. A.5 Roof Plan



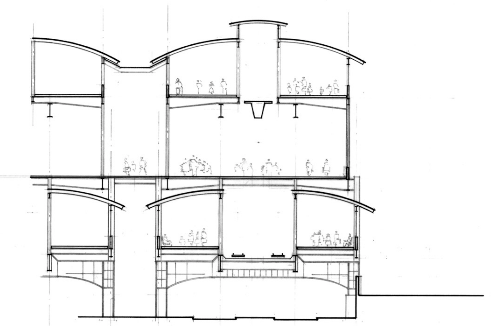
East Elevation



Section Through Bridge



Section at Woodward Avenue



Section at Concourse

Fig. A.6 East Elevation, Section through Bridge, Section at Wooward Ave., & Section at Concourse

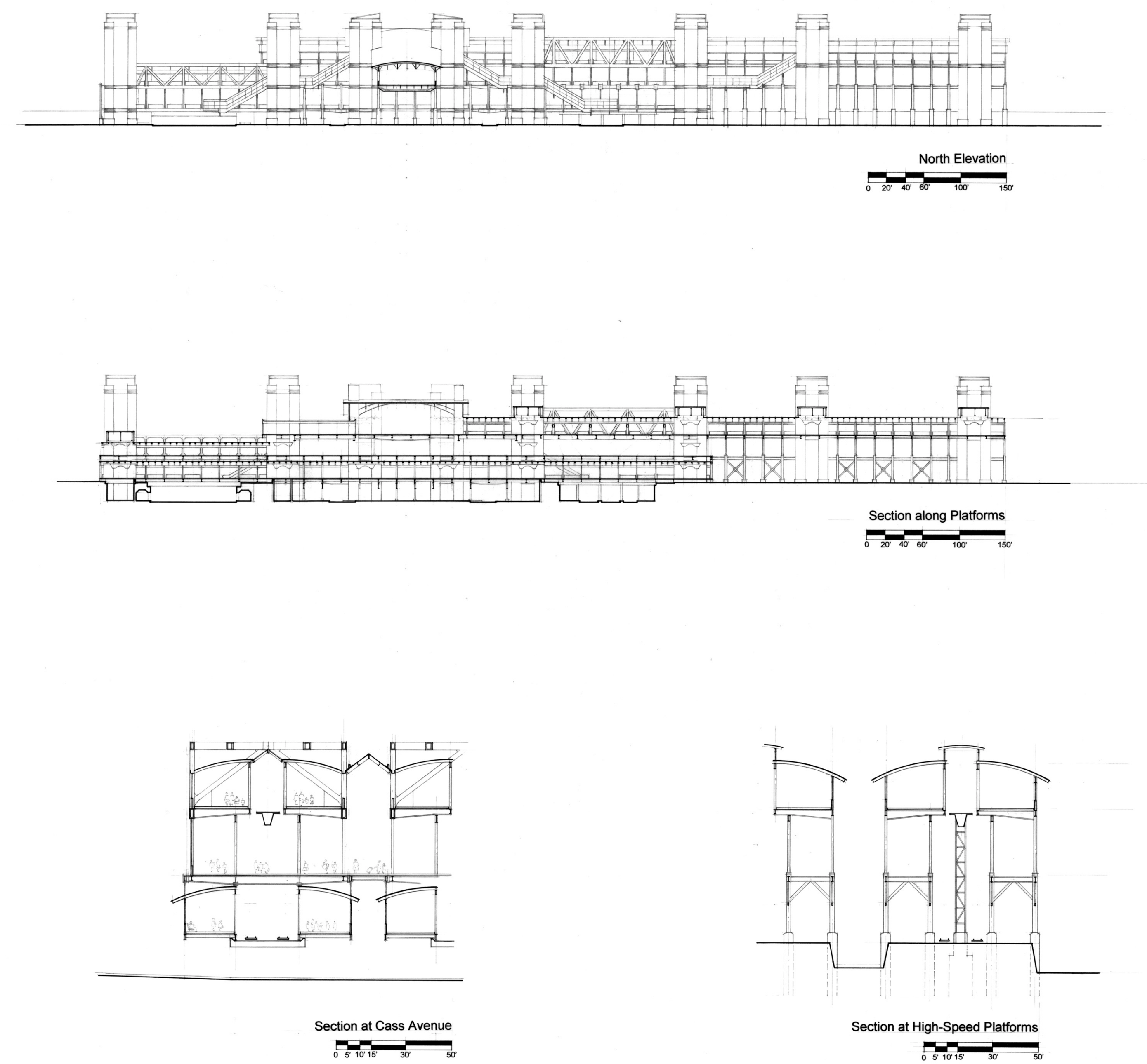
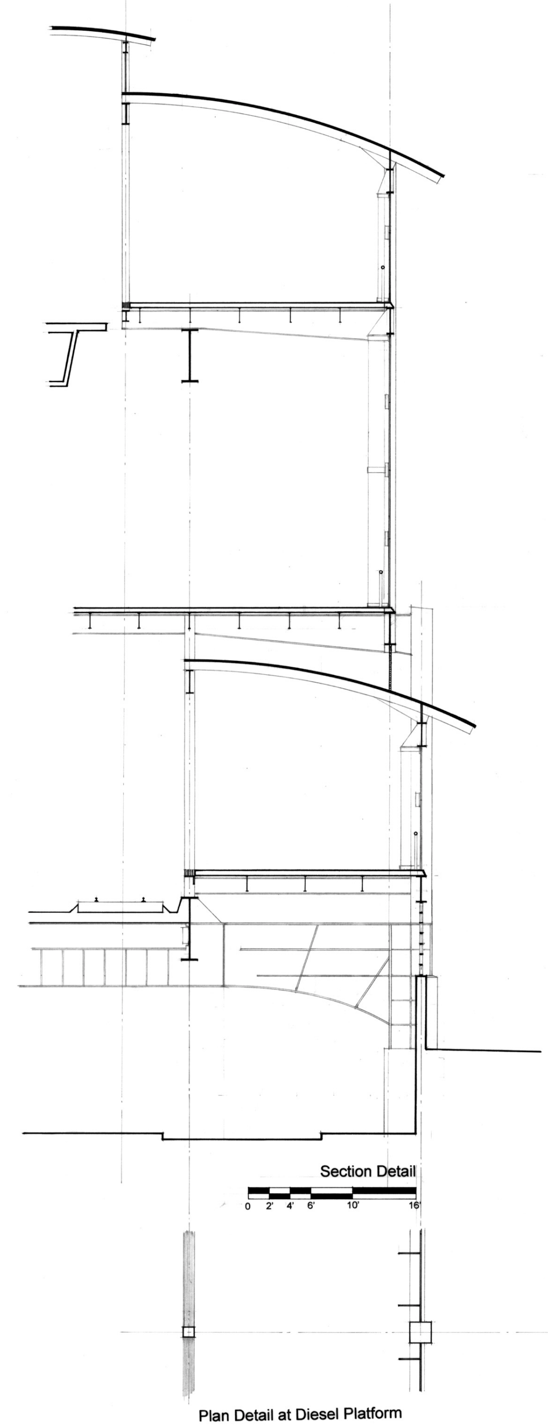


Fig. A.7 North Elevation, Section along Platforms, Section at Cass Ave, & Section at High-Speed Platforms



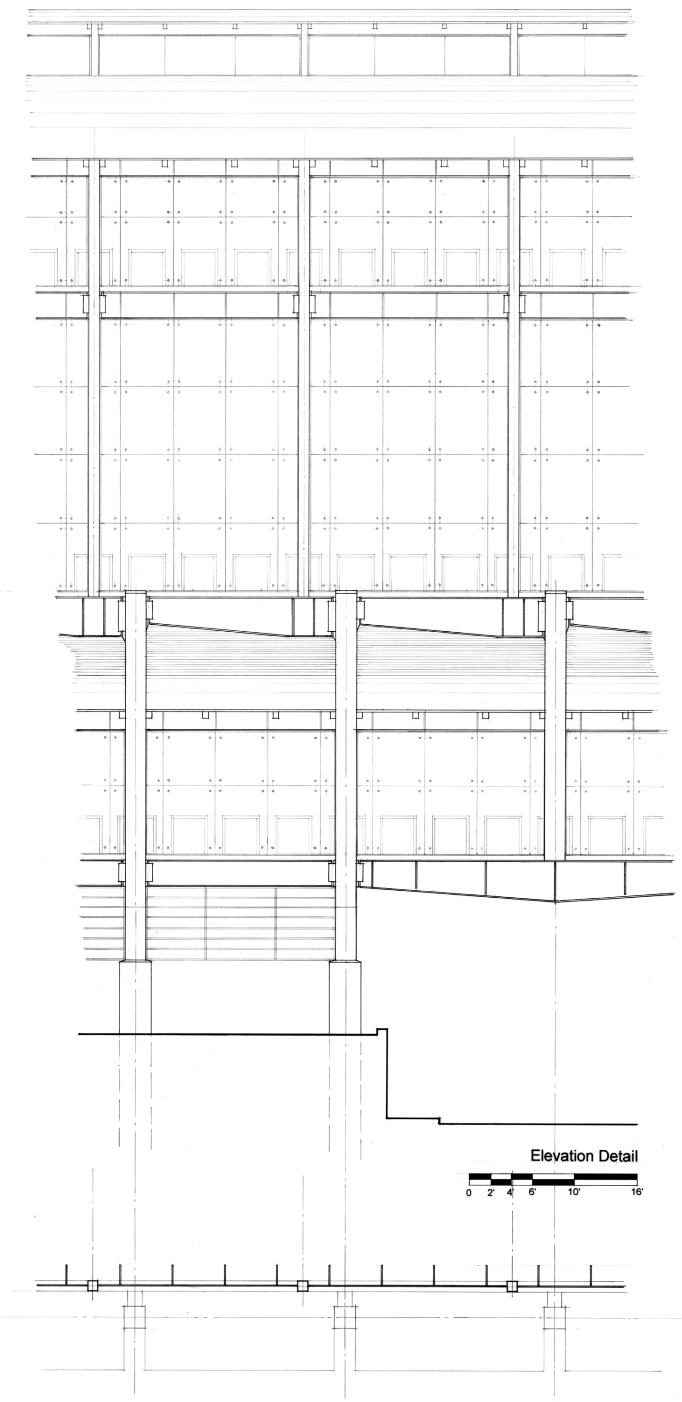
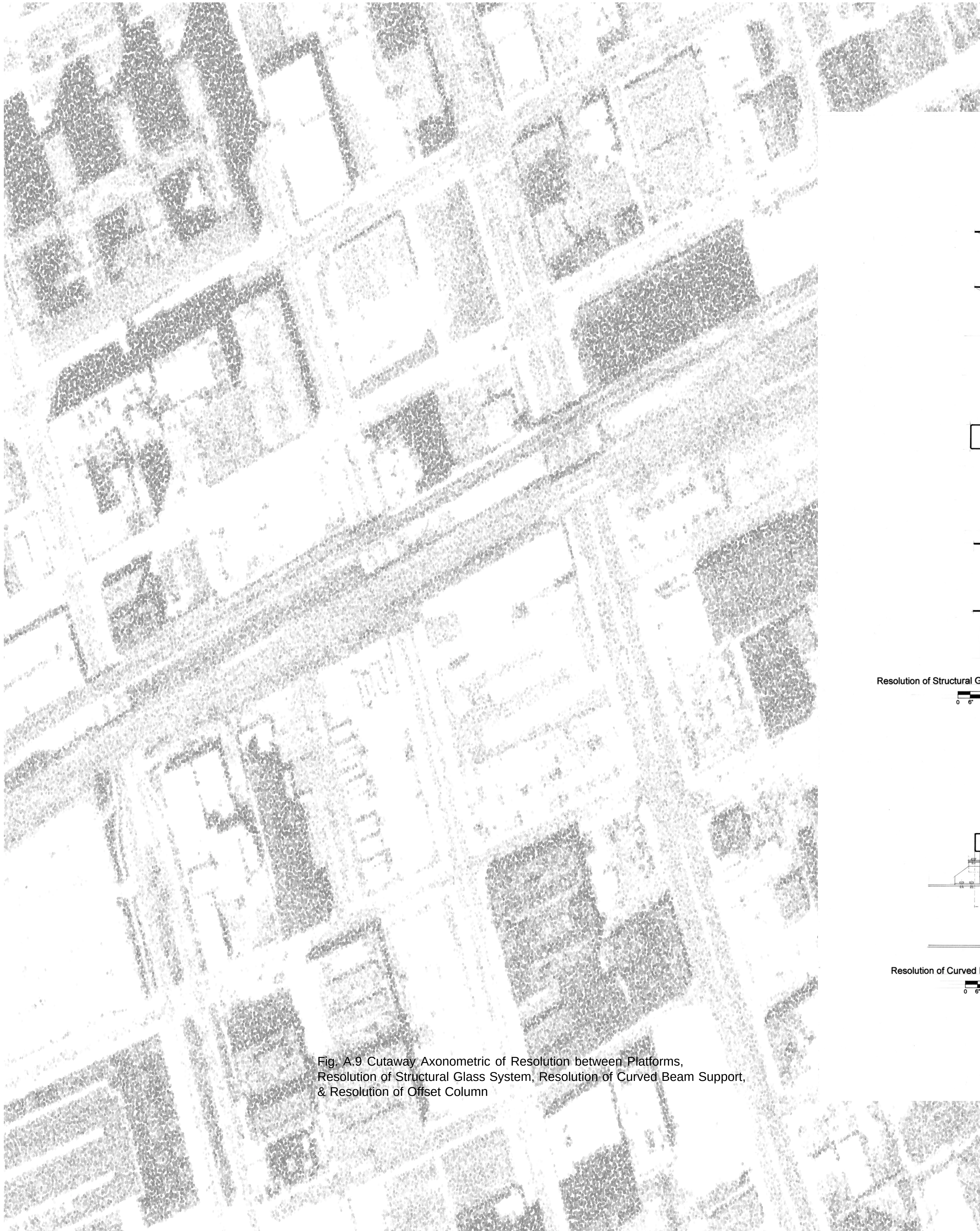


Fig. A.8 Section Detail, Elevation Detail, Plan Detail at Diesel Platforms, & Plan Detail at Concourse



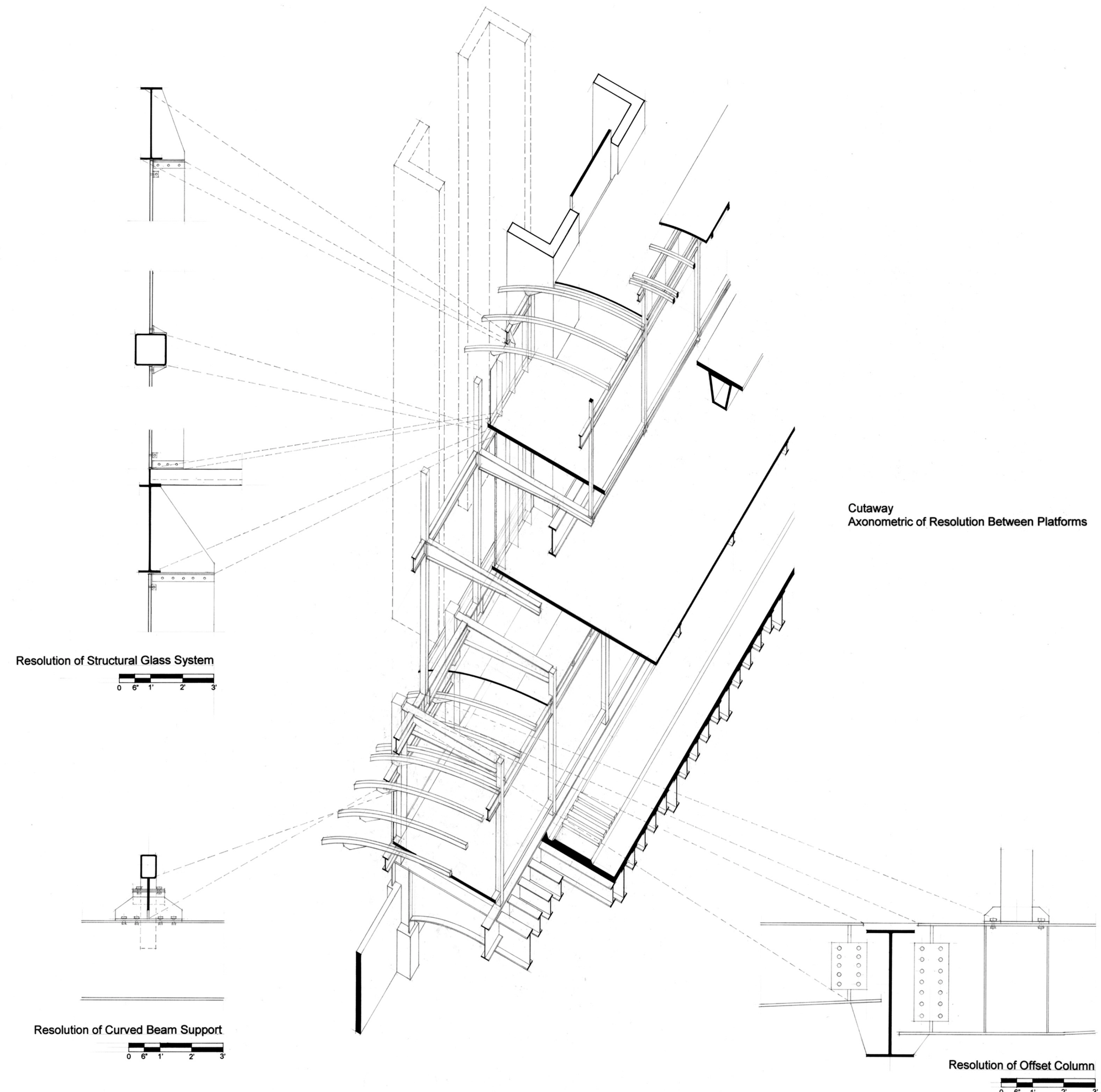


Fig. A.9 Cutaway Axonometric of Resolution between Platforms, Resolution of Structural Glass System, Resolution of Curved Beam Support, & Resolution of Offset Column

VITA

Paul Bielicki attended Eisenhower High School (Washington, Michigan), graduating in June, 1988. Paul participated in competitions and won the Architectural Design Award for High School Students – 1988 and the Michigan High School Architectural Design Award — 1987, 1988.

Paul entered Lawrence Technological University, located in Southfield, Michigan, in August, 1988 and graduated with a Bachelor of Science in Architecture in May, 1993. During that time, he served on many committees associated with the architecture field, including Associate Director, Huron Valley Chapter of the AIA; Adult Advisor, Architectural Explorers' Post of Great Sauk Trail Council, BSA; Member — LTU Student Chapter AIA and President — LTU Chapter of Tau Sigma Delta Honor Society (1992-1993). Also during this time, Paul was a Freiman Scholarship Recipient – 1989.

During 1988 through 1996, Paul worked for various architecture/design/planning firms including Hobbs & Black Associates, Inc. — Ann Arbor, Michigan, as a Project Assistant; the Architectural Studios of Gerald J. Yurk — Rochester, Michigan as a Draftsman/Designer; Urban Land Consultants — Shelby Township, Michigan as a Draftsman; and PDC Design, Inc. — Birmingham, Michigan as a Draftsman.

After working in the architecture profession, Paul returned to school in August, 1996, having been accepted to the University of Tennessee– Knoxville, to pursue Master's degrees in both Architecture and Structural Engineering. Paul has been active in the mentoring program and TAAST. While completing coursework, Paul served the university as a graduate assistant in the School of Architecture and the School of Engineering. During Summer 1999, Paul was a graduate teaching assistant, teaching Structural Design for the School of Architecture. Both Master's degrees were received in August, 2000.

Paul plans to work with an international architecture and engineering firm, while completing the requirements for registration in both professions.