Architecture for
Modern transportation
by Zeyu Li

Thesis submitted to the faculty of the
Virginia Polytechnic Institute and State
University in partial fulfillment of the
requirements for the degree of

MASTER OF ARCHITECTURE

_____
Professor Dave Dugas
Chairman

_____
Professor James Bassett

_____
Professor Heinrich Schnoedt

28 August, 2018
Blacksburg, VA

Fig.1

Abstract

One's way of travel dictates one's perception of the surroundings; People's mode of transportation has also evolved greatly throughout the ages. From foot traffic to carriages, to cars and trains, people tend to travel in faster paces, on increasingly linear paths, and with less freedom to wander. In my opinion, it is starting to become difficult to appeal to this emerging group of moving spectators with traditional ways of building. In the thesis, I explored ways to design buildings that focus on creating perspectival images for the moving spectators who are traveling on modern transportation.

Acknowledgment

My deepest gratitude to my committee for their support and words of wisdom; to the professors who gave me guidances; to my friends and family who loved me unconditionally.

Table of contents

1.1 Architecture and the Virtual: Towards a New Materiality I Modern transportation

Technology has changed the world of architecture, as driving automobiles had changed the urban experiences. Agreeing with Picon's point of view, Characters of modern transportation were analyzed in comparison to the traditional way of transporting, walking.

Comparing to walking, modern transpiration can be characterized as:
1.Moving at a much faster speed and observing from more angles.
2.Traveling on a more linear path.
3.Having less freedom (to wander).

The findings are illustrated in the following diagrams.

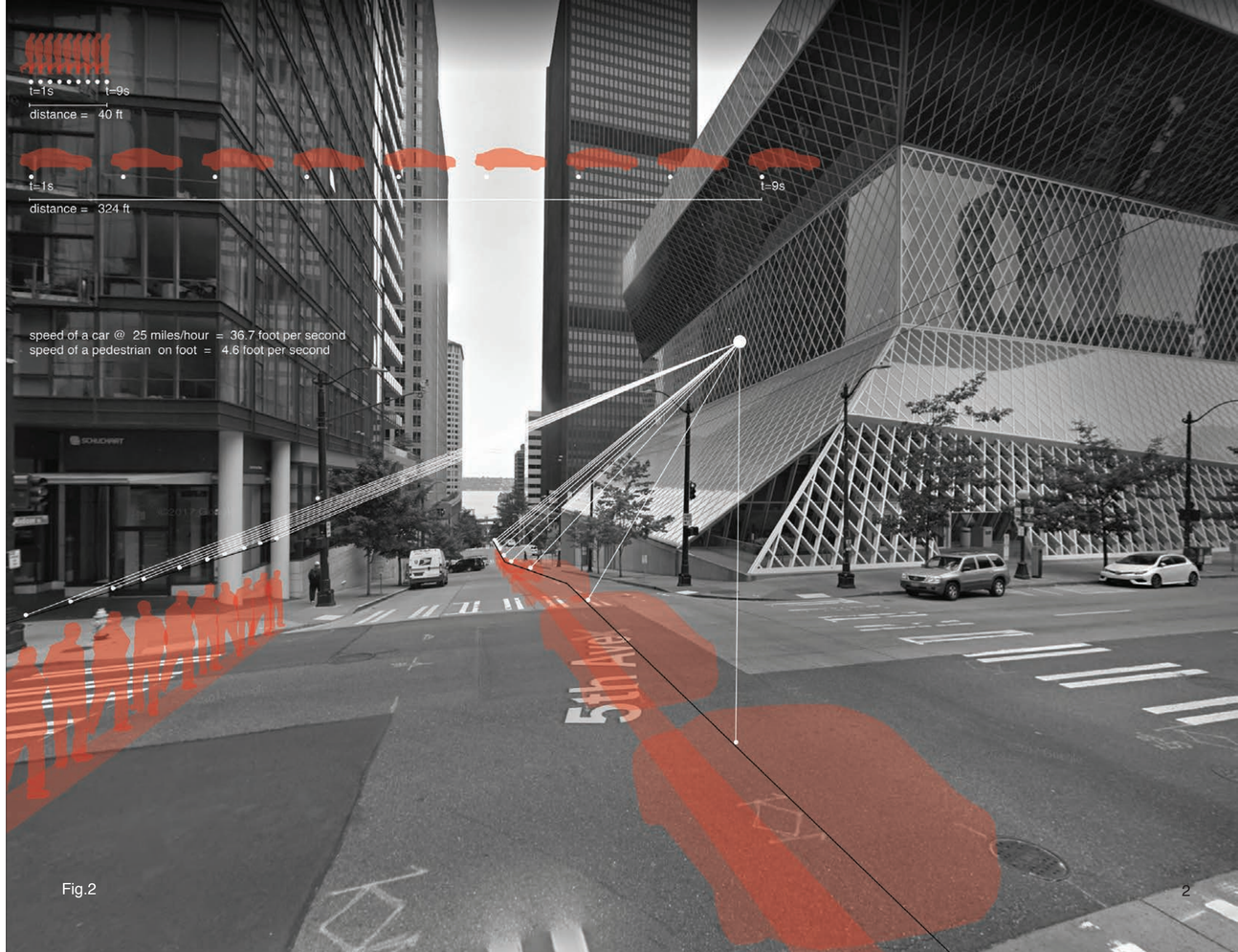


Fig.2

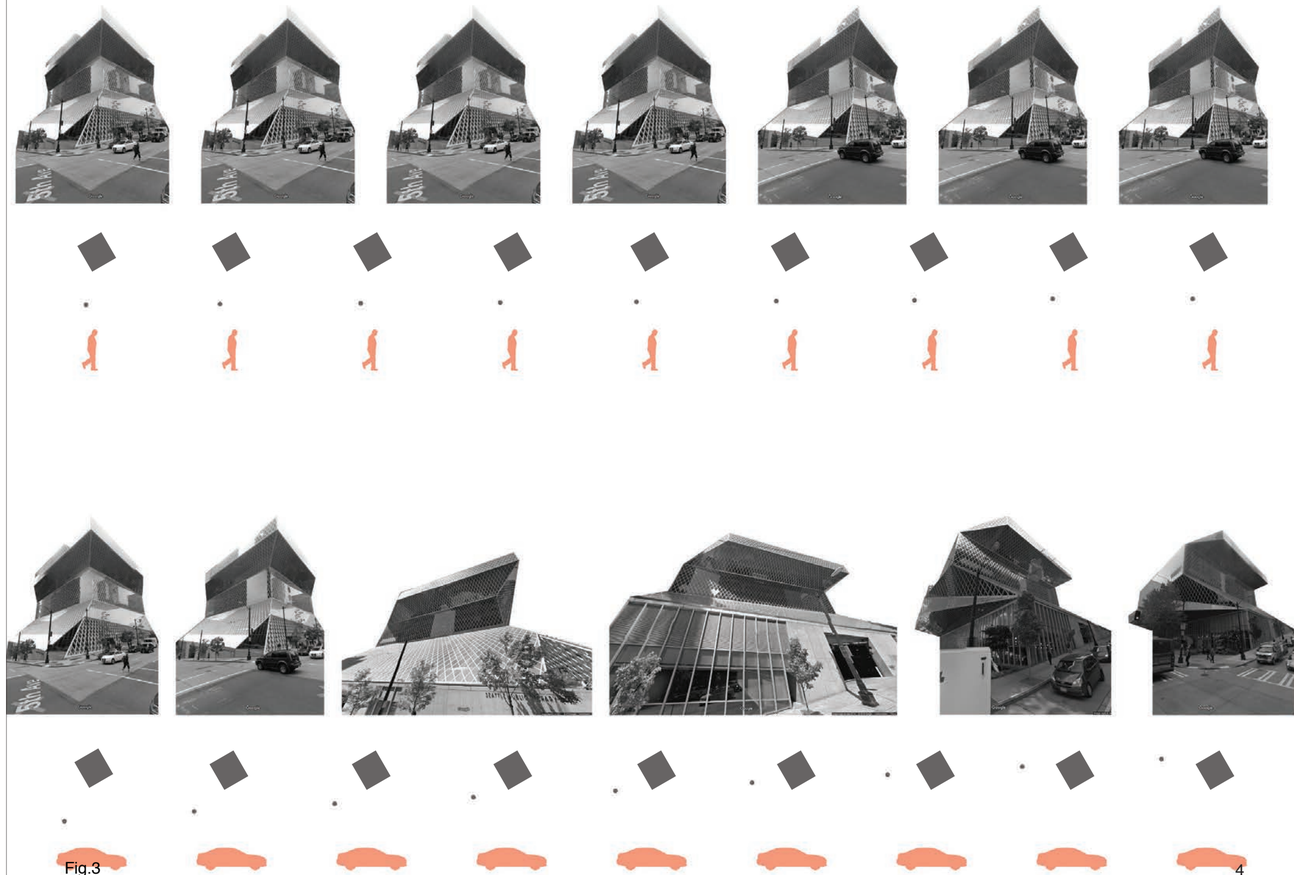
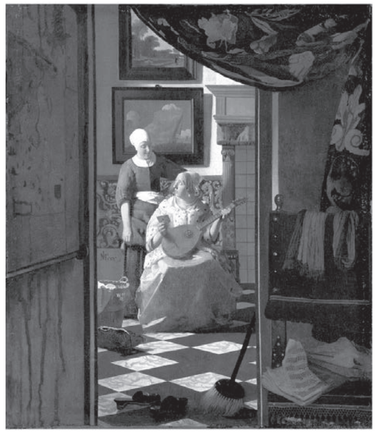


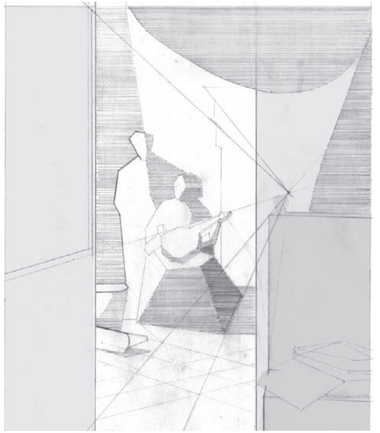
Fig.3

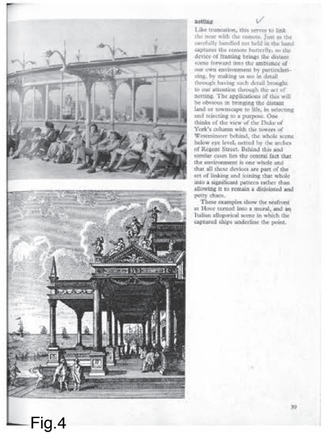
1.2 Law of meander I Different ways to sense spaces and depth

1.2

In the article, Eisenstein discussed two ways to perceive space and depth - either through the movement of eyes or through the movement of bodies. This explained the following two studies on perspectives. The studies on the oil paintings investigated ways to construct senses of depth on canvas, or in other words, through movement of the viewers' eyes. The studies of the parallel walls investigated how space and depth are perceived through the viewers' bodily movement.







netting

Like truncation, this serves to link the near with the remote. Just as the carefully handled net held in the hand captures the remote butterfly, so the device of framing brings the distant scene forward into the ambience of our own environment by particularizing, by making us see in detail through having such detail brought to our attention through the act of netting. The applications of this will be obvious in bringing the distant land or townscape to life, in selecting and selecting to a purpose. One thinks of the view of the Duke of York's column with the towers of Westminster behind, the whole scene framed by the buildings on the arches of Regent Street. Behind this and similar cases lies the central fact that the environment is one whole and that all these devices are part of the act of linking and joining that whole into a significant pattern rather than allowing it to remain a disjointed and petty chaos.

These examples show the seafront at Hove turned into a mural, and an Italian allegorical scene in which the captured ships underline the point.

39

plopcinding

The illumination halfway up the structure draws our attention outward and upward. What is this mystery of the commonplace? At least it takes our eyes off our sore-cups. Even the most ordinary means can be harnessed to the task of arousing in us the sense of otherness through the use of light, through pointing the finger. It is not the thing pointed out but the evocative act of pointing that arouses the emotions.

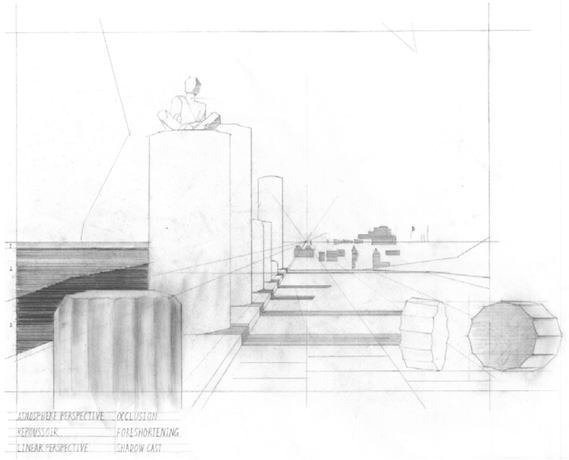
truncation

Foreground cuts out background and the normal, prosaic recession is disturbed. Instead of using the building in its elevational completeness, standing back but upon the same plane as one stands on oneself, the insistence of the foreground is internalized and from there to the building is a leap, a sudden visual break since the intervening floor (marked with objects which aid the effect of gradual recession) is cut out and the two things, foreground and distance, are brought into dramatic juxtaposition. So, instead of the scene making a gradual transition along the scale of distance between oneself and the distant object, this effect nearly juxtaposes the near and the distant. The two examples of truncation shown are, Versailles and a street in Holland.

37

Fig.4 The Love Letter, Johannes Vermeer, 1670

The oil paintings were reconstructed, being stripped down to their most basic geometry forms. Several techniques were utilized by the artists to construct senses of space and depth on canvas (and any two dimensional surfaces.) Similar techniques are also utilized in architecture to construct certain architectural gestures, to define space and to emphasize depth, as noted in Gordon Cullen's *Townscape.*



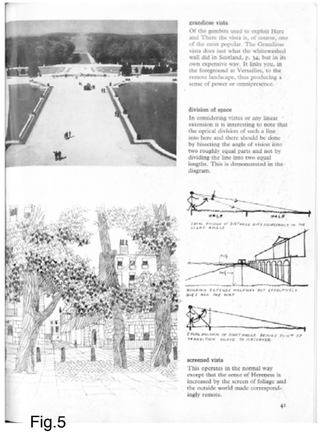


Fig.5

Comparing the oil paintings with the diagrams in section 1.1, one could relate the drawings here to the images perceived by the walking pedestrians as shown in section 1.1. As the pedestrians move slowly, their views of the surrounding objects appear rather static, similar to how one perceives an oil painting. As the paintings, constructed with implied senses of depth, appeal to their observer, decorated facades suit the eyes of a static spectator in a similar way.

Understood the static spectators. In the next section, the focus shifts to the fast moving spectators.

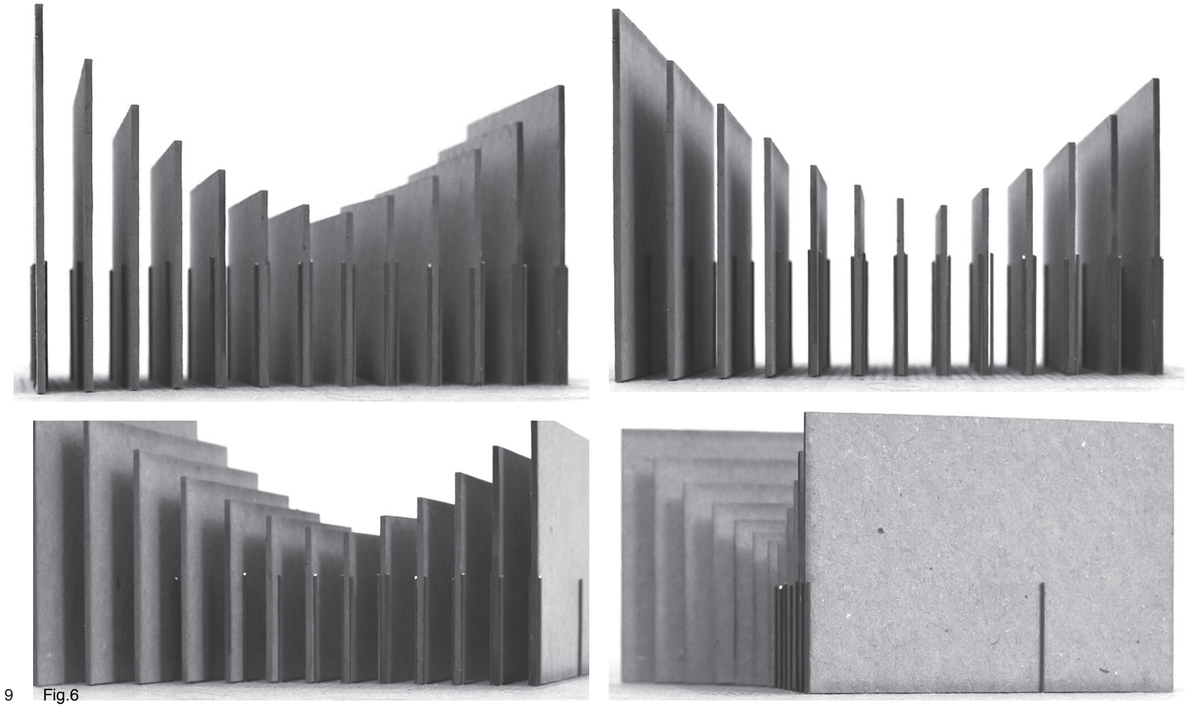
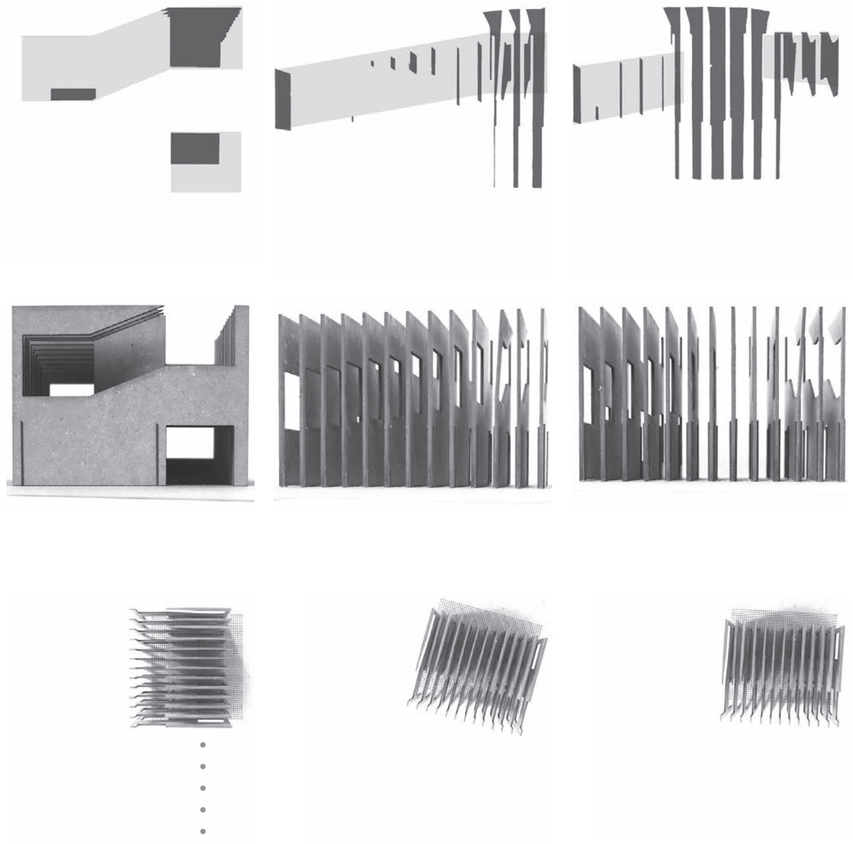


Fig.6



When the spectator starts to move quickly, the implied sense of depth and space created through the likes of oil paintings soon loses its value. Since, as one moves quickly and sees the object from different perspectives, the observer understands the space better and will look beyond the constructed frame, shifting his focus from the details on the surface to the totality of the perceived objects.

A spatial configuration is shown in the diagrams on this page. As the point of view pan through the model, the parallel walls response to the observer's movement through revealing and hiding different part of them. As a result, from various perspectives, different images are projected into the viewers eyes.

Fig.7

1.3 Montage and Architecture I

Architecture expressed through a series of scenes

As with the Acropolis, a building complex could still appear balanced and symmetrical although its plan suggested otherwise. In the case of the Acropolis, such impressions are formed through carefully placed buildings, which appear as balanced scenes in perspectives. In fact, the entire building complex was designed with focuses on the perpectival view from several designated vantage points. The consistency among the series of scenes further enhances the complex's symmetrical impression.

Similar design principles in the Sonsbeek Pavilion by Aldo Van Eyck. The diagrams in the following pages documented studies of these projects.

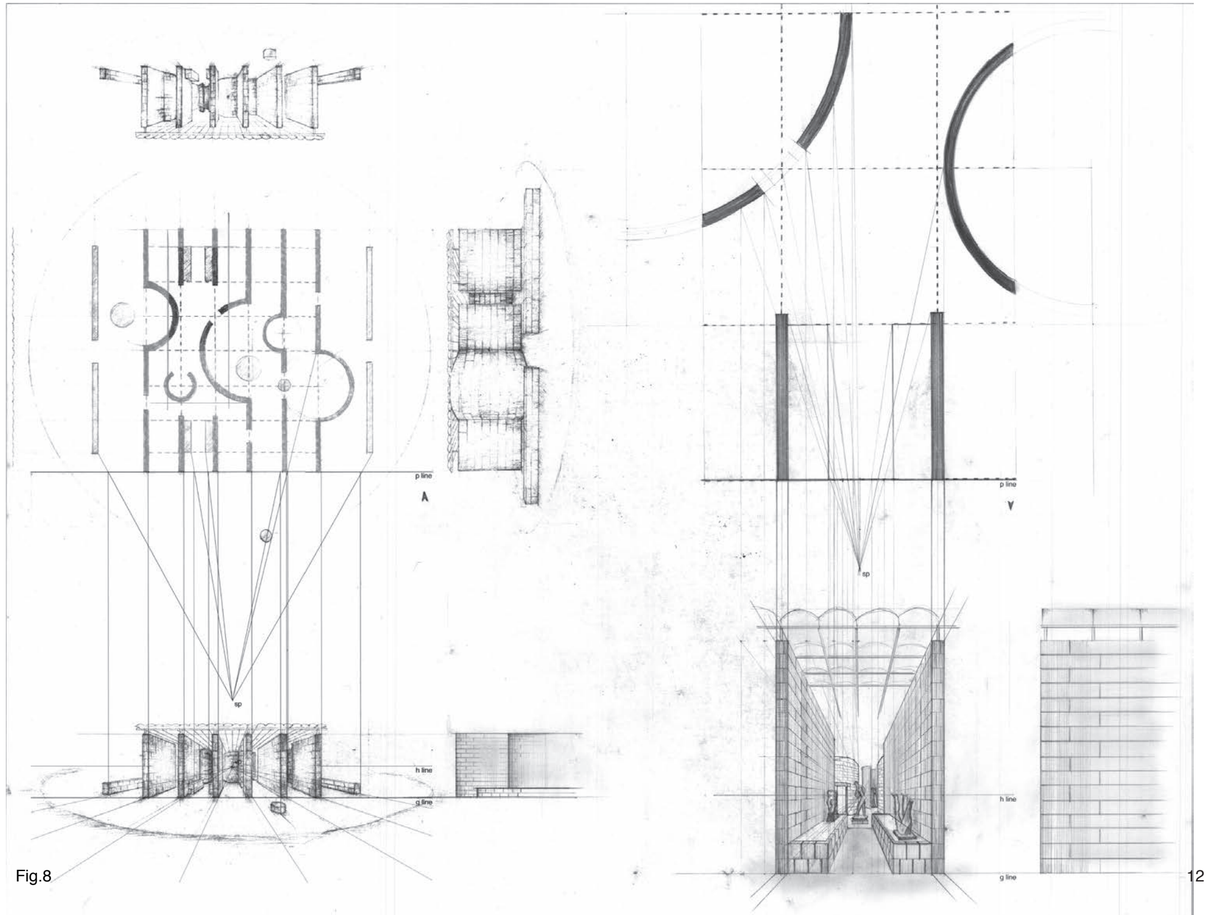
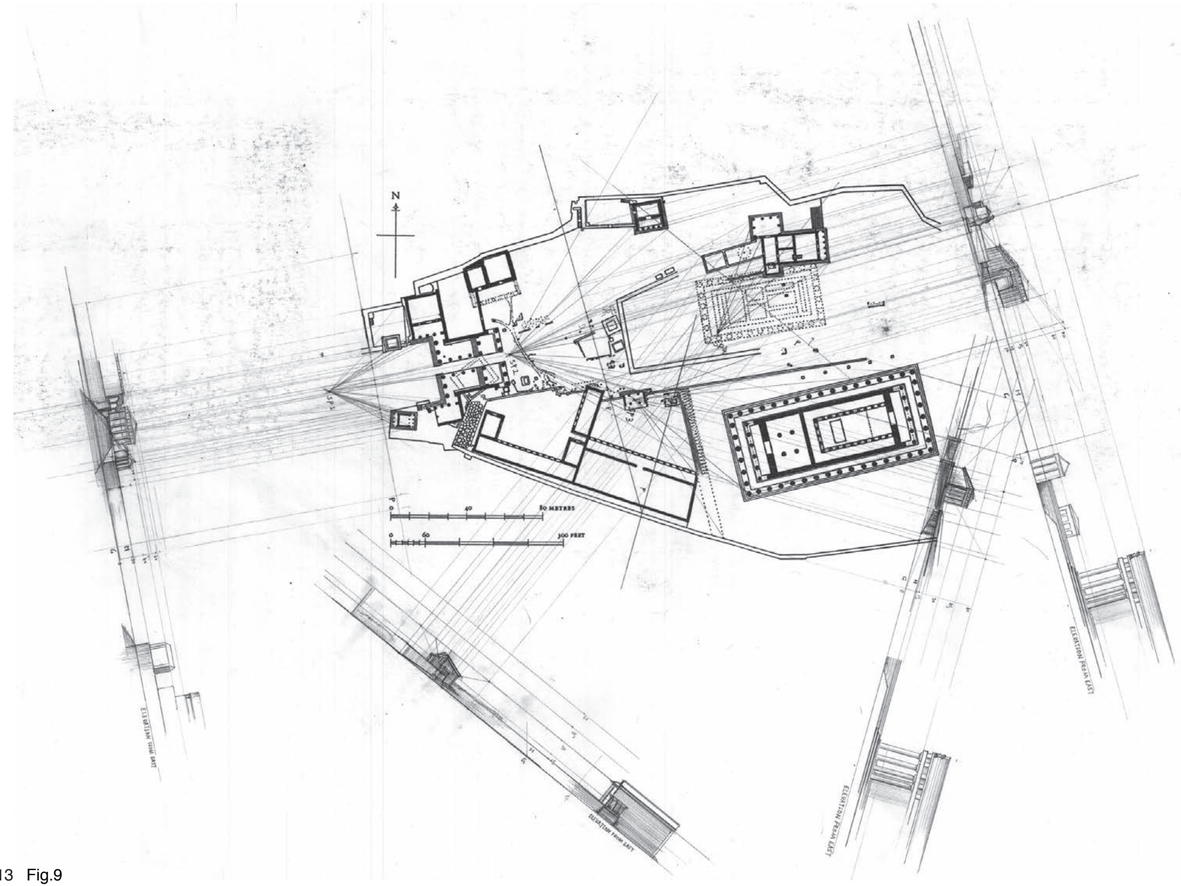
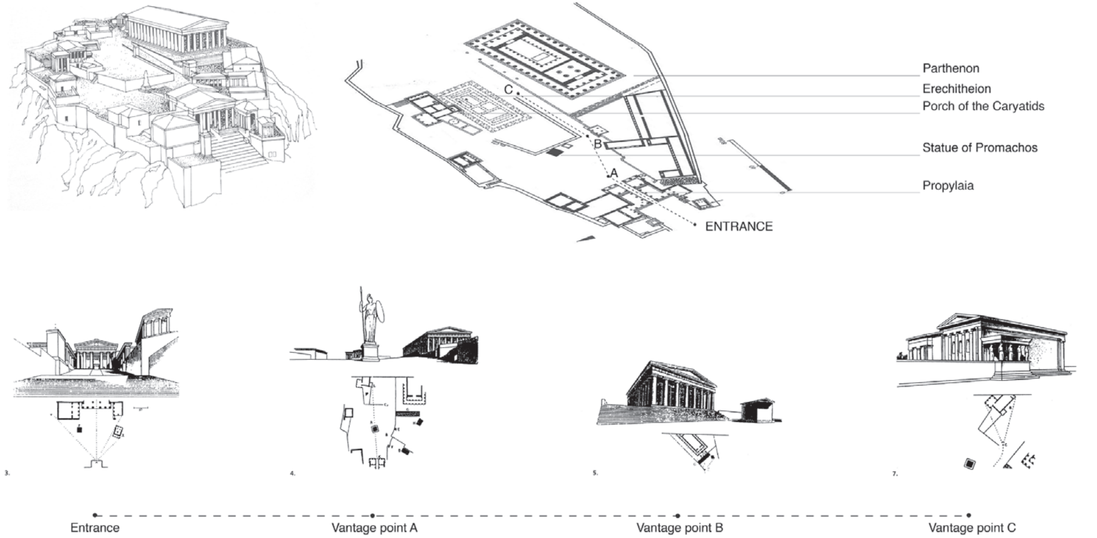


Fig.8





The apparent asymetry of this new Acropolis is only a means of lending picturesqueness to this group of buildings, which have been laid out with more art than any others. . . .

[This] becomes clear from the series of panoramas that unfolded before visitors to the Acropolis in the fifth century B.C.

View of the Propylaeum. The general idea of the plan of the Propylaeum can be seen in figure 3. . . .

We see the symmetrical central block and two noticeably different wings — the right-hand one broader and the left-hand one less so. . . .

At first sight, nothing could be more uneven than this plan, but in fact it constitutes a completely balanced whole in which the general symmetry of the masses is accompanied by a subtle diversity in the details. . . . The optical symmetry is impeccable. . . .

First view of the square; Athene Promakhos. Passing by the Propylaeum, the spectator's eye embraces the Parthenon, the Erechtheion, and Athene Promakhos (figure 4).

In the foreground towers the statue of Athene Promakhos; the Erechtheion and the Parthenon are in the background, so that the whole of this first panorama is subordinated to the statue, which is its central point and which creates an impression of unity. The Parthenon only acquires its significance when the visitor loses sight of this gigantic piece of sculpture.

The Parthenon and its oblique perspectives. To modern thinking, the Parthenon — the great temple of the Acropolis — should be placed opposite the main entrance, but the Greeks reasoned quite differently. The cliff of the Acropolis has an uneven surface, and the Greeks, without altering its natural relief, placed the main temple on the highest point at the edge of the cliff, facing the city (figure 5).

Placed thus, the Parthenon first of all faces the spectator obliquely. The ancients generally preferred oblique views: they are more picturesque, whereas a frontal view of the façade is more majestic.[4] Each of them is allotted a specific role. An oblique view is the general rule, while a view *en face* is a calculated exception (figure 6).

The central body of the Propylaeum is presented *en face*, just as we head straight for the *pronaos* of the Parthenon, crossing the square of the Acropolis. With the exception of the two examples given, where this effect is deliberately calculated, all the other structures present themselves at an angle — as does the temple of Athene Ergane (*H*), when the spectator reaches its precinct at point *E*. . . .

After the first panorama from the Erechtheion, let us continue our way across the Acropolis. At point *B* the Parthenon is still the only structure in our field of vision, but if we move on to point *C*, it will be so close to us that we shall be unable to encompass its shape; at that moment the Erechtheion becomes the center of the panorama. It is precisely from this point that it offers us one of its most graceful silhouettes (figure 7).

The bare wall (*a*) is enlivened by the Porch of the Caryatids, which stand out from it as though against a background specifically created for them.

Thus three pictures have passed before us, corresponding to the three chief points — *A*', *B*, and *C* — on figure 4.

At each of them only one architectural monument was dominant: at point *C*, the Erechtheion; at point *B*, the Parthenon; and at point *A*', Athene Promakhos. This one, principal motif ensures the clarity of the impression and the unity of the picture.

How responsibly and with what careful thought this has been done is witnessed in the following additional comment by Choisy:

Erechtheion and Athene Promakhos. Let us return to the starting point (figure 4), that is, to point *A*', at which our whole attention was concentrated on Athene Promakhos. The Erechtheion with its caryatids is in the background. One might fear that the graceful caryatids would appear crushed by force of contrast with the gigantic statue of the goddess; to prevent this, the architect sited the base of the statue in such a way that it shut out the view of the Porch of the Caryatids — line *A*'*RL*, which only revealed itself to the eye of the spectator when he was so close to the colossus that he could no longer see all of it, and therefore a comparison became possible only in memory.

The calculation of a [film-] shot effect is obvious, for there, too, the effect of the first impression from each new, emerging shot is enormous. Equally strong, however, is the calculation on a montage effect, that is, the sequential juxtaposition of those shots.

Let us, in fact, draw up the general compositional schemes of these four successive "picturesque shots" (figure 8).

It is hard to imagine a stricter, more elegant, and more triumphant construct than this sequence.

Shots *a* and *b* are equal in symmetry and, at the same time, the opposites of each other in spatial extent. Shots *c* and *d* are in mirror symmetry, and function, as it were, as enlargements of the right-hand and left-hand wings of shot *a*, then reforming again into a single, balanced mass. The sculptural motif *b* is repeated through shot *c*, by the group of sculpture *d* and so on and so on.

It would further be of particular interest to analyze the length of time in which each of these pictures was presented to the spectator. We will not go into the details of this here, but only remark that the length of these montage sequences is entirely in step with the rhythm of the building itself: the distance from point to point is long, and the time taken to move from one to the other is of a length in keeping with solemnity.

In the "montage plan" of the Athenian Acropolis we find, of course, the same unsurpassed artistry as in other monuments of antiquity.

1.4 A complete reading list

1.4

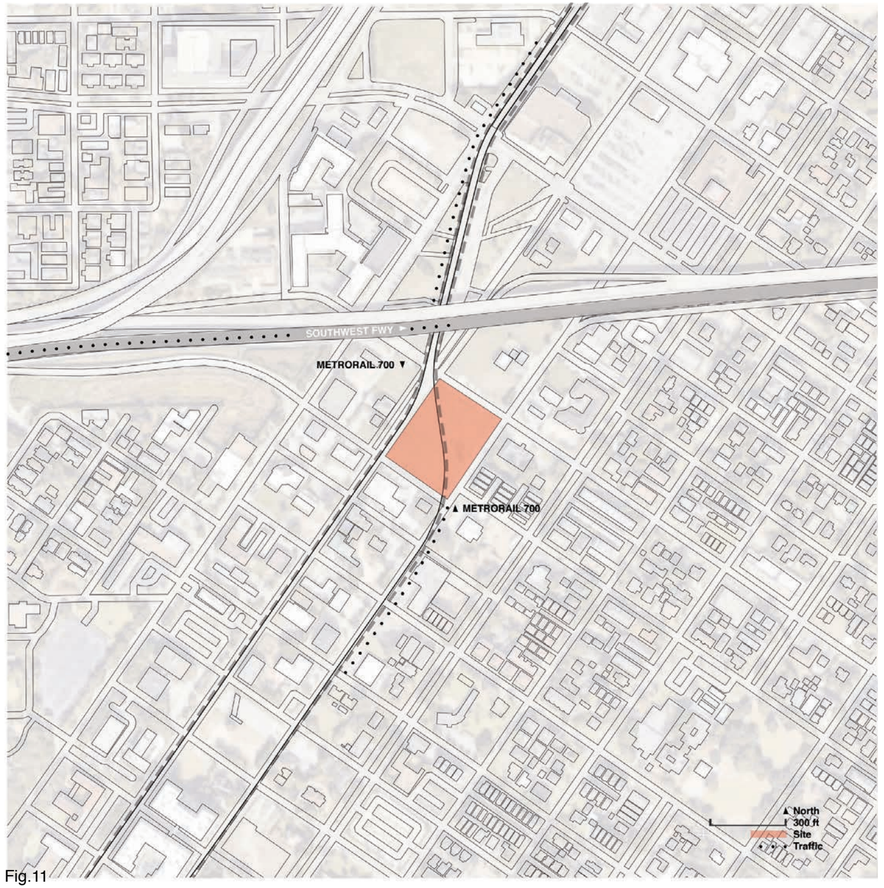
1. Townscape, Gordon Cullen
2. The nature and art of motion, Gyorgy Kepes
3. Architecture Oriented Otherwise, Sergei M. Eisenstein I The Law of Meander
4. Montage and Architecture, Sergei M. Eisenstein I Introduction by Yve-Alain Bois,
5. Architecture and the Virtual: Towards a New Materiality, Antoine Picon

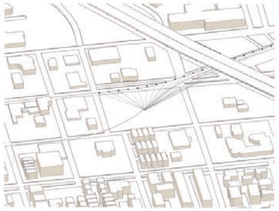
2

2.1 Site selection

2.1

To better explore the relationship between architecture and the moving spectators, the site of the thesis project was chosen to be in the state of Texas, which is known for its heavy dependence on vehicular traffic. More precisely, the site is a plot of land located in the Museum District of Houston, TX, sitting right next to a major freeway, and between two light rail tracks. The site provides suitable conditions for the study of the thesis topic, as it is surrounded by moving spectators traveling on different types of modern transportations. Since there are only few low-rise buildings constructed nearby, the potential building on the site is also easily perceivable by the passing spectators. The exact location of the site is the plot of land bounded by the Blodgett St, San Jacinto St, Wentworth St and Fannin St.





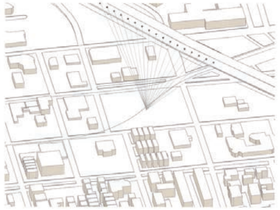


Fig.11

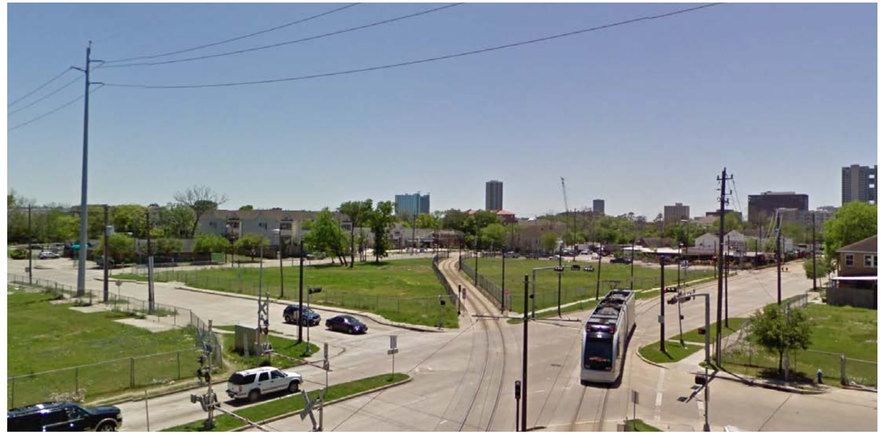


Fig.12

On the left side are the site photos that's viewing the site from the freeway; viewing the site from the opposite street corner. The construction of the concrete site model put the dimensions and relative sizes of the surrounding elements into perspective, as well as clarifying the traffic situation around the site.

Fig.13

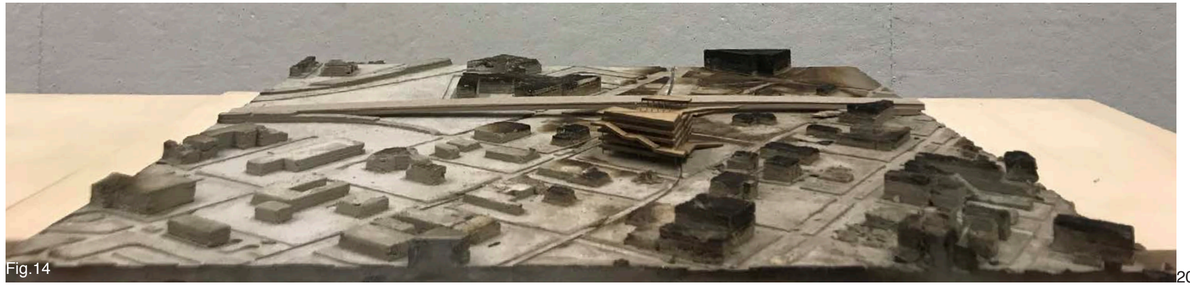


Fig.14

2.2 Program overview

2.2

After trials and errors, taking the traffic condition of the site as well as the project's relation to the thesis topic into consideration, the thesis project was set to be a mixed-use building. With the majority of the building functioning as a parking garage, the ground floor accommodated a light rail station and some retail spaces while a car dealership was built on the top of the building. The project can also be understood as a transportation hub sitting on the edge of the Museum District in Houston, TX.

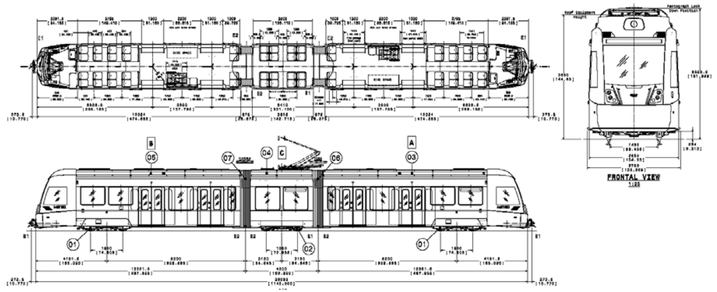
2.3 Supportive research

Researches on several topics that were critical to the design of the thesis project were conducted: the general dimension guidelines for the garage design, the typical configurations of parking garages and the exact dimensions of Urbos LRV, which is the exact model of train that runs on the light rails through the site.

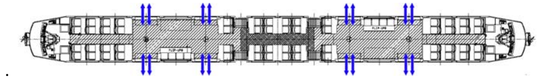
2.3

Houston MetroRail facts:
Name: CAF - Houston LRV / Urbos LRV
Width: 8 feet 8 inches
Length: 95.5 feet
Height (pantograph down): 12 feet 8 inches
Maximum speed: 58 miles per hour
Maximum capacity: 242

Technical Details:



Circulation:



Reference:
https://www.apta.com/mc/rail/previous/2015rail/presentations/Presentations/Igan%20Erostarbe.pdf

http://www.caf.net/en/productos-servicios/proyectos/proyecto-detalle.php?p=251

Fig.15

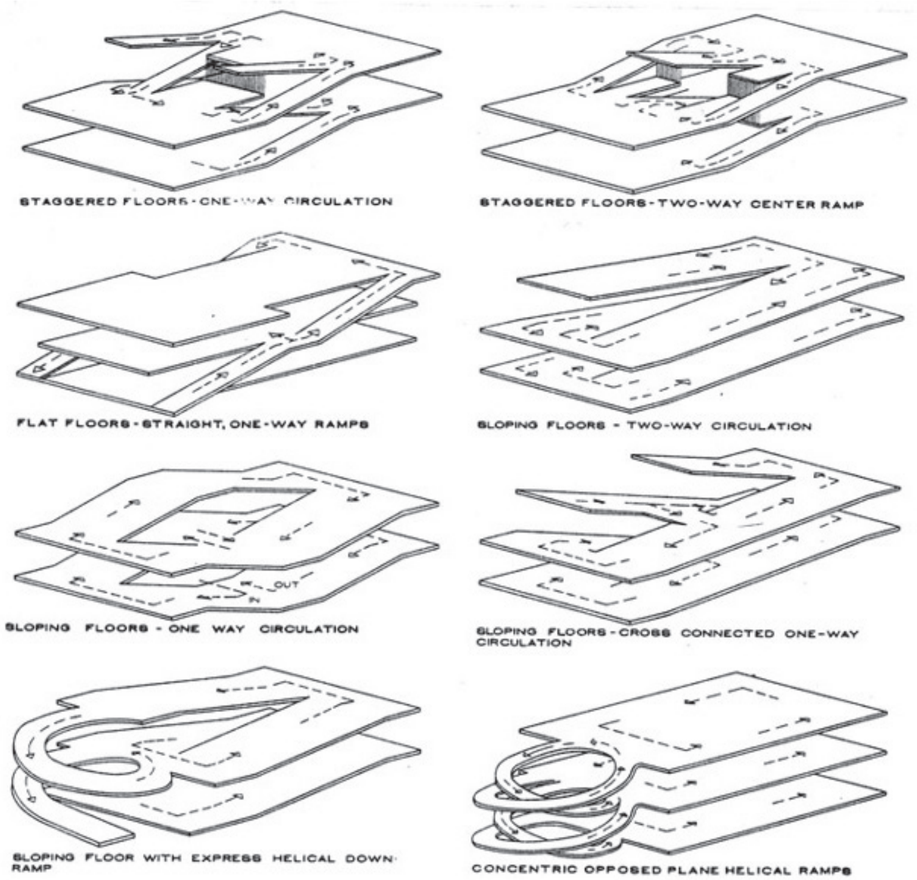
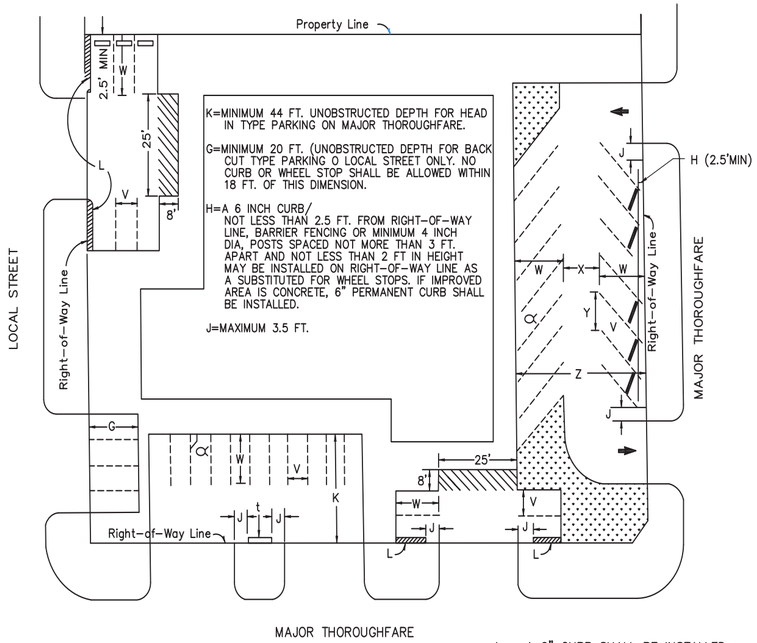


Fig.16

DRIVEWAY GEOMETRICS



NOTE: 1) SPACES FOR COMPACT CARS
7.5' X 17' FOR 90° PARKING.

2) PARALLEL PARKING – MINIMUM 8' X 20'
STANDARD 9' X 22'

L = A 6" CURB SHALL BE INSTALLED AT THE RIGHT-OF-WAY LINE

Angle of Parking	Width of Stall	Depth of Stall 90° to Aisle	Width of Aisle	Width of Stall Parallel to Aisle	Width for 2 Rows & Aisle
Q	V	W	X	Y	Z
45°	8.5	19.4	13.5	12.0	52.4
60°	8.5	20.7	18.5	9.8	59.9
75°	8.5	20.6	20.8	8.8	61.9
90°	8.5	19.0	25.0	8.5	63.0
45°	9.0	19.8	13.0	12.7	526
60°	9.0	21.0	18.0	10.4	59.9
75°	9.0	20.7	20.0	9.3	61.4
90°	9.0	19.0	24.0	9.0	62.0
45°	9.5	20.2	13.0	13.4	53.3
60°	9.5	21.2	18.0	11.0	60.4
75°	9.5	20.8	20.0	9.8	61.6
90°	9.5	19.0	24.0	9.5	62.0

TABLE – MINIMUM DIMENSIONS FOR AISLES AND STALLS

SPACE FOR COMPACT CARS – 7.5' X 17' FOR 90° PARKING

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

SPACE REQUIREMENTS FOR OFF STREET PARKING

(NOT TO SCALE)

APPROVED BY:	APPROVED BY:
CITY ENGINEER	DIRECTOR OF PUBLIC WORKS AND ENGINEERING
EFF DATE: AUG-12-2016	DWG NO: 31–02

Fig.17

3.1 Project concept

3.1

The initial idea on the form was as simple as externalizing the ramp, which is typically located toward the center of the garage buildings. There are three benefits for this. Firstly, by moving the ramps to the exterior, the circulation between the floors (cars moving up or down the ramps) are separated from the circulation within the floor (cars circling for parking spots), and thus it reduces traffic stress and potential congestions. Secondly, the exterior ramps, when strategically oriented towards the exit and the entrance of the freeway, indicate the entrances and exits of the parking garage. Thirdly, if the function of the building transformed in the future, the exterior ramp will have much potential value than the typical zigzagging ramps inside the building.

The form of the building is also tweaked to give more space to the residences in the East. To avoid confusion and maximize the path-finding function of the ramps, a part of the exiting ramp is also hidden beneath the entering ramp.

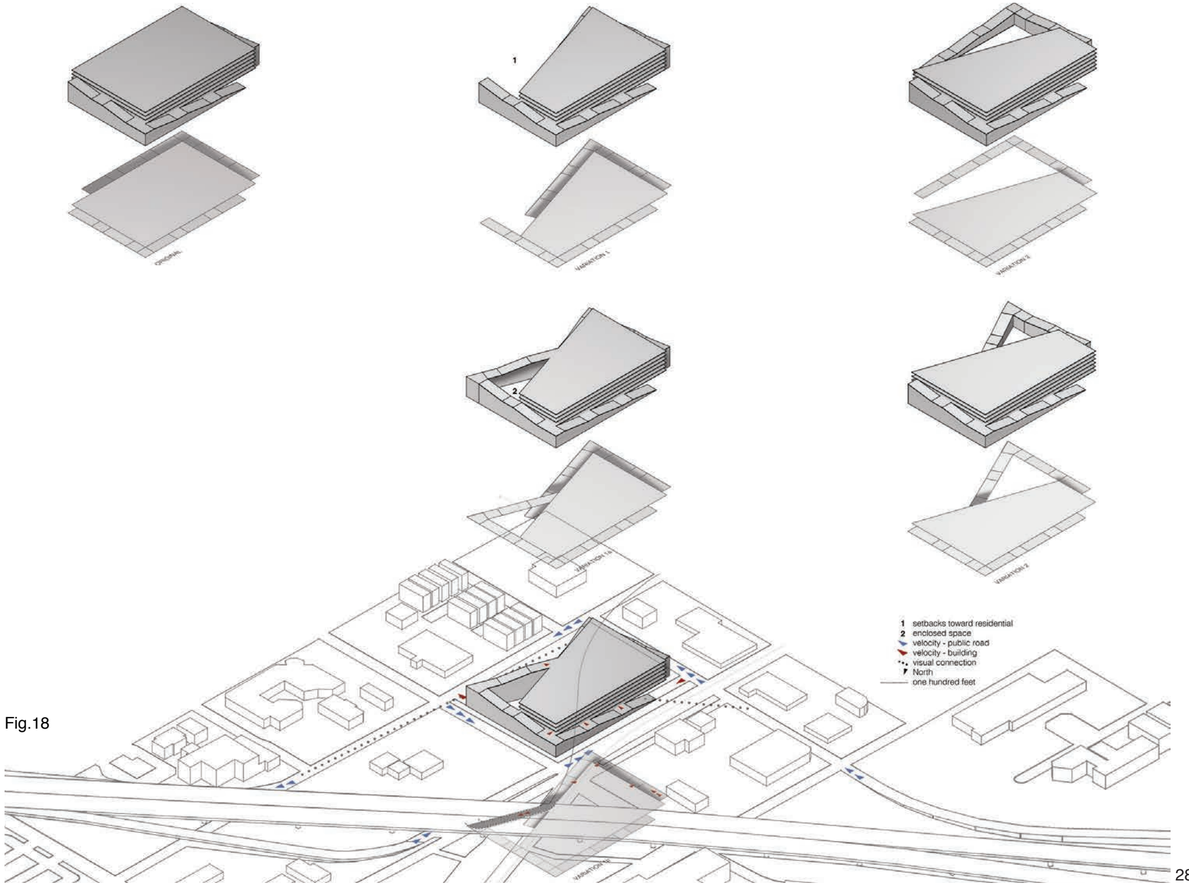


Fig.18

The building has a concrete post and beam structure system. The structure layout in this project is crucial since it also dictates the layout of the parking spaces, the route for cars and most importantly, it is the part of the building that is the most responsive to the spectator's movement.

The fields of columns, while being viewed from afar, appear in different configurations. From certain perspectives, as the columns line up towards the viewer, they even appear similar to the parallel walls from the study model, creating pockets of spaces throughout the floors. As the spectator moves, the columns will appear in disorder again, and rearranging themselves into "walls" again when been viewed at from certain vantage points.

A example of the condition discussed above is shown in the next page, along with a plan of the earlier structural layout.

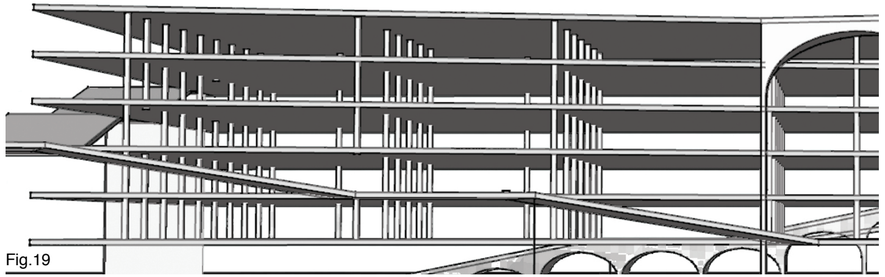


Fig.19

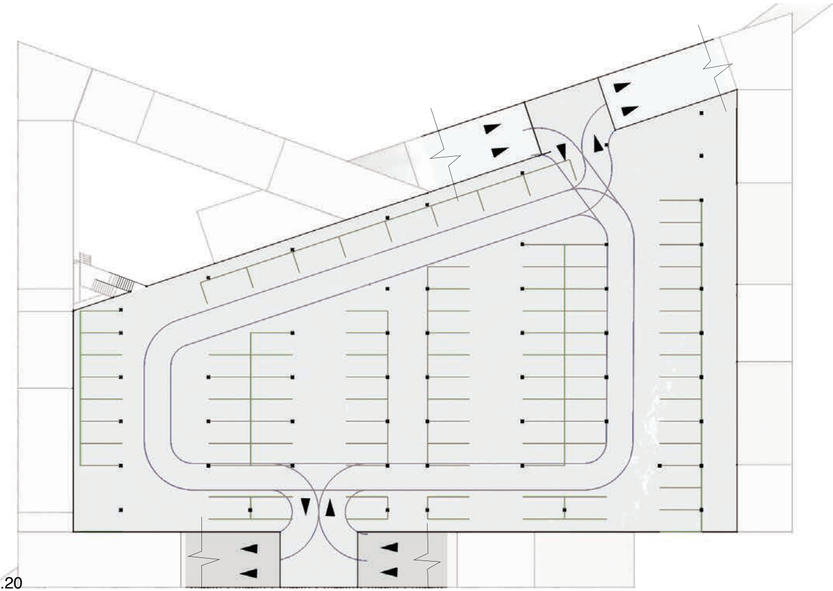
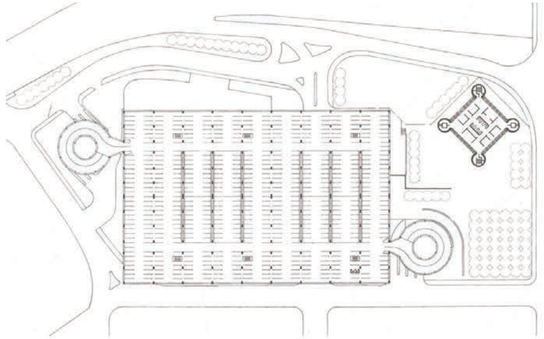
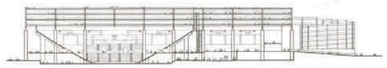


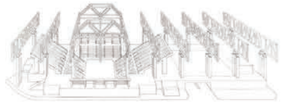
Fig.20

However, the earlier layout had certain defects in it. First and foremost, the columns are located at the end of each parking spot, which made it difficult for cars to park. Secondly and more importantly, since the floors aren't perfectly rectangular, some columns were aligned to the tilted edge of the floor, breaking the order in the fields of columns. As a result, the columns can only line up and appear similar to parallel walls at very few restrictive angles.

Several case studies revealed how the structure were integrated into the parking garages. Projects studied were the Veterans Memorial Coliseum in New Have, Parkhaus Am Bollwerksturm in Heilbronn, Germany and the Car-Park Rotunda in Hamburg. In these cases, the structure were treated as a part of the parking facility instead of a separate system. For instance, in the Veteran Memorial Coliseum, the architect left enough space between the steel members in the floor-to-ceiling tall truss, so that although the truss was built right in the middle of the floor, cars can still drive through it, leaving the car route unobstructed. In the car park Rotunda, the architect designed the beam to be thicker towards the end, and thinner towards the middle of each span, addressing the conflict between structural integrity and height requirement for parking spaces.





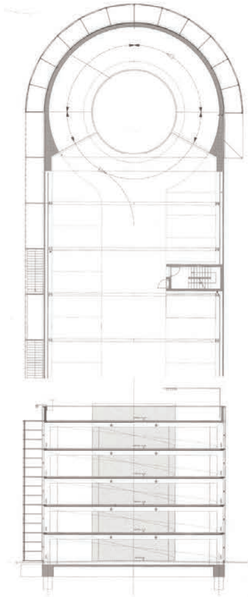


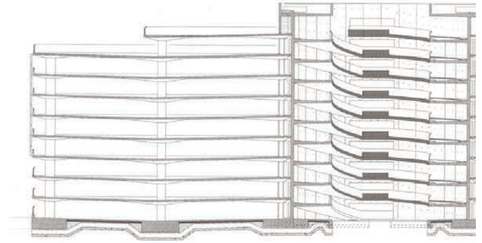
Case Study 01
Veterans Memorial Coliseum
Roche Dinkeloo & Associates
New Haven 1972

Fig.21

Case Study 02
Parkhaus am Bollwerksturm
Mahler,Gunster, Fuchs
Heilbronn 1997-98

Case Study 03
Car-Park Rotundas
Von Gerkan, Marg & Partner
Hamburg 1990-2002





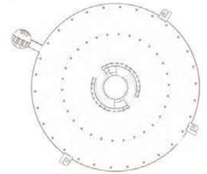


Fig.22

3.3 Finalized structure

3.3

Learning from the case studies, the finalized structure was a simple but effective solution to the problems in the earlier structural plan. In this plan, all the columns are sitting on a 31’ by 31’ rectangular grid without any exception. The grid lines are 31’ apart because they perfectly fit a two way car lane, which is 24’ wide, and two 3’ set backs for the parking spots. The column itself is 1’ by 1’. However, the columns give ways to the car lane at some spots, and the beams at those locations will be deeper to compensate the structure. In other cases, the parking spaces yield to the columns. Under this layout, the columns will line up and appear as parallel walls if viewed from as many as eight directions, as shown on the next page. Some of the supportive columns under the ramps were also extruded into “fins” to form forced perspectives, further strengthening the sense of depth perceived.

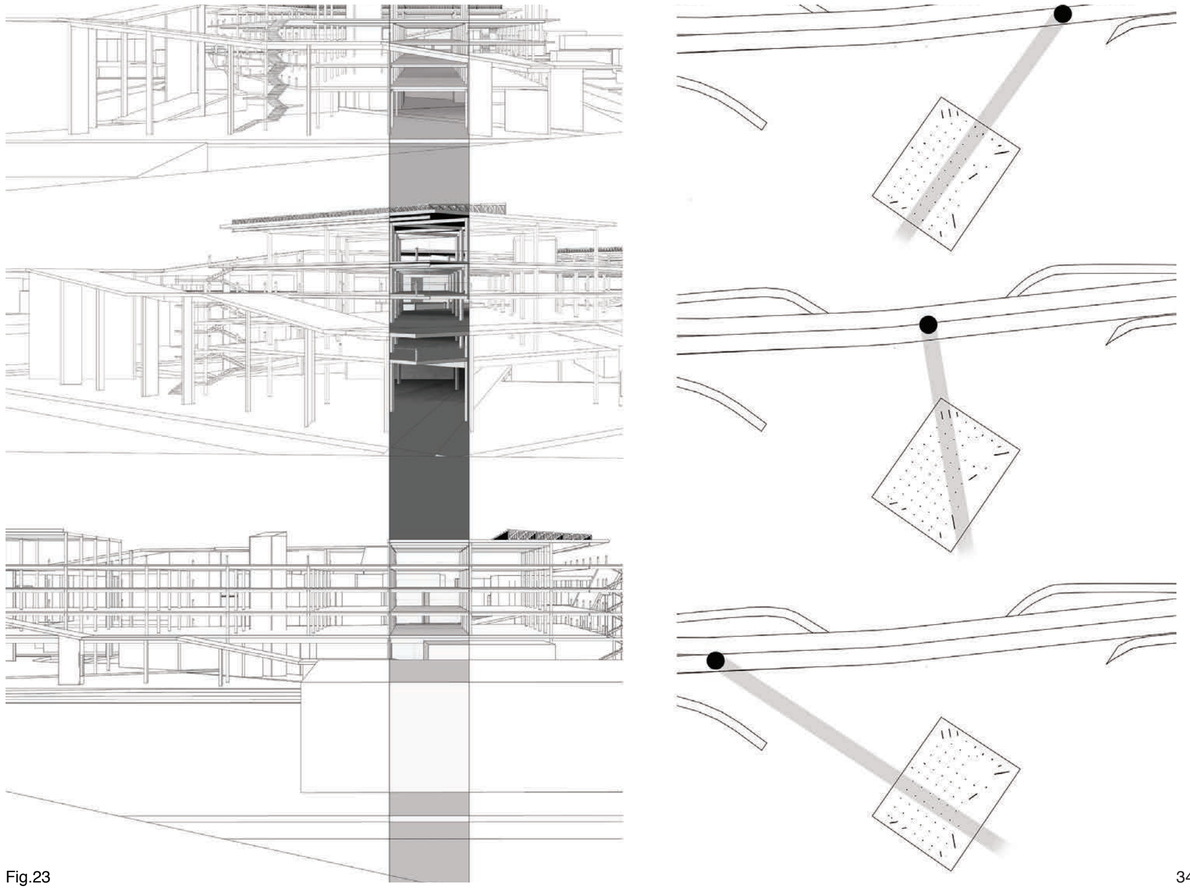


Fig.23

3.4 Programming and circulation

3.4

The ground floor spaces are programmed for efficiency and openness. As shown in the next three diagrams, towards the residential neighborhood (green) , a space for public use is carved out from the building. The train station sits between the two light rail tracks so that it can serve commuters traveling in both directions. The retail area (blue) is placed in proximity to both the train station and the retail stores across the street, so that it benefits from the passenger flow, and the connections to more stores.

The ramp structure, the roof and the retail area were later revised, while the overall programming and circulation remained unchanged.

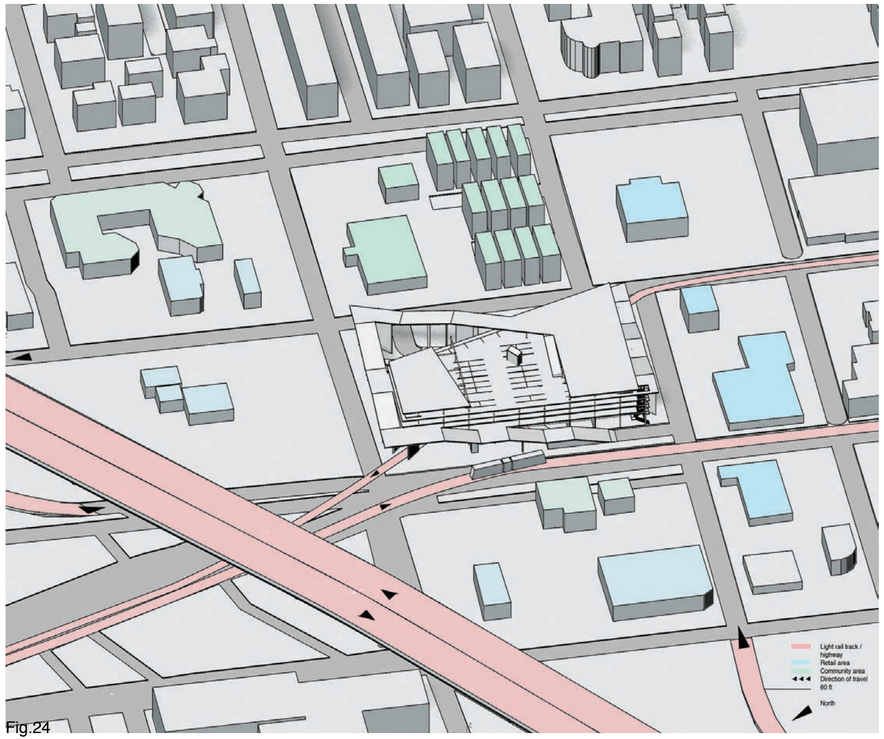
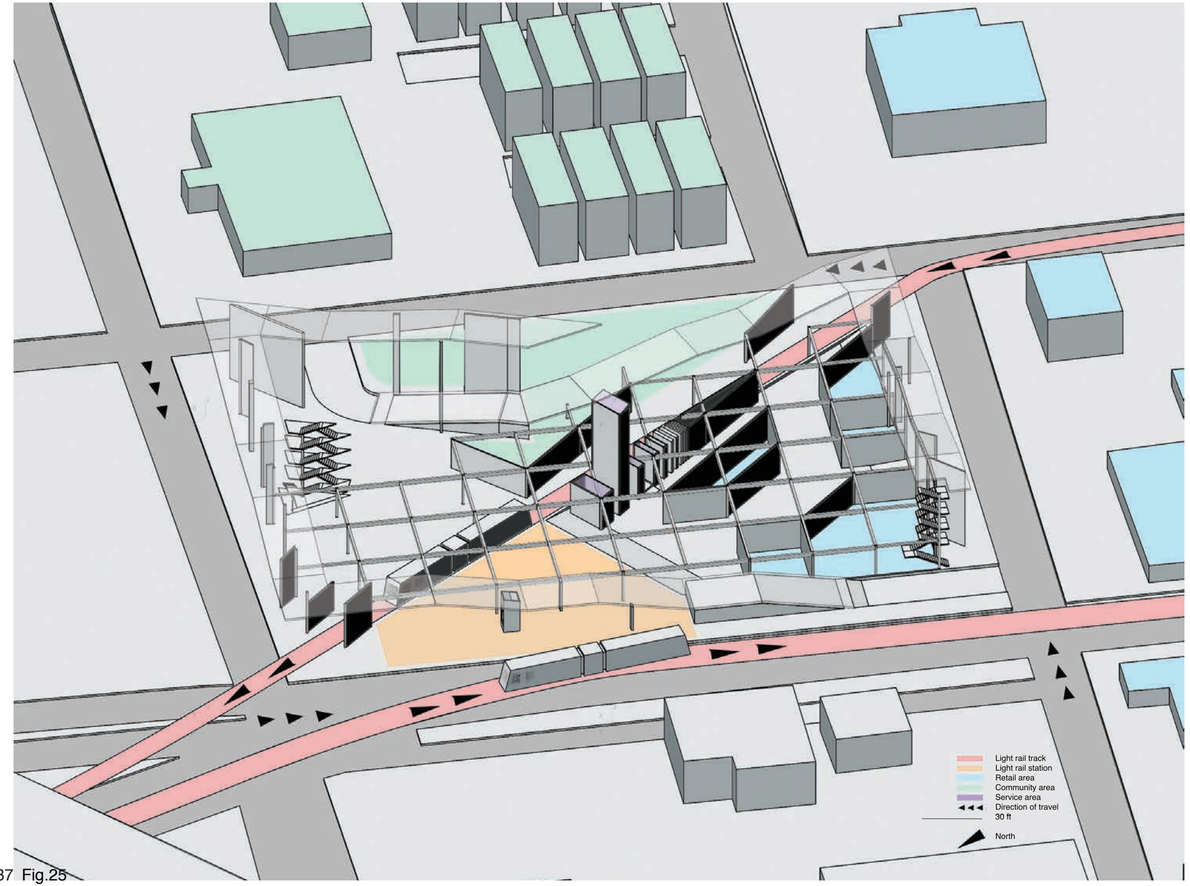


Fig.24

A site analysis showing nearby building types and traffic conditions.


Light rail track
Light rail station
Retail area
Community area
Service area
Direction of travel
30 ft
North

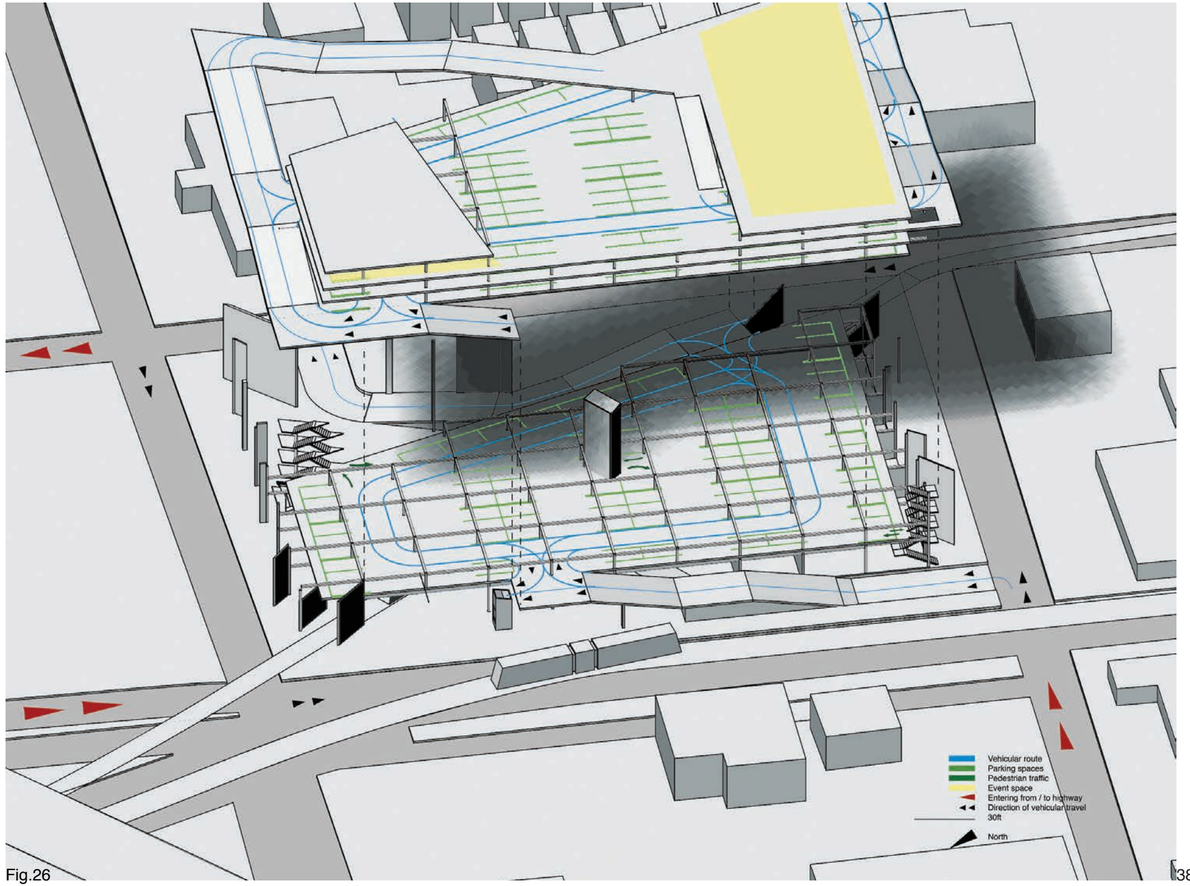

Vehicular route
Parking spaces
Pedestrian traffic
Event space
Entering from / to highway
Direction of vehicular travel
30ft
North

Fig.26

3.5 Plan, section and details

The drawing on the next page documents the roof and how it functions spatially; its corresponding section; floor plan for the retail area on the ground floor; details on the post and beam structure and the suspended part of the floor.

The complete site plan, ground floor plan and section are followed.

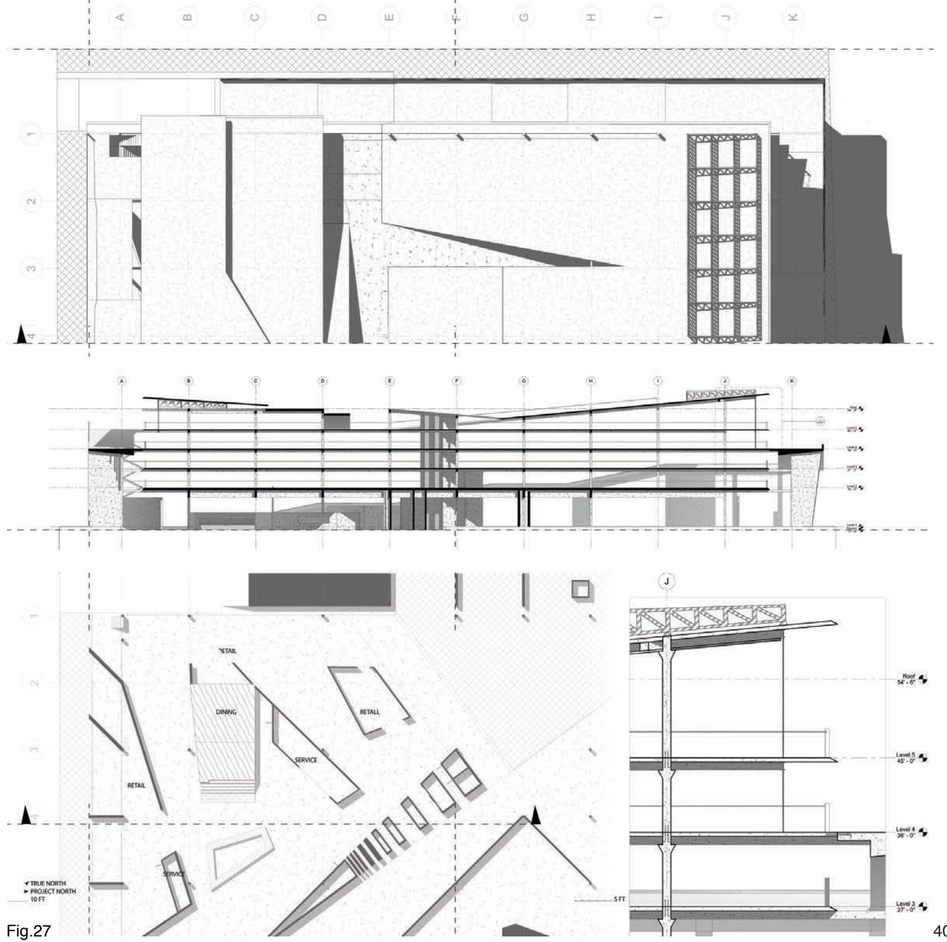


Fig.27

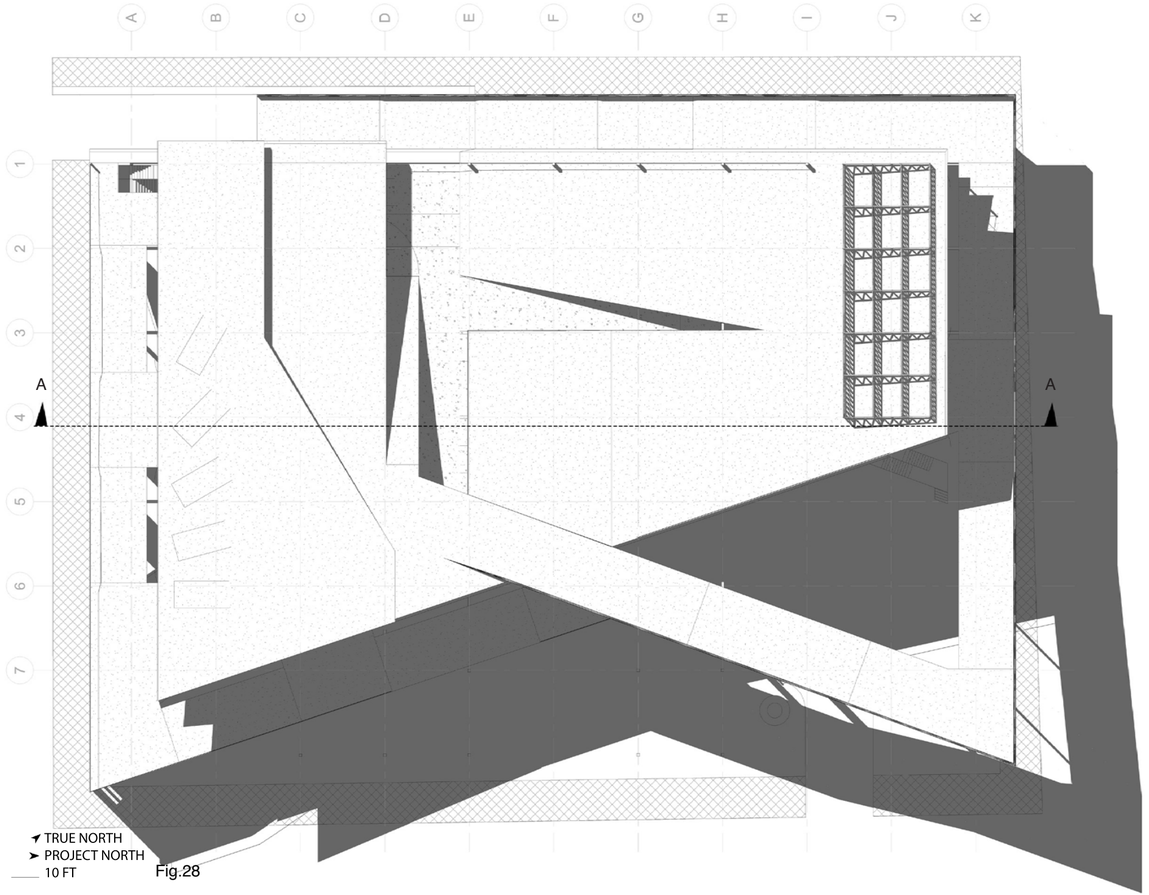

A B C D E F G H I J K
1 2 3 4 5 6 7
A
A
TRUE NORTH
PROJECT NORTH
10 FT

Fig.28

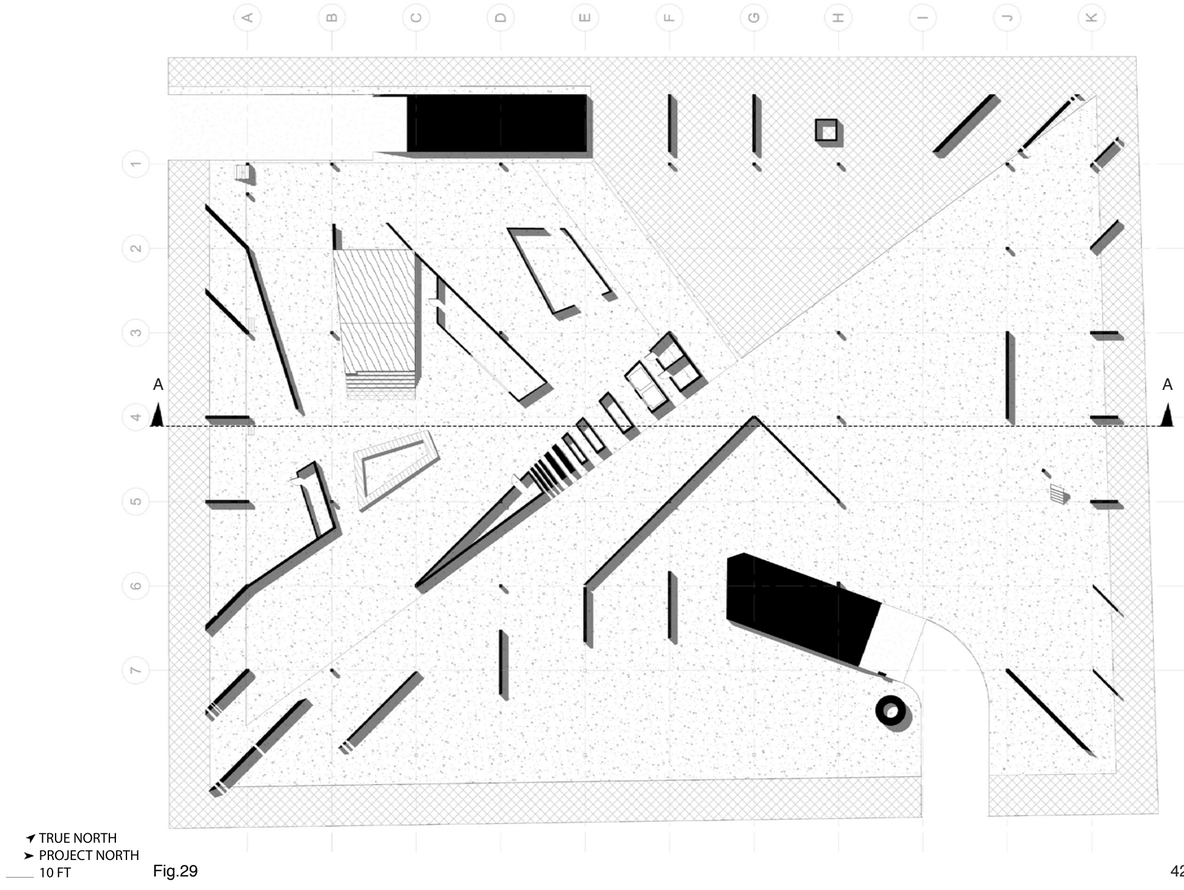
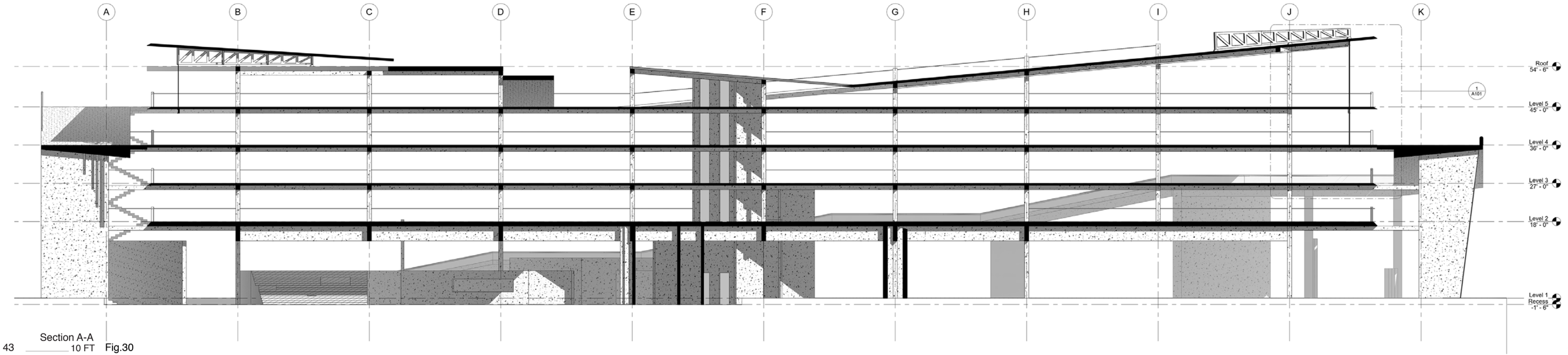
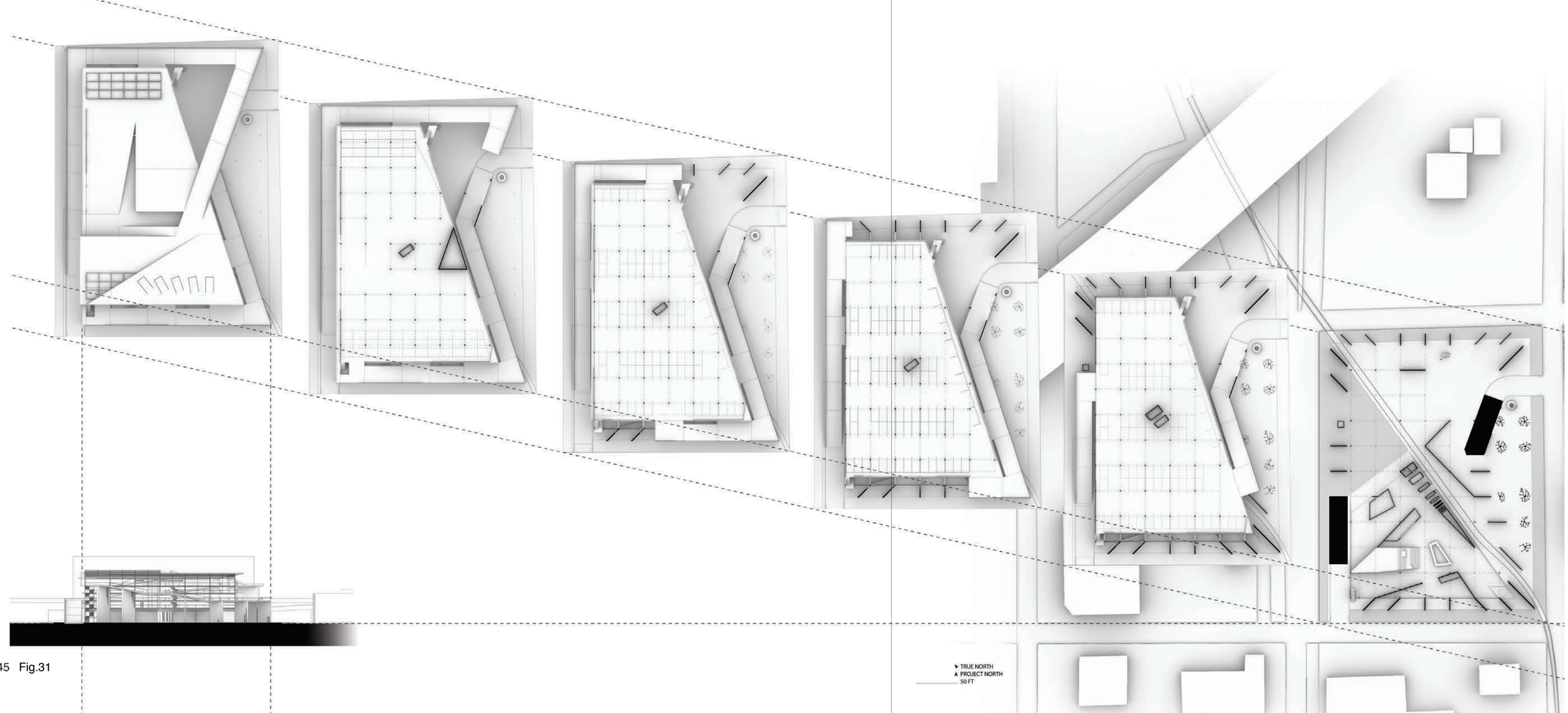

A B C D E F G H I J K
1 2 3 4 5 6 7
A
A
TRUE NORTH
PROJECT NORTH
10 FT

Fig.29



Section A-A
10 FT

Fig.30



45 Fig.31

The complete set of floor plans are also superimposed with reflected ceiling plan on each level, which further explains the concrete post and beam structural system.

3.6 Renderings

3.6

The renderings show the perspective view of the building from several vintage points. The location of the point of view is illustrated on the plan next to each rendering.

Fig.32

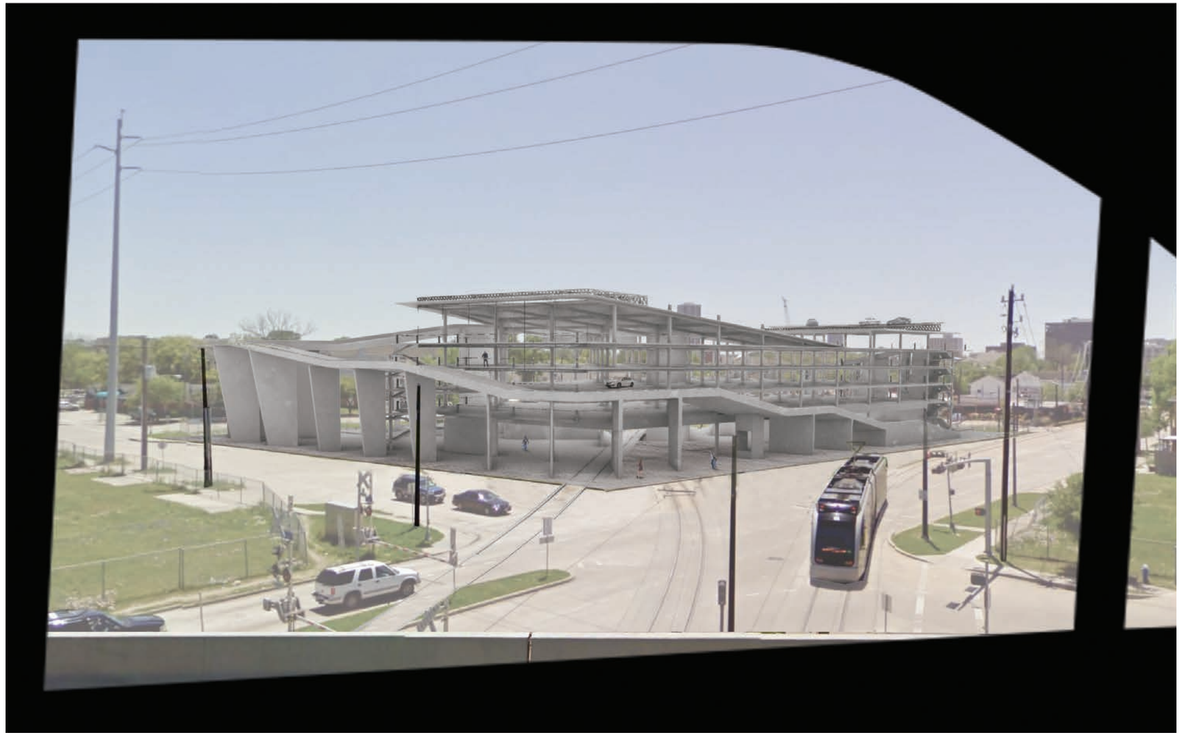


Fig.33

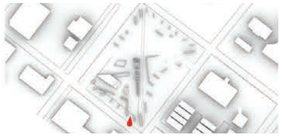


Fig.34

Fig.35

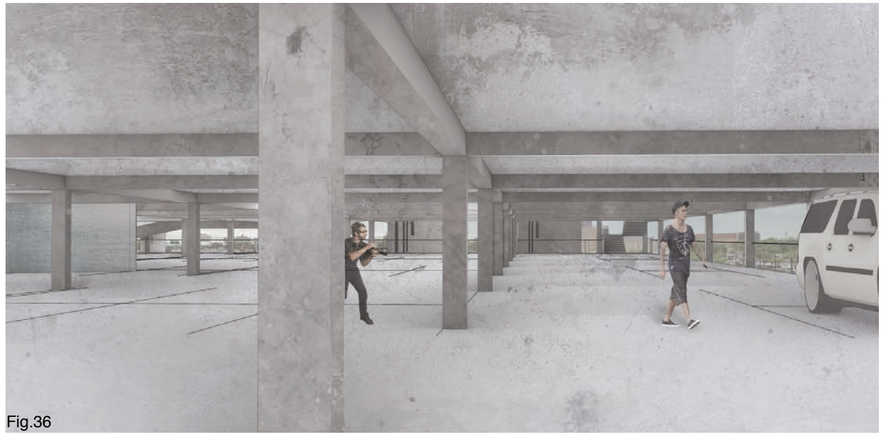


Fig.36

Fig.37

3.7 Photographs of model

3.7

Some photographs of the model help to better understand the interactions between light and spaces in this project.

Model scale 1/8” : 1’.

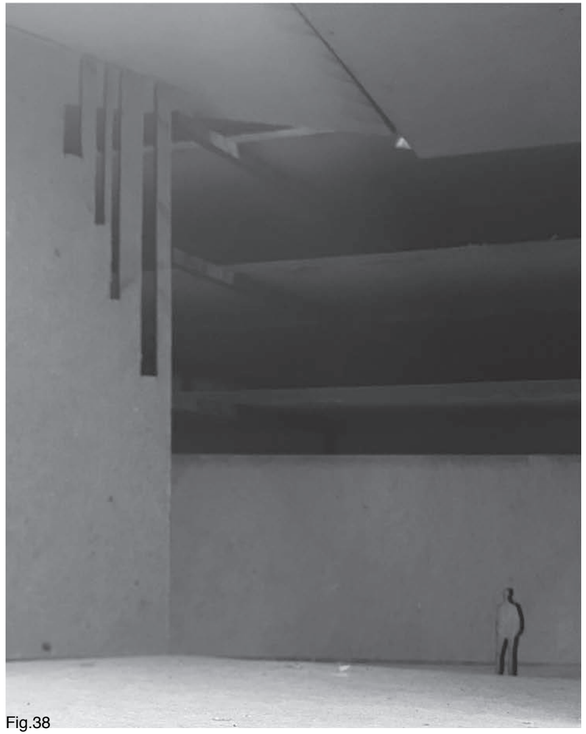


Fig.38

The cut-outs on the structural walls that support the ramps allow more light to enter the parking garage and they also allow people to look out. More importantly, they are negative spaces that also implies columns, further emphasizing the verticality.

Fig.39

The cut-outs located on the corners of the building allow people to look out for passing trains before crossing the train track.

Fig.40

Fig.41

Photo above: Looking over the retail area from the light rail station. As shown in this photo, the ground floor is designed to achieve openness. From certain vintage points, one could see directly through the space, connecting the ground floor to the streets outside.

Photo on the left side: A 3’ gap set apart the ramps from the building. The gap allow more light to enter and creates some interesting lighting conditions.

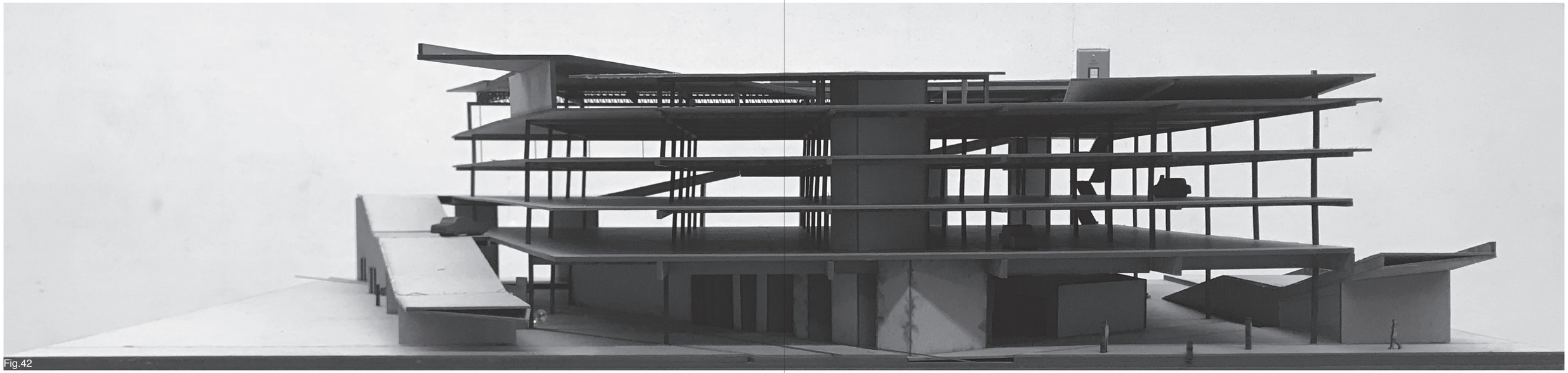


Fig.42

4 Conclusion

Reading a building's facade, as one stands still or moves slowly is similar to perceiving the sense of depth and space in an oil painting through the movement of one's eyes. The relationship between the spectator and the object is static in this case. However, as one travel faster on modern transportation, the individual tend to view the world in motion, and the relationship between the observer and the surroundings are now dynamic. In the thesis study, I demonstrated a way for architecture to appeal to the moving spectators, and that is through reducing the building facade and revealing more of the interior space of the building. As space and depth appear differently from varied perspectives, the building reacts to the spectators' movement as they project itself differently into the viewer's eyes. Depending on the configuration of the revealed parts, even more could be achieved. In my thesis project, the structure of the parking garage can be read as a field of columns on a rectangular grid. As the spectator pan through the...

...building, the columns line up and form pockets of spaces which allow the spectator to see through, break into seemingly disorder from certain perspectives, and line up again from another perspective. In such ways, the building emphasizes its own existence through the eyes of the moving spectators.

5 List of figures 5