An Underground Station for Dulles International Airport

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

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“It would be a mistake to ascribe this creative power to an inborn talent. In art, the genuine creator is not just a gifted being, but a person who has succeeded in arranging for their appointed end, a complex of activities, of which the work is the outcome. The artist begins with a vision—a creative operation requiring an effort.”

-Henri Matisse
Abstract

Architecture is an art form that must answer to the functional requirements of the program, respond to the site, and provide a safe and enjoyable environment for its users. In addition to these important characteristics, architecture should also enhance the experience of the user through means of expression, aesthetics, and structure.

When one thinks of current successful architecture, their first thoughts are of museums, libraries, or even residential housing. One would rarely put successful architecture and transportation facilities in the same sentence.

Several European cities have noticed this lack of interest in public transportation facilities and in recent years have placed a heavy interest on creating successful transportation structures. However, the US has not followed the Europeans’ insight. This is a startling thought because with facilities that so many people come into contact with on a daily basis, why have these designs been left mostly up to the engineers?

In order to truly enhance the environment and to let architecture reach out to the general public— it must be implemented in places that people have to go. Nobody has to go to a museum, but how many commuters opt not to go to the metro station they need in order to get to work.

So, I posed the question—Why has transportation architecture become a lost thought when there are so many possibilities to reach people with well thought out design? Shouldn’t we as designers want to enhance the places were most people go, not just were few choose to visit. Shouldn’t architecture be for the general public to enjoy. That is why I chose to design an underground station for Dulles Airport. It is an opportunity to provide the public with a functional design that they could enjoy, while enriching their thoughts
I dedicate this book to Bob and Peggy Boal.

Without these two remarkable people, I would not have the opportunity to be where I am today. Their love and support has helped form the person I am today. So, I dedicate this book in their names. It is a small token to all they have bestowed upon me.
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“It is art that makes life, makes interest, makes importance... and I know of no substitute whatever for the force and beauty of its process.”
-Henry James

“I think the experiential test of whether this art is great or good, or minor or abysmal is the effect it has on your own sense of the world and of yourself.”
-Sister Wendy Beckett
After spending 17 days in Europe traveling through cities like Paris, Berlin, and Munich, I was again on American soil on the 13th of January 2001. On this day I realized that I had become spoiled in those few days in Europe- spoiled by well planned and designed public transportation.

My plane landed in the much adored Dulles International Airport, outside of Washington D.C. I went through the normal customs routine, then went to meet my friend who was picking me up to take me home. This is when it really hit me- with an international city like Washington DC and an airport as busy as Dulles, why was there no way to get there other then by cars or buses? During my trip abroad I visited much smaller airports that were serviced by multiple means of public transport, so what made DC not follow similar principles? I began to ask myself these and many more questions, which inevitably lead to the decision to design an underground station for the International Airport.

I could not determine why DC had not solved this problem yet. The closest stop to Dulles on the Metro is West Falls Church where you can take a “Washington Shuttle” bus to the airport, but do not depend on this if you need to make it to the airport on time.

So the answer to build a new metro stop at Dulles was obvious, how to design it was not. Many things had to be considered. Through research and reflection I chose to focus on one primary and two secondary concepts.

**Concepts**

- Responding to the tension between above and below ground spaces.
- Creating a sense of arrival.
- Looking at how a transportation facility could be more than just an engineering and planning task- how it can be architecture.
The airport is world renown for its unique design from Eero Saarinen in 1962, at a total cost of 108.3 million. The Airport is named after John Foster Dulles, who was secretary of state under President Dwight D. Eisenhower from 1953-1959. Dulles was built on 10,000 acres in Loudoun and Fairfax counties in Virginia, approximately 26 miles from downtown Washington, DC.

Due to Saarinen’s vision, Dulles has become a landmark for not only DC but for the US. Its roof (modeled from the idea of the Wright brothers and the sense of flight) hovers over the magnificent building with great pride. The main terminal is also set in the landscape like a Greek temple, high and centrally located and symmetrical. All of these factors give Dulles the great sense of arrival that Saarinen intended.

In the late 1980’s Dulles International was moving into the prominent aviation role in the region. The trajectory of growth at Dulles over recent years has greatly surpassed the national average. From 1995 to 1998, passengers using the airport increased by 28 percent- from 12.5 to nearly 16 million. In 1999 Dulles was the fastest growing airport in the country with an annual growth rate of 25.7% compared to the industry average growth rate of 2.9%.

Along with passenger growth came a significant increase in the number of airlines wishing to do business at Dulles, resulting in an increase in the destinations served by the airport. Today’s area traveler can easily reach thirty-two different foreign destinations and seventy-five U.S. cities from Dulles.

Saarinen’s words...........
“Because we feel confident in our period, we can look at the past and derive inspiration instead of falling into imitation.” (To A.I.A. June 16, 1954)

“Intuition plays a large part in architecture, because we don’t have an IBM machine big enough to take all the factors into consideration.” (Horizon interview, June 19, 1959)
Metro opened in 1976, but work was still going on in 1984. The system was just completed to its original plan this year with the completion of the Green Line. It was one of the first U.S. subway systems built from scratch, rather than from several existing railroads like New York or Boston.

From its opening, metro was fully embraced by locals and tourists. Metro also became more than just a way to move people; it became a factor that lead to growth in many areas like Clarendon. Henry Weiss, the architect of the original stations, found the task to be more of an engineering task; however, the result was a clean, well organized and recognized system of stations.

The metro fulfilled many dreams, many things were unrealized. Ideas like the escalators open to the sky are falling apart after years of soaking in the rain and snow. The two track design of the railroad is too simple for increasing demands for service, unlike the separate line service in New York or London. The rail lines do not reach where most movement now takes place: suburb to suburb.

The growth of suburban areas like Bethesda and Falls Church have added to fast growth in metro riders. The subway takes more than 270,000 cars off the road each day; something which should not be forgotten in today’s world. The numbers of passengers would triple if the planned improvements are made to the line. A competition is being held currently for a new system of coverings for metro entrances, surely a great way to revise the system. Another main improvement already planned to the line is the extension to Dulles Airport on the Orange line which would serve not only the airport but also the corporations along the toll road.
In recent years, much progress has been made to expand and improve Dulles. In 1996, a second Customs and Immigration facility was opened in Concourse C. Also in 1996, SOM completed a challenging project at Dulles — the expansion of the Saarinen terminal to complete the architect’s original design. One of Saarinen’s insights for the future was that the main terminal would need to be enlarged. So, Saarinen planned for 300’ to be added onto both sides of the existing 600’ terminal—therefore respecting its symmetry. All SOM had to do, was simply follow Saarinen’s plans and instructions.

The expansion added much-needed ticket counter and baggage claim space. The project also solved the problem of traffic obstruction. Lanes to the roadways in front of the terminal were created to help reduce congestion at curb side and to create a separate roadway system at the ground level for commercial and valet traffic circulation. This new system became highly acclaimed, for it was much easier to pick and drop of passengers.

Today, Dulles serves 20 million passengers. In the future, the Airports Authority has the land capacity to handle up to 55 million passengers when all planned facilities are built. There is no specific timetable for that ultimate build out, but it would involve building additional midfield concourses, additional runways and a system to connect travelers to the expanded midfield. The master-plan also calls for an additional terminal—the “South Terminal”. This new terminal would be on axis and exactly like the existing main terminal, it would just be on the opposite side of all the midfield and runways.

Currently, construction is being worked on for new baggage and international arrivals areas (shown on bottom picture on the right.) In August, 2000, a contract was awarded for the construction of two parking garages with a third proposed—which will be built north and west of the terminal building and will accommodate approximately 8,500 vehicles.

The Airports Authority has also leased land to the Smithsonian Institution for a new National Air and Space Museum Center that is scheduled to open in 2003. One might ask—how are the tourist going to get there without the Metro?

“There is no question that Washington Dulles International is the major air transportation hub in the mid-Atlantic region, and a key link in the world’s aviation system. We have invested almost one billion dollars in improving and adding capacity for our facilities, but that is only the beginning. The next six years at Dulles will bring significant changes and improved customer service.”— Airports Authority President James A. Wilding.
“Quality is never an accident, it is the result of intelligent effort.”
-Ruskin

“So I hope it will remain during my life as architecture is my delight.”
-Jefferson
Probably the number one reason I returned from Europe sure that my thesis would be an underground station— the effect of the Jubilee Line success. Ten London-based architects have transformed the civil-engineering job of creating underground stations in the new Jubilee line. Boring a 10 mile long line underneath the historic city shooting through existing lines, and foundations of thousands of buildings can make what is already a difficult task, a near impossible one. Many attempts have been made over the past several years to build an east-west line along the south side of the Thames River, but they all failed due to poor soil conditions, concerned citizen groups, and politics. All of these factors make the completion of the Jubilee line somewhat of a miracle.

Richard Paoletti, the chief architect of the line, was brought to the project in 1990. Wilfred Newton, the chairman of the project, and Paoletti worked together previously in Hong Kong to build 36 stations in 12 years. Paoletti hired architects to lead the teams of engineers. He had a strong vision to make each station fused, where you could not tell where engineering ended and architecture began.

Each station had its own conditions and issues. Paoletti searched for architects that could give each station its own identity. JLE Architects (Paoletti’s in-house group) are the only firm to work on the design of two stations.

It would be hard, if not downright impossible for me to pick a favorite station. They each have their own greatness and individuality. Some were amazing engineering feats which became magnificent architectural journeys. I was fortunate enough to work in London when the Jubilee line was completed. The next few pages show some examples from the great 11.
Creating a new underground for Parliament, London’s biggest attraction was a challenge. Complicating the project, the District and Circle lines running diagonally across the site had to remain in use.

The site and program restrictions led to the decision to build the station 104’ below the ground. Obviously this became a time when architecture is the engineering. Michael Hopkins answered the challenge by creating a station that is direct, functional, and heavy, but it is also a great experience to
Southwark serves the new Tate Modern and Globe Theatre and called for a design that would show its true genius below ground. Space was a virtue in this project due to the connection of Waterloo East and the piles of recent buildings. There is also an abrupt change in direction (due to site restrictions) to get from the ticket hall to the trains. This space becomes the centerpiece for the station by opening it up and letting daylight into the 52’ tall space with an amazing curved glass wall that is 131’ long. The station is amazingly complex, yet remains simplistic in feel. Simple geometry and careful attention paid to lighting, gives Southwark a welcoming feeling that is hard to do 70’ below the ground.

by Richard MacCor-mac
With a working population of over 25,000 people in 1999 (set to double in the next decade) Canary Wharf needed to accommodate large growing numbers. An elegant oval glass canopy is created to glow at night and to grab light into the station during the day. A generous park is created between the two canopies, providing a great space to both travelers and non-travelers.

Inside elegant slender elliptical columns were designed for high performance. The mezzanine concourse level, weighing 2500 tons, was suspended from above to avoid intrusions into the platform space. Sometimes referred to as “the wing station” Canary Wharf is truly one of a kind.

by Sir Norman Foster
Connected to local bus routes and of course the famous Millennium Dome, North Greenwich is one of the most heavily used stations in London. However, like many of the station, the site brought problems to the design. The site was heavily polluted and waterlogged, so a cofferdam had to be constructed before the huge, 1,174’ long box for the station could be excavated. But once all the site conditions were taken care of, Alsop and Partners took charge.

The platforms and trains are integrated into the main volume of the station, providing a strong drama. Color was a key element in the design. The vibrant bluish purple mosaic columns helps break down the edges of the volume. While staying true to the common clarity of the entire line, North Greenwich
This beautiful bridge in Valencia Spain, is much more than most of Calatrava’s unique bridges. Yes, the bridge stands up to Calatrava’s standards and is quite elegant, but there is another world underneath the bridge.

Using White reinforced non-faced concrete, this metro station creates its own universe. Calatrava uses repeated skeletal like elements that vary in section. These concrete ribs interact with each other to create a web effect. Calatrava also allows natural light through the openings of the concrete ribs. On the ground the openings are magnificently illuminated at night and become a hint to the world below.

A unique answer to solving the problem of how to design an underground station where the traveler does not feel like they are in the deep depths of the earth. They actually have a nice connection to the world
O’Hare is the terminus of the rail link between the city Center of Chicago and the large international airport. The three story station is located below a parking structure and is 180m long, 21m long, and 9m high. Deep beams are part concealed by an undulating glass-block wall. This wall not only hides part of the massive structure, allows the station to light up in a way most underground structures never do. The wall gives the illusion of daylight, since the lights are behind the glass block, it is somewhat a mystery where the light is coming from. This effect makes the space seem more welcoming and not as unsafe.

There are moving walkways at O’hare that are also flooded with light, art and music.
Getting people to the airport is obviously important to Munich. This new connection between the city’s transit system and international airport is dynamic yet very functional. Since the transit connection is added to an existing terminal, it was more functional to build the train station to the left of the existing terminal and have a connecting walkway to the airport. The design made the walkway much more than a long passageway by using multicolored lights and offering many different things to catch your eye while moving to the terminal. It truly felt like the distance between these two separate entities was a third of what it really is.
Paris is always known for its style, but until now that never included underground stations. The city built a new underground line, number 14, which would connect several different lines and most importantly go to the new biblioteque. These new stations are very similar, with slight changes depending on the site. There are snake like lights that direct you through the space. The Parisians also decided to cover the track with glass structure, making it safer and less likely to become another place for graffiti. Every detail down to the seating was thought of to showcase that even underground stations can depict Paris as the
“I will study and get ready, and maybe my chance will come.”
-Lincoln

“The man who gives up and says “I can’t” is usually right about it.”
-Barkelee
Several study models were built to determine the appropriate placement for the station. Locating the station under the Main Terminal was considered. The studies shown here place the station under the existing parking area out front of the Main Terminal.

Locating the underground station in a large opening out front of the Main Terminal. Providing views of the airport, while not crowding the main terminal.

Locating the underground station in a large opening in the center of the Main Terminal. Having the trains arrive perpendicular to the station- not practical when considering the programmatic needs of the trains.

Creating a series of slit like openings in the earth to allow light to enter the underground space, while also allowing for views of the Main Terminal.

Pushing back the station and creating a larger underground world, with cuts in the landscape pointing towards the station.
Final Concept Model
The station is placed under the parking in front of the Terminal. There is a large opening in the ground that is symmetrical to the Terminal. The Glass opening reflects the form of a wing.

There are two principle elements to the scheme—the underground tunnels linking the new parking structures to the station and to Dulles, and the connection between Dulles and the metro station.
Conceptual Plan
This early plan depicts five underground tunnels linking people from the parking garages to the metro and to Dulles. There are three tunnels to the North Garage and Three separate areas bringing people to Dulles. The walls in the long tunnels grow closer together as you move toward the station.

This plan was not chosen because I found three tunnels to be excessive and disruptive to the symmetry of the airport. I also found the angled walls placed emphasis on the parking garages instead of the Main Terminal.
Module Study
I began to look at the structure as a series of repeated elements. Due to the type of needed construction, I began to explore how the structure could become the visual language for the station.

Here the column form is also used to create the arches which would hold up the concrete shell. A problem with this module is it seemed very static and problematic with circulation.
Form Z studies

I wanted to understand what made the previous module so static, so I explored it further in the computer. The moving walkways (people movers) were placed underneath the column, so you there was a true sense of being under a tree like structure. The pictures above also illustrate the idea of creating a second (balcony) level in the walkways. This idea became problematic with circulation, structure, and the visual interruption that it created.
Final module study
From previous models and explorations, I moved to this module. Here, the column is eliminated. The arches are crossed to divide up the space into three sections. It is similar to that of a nave and aisles of a great cathedral.
"A work of Art is an offering to art."
-Kahn

"Art is the only thing we have."
-Phillip Johnson

"I’d rather die in passion then live in boredom."
-Van Gogh
The final decision was to place the metro station parallel to the Main Terminal, located underneath what is presently called the “bowl parking lot.” There are three underground tunnels connecting to the parking structures and one connection bringing you up to grade to enter the Main Terminal. Every attempt was made to bring as much natural light into the space as possible enabling the underground space to be more enjoyable while providing the users with a sense of awareness of where they are. The fold-out of the site plan shows these openings in blue.
Aerial View of the Site

The view you would see flying over the metro station viewing the numerous openings with skylights. The form of the principle skylight (which is symmetrical to the length of the Main Terminal and the Train level) mimics that of a wing to simulate travel and to reflect upon the influence Saarinen used in designing the Main Terminal (The Wright brother’s wing.) Also shown are the openings in the taller portion of the North Tunnel, the skylight over the portion leading to Dulles, and the three smaller openings in front of the garages.
The Plan

This drawing shows the first level underground - which is the main underground level - with three tunnels linking to the garages, the main concourse (bridge) over the train level, and the section leading you to the Main Terminal. The plan also presents the relationship between the arches and the tunnels. The tunnels are straight except for when they are terminating at the parking structures, where walls are angled to reflect light better from the skylight above. The fold-out of the plan depicts the section lines in red.
View of Main Concourse

This is a view from the main concourse (bridge) that is directly over the train platform. Here you are standing near the intersection of the North Tunnel and the area leading towards the Main Terminal. You are looking towards the East Tunnel, and viewing escalators and control ticket points which lead down to the train level. It is clear to see the main skylight dipping downward to a point which is the center of the station and the Main Terminal. To support the massive glass structure, a truss was implemented. Also, to support the ground around the skylight, unique beams were designed. These beams span the width of the concourse and intersect through the skylight. The beams curve towards the end to create a nice arc that connects to the large retaining walls. The arc responds to the visual language and continuity of the project.
Train Level Plan and Section 13

Showing the long train level (symmetrical to the Main Terminal.) It is very typical of metro plans - with changed texture to indicate closeness to the tracks, grates for ventilation, and plenty of circulation. What is not typical of the DC metro stations are the concrete arches springing from the wall, and the arches over the train tracks. The fold-out of the plan shows the section and blow up areas in red.
Train Level Views
These views taken from the train level show the large arches springing from the wall that help support the bridge above the train level. The smaller arches on the sides are steel and hover over the train tracks supporting two glass walls with automatic doors which open when the train arrives. This is a safety feature, but it also helps create a more dynamic space. These smaller arches and glass walls also make the scale of the long and tall train platform easier to understand and relate to.

The top picture shows an area of the platform where escalators bring people down to the tracks. On the sides of the escalators are 4 columns also helping support the bridge above. The bottom picture represents where one of the two elevators enter the train level.
Arches Over the Tracks

The image on the left shows the arches described earlier that hover over the train tracks. This system is used in underground stations in Paris and London, and is both a safety feature and a design element. The arches span the tracks, with glass walls on both sides. These glass walls have automatic doors that open up when the trains arrive, therefore making the tracks unavailable for litter or safety hazards.

The bottom image shows the system implemented in the Paris line number 14.
Sections 1 & 2

These sections are taken through the North parking Garage all the way to Dulles. They show the spatial relationship between the long tunnels and the more open space of the bridge, train level, and also the existing context. Since these sections were taken through the North Tunnel, they also show the area that was able to be extended out of the ground with taller arches and a skylight. This was the only part of any of the tunnels that was able to do this due to traffic flow restrictions. These sections also show the type of substructure needed for the site—due to site restrictions and conditions, caissons were needed to be the support for the massive underground structure.
Section 3

Taken through the escalators, this section (as well as sections 4) show how the skylight in this area widens as it moves closer to the Main Terminal. To support earth, beams (similar to those in the main concourse) are implemented. Also important to notice in this section are the two elements on outer sides of the elevators. This is a sculptural element (the form mimicking that of a wave) that is created to keep one from straying into portions of the area where there is not accessibility leading to the Main Terminal. Since the sculptural element is made of Stainless steel it also serves to reflect light into the space. The picture on the top left is depicting the model in this area.
Detail of Glass in the Skylight Leading to The Main Terminal.

These sections show the structural character that this particular skylight has. The glass opening spans a large distance at the farthest point, so measures had to be taken to insure safety, while also keeping the structure as light as possible. A steel beam is used to span the distance of the skylight. The cross section at the top shows the steel member becoming narrower towards the center. The section also shows the angle at the connection of the beam to the wall helping distribute the load at this point.

The bottom longitudinal section shows the placement of these beams with respect to the concrete beams below them (supporting the roof) and the mullions.
Section 4

Taken right before the escalators, this section also helps show the relationship between the escalators, elevators and the skylight above them. Being right in front of the sculptural (wave like) element, you can also see the different levels it is divided into.

The bottom rendering is the view you would see in the area that the section is taken. Noticing the beams spanning across the width of the space, the stainless steel wavelike elements, and the Main Terminal peering beyond the glass.
This section, taken before reaching the skylight, shows the area that leads to grade and the Main Terminal. There are two columns serving as structural elements, but also as entrance gates. These columns are identical to the ones placed at the end of each long tunnel and on the sides of the escalators on the train level. The columns serve as dividing elements symbolizing that something different is ahead. In this case, it is the different experience of ascending to grade and to the Main Terminal. In the section you can see the escalators, elevators, and wavelike elements, beyond the columns.

The picture on the top right shows this area in the model.
Section 6

The North Tunnel is different from the rest of the tunnels leading to parking garages. The North Tunnel has a portion that is extruded above the ground with taller arches and a skylight. The other tunnels could not have this option due to restricted traffic flow on grade level. This section is taken right after the taller portion of the tunnel. At this point, you are again completely underground, noticing the light in the area in front of you. As mentioned earlier you notice the column at the end of the tunnel marking your entrance into a different space— the concourse.

The rendering at the bottom illustrates the view you would have while proceeding underneath the column looking straight ahead towards Dulles.
Section 7

Taken through the taller portion of the North Tunnel, this section depicts the relationship between the taller arches and the skylight above them. This section also illustrates the different shape of the concrete (retaining) shell which separates the tunnel from the ground. The line in the background is the line of the shorter ceiling area ahead (section 6.) In the middle of this area are the moving walkways, which help move people quicker through longer distances.

The rendering at the bottom shows the view seen in the tall space looking towards Dulles.
The drawing below shows the train level arch in elevation with the formwork in place. The drawing also depicts the temporary work needed to help support and center the formwork it holds up. This temporary structure would be tubular steel scaffolding and would be taken apart and reconstructed several times to make other similar arches.

I began to look at similar concrete construction both in history and the present. Santiago Calatrava, Pier Nervi, and Felix Candela became the most influential designers to study while determining the best approach to construct the arches.

Steel forms became the best material for constructing the concrete arches. Steel forms are obtainable for any type of structure and shape, and have replaced wooden forms entirely for certain structures. In this project, the benefits of steel formwork were numerous. There is great economic benefit to using steel instead of wood, especially with complicated forms- that is if the form could be reused numerous times, which it could. Labour and erection of steel forms is much easier and saves a tremendous amount of labour cost and time. The methods of connecting panels, bracing and tying being already provided for, erection is almost mechanical. Another advantage with steel forms is that they produce smoother surfaces, requiring very little retouching.

In constructing the arches I also wanted to specify the fixings to be concealed and for fibrous drainage matting (stretched over the face of the formwork) to be used. Both of these design details would help produce a high-quality finish with fewer pores that would look more like a flowing form than several separate forms placed together. The concrete needed to construct these arches would be 8,000-10,000 psi and would be fine quality in situ concrete.

The drawing below shows the train level arch in elevation with the formwork in place. The drawing also depicts the temporary work needed to help support and center the formwork it holds up. This temporary structure would be tubular steel scaffolding and would be taken apart and reconstructed several times to make other similar arches.
Section 8

This section is also taken through the taller portion of the North Tunnel. However, this section is looking North down the tunnel towards the parking garage. The line that you see in the background of this section represents the ceiling of the shorter section of the tunnel (section 9.)

The picture at the top illustrates the model of this section.
Detail of Arched Skylight in the North Tunnel

This skylight (like the others mentioned earlier) also spans a large distance. The arched shape of the skylight called for a different type of detailing than the triangular openings. I decided to use a method that is very similar to the glass structure in Canary Wharf by Foster and Partners (pictured top left.) The concrete shell extends slightly above the ground providing a base to connect a steel arch that spans the width of the skylight. The extension of the concrete shell also helps hint towards the underground world below.
Section 9
This section is taken in the shorter area of the North Tunnel. This is the typical section of the entire East and West Tunnels, since there are no taller sections of those tunnels. It is clear to see the different spacial relationship represented between the arches and the concrete shell (much tighter and a narrower arch.) In this area a glass railing is placed along the sides where a 10' clearance is met to prevent any access to shallower areas. Moving walkways are again in the center underneath the crossing of several arches. Since you are looking South towards Dulles you see the taller arches ahead in the background.
**Section 10**

Taken at the end of the tunnel by the parking garage, this section is also typical for the East and West Tunnels. I decided that there should be some natural light at the end of the tunnels, so when you are walking towards the parking structures there is something that seems to draw your attention- just as the main skylight would if you were walking in the opposite direction. The skylight in plan is a triangle and in section rises up to 10’ high. Inside, the vertical tunnel cut out of the ground (and out of the concrete shell) needed to have bracing to counteract the massive forces being placed on it. The bracing is handled by dividing the large triangle into 16 smaller triangles made out of concrete. To heighten the effect the light coming from this skylight would have, I decided to angle the walls at the end of the tunnel.

The rendering at the bottom illustrates a view you would have looking up the skylight from the tunnel.
Section 11
Looking to the West, this Section illustrates the relationship of the elements in the concourse area to the ones on the train level. In this particular location, the skylight is dipping bellow and will soon meet the center (deepest) area. The arched beam is springing from the large retaining wall and intersecting the skylight to span to the other side. This section also allows a clear vision of the scale of the truss in the skylight.

View of the concourse area of the model. Showing the skylight and the beams cutting through it.
Section 12

This Section, also looking West, is taken where the skylight is much narrower and is completely above grade. Here, the beam spanning between the two retaining walls does not intersect the glass at all, it just works to hold up more earth than in section 11.

The rendering in the middle of the page is a view taken from the end of the West Tunnel looking down the entire concourse area, seeing some of the train level as well.
Plan of Area 14
To help illustrate areas that might be hard to understand, I took some areas and blew them up. This area is part of the concourse level. This portion illustrates the bridge over the train level, which is 60' wide and the length of the station. I chose to make certain parts of the bridge sandblasted glass with a steel grid to allow for light to enter the train level. Section 13 best shows which areas are chosen to be glass and which are concrete.

This drawing allows a clearer understanding of the ticket control areas located in front of the escalators. It is also possible to understand the relationship between the truss system of the skylight and the beams that intersect and run through the skylight. The truss is spaced at 20', while the beams are at 40' spacing.

The open 30' on each side of the bridge also allows you to see the train level.
Plan of Area 15

To make the train level clearer, I chose to blow up this area. Here, you can understand the arches overhead and their relationship to the tracks and escalators.

Over the tracks you can see the spacing of the steel arches that hover over the glass walls. You can also see the change of texture close to the tracks alerting that the tracks are near for safety reasons. There is a grate for ventilation on the other side of the tracks right before the retaining wall.
Additional Model Photographs

This page and the following page illustrate different views of the model.
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Images
All the photographs included in this book were taken by the author-
Deborah E. Boal except the following.

Page 2 Washington Flyer Magazine.
Page 3 Eero Saarinen on His Works.
Page 4 The Washington Post (except the photograph of the metro
station which the author photographed.)
Page 5 Metropolitan Washington Airports Authority.
Page 7-11 The Jubilee Line Extension.
Page 12 Santiago Calatrava.
Page 13 Helmut Jahn, Design of a New Architecture.
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