The Washington Dulles International Airport Terminal: Designed for Air Carriers or for Air Travelers?[1]

Part of my dissertation on the history of Washington Dulles International Airport naturally focuses on the award winning terminal building designed by Eero Saarinen. Getting at the story behind how this building was designed quite naturally required researching the Eero Saarinen archives held by Yale University. Among the many documents and architectural drawings contained in the archive were three boxes of documents containing material collected from an extensive research into airport terminal design conducted before Saarinen and his associates began designing the terminal building for the new airport. Most of material were notes collected during on-site visits to eighteen airports in this country as well as three foreign airports—Vancouver Airport in Canada, Gatwick Airport in the United Kingdom and Frankfort Airport in Germany. Saarinen's teams collected information on the design of the terminals at these airports and data on passenger flow in and the average time departing and arriving passengers spent getting from the vehicle that brought them to the terminal to the departure gate and vice versa. The most interesting items were several articles from architectural journals that discussed innovations in terminal design with highlights and marginal notes that had been cut out of their original publication and kept along with five pages of handwritten notes on these articles and the airport visits.[2]

Washington Dulles International Airport was the first airport in this country built specifically for jet aircraft. It was a new airport rather than an expansion and modernization of and existing airfield. Because of this new airport and the research conducted on air terminals in the archive it appears that Saarinen was looking to make a fresh start with this project. This

[1] Unless otherwise credited all illustrations in this paper are by the author.
[2] Eero Saarinen Archive Box 460, Folders 1289-92; Box 461, Folders 1293-99; Box 462, Folder 1300

paper will examine of the documents from the archives to see how they influenced the final design for the Dulles Terminal.

The first part of this paper will be a brief overview of the development of civil air transportation in the United States to provide context on why the architectural journals of the 1950s reviewed by Saarinen were interested in changing the way airport terminal were designed. The next section will look at the debate carried on these journals over what should be the primary focus of terminal design, the needs of the air carriers or the needs of the air travelers and some of the solutions suggested by these articles and Saarinen's thoughts on these suggestions. The final section will discuss those concepts adopted by Saarinen in the final design of the Dulles terminal building.

The civil aviation industry in the United States after World War Two had little resemblance to what it was before the war. Unlike Europe, civil air transportation was slow to develop in the United States during the decade following World War One. In 1927 when Charles Lindberg left Roosevelt Field in New York for *Le Bourget* Aerodrome outside of Paris, France on the first non-stop flight across the Atlantic he departed from a typical American airfield the home to several business supporting aviation enthusiasts but with no passenger service. *Le Bourget* by contrast was a major passenger hub and had been since shortly after the end of World War One. By 1927 most European countries had national airlines flying passengers in purpose built airliners that could accommodate 10 to 15 customers between their capitals. The United States only had a commercial airmail service flying purpose built mail planes that could accommodate two to four passengers if they were carrying less than a full load of mail. The airports in America were also inferior to those of Europe. In view of this Lindberg

devoted considerable energy using the notoriety of his flight to promote the building of commercial airports and the promotion of air travel.[3]

The passage of the Air Commerce Act in 1926 along with the efforts of Lindberg and other airminded individuals in the late 1920s spurred the development of municipal airports across the country and the growth of passenger airlines to the point where in the five years prior to World War Two this nation's civil air carriers emerged from the uncertainty that characterized their first decade and began to build profitable businesses. The provisions of the Civil Aeronautics Act of 1938—including creation of Civil Aeronautics Board (CAB) to regulate air commerce—helped nurture in this country the three requirements for a successful air transport company first identified in 1919 by Albert Plesman—the founder of KLM, the Dutch National airline. These requirements were "adequate capital, aeroplanes designed specifically to carry passengers and an airminded public. Fees from their contracts to carry mail and the CAB's regulation of fares and routes restraining competition between the various airline companies ensured those companies sufficient profit to expand their businesses. The introduction of the Boeing 247 in 1933 and the DC-3 in 1935 America's air carriers two of the most advanced passenger aircraft of the time. As for airmindedness[4], it had grown steadily in the United States since Lindbergh's flight in 1927. While passenger revenue grew an average of 31.5 percent a year during the five years leading up the United States' entry into World War Two.[5]

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[3] Alastair Gordon, *Naked Airport: A Cultural History of the World's Most Revolutionary Structure*, 1st ed (New York: H. Holt, 2004), 13, 22–25.

[4] The OED defines airmindedness as an interest in and enthusiasm for the use and development of aircraft.

[5] Kenneth Hudson, *Diamonds in the Sky: A Social History of Air Travel* (London: Bodley Head : British Broadcasting Corp, 1979), 38; Joseph J Corn, *The Winged Gospel: America's Romance with Aviation, 1900-1950* (New York: Oxford University Press, 1983), 25–7; Civil Aeronautics Board, *Handbook of Airline Statistics* (Washington, D.C.: Government Printing Office, 1973), 18.

The outbreak of World War Two slowed but did not halt the growth of civil air transport in the United States. The war placed restrictions on non-essential travel but it also created an increase in official travel that supported the war effort. Official war travel resulted in more individuals from the middle class traveling by air than was the case before the war. This provided the airlines with opportunities that positioned them to realize even greater growth after the war than they experienced before it. While average annual growth in passenger revenue of 20.9 percent during the war was less than that during the years immediately preceding the war not a year went by where this revenue did not grow. In 1945 6.7 million passengers were carried by the domestic airlines. A year later the number nearly doubled to 12.5 million and it would continue to grow every year for the next several decades. This post war growth may have been good news for the air carriers but it posed a dilemma for the municipal and state governments throughout the country that operated the nation's commercial airports. Municipal airports of the pre-war era designed to accommodate a handful of DC-3 flights a day found themselves having to accommodate dozens or even scores of daily flights most using aircraft with double the DC-3's 21 passenger capacity. These local governments found themselves faced with demands from the aviation transport industry and their constituents to upgrade their airports.[6]

During the two decades following World War Two the United States experienced a boom in civil airport construction. Where the pre-war growth in the number of civil airports came from the birth of civil air transport in this country post-war construction resulted from developments in aviation technology and other factors brought about by the war that made the pre-war generation of airports obsolete. Even those airports completed just before the war such

[6] Daniel L. Rust, *Flying Across America: The Airline Passenger Experience* (Norman: University of Oklahoma Press, 2009), 127–30.

as New York City's LaGuardia Airport and Washington, DC's National Airport and considered state of the art when they opened were quickly becoming obsolete needing either upgrade or replacement. Three of the causes for this accelerated obsolesce were the demands of the military for air transports that could carry bigger loads greater distances resulting in aircraft that were not only larger and longer ranged but safer and more reliable than pre-war designs. Following the war many of these transports were declared surplus to peacetime needs and acquired by the air carriers at cut rate prices. Not only were air transports considered in excess of peacetime needs but thousands of military pilots with experience flying large multi-engine aircraft were discharged from military service and available for hire by the air carriers. With more reliable and safer airliners the air carriers were able to attract more passengers. More passengers meant more flights. The impact of all this on the nation's airports was that these larger planes needed longer, stronger runways. The increase in the number of flights by the major scheduled airlines along with the rise of unscheduled air carriers—small operators that offered reduced fare flights on an irregular schedule—both operating the newer high capacity aircraft meant more passengers using the terminal buildings as well as the need for more gate space to accommodate peak traffic loads.

In response to the post war demand for new or expanded airports several articles appeared in professional journals debating the various ways architects and engineers should approach designing these new terminals. The article "Airport Design" in the January 1951 edition of *Architectural Record* opened with the observation that airports were now "facilities for handling people—that is, the emphasis has shifted from 'flying planes' to 'flying people'." Other journals called for a reconsideration of existing ways of designing them because "of all the

facilities built to serve the needs of modern man, the airport probably demands a higher degree of collaboration among the design professions than any other." Due to this collaboration the design process for a terminal building was seen to be "difficult, trying and oftentimes frustrating". Before the war architects subordinated their designs to the engineering aspects of handling airplanes and the desire by the politicians and the public whose money built the airport for a monument to civic pride. Now with the growth in civil air transport more emphasis needed to be placed on the passenger. Saarinen agreed with these observations writing in his notes "Airports have become facilities for handling people rather than airplanes in the primary sense."[7]

Achieving a design that handled people required the architect to evaluate the design using the following criteria: Can passengers and baggage move easily through the facility; is the terminal the correct size for the traffic it generates; and can it be expanded economically to meet future growth. Using these criteria the articles in Saarinen's files went on to offer various solutions to achieve them.

The most common pre-war air terminal design now considered unsatisfactory was the frontal terminal. Aircraft taxied up to the front of the terminal parking near the building thus the term frontal. This design accommodated the airplane since there were no permanent obstruction on the field giving the pilot more room to maneuver close to the terminal without fear of hitting anything besides other aircraft. Departing passengers walked from the terminal across the tarmac and up mobile stairs to board their flight. Arriving passengers followed this path in reverse order. Walking across the tarmac presented the passengers with a number of challenges including exposure to the inclement weather and the risk of injury from ground equipment such a

[7] Walther Prokosch, "Airport Design: It's Architectural Aspects," *Architectural Record*, January 1951, 112, Box 461 Folder 1293, Eero Saarinen Archive; Unknown, "New Thinking on Airport Terminals," *Architectural Forum*, November 1952, 131, Box 460 Folder 1288, Eero Saarinen Archive; Eero Saarinen, "Handwriten Notes on Airport Operation and Design," n.d., 5, Box 460 Folder 1288, Eero Saarinen Archive.

fuel trucks and baggage carts. Another feature of these terminals is that all passenger and baggage movement took place on one level. Figure 1 is an example of a frontal terminal.[8]

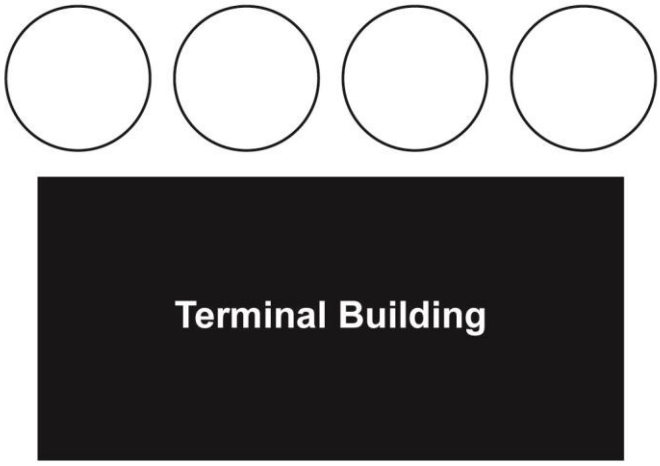

Figure 1 - Example of a Frontal Terminal

Besides passenger safety and traffic flow issues there was an additional problem with the frontal type terminal, it did not lend itself to high volume airports. Aircraft take up a lot of space which translates into how far apart the terminal gates need to be spaced, the bigger the airplane the further apart the gates. Terminals also need a sufficient number of gates to accommodate peak loads. Increased traffic equates to more gates which means longer frontal area to park the airplanes and greater distances for passengers to traverse to reach the furthest gates. Introduce larger airplanes that require more space between gates and the travel distance for passengers increases even more.

Addressing the problem of efficient passenger flow every publication reviewed by Saarinen presented two level circulation of passengers and baggage as a solution. In its most basic form two level circulation had the passengers use the upper level of the terminal and concourses while baggage and other services used the lower level. The landside of the terminal

[8] "Planning of Jet Airports," *Architecturtal Record*, March 1960, 171, Box 462 Folder 1303, Eero Saarinen Archive.

building could be built up so that passengers entered on the upper level and remained on that level to the boarding gate. In early presentations of this solution passengers descended to ground level and walked across the field to board their aircraft, however, by the mid-1950s conceptual drawings of a boarding bridge from the terminal or concourse to the aircraft door began to appear. Most airport terminals today use some variation of the two level design. Additional concepts to improve traffic flow were summarized in the handwritten notes. These concepts include: having departing passengers drop off baggage close to the entrance to the terminal; logical and well-marked routes to departure gates; keeping passenger and baggage flows separate; and placing baggage pick-up for arriving passengers close to the exit from the terminal.[9]

Getting the size of an airport terminal right for the anticipated traffic was not easy and resulted in more solutions in the professional journals than did creating a logical passenger flow. In determining the size of a terminal the designer needs to reconcile the difference in scale between the passengers walking through the terminal and the aircraft that had to park next to it. As mentioned earlier a correctly sized terminal must have sufficient gates to handle peak traffic. At these busy times every aircraft using the airport needs a gate. The air carriers did not want arriving flights waiting any longer than necessary to park and unload since delays cost them both money for extra fuel used and passenger good will. The air carriers also wanted flights to depart on time since their reputation with their customers depended on providing reliable service. Each gate takes up certain amount of building frontage, more gates equates to longer frontages. For this reason a frontal type terminal would not work since it soon would become unreasonably

[9] Prokosch, "Airport Design: It's Architectural Aspects," 115–6; Unknown, "New Thinking on Airport Terminals," 132; "Planning of Jet Airports," 170; Saarinen, "Handwriten Notes on Airport Operation and Design," 2.

large. Among the solutions to this problem were the concourse design, the unit terminal design, and designs using direct to airplane people movers.

The concourse is a narrow structure that extends out into the tarmac at an angle from the main terminal building. The concourse presents three sides to the airfield and so can accommodate more than twice the number of gates a similar amount of frontage on a frontal terminal could accommodate. A concourse terminal typically has most of its functions—ticketing, baggage check, and major concessions—located in the main part of the building with the waiting areas and gates in the concourse. This type of terminal easy to expand by lengthen the existing concourse or by construction of additional concourses. There are several designs for concourses but they all address the frontage problem by presenting multiple sides to the airfield. Figure 2 is a rendering of the terminal at the Philadelphia airport showing an older frontal type terminal that had concourses added.[10]

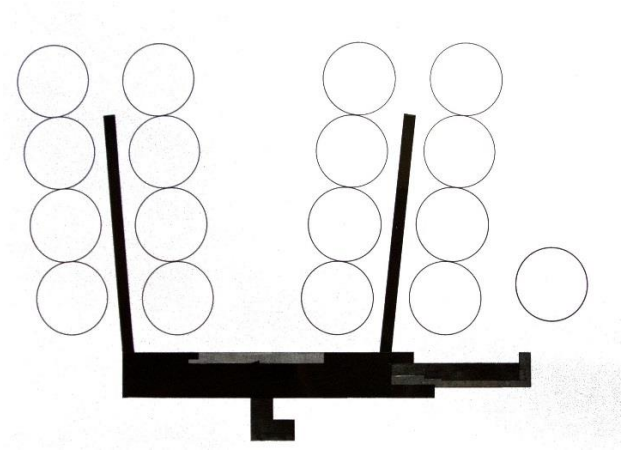

Figure 2 – Philadelphia Airport Terminal[11]

The unit terminal concept was first used in 1955 when the terminal design for New York International Airport was finalized. The Port of New York Authority was faced with building a

[10] "Planning of Jet Airports," 171.
[11] Eero Saarinen & Associates, "Philadelphia Airport," n.d., Box 496, Folder 1363, Eero Saarinen Archive.

terminal that would have a very high peak traffic load. As an alternative to building a single large terminal the Authority adopted a unit terminal design where each air carrier would build its own terminal. Each of these unit terminals would only have to accommodate that portion of the peak traffic belonging to the owning air carrier and so could be of more reasonable size. The city of Los Angeles also adopted the unit terminal design in 1957 when it built a major expansion of its international airport. Unlike New York where each airline built its own terminal creating a grouping of unique designs the City of Los Angeles built all the terminals to a single design and leased them to the individual air carriers. Figure 3 shows the eight unit terminals that made up the New York International Airport Terminal Complex in the late 1950s.[12]

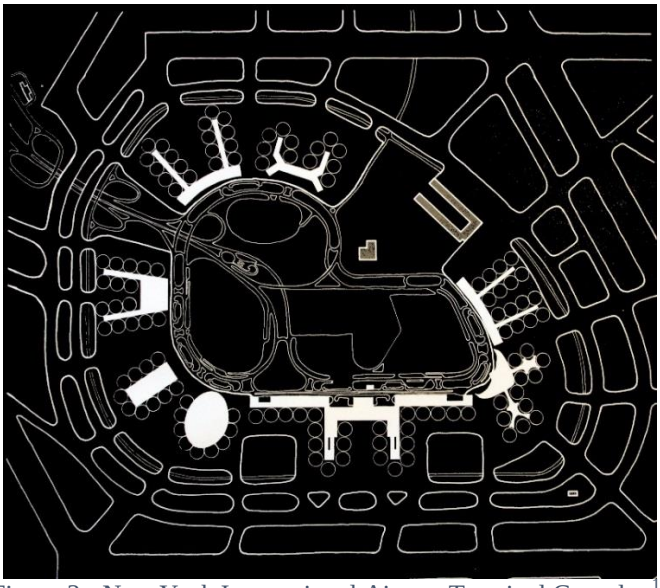

Figure 3 - New York International Airport Terminal Complex[13]

The last of the concepts presented in the journals that interested Saarinen was using some type of people mover to get passengers from the terminal to airplanes parked out on the apron. A

[12] The Port of New York Authority, "New York International Airport Passenger Terminal Area" (The Port of New York Authority, February 21, 1955), Box 461 Folder 1294, Eero Saarinen Archive; City of Los Angeles Department of Airports, "1957 Annual Report" (City of Los Angeles, June 30, 1957), Box 461 Folder 1295, Eero Saarinen Archive.

[13] Eero Saarinen & Associates, "Idlewild Terminal Complex," n.d., Box 460 Folder 1288, Eero Saarinen Archive.

November 1952 article in *Architectural Forum* questioned the need of a "big" terminal when it reported on Swiss K. K. Perlsee's proposal to use specially built omnibuses to move passengers between the terminal and the airplane. Perlsee's main reason for this proposal was that the size of the terminal would no longer be dependent on the number of boarding gates. This type of terminal needed to be no larger what was necessary to accommodate ticketing, baggage handling, airport operation, air carrier operations, and concessions. Saarinen not only mentions this article in his notes but also refers to a January 1954 article in a publication not included in his files that also mentioned Perlsee's use of buses. The same *Architectural Forum* article also mentioned that the U.S. air carrier American Airlines was investigating a concept they called the "Mobile Gatehouse". The Mobile Gatehouse was a double decker bus equipped with a movable ramp on the upper level. The bus take passengers from the terminal to the airplane and the ramp would then extend and raise or lower as necessary to mate with the aircraft door. Another article in the June 1956 issue of *Architectural Forum* reports on how "London and Zurich, among other European cities, use buses to loading positions on the apron, particularly for noisy Comet jetliners which have been relegated to remote start-up areas." The same article goes on to speculate that the American Airlines mobile gatehouse could take a further step toward eliminating the big terminal by collecting passengers and luggage at the airline's mid-city ticket offices and deliver them directly to their plane. In addition to these articles Saarinen's team spent time investigating the use of buses at Frankfort Airport. The archives include a report by one of the investigators on this use of buses. Buses were considered necessary by the airport since 65 per cent of the boarding positions were 70 to 100 meters from the building. The folder also contains photographs of bus operations.[14]

[14] K. K. Perlsee, "Ein Neuer Flughafentyp Mit Relais-Omnibussen," *Das Werk*, 1952, 222–3; Unknown,

The Saarinen archives also an article that presented an underground airport concept. After World War Two the Australian Department of Civil Aviation (D.C.A.) contemplated a buried terminal concept and developed a plan for civil jet airports using this concept. The Australian plan was to construct a single level terminal then build up the ramps and parking aprons so that they were level with the roof of the terminal. Passengers would travel through tunnels to the boarding area where elevators would raise them up to the airliner's door. A ramp would then extend from the elevator allowing the passengers to walk directly onto the plane. Baggage would also be delivered underground and brought to field level by elevator. According to D.C.A.'s supervising airport engineer this concept would address problems associated with safe passenger and aircraft movement. The design was expandable making growth to meet future traffic demands economical. The D.C.A. also claimed this design provided a means of handling aircraft without expensive handling equipment which may be true but the expensive aircraft handling equipment—boarding stairs, baggage carts, and aircraft towing tractors—was replaced with expensive elevators and retractable aircraft chocks. The D.C.A. may have been enthusiastic about this concept in 1953 but in the end no airports adopting this concept were built in Australia and there was no specific mention of it in Saarinen's notes though the article was in the files.[15]

While no underground airport terminals have been built does not mean that designers have not adopted some of the concepts they proposed. Several airports in the United States use

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"New Thinking on Airport Terminals," 143; Unknown, "Unknown," *Engineering News-Record*, June 5, 1958, Box 498 Folder 1386, Eero Saarinen Archive; Unknown, "Information Required on Bus and Terminal Operations at Frankfort, Germany," undated, Box 460 Folder 1292, Eero Saarinen Archive; Unknown, "Frankfort Airport Buses," n.d., Box 499, Folder 1404, Eero Saarinen Archive.

[15] John Loughlin, "Australia Engineers Plan Jet Aircraft Airport Sending Users Under Ground Part One," *Arcitect and Engineer*, September 1953, Box 461 Folder 1293, Eero Saarinen Archive; John Loughlin, "Australia Engineers Plan Jet Aircraft Airport Sending Users Under Ground Part Two," *Arcitect and Engineer*, October 1953, Box 461 Folder 1293, Eero Saarinen Archive.

underground tunnels to access mid-field boarding structures. The mid-field structure being completely surrounded by the apron area of the airfield can park aircraft on all sides making maximum use of its frontal space and thus resulting in a smaller structure. Los Angeles International Airport, one of the airport analyzed by Saarinen, was one of the first to adopt this concept. As mentioned above this airport is a unit terminal design. Each terminal unit has an associated oval shaped boarding structure located about one thousand feet away which is accessed by an under field tunnel. Figure 4 shows these oval boarding structures surrounded by aircraft parking positions.

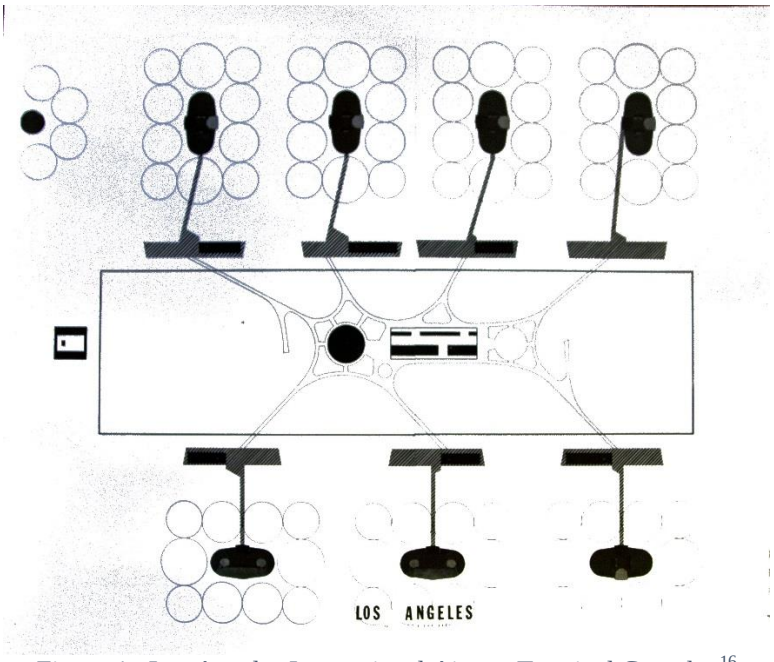

Figure 4 - Los Angeles International Airport Terminal Complex[16]

Underground access is also a feature at airports that incorporate mid-field concourses in their design. The mid-field concourse is a modification of the concourse type where the concourse is detached from the terminal building and moved out into the airfield. This configuration is suited for large busy airports such as the Hartsfield-Jackson Atlanta International

[16] Eero Saarinen & Associates, "Los Angeles International Airport Terminal Complex," n.d., Box 496, Folder 1363, Eero Saarinen Archive.

Airport in Atlanta, Georgia USA. This airport is the world's busiest for both the number of daily operations—take-offs and landings—and the number of passengers. Figure 5 shows the configuration of this airport taken from the official Federal Aviation Administration map. The main terminal is located on the left hand side. This terminal serves domestic flights. A separate international terminal is located between ramps 8 and 9 on the map. Between these two terminals are five mid-field concourses. Each mid-field concourse is over two football fields long and accommodates between 28 and 43 gates. An underground automated rail system connects these mid-field concourses with the main terminal and each other.

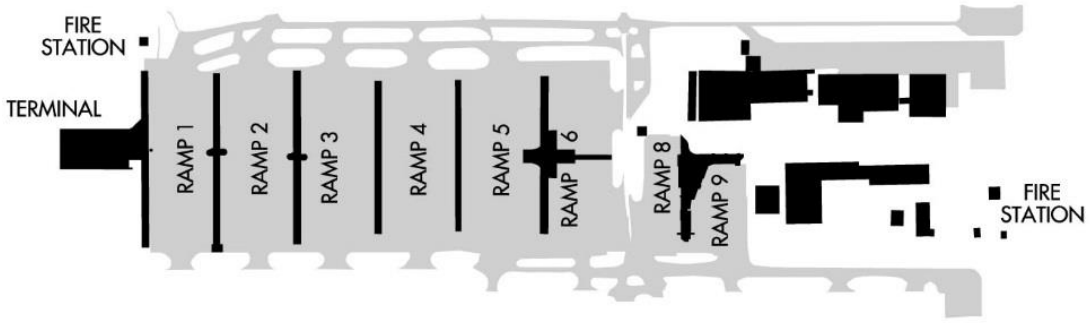

Figure 5 - Hartsfield-Jackson Atlanta International Airport

The contract to begin building what was to become Washington Dulles International Airport was issued at the in March 1958 to the engineering firm of Ammann and Whitney. As prime contractors they selected the firm of Eero Saarinen & Associates as the architect for the terminal building. As has been shown above the architects researched existing airports and the professional literature before starting on any designs. By June 1958 Eero Saarinen had determined that he was going to implement K. K. Perlsee's concept of buses, called mobile lounges, as the sole means of moving passengers from the terminal building to their airplanes. Saarinen presented this concept to the Civil Aeronautics Administration (CAA) on the July 1,

1958 along with his rational for choosing this unique concept along with possible alternative design concepts. In his presentation Saarinen explained how the mobile lounge satisfied of designing a airport around handling people while at the same time providing the airlines with the same flexibility of movement on the apron that the older frontal terminals provided. In November of that year the CAA approved the mobile lounge concept. The terminal building Saarinen then designed incorporated several of the concepts discussed above.[17]

First of all the original terminal building was compact measuring only 600 feet long and 150 feet deep. It was designed so that it could be economically enlarged at some future date to 1,200 feet in length to accommodate growth in traffic. It was expanded to this length in 1996. The Dulles terminal uses a three level configuration to ease traffic flow of passengers through the terminal and vehicles dropping off and picking up passengers at the terminal. Departing passengers and their vehicles would arrive at the upper level. Arriving passengers and their transport would use the middle level. Passengers who chose to park their vehicles at the airport would enter and leave through the lower level.

Eero Saarinen's vision of passengers being transported efficiently between airplane and terminal did not prove practical in the long run. Even though it based in part on a concept developed by American Airlines it did not prove popular with the air carriers. The first problem with the lounge concept came with the introduction of the Boeing 747 and other jumbo airliners. The lounges had to be modified to reach the doors on these aircraft and the number of passengers required multiple trips to get everyone off or on delaying operations. Making connecting flights was difficult which while not a great concern when the terminal was built in 1962 and the

[17] Herbert H. Howell, "Remarks Made at Briefing to Mr. Quesada," January 13, 1959, 15, Record Group 237.4.1 Box 2, Folder January 1959, National Archives and Records Administration.

airlines were operating on a trunk system became more of an issue after deregulation in 1978 and the airlines adopted the hub and spoke system. As a result the airport built its first mid-field concourse in 1983. Subsequent modernization including the construction of an underground rail system connecting the mid-field concourses with the main terminal has relegated the mobile lounges to transporting international arrivals from the mid-field concourses to customs and immigration in the main terminal. Still the multi-level design moves passengers efficiently through the terminal and the building is still as striking as it was in 1962.