

‘The Architecture of Airport Terminals: Gateway To A City’

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ABSTRACT

This paper looks at Airport Terminals as icons in a city and the design aspects for the Terminal building which is the interface between ground & air transport. The architecture of Terminal building involves diverse perspectives of analysis and understanding. As glamorous gateways to a city, Airports are representative and first impressions of the city. Hence, form and function of Terminal buildings are both equally prime aspects of planning & design. Cities vie for world class airports- domestic or international, as they are a city’s pride like any other monument or landmark, catering to visitors across cities and nations. Airports are generally planned for a longer life term functioning at least for half a century with intent of good possibility of future expansion. A Terminal has two sides to it; land-side and air-side. While passenger comfort and safety are of utmost importance, on air-side the operational activities of the aircrafts require critical planning and management. They are large establishments involving architecture and technical design detailing at various scales. Apart from the primary objectives of passenger needs, airline operational needs, airport management- safety & security, there is a community objective as well; which involves a facility for citizens; airport building itself being an aesthetic and integral part of the city. Indian cities are witnessing unprecedented growth in air travel and expectations of a good experience at the Airport is deemed prerogative. ‘Green Airports’ are the current theme in India going the social & environmental way of design & conceptualization.

1. Introduction

An airport Terminal forms the interface zone between land transport and the infrastructure provisions for passenger to access airplanes. It is a building that houses all managerial and operational activities for the aircrafts. It is a point for many activities related to passenger movement and activities before boarding onto or alighting from a plane. The Terminal becomes a crucial node where air passengers need to book tickets and pass through security checks with their baggage. In this process, passengers interact with the air management and administration staff. Concourse is that space which houses various ‘gates’ providing approach and access to aircrafts. At times, Terminal and Concourse are housed in the same building normally at domestic airports. While, airports such as Denver International Airport (Fig 1) have one Terminal with multiple Concourses. To provide access, elements of connectivity such as sky bridges, travellers or subways paths are designed. Some International airports such as New York’s La Guardia Airport & Dallas Airport have multiple Terminals, each with own set of Concourses.

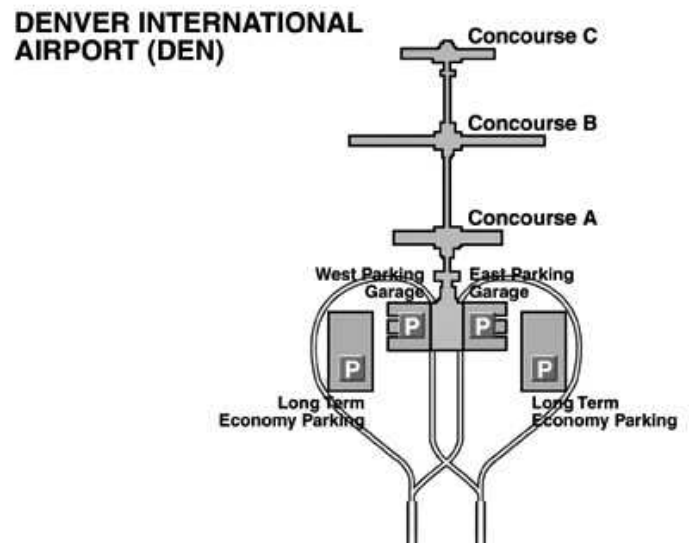


Figure 1. Single Terminal connected to multiple Concourses (Source: <http://denver-den.worldairportguides.com/maps.php>. Accessed May 05, 2019)

In India, Air transport is gaining momentum since the last decade with many budget service providers in the field apart from the pioneers- Air India and Indian Airlines. What was once considered as an elite form of transport is now a common man's mode. People are opting for air travel regularly and expectations of a good experience at the Airport is deemed prerogative. Design of the Terminal must make this possible along with primary aspects of safety, security or circulation of multiple user groups and sequence of functions. In India, Directorate General of Civil Aviation (DGCA) regulates civil aviation and the related safety norms for all forms of domestic and international transports. Whereas, the responsibility of building and operating airports is carried out by Airports Authority of India (AAI) as per 1994 Act. This paper shall discuss two aspects; the basic design considerations for a Terminal building and understanding the relevance & evolution of the architecture of the Terminal buildings in a city.

2. Why is Architecture of Terminal Building Critical?

Airports are gateways to a city, rather the glamorous and fascinating ones; they are large establishments involving architecture and technical design detailing at various scales. Cities are known by their Airports, which at times become the iconic symbols by themselves. Amongst the different modes of transportation, air travel is deemed as the one for longer distances, across the oceans, modes of luxury travel

or as quickest modes of transportation. There is a certain fixation of awe, sophistication or anxiety concerned to air travel and airports. People and cargo of various sorts are transported daily by air. Air travel has seen unprecedented demand in recent times nationally & internationally. Cities vie for World class airports because airports are a city's pride. They are first point of introduction or impression of the city upon arrival. Many prime cities in the world are now hosting more than one airport, normally dedicated to domestic and international travels respectively. Should airport Terminals be massive, awe-inspiring or intimidating? Or should they be miniscule in scale, bringing the already anxious passenger at ease? Airports are fairly new typologies born in early 1900s and has seen advancement in design just over half a decade. Terminal buildings which are the iconic symbols of airports have been built by each city in different ways such as:

1. Plain style - nothing significant but only functional in objective
2. Monumental (Baghdad International Airport)
3. Architecturally magnificent (Terminal 5 at New York's JFK Airport) (Fig 2c)
4. Representative of the place's indigenous culture (Albuquerque International airport, New Mexico, designed by architect J GMeemin the Pueblo Revival style) (Fig 2b)
5. Structural marvels (Terminal at Hong Kong International Airport - Chek Lap Kok) (Fig 2a)



Figure 2. (a) Engineering marvel- Hong Kong International Airport - Chek Lap Kok (Source: skift.com), (b) Culture of the place-Albuquerque International Airport, New Mexico (Source: Albuquerque International Sunport on abqjournal.com), (c) Architectural Masterpiece-Terminal 5, New York's JFK (Source: By Wylkie Chan on commons.wikimedia.org)

“The Pittsburgh International Airport project will be reflective of its community; a design that is bold, unique and competitive and that will provide the first and last impression that people will carry with them of the Pittsburgh region,” Luis Vidal says of his team's design on the new airport. (cseengineermag.com, July 24, 2018). Not all airports may have stand-out Terminal building architecture, but rather the run-ways which are unique features especially as seen in Indian hilly regions such as Shimla or Leh; in islands such as Port Blair or Lakshadweep.

3. Design Objectives For Terminals

Key issues in planning airport Terminals include aspects related annual performance projections in terms of traffic quantum, peak traffic movements, infrastructure standards for area norms and costing. Form and function of the building are two sides of the same coin. The notion that airport buildings are just Terminals is obsolete. Instead, explorations for wider implications as facilities for the people and as artifacts themselves in the city are seemingly

increasing. Reporting-time & Check-in time much prior to flight timings requires passengers to spend a good amount of time at the Terminal, hence meaningful and basic activities for engagement is essential which also creates businesses. Hence, envisioning Terminal buildings as a functional yet an experimentative creation of architecture & engineering marvel is witnessed. A Terminal has three major components or interfaces: Point of interface between ground transport including parking, bus or cab drop-offs and road access for citizens; Point of exchange of formalities with the staff towards check-in, legal norms and processes; Point of entry/exit to the aircrafts via gates. As per Norms & standards for capacity of Airport Terminals published by GOI (2009) the four main objectives for Terminal design are to cater to passengers, airlines, management and the larger community or the City as well.

4. Site Location For A Terminal Building

Airport Terminals and deciding their location depends on certain crucial parameters involving logical analysis and decisions. Allocation of sufficient area while keeping in mind the current needs and future expansion is essential. Likewise, assigning area for roadways and vehicular parking in the Master plan must be taken care of at programmatic and conceptual stage. Airports require vast stretch of land, which normally is available on city outskirts. Hence, a convenient access from the Highway or appropriate main road is important. Location of the building ideally in central position w.r.t runways is advisable. Proximity and easy installation of utilities like water, electricity, sewage and telephone also is a basic point of planning. While site planning, a favorable orientation w.r.t topography, sub-soil characteristics, natural drain of the land, sun path and prevailing winds needs to be efficiently analyzed.

5. Principles of Passenger and Baggage Flow

A Terminal has two sides- Land side and Air side. (Fig 3). The Air-side belongs to aircrafts and their operation. Aircraft parking and their supporting taxi lanes which very much determine the overall efficiency of passenger processing through the Terminal is paramount. There is a technical plan in place for design of the air-side's large spatial requirements as per geometry and norms in relation to the land-side components. Hence, largely the primary elements shall include:

- Aircraft parking norms with the ATC- Air traffic Control tower line-of-sight
- Aircraft maneuvering design with details of taxiway, taxilanes and pushback areas

- Aircraft parking with the Terminal gates, wingtip clearances, parking guidance systems
- Apron design with the apron gradient and hydrant fueling

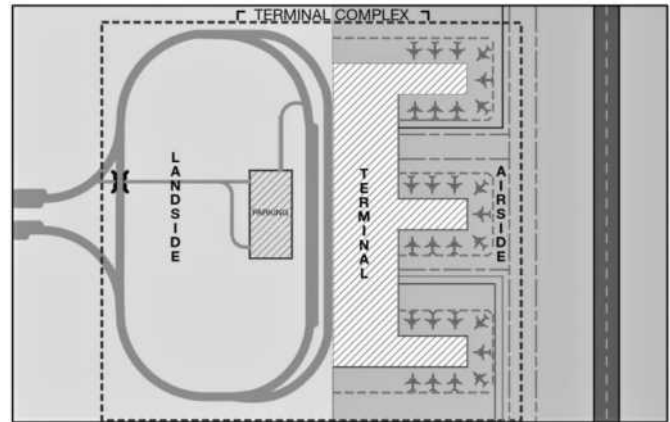


Figure 3. Terminal complex layout (Source: Landrum & Brown)

The Land side includes accessing the airport Terminal by car/bus/ metro rail from the city; parking layout for the same and entering the Terminal after passing security & verification at the main entrance. Also includes other ancillary & supporting facilities as well. Thus, the zones/facilities in a Terminal building may be basically classified as:

5.1 Pre-security

- Ticketing & enquiry counters
- Check-in counters
- Restaurants & Retail outlets
- Waiting lounge, telephone booth and rest rooms
- First aid room

5.2 Post-security

- Waiting lounge, telephone booths and rest rooms
- Duty free shops
- Restaurant & Retail, Gift shops
- Gates & boarding area
- Baggage claim
- First aid room
- Post office counter & banking facilities

5.3 For International Airports

- Immigration & Customs
- Passport & health check
- Special waiting and resting area with dining
- Currency/Foreign exchange counters

5.4 Operational Facilities

- Handling & processing mail, express & light cargo
- Control tower
- Meteorological department
- Office for airport staff
- Offices of other government services related to aviation

As per standards, it is seen that as passenger should not walk for more than 180 m upon arrival at the land-side upto the boarding point (Fig 4). Additionally passengers should not have to carry baggage for more than 22.5 m upto the check-in counter, which needs to happen within 3 minutes of wait period. Baggage claim on the conveyor belt should coincide with the first passenger reaching the area.

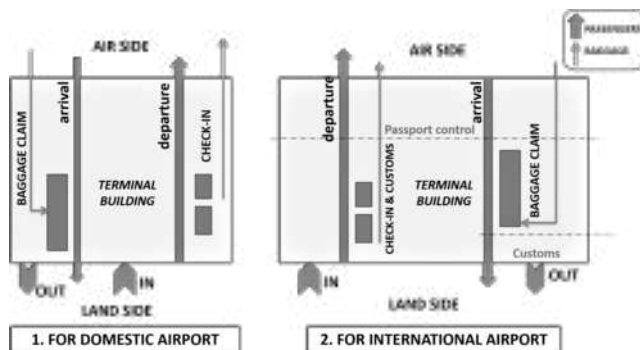


Figure 4. Terminal building - Basic flow of passengers and baggage (Source: Author)

6. Terminal Building Configurations

There are largely two main principles in Terminal design: Centralization & Decentralization. In the Centralized plan, there is one Terminal building from where dispersion to various aircrafts are made possible as in Bangkok's Suvarnabhumi International airport (Fig 5). It is easy for rail & other form of public transport connectivity. But as the capacity increases w.r.t number of planes and gates, it becomes difficult to operate. In contrast, Decentralized Plan includes smaller buildings more at human scale with shorter walking distances. Passengers & Baggage arrive at a point near their departing plane. Works well for individual airlines having distinct operations such as in JFK, New York (Fig 6) where American, United and Delta have their own operating complexes. The concern in decentralized plan is that it complicates transfer between aircrafts & airlines may not be able to maintain their own units; there is difficulty in providing a central rail station. Hence, a third plan 'decentralized-centralized' also called 'Unit Terminal principle' has been popular in recent times.



Figure 5. Centralized plan- Bangkok international airport (Source: OTC Planning & design)



Figure 6. Decentralized plan- NYC/ Newark (Source: Port Authority of New York & New Jersey)

Terminal buildings may be designed as piers, satellite, semi-circular or other few types such as hybrid layout or mobile lounges.

6.1 Pier Design

A pier design is simple including one narrow building, aircrafts parked on both sides. This long building has entry/

exit to land-side on one end, hence drawback is longer walking distances upto boarding gates. Kansai Airport is a pier where distance is up to half a mile. Pier design has been incorporated in Chicago's O'Hare International Airport, Frankfurt International Airport, London Heathrow Airport, Amsterdam Airport, Kuala Lumpur and Indira Gandhi International Airport, New Delhi. (Fig 7)



Figure 7. New Delhi - Indira Gandhi International Airport ariel view (Source: Dipalay Dey on Flickr)

6.2 Satellite Terminal Design

In this case there is a main building with another terminal at a distance with aircrafts parked immediately around the satellite building. London Gatwick airport was a pioneer to use satellite design. Satellite buildings may be designed in various shapes. *Circular*-Paris's Charles de Gaulle International Airport, *Multiplier*- Orlando and Pittsburgh International Airport, *Linear*- Denver International Airport, *Cross-shaped*-Kualalumpur international airport or *Rectangular*- Sea-Tac International Airport.

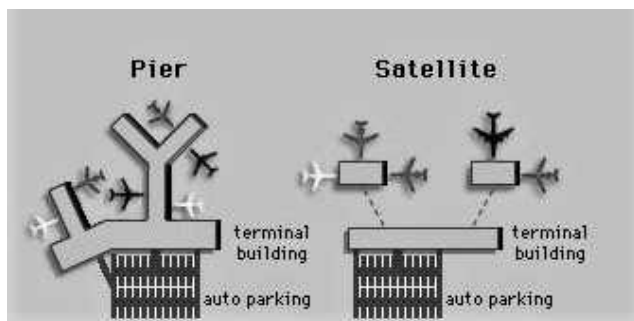


Figure 8. Pier and Satellite layouts (Source: Britannica, 1999)

6.3 Semi-Circular Design

Being semi-circular in shape, air-side is one edge, land-side on the other. This is advantageous as time and travel

from check-in to boarding is less, but may result in longer distances between connecting flights. Seen in Mumbai Airport (Fig 9), Dallas International Airport and Seoul's International Airport.



Figure 9. Terminal 2, Mumbai airport with a Semi-circular layout (Source: Google earth)

6.3 Other Terminal Designs

There are few other configurations such as *Mobile Lounge or Transporter*, in which passengers get onto a a ground transport vehicle that latches onto the aircraft. (Washington Dulles International Airport)(Fig 10) *Hybrid layouts* are a combination of different pier layouts. (San Francisco International Airport)

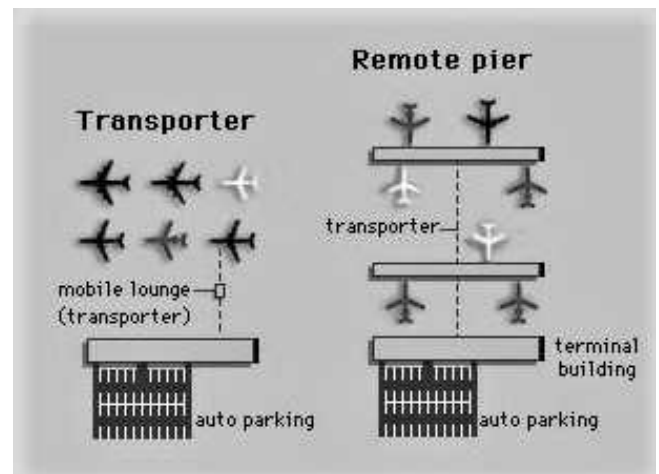


Figure 10. Transporter & Remote pier layouts (Source: Britannica, 1999)

7. Evolution of Terminal Buildings

Airports saw the first emergence only in the early 1900s and beyond, after Wright brother's first flew in 1903. Passenger

experience was not a prime driver in airport designs as seen in the College Park airport in Maryland, USA. They were just Hangars in an open field. Airports in early twentieth century were designed in art deco style. The 1940 Houston Municipal Airport Terminal (Fig 11) and the Long Beach Airport (1941) are good examples of the same. Here, Terminal building were longish with one side where car parking and people bidding bye to loved ones, and the other side passengers overlooking the runway anxiously waiting for their flights. It may be noted that Terminals were designed with efficiency in transporting people rather than an enjoyable human experience.



Figure 11. 1940 Houston Municipal Airport Terminal (Source: Wikipedia)

Further, there was a shift in the perception of airports; passenger comfort and engagement along with commercialization took prominence as well. Complexity set in the designs. Terminals interfaced with the runways and passengers walked to board their flights. Post 9/11 incidence of 2001, air security took forefront along with the other two aspects of economics and consumer demand. London Gatwick airport was a pioneer to incorporate a satellite terminal design with an underground tunnel pedestrian connectivity from the main building. Tampa International airport was the first to use a travellerator for people movement between main terminal and satellite terminal. Dubai International Airport- Terminal 3 had the largest Terminal in 2008 catering to 43 million passengers comprising of two concourses. Chek Lap Kok and Beijing airport Terminals also have large Terminal building.

The award-winning, resort-like Koh Samui Airport in Thailand is considered as a beautiful creation envisioned to be environmentally friendly as well. The construction has used locally available materials such as palm products and adopts a natural cooling system of design. This is a new paradigm in airport design, with an informal outlook as against the conventional perceptions of airports. (<https://www.airport-technology.com/projects/koh-samui/>)

8. 'Terminal' Architecture In India

In India, recent development has seen airports highlighting the social and environmental responsibility in their designs. Cochin International Airport (CIAL), Kochi which is a pioneer in PPP model is the world's first airport to adopt the green concept that operates on solar energy. 45 acres near the Cargo complex is designed with Solar panels to tap solar energy upto 60000 units of electricity producing the airport's daily requirement. Similarly, Indira Gandhi International Airport at Delhi is deemed as 'Carbon neutral' airport. Newer ones such as Chandigarh and Vadodra also are adopting green building features.



Figure 12. Bengaluru Airport Terminal (Source: BIAL)

Bengaluru International Airport Limited (BIAL) is envisioned as the 'Gateway to South India' (The Hindu, Business Line, Aug 4, 2018) It is one of the prominent and busiest airports with one Terminal building having 12 gates, 6 each for domestic and international travels (wiki). The addition of Terminal 2 is underway, conceptualized with a 'garden themed' designed by Skidmore, Owings & Merrill (SOM) and executed by L&T. (DH. Oct 30, 2018) Reflecting the *Garden city image* of Bengaluru, the massive Terminal building with 213 counters shall be glorified as a natural extension of the city's much-heralded green aesthetics based on sustainability. This is achieved by the Terminal enclosure used to temper natural light, while minimizing reliance on artificial illumination. Systems will be developed to capture and reuse water where possible and leveraging the temperate climate of Bengaluru to reduce dependence on mechanical conditioning (DH. Jan 15, 2018) The most visually impressive feature is the large and elegantly swooping roof that unifies new and old structures (Fig 12). The Terminal is going to be connected by Metro rail to help easy and quick approach from the city for over 35 km. BIAL has Check-in and baggage claim on the lower floor, while all departure gates are located on the upper floor.

Under passenger initiatives, BIAL has run a third edition of Playport (summer festival for the young travelers) and Season of Smiles (Flagship shopping and musical

festival). The airport also celebrates festivals of culture such as the state festival Dasara with music and varied forms of art displays.

Conclusion

Airport Terminal buildings are public amenities; with extreme possibilities of exploration of form- architecture & engineering wise. Uniquely signified as large spanned structures that are deemed to make a statement and mark on a city's landscape, they are a monument of sorts depicting the progressive side of the city. Having said this, the city certainly cannot afford to go wrong with its design of the Airport and the Terminal buildings. In fact, flaws in the design at the cost of the major investments & stakes involved are uncalled for and a risk of that high degree proves precarious. Airport terminals are designed for long term vision of existing & extending in time to cater to the advancements and demands. Airports host many other commercial activities such as retail, hospitality and entertainment that cater to passengers plus cargo that forms a crucial aspect as well. Architecture and design of airports shall be preceded by holistic urban planning and design decisions at regional level analytical understandings to derive solutions based on environmental, climatic, social and community aspects, transport and connectivity implications. The architecture of the Terminal building as iconic representation of the city's

airport thus becomes derivative of these various influencing parameters.

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