TERMINAL ILLNESS

ADDRESSING THE MALAISE OF THE CONTEMPORARY AIRPORT

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Master of Architecture

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▸ ABSTRACT

Airports are often compared to the great ferro-vitreous European train sheds of the 1800s. There is however, one crucial difference. While most train stations have functioned effectively for more than a century, many airport terminals are obsolete as soon as they are built. Today's large airports are perpetual construction sites, forever struggling to adapt to demand and changing terms of reference. By contrast the planes they serve are significantly more permanent; most Boeing and Airbus aircraft families have undergone only minor modifications since the '70s.

Given their location at the tail end of the terminal, the passenger experience degenerated the closer travelers got to their gates. The design aspirations of the great departure halls barely made it past the ballooning security screening area. With the advent of satellite terminals, however, aggregations of gates have become places in and of themselves. Having been subjected to increasingly invasive searches and security protocols, passengers are simultaneously quarantined and treated to these terminals. While huge amounts of design expertise continue to be lavished on departure halls, satellite terminals have gradually usurped them in importance. The bulk of the non-processing programs of the airport have decamped to these stand-alone oases.

This thesis is an exploration, through design, of the satellite terminal and the renewed importance of the gate area. It uses this investigation to delve into the relationship between Marc Augé's 'non-place' and Ray Oldenburg's 'third place,' contending that the latter, in the form of the satellite terminal, compensates for the former, which is associated primarily with processing and regulation.

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1.0 AIRSIDE PLANNING

▸ 1.1 Philosophical Observations on Placelessness, Extraterritoriality and Modernity

Any discourse on airport architecture and aesthetics portrays airports alternatively as uplifting symbols of modernity or as dystopic visions of the future. More than any other type of contemporary architecture, airports simultaneously highlight the freedoms and restrictions of contemporary life. They are portals to the infinite possibility that only the sky can offer.

Growing up in Pakistan, I would dream of the runway at Islamabad Airport, where exotic aircraft from the far-east or Europe would come and go. The airport was where the world touched down, where the world of tomorrow greeted me. Later in life, living in Canada, I yearned for the runway at Dorval a tangible connection back to the land of my childhood.The idea of flight is a fabled one.

The invention of the kite, the legend of Icarus and Leonardo da Vinci's flying machine are testaments to human aspiration to escape gravity. The human consciousness allows us to draw on our surroundings and construct a bird's eye plan of what is around us. But it pales in comparison to the thrill of an aircraft taking off with the earth receding below. The desire to fly is a universal human trait and the idea of the airport predates not only the reality of air travel but, in some respects, the idea of the airplane itself (2 p. 31). Why is it that so many contemporary airports today have degenerated into monotonous and uninspired machines for processing people?

At most airports long lines, bulky x-ray machines and interrogation cubicles have stifled architecture that was, to begin with, a besieged response to an exponentially growing industry. People are forced to relinquish their everyday right to privacy as they inch along, shoe-less, with their belongings displayed in plastic bags. The unpleasant experience is specially heightened for people of color especially in the wake of President Donald Trump's 2017 executive order restricting immigration from some Muslim-majority nations to the United States.

High passenger volumes and labyrinthine security protocols have made airports, out of necessity, what Marc Augé calls a non-place (1). They inhabit an extra-territorial world beyond and between states; visitors cannot go back as they wait to go forward. They are briefly transformed into liminal beings: displaced, suspect and monitored. However, most commercial airports have become adept at veiling this reality with a proliferation of retail zones, non-denominational prayer rooms, food courts, cinemas, lounges and bars.

Figure 1: Seen from above there is something about airports that is awe-inspiring, even beautiful, like a Kandinsky composition. The clustered aircraft, which we know to be massive, seem petite when compared to the buildings that feed them. Since the advent of budget travel in the 1960s the airport has had to become a mass-processing plant, albeit one with an extraordinarily high emotional pitch; equal parts anxiety and anticipation. Source: Wikimedia Commons.

Passengers find themselves integrated into networks of communication and control systems in which there is no room for individuality. Inside the terminal, the computer at the check-in desk must be consulted. Hundreds of schedule boards must be monitored for updated flight information. And the stentorian voice over the loudspeaker, calculatedly generic and multi-lingual, reaches into every conceivable space, even the toilet cubicle. Everything seems a little more modern and methodical than in the world outside. One might argue that since the start of the 20th century, the airport terminal – an island of advanced development where familiar standards and definitions begin to seem uncertain – has provided a glimpse of what the future may hold.

Airports are totalitarian in how completely they reorient the passengers they serve. One's sense of place is replaced with a new itinerant mindset. The carefully controlled thresholds and our orchestrated movement through them pacifies the mind. We are no longer citizens defined by civic obligations and rank. But, instead, travelers to which any destination is theoretically open; our lightness of baggage mandated by the system. This non-place city comprises a population of transient, purposeful passengers whose differences of nationality have been superseded by bonds of common destinations.

In such a space, time zones and time lags are amplified to assume concrete realism. The idea of the 'border' loses its physicality and reveals itself to be a theoretical construction that can materialize anywhere. The airport functions as a national frontier on the outskirts of a major city far from any actual border-line. The process of getting people in and out of airplanes, which might be seen as antithetical to the making of architecture , in fact articulates the split between different dimensions. Within this building, there seems to be a morph in the constraints of time and space. This is ultimately the most exciting design possibility. In his book, Airspaces, David Pascoe sums it up beautifully: "The terminal concourses are the agoras of the future city, time-free zones where all the clocks of the world are displayed, an index of arrivals and destinations forever updating itself, where briefly we become true world citizens" (2). Such places erase the past and the future, leaving only the relative present. The proliferation of clocks and time zones, ironically overwhelms the past and frees us from Time (4).

Architecture has been described as an art of immobility: suspended animation and frozen time. In a society where, perpetual motion obliterates meaningful places, architects seek to strengthen values of identity and stability by preventing everything from becoming indistinct flows. The fundamental tension between movement and immobility presents exciting aesthetic possibilities for airports. Neither monuments to immobility nor instruments of the mobile society, airports are the improbable union of both. A successful airport is an organic entity that not only fits into pre-existing infrastructure but also adapts to new technologies, economic trends and emerging geopolitical dynamics. With their clean lines, straight edges, conveyor belts and constant surveillance, airports can be seen to embody modern existence. The terminals are hybrids, part transport interchange, part factory, part distribution center and part shopping mall. They are a curious mix of the static and the dynamic. People rush to get there only to find themselves marooned in limbo for several hours.

It is not single-mindedness but a resonant duplicity; the double feeling of hating control and cherishing it, of reaching for the sky and yet being fixed in place, of wanting and not wanting to take off. Bridging over this dichotomy like vapor trails in the sky, is the sensation of imminent catastrophe. Technology may have extended human control over the environment but once deployed, these powers escape our abilities to manage them. Hence an overwhelming fog of ruin infects airports, in turn adding fuel to the desire to escape still further – to accelerate away. The practical implications of these observations about the airport as the physical embodiment of placelessness, extraterritoriality and modernity are explored further in Chapter 2.

▸ 1.2 Marc Augé and Non-Place

In his book 'Non-Places: An Introduction to an Anthropology of Supermodernity', Augé defines place as a space that is relational or historical and concerned with identity (1). The concept of non-place is applied to anthropological spaces that do not hold enough significance to be recorded as places. They are a product of supermodernity and emerge from an accelerated need to move capital and people. Such places include airports, highspeed roads, ATMs, bus stops, shopping malls, railways and supermarkets. The space of a nonplace creates neither individual identity nor relations, only solitude and similarity. In other words, non-places separate people from their identity creating mass groups such as commuters, passengers, shoppers and consumers (1). People are subservient to the architecture, which synchronizes its users, funneling them into a ticket barrier or tunnel. They walk fast, stopping momentarily to validate themselves and continue onward. Sets of signs and arrows direct groups in particular directions; the physicality of the space encourages certain behaviors whilst giving us the illusion of being in control. In a nonplace, one performs one's best social self: placid and compliant. But despite performing these socially acceptable behaviors, no organ of social life is possible.
At the airport place becomes journey and identity becomes biometrics, data and a boarding pass. The space is individuated, the barriers and queues physically discourage social interaction. Eye contact is used sparingly as a micro-aggression to determine who has the right of way. In the queues, movement is so predictable that there is no need to see or hear the space or the people sharing it. There is no conversation, no brushing of shoulders. There is, however, some comfort in the familiarity of the experience knowing it will be the same every time. But If the nonplaces of supermodernity are so paralyzingly prescriptive and solitary, how is it that crossing the immigration threshold or feeling the lift of rotation can feel so liberating? Why do airports embed themselves in our memories as places of emotionally charged farewells or torans to our loved ones?

There is clearly something to the motionless motion and placeless place of jet aviation (4). The experience of becoming airborne, anonymous and aloof can be glorious, just as becoming identified and grounded can be banal. Comparing Augé's view of non-places to Guy Debord's psychogeographic guide to Paris is interesting. The Situationists International contended that by drifting through the city and abandoning one's learned behaviors, one could truly engage with space. A passenger in transit with hours to spare or a child as yet unindoctrinated may drift through the airport; Heedless of the signs that urge movement and aloof from the crowds pressed for time. In the words of Rem Koolhaas an entire space can come unstuck due to the non-conformity of one of its members (5).

Figure 1.1: Examples of 'Non-Places' where the architecture discourages individual identity and compels people to move, stopping only to identify themselves.

At the heart of my thesis is the idea that airports are transforming from 'non-places' to 'third places.' The term "third place" refers to a social setting that is different from both home, the first place, and work, the second place. As such, they provide a reprieve from the first two and foster a sense of community. The concept was coined by Ray Oldenburg in 1989 (6). The core function of the airport is to process people efficiently and most of the building used to be dominated by spaces allocated for ticketing, security, baggage handling, etc. Today, however, airports are more than transportation hubs. They are taking on an unprecedented stable of retail, dining, leisure and cultural amenities. Reflecting this, their business models have also shifted with profits from retail outstripping airline-related revenues. This discussion is explored further in Chapter 2.

1.3 The Goals of this Thesis

The airport, as we now know it, has taken a century to develop. It combines elements of several other buildings and its roots can be traced to building types varying from botanical glasshouses and railway stations to military barracks and factories. When this amalgam of architectural types was beset, in the 1960s, by a boom in passenger volume, terminal buildings became mundane and sterile. Though efficient, those airports are largely responsible for the weary mentality we now associate with air travel. I believe the successful airport is so much more than the embodiment of military precision. As passengers spend increasing amounts of time here, architecture must be called upon achieve many goals. Since the 1980s, the importance of the gate area has risen. As more people are spending more time waiting for their flights, the holding rooms and generic waiting areas of older airports are inadequate and inappropriate. I explore how, in the satellite terminal (as an aggregation of gates) has become a place in its own right. Having undergone all the ignominies and vicissitudes of security screening and immigration, passengers are banished to these satellite terminals where they are treated (and/or subjected) to a growing stable of activities and amenities. As such, these mid-field terminals are taking on many of the functions and design aspirations traditionally associated with the departure hall. Once the last appendage at the end of a fatiguing process, in this building type, the gate is becoming an exalted space.

I have always had a passion for aviation and I have travelled through many airports as a result. I want to hone this general interest through the detailed design of a portion of an airport, namely the satellite terminal, by exploring the relationship between the part and the whole. Using this design as a form of research, I am interested in exploring the overlap between the fundamental 'placelessness' of airports and their recent transformation into 'third places.' I also want to use section to address the chaotic overlap between arrivals, departures, waiting and shopping – all of which are associated with the process of being in transit.

Air travel can be an ordeal to be endured but design can remedy some of this with the goal of reigniting the lost sensation. At present airports are among the most strategically important building types in any country. I would argue that few other building typologies have had to develop so rapidly or have been called upon to handle such a wide variety of programs and processes. But constructed from the departure hall outwards to the aircraft, the final connection between building and machine becomes generic and underwhelming. Design aspirations are lavished on the departure hall but peter out as they reach the gate. Together the gate and jetway are the umbilical cords of the airport and they deserve more attention.

Recently the emphasis in airport design has shifted towards stringent security, environmental concerns and rising fuel prices. Airports are at a moment of change. Despite temporary downturns in global traffic after 9/11, the outbreaks of 'super-viruses' such as SARS & Ebola, and hikes in fuel prices, the overall trend forecasts greatly increased air travel across the globe, especially in parts of the world like China and Africa

that are still in the process of opening to aviation. The frantic activity of airport building is slowing down in the western hemisphere. But the expertise of western architects and engineers is being disseminated to developing countries. I would argue that some of these exported templates are already outmoded. For every great airport there are many underwhelming and generic examples being built.

Airports offer architects the potential to design on a grand scale not seen since the 20th-century plans of new capitals like Canberra, Brasilia and Islamabad. Larger airports come close to being independent cities providing employment to and housing hundreds of thousands of people in their vicinity. Yet, like any city, the key to their success is to constantly adapt to changing circumstances. While there is no shortage of precedents, many airports are built only to already be obsolete. Keeping this in mind, I've chosen several case studies to profile in Chapter 3. Where possible, I highlight the gate area and explore how gates have been aggregated into stand-alone terminals. I contend that advancements in the reliability and production of people movers has made that satellite terminal the most efficient typology for the large international airport, the evolution of which is outlined in Chapter 2.

Figure 2: Design and starchitect credentials are lavished on the front-of-house but the gate area ¬where departing passengers spend most of their time and arriving passengers get their first taste of the destination is banal and utilitarian.

EHAM

AMSTERDAM - SCHIPHOL
DEPARTURE HALL (ABOVE)
ARRIVALS LEVEL (BELOW)

EDDF

FRANKFURT - RHEIN MAIN FLUGHAFEN
DEPARTURE HALL (ABOVE)
GATE AREA (BELOW)

KJFK

NEW YORK - JOHN F. KENNEDY
DEPARTURE HALL (ABOVE)
DUTY FREE (BELOW)

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2. **Pascoe, David.** *Airspaces.* London : Reaktion, 2001.

3. **Doganis, Rigas.** *The Airport Business.* London : Taylor & Francis Ltd, 1992.

4. *Airport: the Cities of the Future.* **Ballard, J.G.** s.l. : BLueprint, September 1997, Blueprint, pp. 50-53.

5. **Koolhaas, Rem.** Junkspace. *October.* Spring, 2002, Vol. 100, pp. 175-190.

6. **Oldenburg, Ray.** *The great good place: cafe's, coffee shops, bookstores, bars, hair salons, and other hangouts at the heart of a community.* s.l. : Da Capo Press, 2005.

2.0 EVOLUTION OF THE MODERN AIRPORT

▸ 2.1 From Marsh to Aerodrome & Beehive to Satellite

It is difficult to pin down the first airport. Farm fields morphed by necessity into operational but rudimentary landing strips as early as 1910. Some of these fields were upgraded into military bases, others into airports, and some returned to farmland. While the story of each early airport is fundamentally connected to its unique location, the subsequent spatial development is largely repetitive: flat and relatively undesirable land at the periphery of a city became a landing strip which was later paved. Rudimentary sheds were replaced with terminal buildings. As Gillian Fuller sums it up, 'the repetitiveness of the experience is part of the point. A large chapter in the history of airports is the ceaseless remediation of the awkward materialities of place (like swamps and farming lands) into space that can be measured, represented and standardized (1).

Fields turn into aerodromes, then airports that morph into cities, frontiers and brand names. The airport is in a constant state of evolution – perpetually overcoming its own limitations. Some components of this complex machinery, like runways, have remained relatively fixed while others, like the layout of buildings, the signage within them and the landside interface, have undergone constant transformation. Recurrent motifs have appeared, namely metal detectors, expanses of curtain wall, moving sidewalks, clichéd retail space and trains of tandem seating crowded under low ceilings. It may be argued that this familiar tune soothes the disorientation of travel.

Just like the uniform apron flattens and suppresses the local terrain and flora, so do airports succeed in displacing history and patching it with worthier alternatives. They celebrate and support, at least at face-value, mobility and communication which are central tenets of any post-industrial thinking society. To some extent, airports around the world share a predictability. Wherever I am in the world, I know where I am when I'm at the airport. I'm on my way to somewhere else (1).

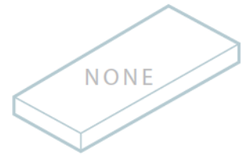
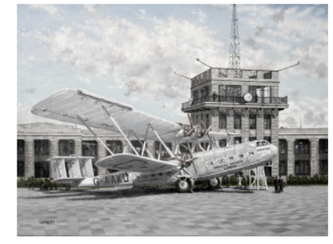
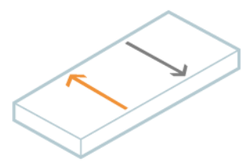
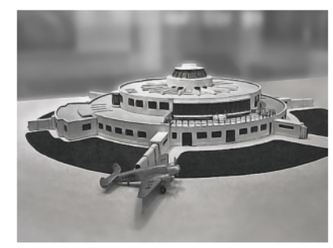
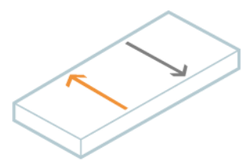
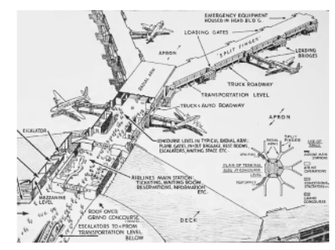
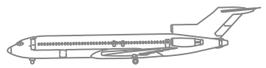
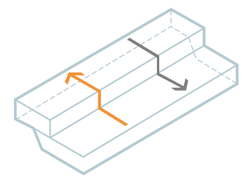
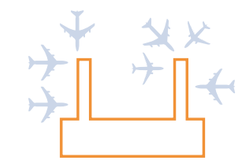
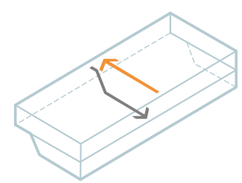
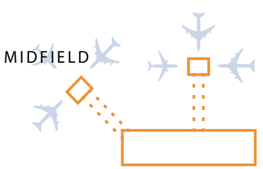
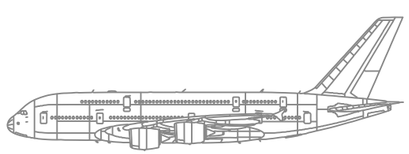
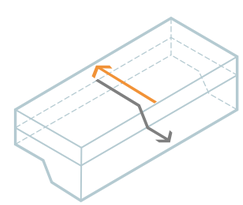
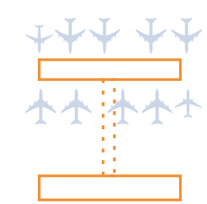
DOMINANT AIRCRAFT	PASSENGER SEPARATION	EXAMPLE AIRPORT +DECADE		BUILDING TYPOLOGY
 EARLY AIRCRAFT		CROYDON 1910		SHED 
 COMMERCIAL PROPS		GATWICK 1920		BEEHIVE 
 GOLDEN AGE		O'HARE 1950		PIERS 

Figure 3 (Continued): This section explains changes in airport terminals from the Golden Age of flight into the Jet Age and the start of the 21st Century.

DOMINANT AIRCRAFT	PASSENGER SEPARATION	EXAMPLE AIRPORT +DECADE		BUILDING TYPOLOGY
 JET AGE		LOVE FIELD 1960		PIERS 
 FLIGHT FOR THE MASSES		LAX 1975		SMALL MIDFIELD PIERS 
 CURRENT	 DEPARTING ARRIVING	DUBAI 2000		MIDFIELD LINEAR 

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At first glance airport terminals can seem to have infinite variation in their shape and arrangement. But the rules governing their development are quite simple. The fundamental design problem of the terminal building is to efficiently bring passengers together for processing only to disperse them for aircraft-boarding afterwards. In this section, I trace the rise and fall of major layout types.

The earliest airport buildings were very simple. Little more than a repurposed enclosure between a road and a field long enough for aircraft to land. The path from landside to airside was a simple walk through the terminal to the constantly visible planes (Figure 3). As aircraft evolved, passenger volumes increased, and buildings became increasingly sophisticated.

TERMINAL WITH PIERS

1950s

This was a first response design for the need to serve dozens of gates by a central processing hall.

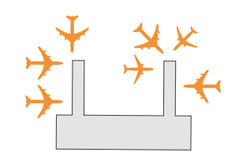

Figure 4

In the US where airlines tended to operate from dedicated terminals, a popular variation on this design were multiple unit-terminals (Figure 5), each with their own piers and connected by roads and (sometimes) people-movers.

Figure 5

Examples include Newark Airport (KEWR) or O'Hare (KORD). However, at large airports with many gates or transferring flights, passengers had to contend with complicated connections by foot or bus between terminals.

TERMINAL WITH SATELLITES

1960s

In the '60s gates were eliminated along fingers so that they can branch from a smaller central building. Aircraft, which were increasing in wingspan, could then be concentrated at the ends. The pier connections are generally above-ground but with notable exceptions like Terminal 1 at Charles de Gaulle (LFPG) designed in 1966.

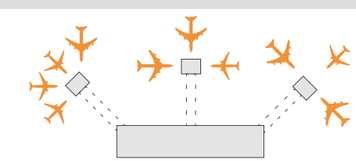

Figure 6

In this configuration space on the apron is lost to accommodate multiple encircling taxiways and each individual satellite usually requires its own security checkpoints, making the whole, needlessly complicated. Aircraft cannot maneuver freely, and time is often wasted while they wait their turn to pushback or taxi in. In recent decades, people movers like trains or moving walkways have become cost effective for hub airports. New airports can practically span several kilometers with multiple midfield concourses that don't require walkable connections to the landside terminal (2). This brings us to the final airport configuration; one that, I contend, makes older layouts obsolete.

Figure 8 (Source: Hong Kong Airport Authority, Master Plan 2020, published in 2001 and updated in 2006)

TERMINAL WITH MIDFIELD CONCOURSES

1960s

Reliable people movers are indispensable to this type of operation where major buildings are located far from the processing hall. Airlines prefer this arrangement because aircraft get an abundant area to maneuver between terminal buildings.

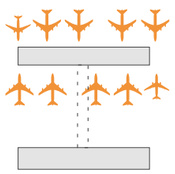

Figure 7

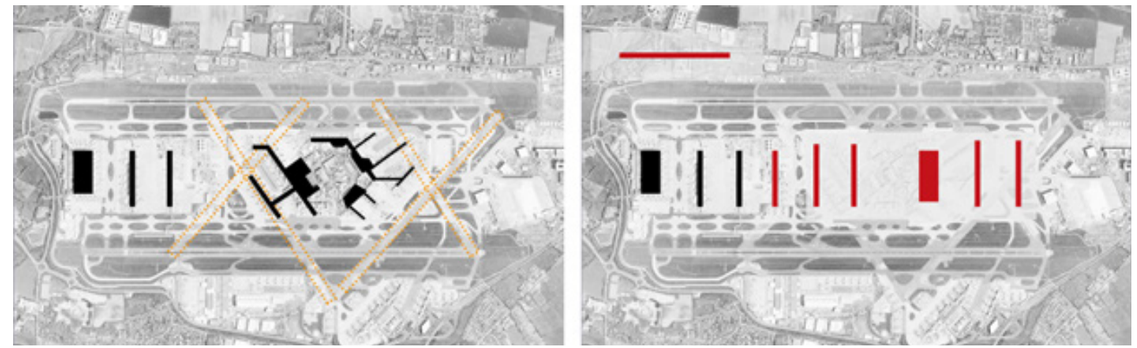

Figure 9: London's Heathrow Airport (EGLL) in its current state on the left and the 2026 development plan on the right.

Examples include Atlanta Hartsfield-Jackson (KATL) which was the world's largest terminal when it opened in 1980, Denver (KDEN) which began construction in 1989, and London Stansted (EGSS), which opened in 1991. Midfield terminals were also added to older airports like Chicago O'Hare (KORD), Munich (EDDM) and Zurich Kloten (LSZH).

The X Shaped midfield satellite (e.g., at Pittsburgh KPIT) is an alternative configuration that is suited to tight spaces or where the distance between parallel runways is prohibitive. They can alternatively be 'X' or 'T' shaped. The advantage here is that the maximum distance to the furthest points is less than in a linear building. But unlike linear configurations, it is hard to expand.

Kuala Lumpur International Airports' 1992 masterplan used X-shaped satellites between parallel runways that were close together. But in 2008, the runways were pushed apart to replace the X-shape by linear terminals citing optimized space utilization (3). The initial master plan for Hong Kong Intl also featured a large X-shaped midfield addition (See Figure 8) but this was later changed to linear midfield concourses. Smaller in size, the latter are faster and more economical to build and can be repeated incrementally as demand increases.

Older airports (like London's Heathrow EGLL) with runways in multiple directions that hearken to the days of aircraft being unable to land in severe crosswinds are planning for 2 or more parallel runways that flank rows of mid-field terminals (See Figure 9). In the past, diagonal runways left awkward residual spaces for aprons but modern aircraft with instrument landing capabilities can safely operate in all but the worst wind conditions. Figure 9 shows the current layout at Heathrow. On the left, Richard Roger's Terminal 5 (circa 2008) and its two satellite piers, 5B (2008) and 5C (completed in 2011), stand out as a clear departure from the older terminals. The three buildings are connected via an underground people mover. Marked in orange on the same image are the vestiges of previous runways that defined the locations of the original terminals. On the right, is the proposed plan for 2026, showing 8 midfield buildings supported by two large processing terminals.

As documented in this section, the trend in airport design is toward centralized processing facilities with linear mid-field satellite terminals. This configuration optimizes efficiency in aircraft taxi operations, which is fundamentally important not only to airlines but also to passengers through trickle-down cost savings. Another reason for this trend is reliable and cheaper transporter technology which has made satellite terminals more cost effective. Finally, this configuration offers the ability to adapt to evolving traffic types and the increase in international or transfer passenger volumes.

2.2 Passenger Types

The days when travel was considered adventurous seem to have passed. As flying becomes increasingly democratic, it loses some of its magic. Yet, airports are among the most significant buildings in a city. This is not merely a response to the need for a better flight facility. It is deeply political, because airports propel business and the control of a hub-airport translates into political clout. The airport industry is fast-becoming a cut throat-market, especially in the Middle and Far-East. Hong Kong Intl Airport, a traditional hub because of its location and local economy, has a 4.5 billion (US dollar) program dedicated to staying ahead of close competitors.

Yet understanding the people who fly is easier said than done. In and among the “frequent flyers” are a high proportion of first-time flyers. There are those that travel for business and those flying purely for leisure. Finally, there are fringe groups such as those flying against their will to be repatriated.

The business person is usually travelling on a high-cost ticket and extremely time-conscious. This passenger may interact with all the commercial areas of the airport from the business lounges through to the airport hotel. Business passengers are more common at global-hub airports.

The leisure passenger is unlikely to want or have access to a business lounge. This type of passenger is seasonal as more people vacation in the summer. Airport facilities (especially retail, food and entertainment) matter greatly to these passengers because they are 'on-holiday.' A third group, low-cost travelers, are currently confined to places like the US and Europe but the idea is gaining fast traction in the middle east, India and China. 'Low-cost' (also called 'No-frills') airlines further democratize access to flying. This group consists of passengers who have compromised their lifestyle and comfort to travel more frequently.

Regardless of the differences in profiles, all these people mix together in the airport, forming a complex design challenge. Understanding these demographics is key but they are all united by one common thing: for an extended period, they have nothing to do but wait for an aircraft to land or take-off.

2.3 The Transit Airport

John Kasarda posited the idea that cities of the future will be aerotropolises, centered on their airports, transitional places focused solely on mobility. The rise of the transit airport, where the majority of passengers stay only for a short time before travelling ahead is an evidence of this likelihood (7). Where traditionally cities developed around centers – adding layers over the course of history that are always place bound – the aerotropolis is just one component in a global landscape.

I have spent many hours in transit at Zurich Airport. I have used the rooftop viewing platform, slept and showered there, shopped at the many duty-free kiosks, discovered quiet places to sit and read. I have even memorized, involuntarily, the sequence of flights that preceded my own to Montreal at noon. Literate in the language of shopping malls and airports, I can instinctively navigate Zurich as well as most other international hubs. However, I have never left the airport and the city itself is abstract to me. On my way to somewhere else, I have pressed against the frontiers of the city from within its geophysical boundaries. I have glimpsed its factories billowing smoke and its cars driving under the aircrafts swiftly moving shadow. I have been to Zurich without ever having been in it.

The world in the information age is in a state of constant transit. This year, 11 million people were in the air on any given day (4). The airport becomes a machine to process mobility that operates on a programming language of capacity and flow. Passengers are tagged with packets of information and transmitted. As I travel from Islamabad to Montreal I am involuntarily engaged in a series of protocols. I am scanned and checked, I am made to feel guilty and to declare my innocence. My name becomes my seat number, PAX 23A. I am tagged with a citizenship, a baggage allowance, a cost index, a class of travel and my routing (ISB DXB ZRH YUL). All this becomes my password to gain freedom of mobility.

2.4 Post-9/11 Airports

The September 11, 2001 terrorist attacks prompted swift security measures that left airports crowded and passengers agitated. The post-security area became a place to allow passengers to reacclimate themselves. Since passengers were arriving earlier and spending more time in terminals, airports also began to provide a growing list of amenities. The design of terminals intentionally camouflages security equipment to keep the experience as streamlined as possible. Scrutiny, however, follows a passenger as long as they remain within or near an airport, on an airplane or on the tarmac (5). In place of the contractual exchange there is a faint but ever-present threat of terrorism. Since 9/11, airports have performed symbolic work (1). Security groups expend endless energy and resources to engender docility and a willingness to be transparent among those who travel. Passengers who appear to be opaque are suspected or misrecognized as belonging to the elusive category labelled ‘terrorists.’ Anything that is not completely visually accessible to the watchperson/monitor raises suspicion (6). According to Mika Aaltola, “Airports are places where authority is recognized, and instructions given for making ‘proper’ judgements... Airports teach people the central rituals of acknowledgement that are needed to navigate the structures of the modern hierarchical world order,” (7). For better or for worse, they encourage us to be suspicious of one another other.

In a 2003 essay entitled ‘Life in Transit: Between Airport and Camp’ Gillian Fuller observes that post-9/11, the airport functions as an exceptional space (or a camp in the terminology of Giorgio Agamben) where normal order is suspended. Fuller compares the refugee camp to the airport by contrasting mobility with immobility. “If freedom of movement is, as Arendt claims, one of the most elemental of freedoms, then the camp provides the ultimate backdrop to the sublime feelings of placelessness that many experience as they wander through the airport. The camp, like the airport is built for transit, yet in the camp no one moves. Both airport and camp constitute zones of exception, each are limit concepts of the other. One facilitates movement and the other denies it, yet both are zones of perpetual transit and futuristic promise,” (1). This seems especially true for the passenger in transit who is contained within the satellite terminal.

▸ 2.5 From 'Non-Place' to 'Third Place'

The average time spent at airports increased dramatically after September 2001, but so did the number of people who travel. As a result, airports have a captive audience; more people are spending more time in them than ever before. News kiosks and benches are no longer sufficient, and passengers are seeking ways to make their wait more meaningful.

The concept of the 'third place' was coined by Ray Oldenburg and refers to an environment distinct from both home and work (9). Third places can range from coffee houses and community gatherings to spas or pubs; they provide a reprieve from home and office thereby fostering a sense of community and place.

Just as Starbucks famously aspired to be the 'third place' between work and home, airports are striving to play a more significant role in our lives. Having observed the rise of the satellite terminal and the transformation of the gate from a banal appendage to an exalted space, the idea of airports becoming the 'third place' between home and destination is central to my thesis. Hong Kong Airport (VHHH) has incorporated a 9-hole golf course, while Kuala Lumpur (KLIA) has enriched the passenger experience with a constructed rainforest at the heart of its terminal. As noted in Chapter 3, Singapore's Changi airport is currently constructing the 10-story "Jewel" that seamlessly integrates retail and leisure for the enjoyment of residents of the city and transit passengers alike.

While I concur that the raison d'être of airports is efficient passenger processing, historically this was evident, maybe too much so, in the spatial properties of terminals. The space allocated to check-in, waiting areas, security, ticketing and baggage handling far outstripped space allocation for anything else. But now, the aesthetic experience of starchitect-designed departure halls is being supplemented with cutting-edge technology to reduce the drudgery and vicissitudes of air travel. Faster processing speeds mean more time is spent at the airport to the benefit of non-flying revenues. Historically ingrained spatial arrangements are being uprooted in favor of more retail, cultural and leisure conveniences. The idea is that passengers will get there faster and stay longer because the airport is a compelling and engaging place to be. Even those who aren't travelling, may come to experience what the airport has to offer.

The trend towards establishing a 'third-place' is most obvious in the Asia-Pacific region where global airport growth is strongest. At Singapore Changi, for example, there are several themed gardens, an entertainment deck with free gaming stations or a theatre playing 24/7 movies. For those in the know, there are also 'snooze lounges' full of recliners, a rooftop pool and the world's tallest airport slide.

The trend is also catching on in Europe, where many international hubs are offering services not traditionally associated with airports. Amsterdam's Schiphol (EHAM) offers an exhibition of Dutch artwork in an airside extension of the Rijksmuseum and an airport library with books and multimedia stands focused on Dutch culture. Zurich (LSZH) airport now hosts children's birthday parties at its newly renovated rooftop viewing platform while Munich (EDDM) echoes its Asian counterparts with a 60-seat cinema supplementing its world renowned public spaces that host concerts and tennis tournaments.

▸ 2.6 Conclusion

Although I made a distinction between the person who arrives at the airport from the associated city to catch a plane and the passenger in transit, both are now subjected to long waits at the airport. Even domestic passengers must check in an hour prior to departure. This, in turn, relates to the increase in the number and importance of workspace, retail and other amenities in airports. The airport itself must be redesigned to truly take advantage of this categorical shift towards a cultural hub. By and large, it is up to the satellite terminal to take up the slack. It is essential to reanalyze what passengers are looking for because it is now much more than a kiosk to buy a magazine or a place to charge one's phone while waiting. Airports have a larger and larger captive audience to entertain and on which to prey for retail revenue. The fact that different people with different trajectories are thrown together in the same space to wait hours for their flight only amplifies the need for a better solution. The traditional gate area, dominated by a moving sidewalk and with little to offer except rows of seats needs to be improved. One of the characteristics of a non-place is that they are reassuringly familiar. To some extent, airports around the world share a predictability. How far can the gate be changed before it risks disorienting the very passengers it serves?

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3.0 CASE STUDIES

▸ 3.1 Stansted Airport

Essex, United Kingdom, Foster + Partners 1991
8 million passengers per annum with potential growth to 15 million
2 initial satellite piers with provision for 2 more to meet demand

In their design for Stansted airport, Foster + Partners attempted to restore clarity to the airport typology. The single-story processing building was hailed a great success and frequently appears as a case study in airport design literature. Moving the aircraft gates to satellite terminals cut complexity in the processing area and allowed fast and clear movement from the entrance to shuttle train or vice versa.

Where most buildings incorporate mechanical services into the roof, Stansted turned this practice upside-down (See Figure 11). A train station, HVAC and baggage handling were hidden below ground. Access to the vast undercroft is handled through the trunks of the columns that support the roof canopy. I chose Stansted as a case study because, even though the departure hall has received critical acclaim, the satellite terminals are rarely mentioned, much less discussed.

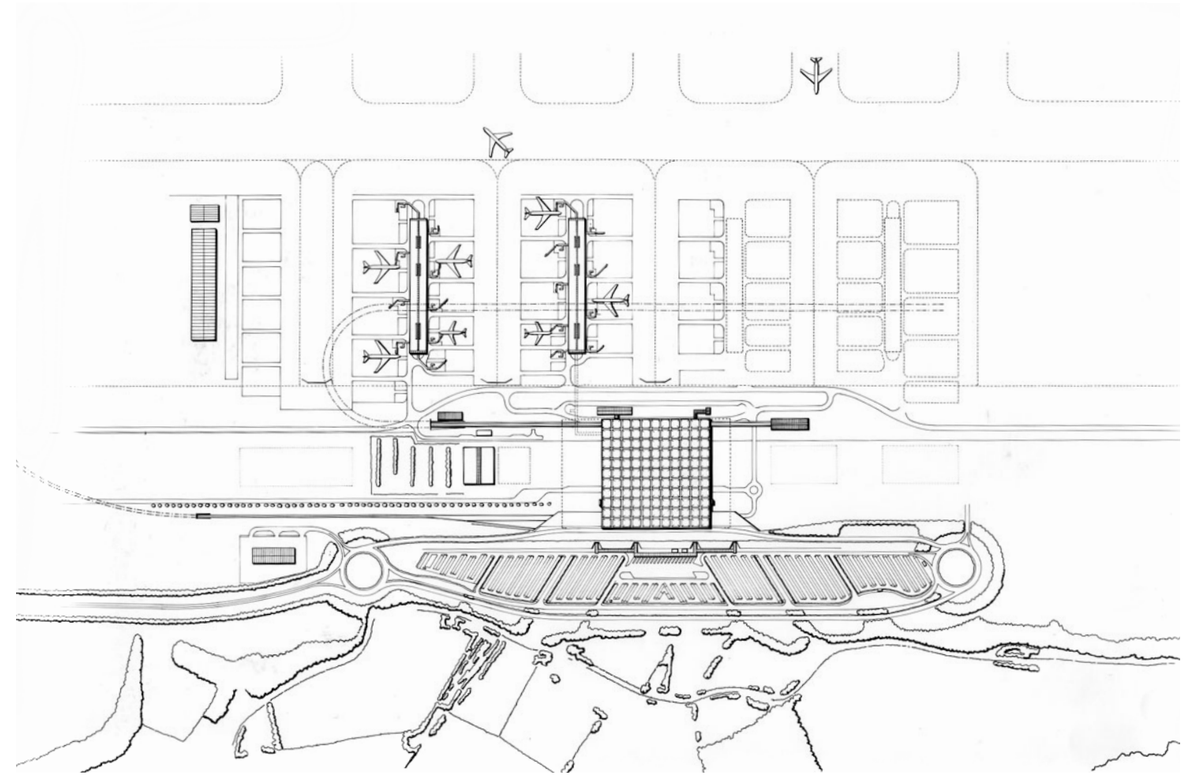

Figure 10: Plan for Stansted (EGSS) showing two satellite terminals with space for two more. Source: Foster+Partners

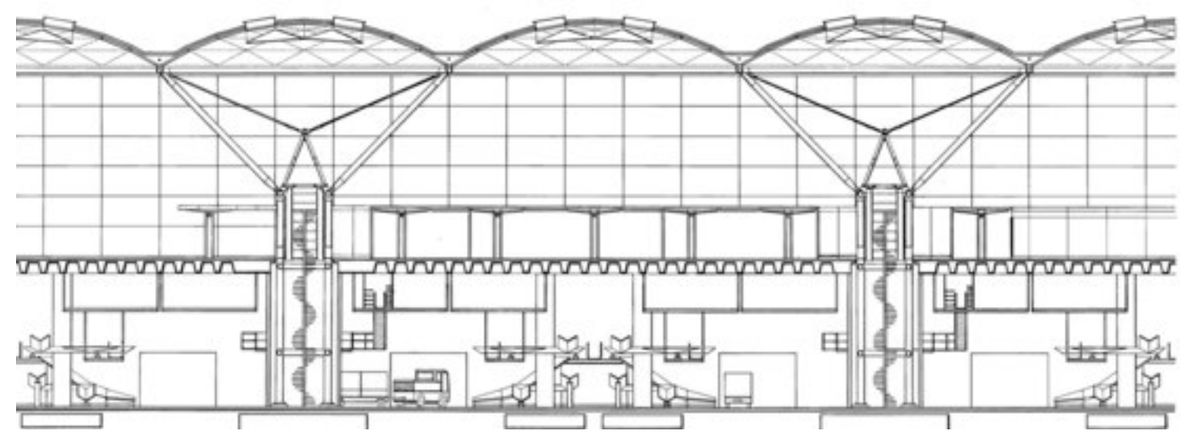

Figure 11: Section through processing concourse. Source: Foster+Partners

In truth, though much attention has been lavished on the front-of-house departure and arrival halls, the satellites are banal with little room to accommodate any functions beyond moving passengers to and from their aircraft (See Figure 12 and 13). In 2015, Stansted announced plans to rejuvenate its satellite terminals and enhance the facilities offered to passengers. Since space in the original plan is limited, however, there is limited space to accommodate retail, restaurants and other amenities closer to where passengers wait to board (See Figure 14).

Nevertheless, important lessons can be learnt from the elegant structural solutions employed in the main processing area. Figure 15 shows a study model of the structural system at Stansted reconfigured as a satellite terminal.

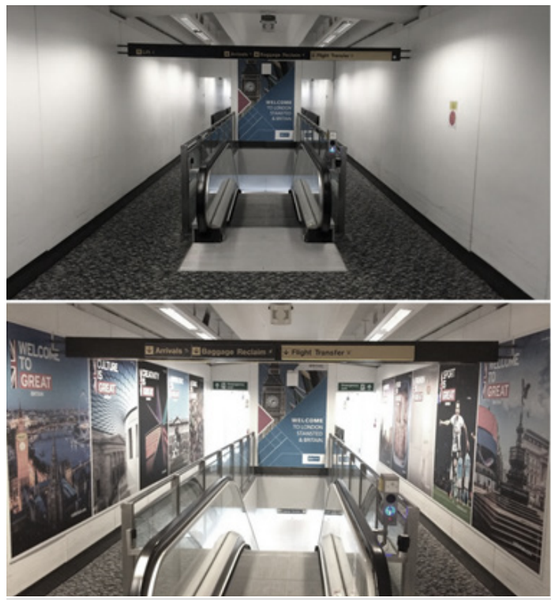

Figure 13: Stansted Airport's twitter account. Caption: "Our Satellite 1&2 Arrivals Corridor went from grey to great overnight."

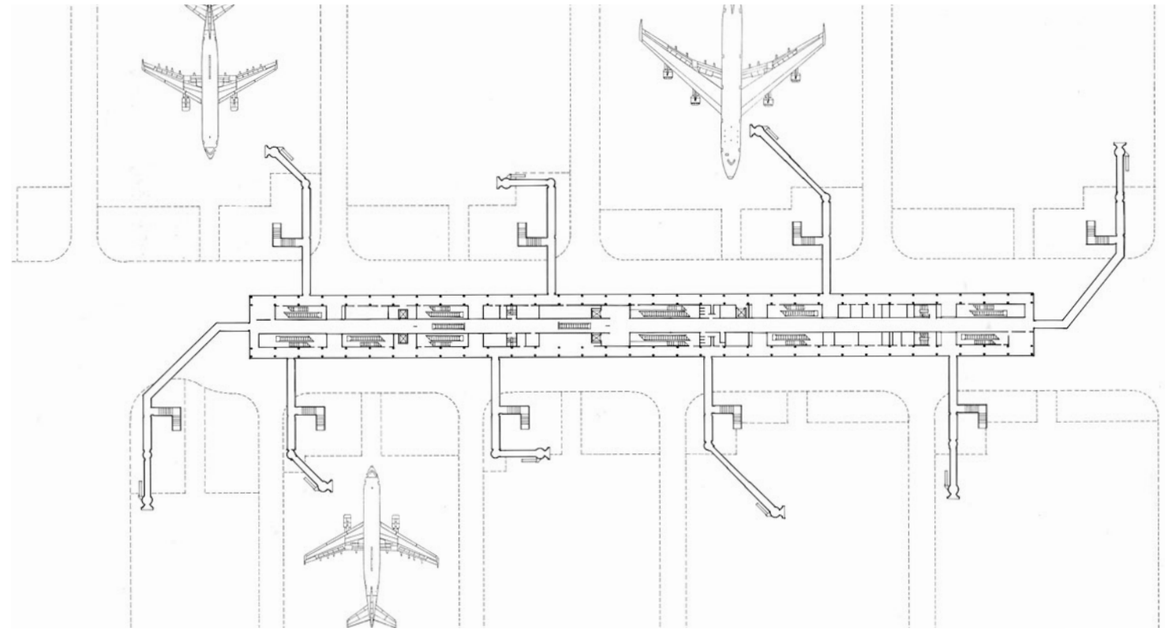

Figure 12: Plan of the departures level of a satellite terminal. Passengers deplane on this level but are funneled below ground via escalators. Source: Foster+Partners

Figure 14: Stansted Airport Satellite 1 interior refurbishment to improve passenger's end-to-end experience. Source: Pascall+Watson

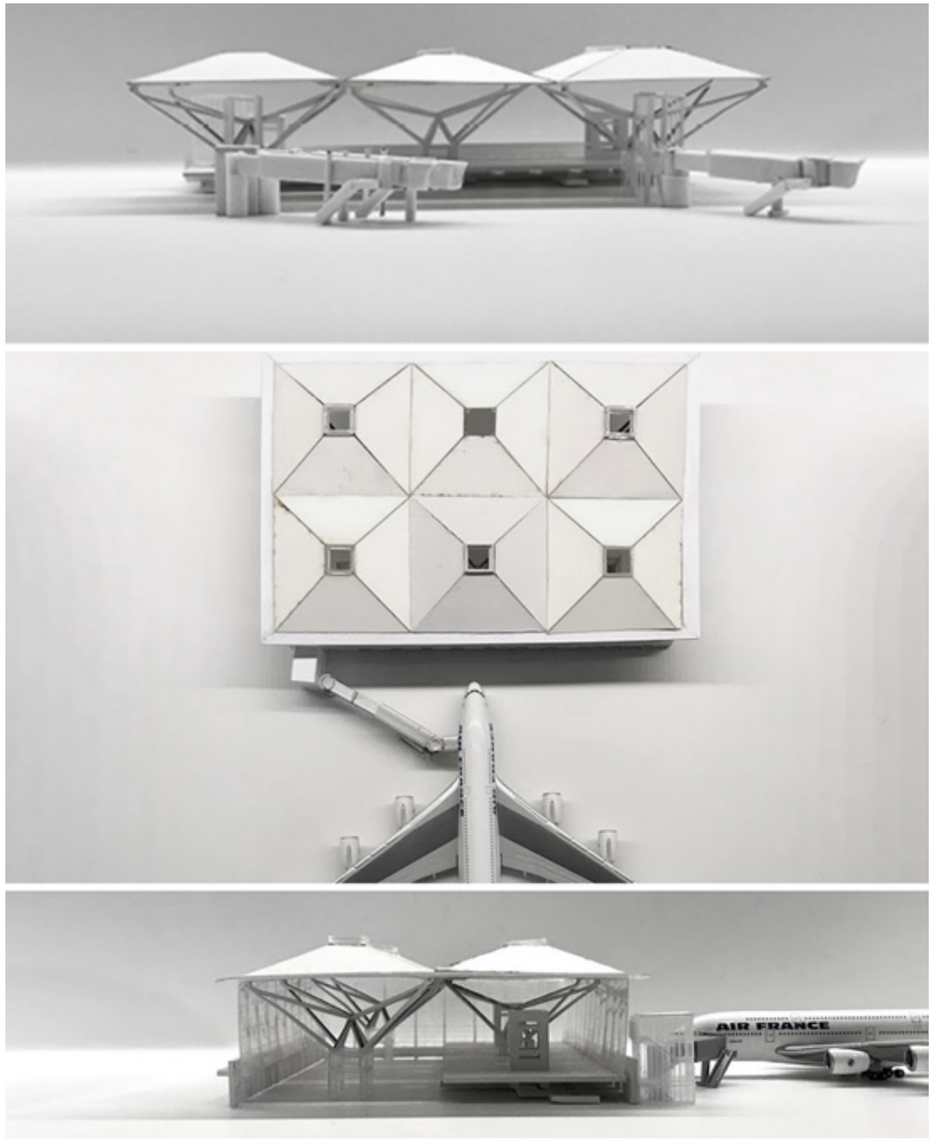

Figure 15: Study of structural system of 'trees' spaced 36m apart adapted to become a gate area. This is a theoretical exercise I undertook early in the design to explore the spatial quality Stansted could have had if the beautiful roof structure was extended to the satellite terminals. The structural-trees play a double role of providing services as well as delineating the entrance to each gate.

3.2 Queen Alia International

Amman, Jordan, Foster + Partners 2012

3.5 million passengers per annum with potential growth to 12 million

2 piers connected through walkways to main terminal

Foster + Partners further articulated the archetype they developed for Stansted in airports across the world. Queen Alia Airport in Amman introduced concrete which had fallen out of fashion since its heyday with Eero Saarinen's terminals at Dulles and JFK. As with Stansted, the vast roof is still the star of the show, but Foster adapts it to the desert context where temperatures vary markedly over a 24-hour period. The airport passively controls the environment by utilizing the high thermal mass of concrete to store heat during the day and release it at night.

Gates are aggregated into two 'satellite piers' tethered symmetrically to either side of the main terminal by long concourses (See Figure 16). Both terminals are two-sided; larger aircraft on the far periphery are served by jetways while smaller planes are accessed on remote stands by buses.

There are two different gate modules – one large enough for wide-bodied planes and smaller gates for regional flights. In the trek from the departure hall to the gates – which is done entirely on foot – passengers are divided twice. After passing through security, passengers can continue straight into a retail area or head to the satellite terminals to the right and left. As they arrive at either terminal, passengers are again directed either left or right around a secondary service/retail hub, depending on the size of aircraft they will be boarding.

Each jetway has an annex (fitted with elevators and escalators) that connects it to the building. Deplaning passengers change level within the annex before entering the building on the lower arrivals level. By moving some of the monumentality of the departure halls out to the flanking gate areas, an attempt is made to make them feel more important. However, the walk to and from the processing area is quite long. And the plan is the embodiment of the gate as a tail, attached to a tail that is attached to another tail-end (See Figure 17).

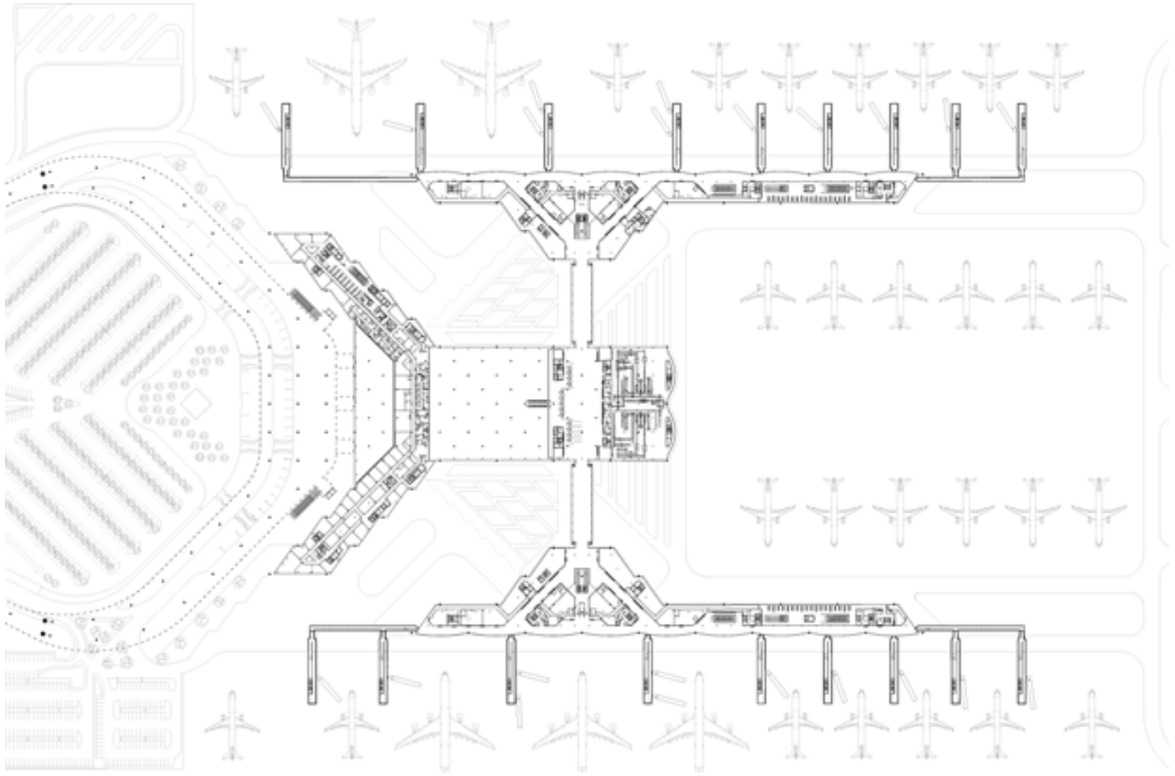

Figure 16: Level 2 (Arrivals) Plan. Source: Foster+Partners

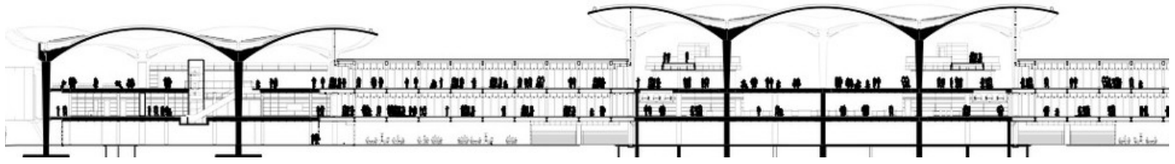

Figure 17: Section at the connection between gate concourse at either end and the retail area in the center. Foster + Partners

The further one gets from the main building, the more peripheral the gates become until unceremoniously ending in a few rows of seats and an airline lounge. Since retail and services are centralized, the gate areas are dominated by circulation and seating, offering few options for waiting passengers to occupy themselves (See Figure 18). This terminal typology is not well-suited to expansion since increasing the number of gates will add too much pressure on the existing connections to the main building while also increasing distance which are already over-long. This inevitably opens the way for a detached satellite terminal accessed by people movers.

Figure 18: View looking down north gate area on the departures level (left) compared to a render (right). Source: Tuomi/Foster+Partners

3.3 Changi Airport

Singapore, Various Architects, 1990 - Present

82 million passengers per annum with growth to 132 million by 2030

Plans to switch to Satellite Terminal configuration for future growth

These are the latest expansions to Singapore's main airport . The oldest of the airport's 4 terminals dates to 1981 while Terminals 3 and 4 were completed in 2009 and 2017 respectively. Land reclamation is underway for Terminal 5 and a third parallel runway. Changi Airport is one of the industry leaders, having been voted the world's best airport for five consecutive years since 2013 by Skytrax.

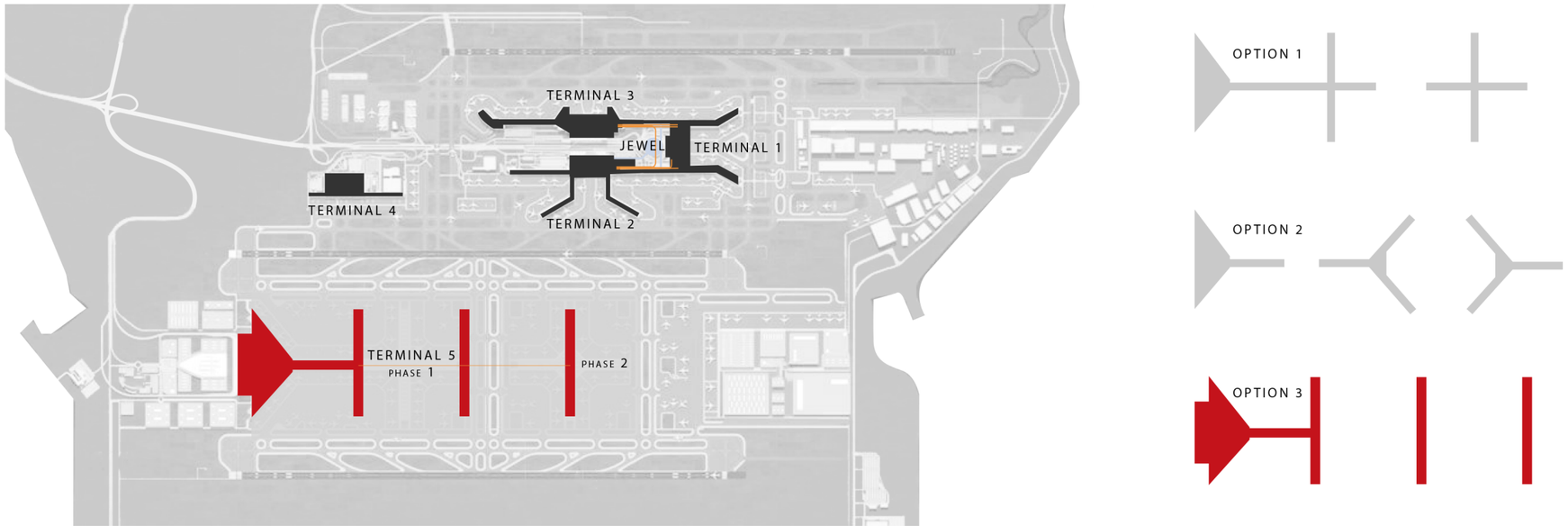

Figure 19: A layout of existing terminals in black with proposed Terminal 5 in red.

Terminal 3 (circa 2009) is a seven-story building with an entire level devoted to retail. Attempts have been made to create a sense of place by incorporating lush greenery in the form of multiple indoor gardens and a large green-wall (Figure 20a). Although a lack of available land constrained the shape of the building, clarity of the passenger journey is achieved through the use of textures and subliminal architectural clues (2).

Natural light and views outward towards aircraft are employed to enhance the sense of openness. While retail, concessions and food are organized in the form a central street, art and interactive displays are distributed among gate areas to combat monotony (Figure 20b).

Figure 20a: Interior of terminal 3 processing concourse at Changi. Source: Changi Airport Group.

Figure 20b: Interior of terminal 3 at Changi. Source: Changi Airport Group.

Technology is at the heart of the 2-story Terminal 4, which offers 'fast and seamless travel' (or FAST). At many of the points where passengers typically encounter queues (e.g., check-in and bag-drop, immigration, and boarding), self-service turnstiles offer a more streamlined and intuitive experience (See Figure 21). New technology at the security checkpoint allows passengers to keep belongings in their bags. The space saved results in Terminal 4 being half the size of Terminal 3 but with a passenger-handling capacity two thirds that of its larger sibling. As yet unconnected to the other buildings, Terminal 4 serves as a pilot project to test out new processes and protocols. Chapter 4 explores how new technologies wil impact the architecture and passenger experience of airports in the next several decades.

Figure 21a: Self-serve gate boarding area at Terminal 4. Source: Changi Airport Group

Figure 21b: Self-serve immigration area at Terminal 4. Source: Changi Airport Group

Figure 21c: Theatrical performance screened on heritage shop facades at Terminal 4 Terminal 4. Source: Changi Airport Group

The most recent addition to the Singapore Airport, the Jewel , is a huge dome currently under construction in what was previously a parking lot. It is not a terminal but an entertainment-hub atop a massive underground parking structure which, upon completion in 2018, will open 134,000m^2 of new retail, entertainment, and dining spaces to passengers and locals alike. At its center, Moshe Safdie's spheroid enclosure features a 40m tall waterfall cascading into a tropical canyon (See Figure 22). Elevated walkways connect to three terminals and a sky-train offers passengers travelling to and from the other terminals a view into the area. Transit passengers, locals, parking and retail are separated on different levels (See Figure 23).

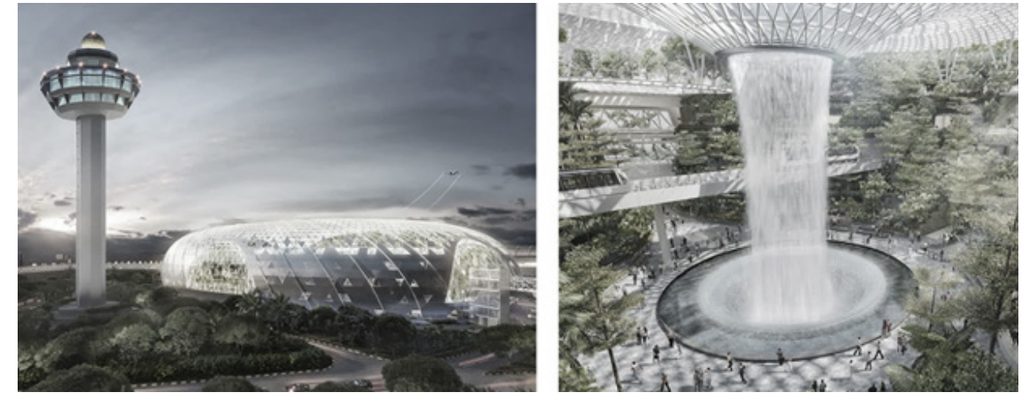

Figure 22: Exterior and interior renderings of the Jewel interchange hub. Source: Safdie Architects.

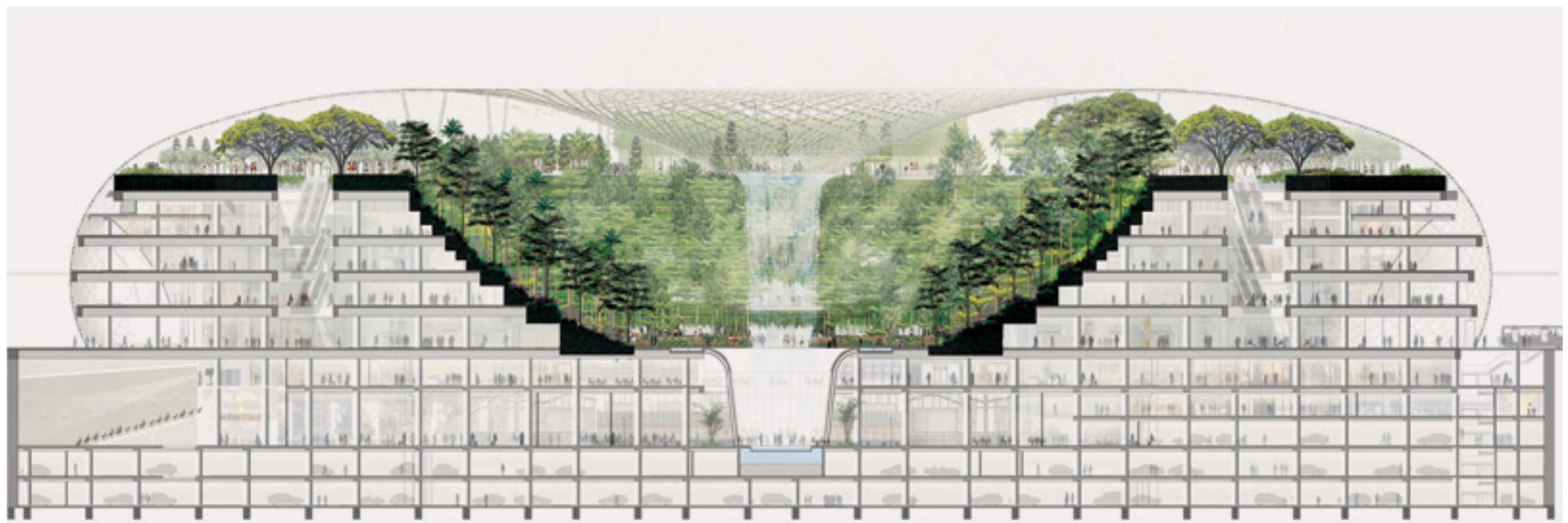

Figure 23: A cross-section of the Jewel interchange hub – The sky-train that soars through the planted atrium is not shown but can be seen in Figure 22. Source: Changi Airport Group

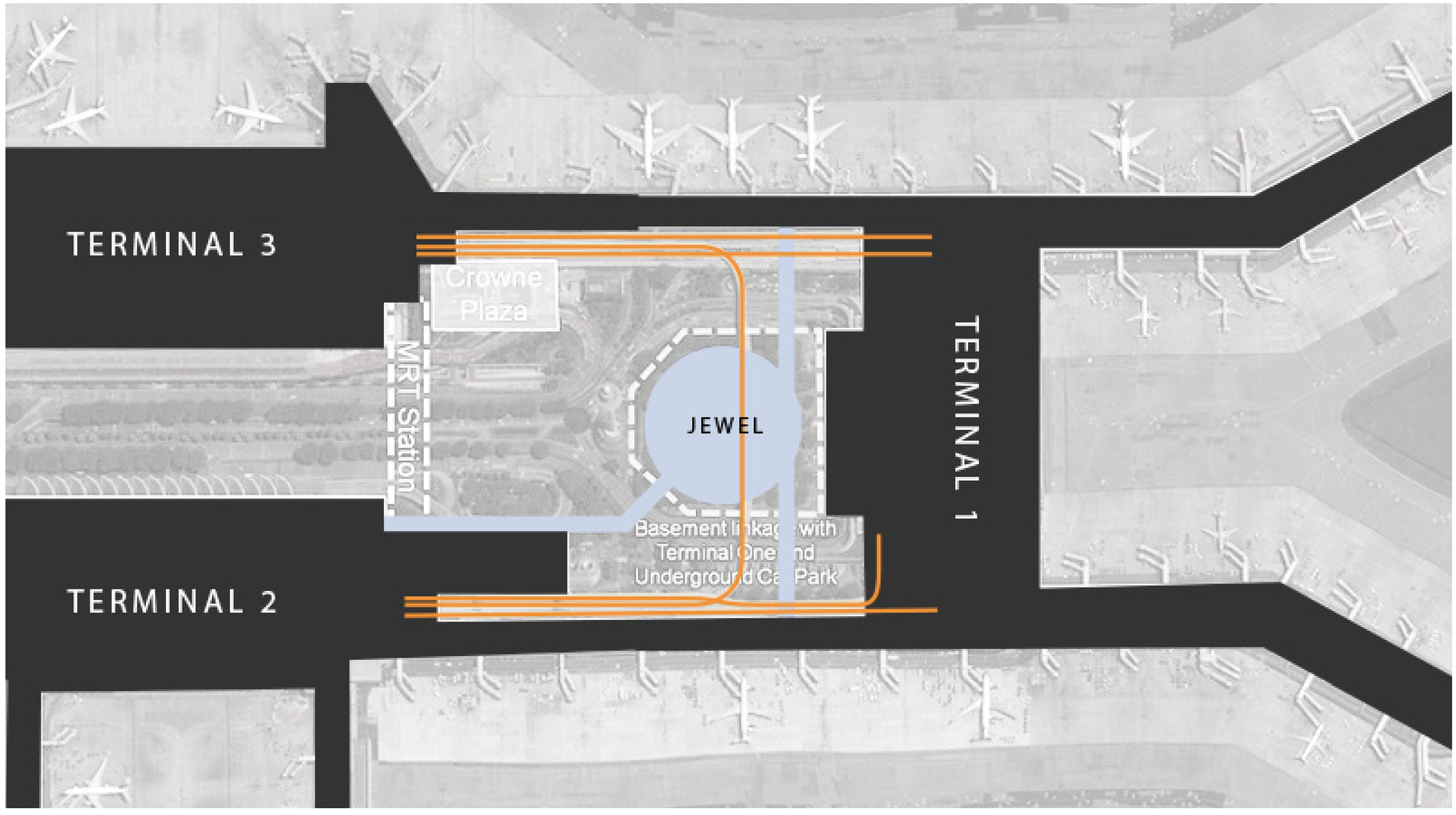

Figure 24: The Jewel connects Terminals 1, 2 and 3. The automated people mover runs through the building without stopping in it so that passengers with less time still get a taste of the space.

Tom Wilkinson of the Architectural Review(1) describes the Jewel as a futuristic realization of Pereira and Luckman's unbuilt dome for LAX (see Figure 25a). The glass dome in Los Angeles was intended to connect all the terminal buildings and parking structures. Safdie's Jewell adapts this idea to an Asian context, where an increasing mix of uses is the norm (1). While Singapore's airport is popular with locals as place to go to dine and 'plane-spot,' airports around the globe are beginning to market themselves as destinations for non-travelers – offering venues for sports, concerts or other events (e.g. Munich EDDM and Zurich LSZH), day-passes to non-ticket holders (e.g. Pittsburgh KPIT), and/or panoramic areas for locals to watch planes (e.g. Montreal CYUL, Changi WSSS, Geneva LSGG or Frankfurt EDDF). They are rebranding and transforming themselves into hyper-regional malls and entertainment venues (See Figure 25b).

Shown in Red in Figure 19, Singapore's Terminal 5 is a stark departure in layout from the existing ensemble of terminals. It continues the trend towards mid-field satellites that this thesis has traced (See Figure 19). Terminal 5 will be developed in 2 phases, with an initial capacity of 50 million passengers a year. The final design (Option 3 in Figure 19) was selected over earlier iterations because it offers travelers the shortest walking distances, reducing connection times for flights and easing the challenge of getting around. As noted in Section 2.1, long linear piers without cul-de-sacs or sharp corners offer the greatest flexibility when it comes to accommodating changes in demand and in aircraft design. They are also the most efficient with respect to taxing operations.

Figure 25a: The unrealized dome at KLAX (left) compared to a rendering of the Jewel (right)

Figure 25b: Christmas market at Munich Airport Center 2017. Source: Munich Airport

3.4 Conclusion

These three case studies were selected to demonstrate the shift in airports from transport hubs to an amalgamation of cultural center, shopping mall, town square, art gallery and of course transportation. At the same time, airport design is trending towards centralized processing facilities with multiple, linear, mid-field satellite terminals. This configuration has proven to be the most efficient and adaptable. Because these areas are separated from the main terminal by an underground concourse or train ride, the conventional practice of consolidating retail and cultural programs in the main terminal needs to be rethought. Though Queen Alia International and Stansted (with retrofits) try to solve this problem by creating secondary retail and service areas, the resulting designs do not fully embrace the challenge. The gate areas in both are little more than rows of modular seating flanked by circulation. Both of these airports are also biased in favor of the departure experience. For example, passengers arriving in Amman are immediately directed to a lower level and deprived of the main architectural feature of the building: its concrete canopy.

By contrast Singapore's airport, which is consistently lauded by users, is a great example of the importance of providing passengers zones in which to relax, work, shop and eat. Moreover, these zones are distributed along gate areas to prevent monotony. Despite the logistics of passenger flow separation, transit and arriving passengers can view and understand the building as a whole instead of being relegated to placeless corridors en route to retrieving their baggage. Changi is also one of the first airports in the world to pilot a queue-free end-to-end experience using self-service technology.

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4.0 ISSUES AND OPPORTUNITIES OFFERED BY NEW TECHNOLOGY

While researching case studies I found instances where buildings were outmoded even before being completed. This chapter outlines new technologies that airports may embrace in the next few decades and their possible impacts. Though many of these are related to the processing of passengers in the main terminal or to background processes like surveillance and baggage handling. Some directly change the passenger experience. Inasmuch as it affects retail revenue, airports are motivated to implement any technology that will improve passenger experience. A successful airport must be able to work with pre-existing infrastructure while adapting to new technologies, economic trends, changes in the volume and nature of demand, and emerging geopolitical dynamics.

Most airport buildings, though somewhat flexible, could not cope with changes since the 1970s and had to be entirely rethought. This related primarily to the changes in the sizes of aircraft over the course of the '60s and '70s. Since the Boeing 747 was introduced in 1970, however, aircraft have not changed significantly. The terminal's intransigence, particularly after certain events (environmental regulation, economic uncertainty and most significantly, security) is evident. For example, large cumbersome explosive detection machines are showing up in 'the-front-of-house' of airport terminals. As each one can weigh as much as 10 tons, structural loading becomes a major issue. Ideally, these systems should happen in the background because airports already emanate an aura of surveillance. Airline mergers, very common in the US, create further stress for airports where single-airline terminals are left without clients. Despite this, however, demand for air travel continues to rise along with the overall rate of urbanization and with global GDP. Research by Airbus and Boeing predicts a 5% growth in aviation over the next 15-20 years (9).

The issue of physical flexibility must be tied to the larger design approach. As different areas of the airport are under different pressures to change, it makes increasing sense to divide airports into several discrete components that can be swapped out or modified independently of each other. By separating gates from processing areas, it is possible to design a satellite terminal that can withstand change better than combined versions. Such a terminal could operate independently of aspects like security protocols or check-in methods that may change with advances in technology. Especially since September 2001, people are keen to clear security as quickly as possible upon arriving at the airport. Given this, it makes sense to shift more of the growing stable of airport amenities to the satellite terminal, closer to the gates.

The importance of workspace, retail, entertainment and cultural amenities in the terminalis increasing so quickly that airports must be among the earliest adopters of technology (Singapore Changi is a good example). Much of this innovation is geared to supporting self-service for passengers. Some software also aims to increase retail revenue. At Frankfurt Main (EDDF), for example, software tracks the predominant origin of arriving flights and changes products in retail areas to reflect buyer's cultural tastes.

Where passenger processing is concerned, governments are keen to capitalize on the reliability and speed of biometrics. E-gate passport control, for example – where trusted travelers can enter a country by using a machine equipped with biometric capabilities – is more reliable, faster and cheaper than staffing immigration counters.

In contrast to airports and governments, airlines are not embracing technology as quickly. At the gate, a ticket agent still requires passengers to show their boarding pass and passport. These line-ups at the jetway can be avoided if the entire process occurred seamlessly through a machine – a technology that is already being tested in Singapore's newest terminal and will certainly be commonplace in the future.

Two issues are pushing airports to modify the way they operate: passenger experience within the airport and "off-airport processing." Evidence suggests that happy passengers spend more money. Results of a survey conducted by the Airports Council International (ACI) concluded that a negative passenger experience has a negative effect on non-aeronautical revenues. As such there is a very strong business case to be made for improving passenger experience.

Passengers can now purchase tickets online, benefit from faster check in and automated bag-drops, take advantage of personalized retail shopping, and better control in-flight entertainment by using their own devices. Statistics show that 97% of all passengers today travel with a smart device. One in every five passengers is carrying three devices: a laptop, a tablet and a smart phone (7). Reliable, free Wi-Fi is quickly becoming a requirement and not an amenity. Moreover, the importance of stentorian announcements is decreasing because most travelers can access individualized flight information via their devices.

The International Air Transport Association's (IATA) fast travel program, instituted in 2007, aims to provide 80% of all passengers with technical solutions to enable full self-service by 2020. This means that, from arrival at the airport to boarding the aircraft, most passengers will not need to deal with queues for security, ticketing or screening. There have been many improvements in this area and this fast travel program could take effect in the next few years (7).

There is also a shift towards off-the-airport processing to enable passengers to do things on their own schedule. This will relieve some of the stress of flying and give passengers more time to experience what airports have to offer. While, for aeronautical reasons, airports require huge amounts of space, some of the real estate required for processing can be reduced. A lot of this shift has already happened, for example online/mobile or automated check-ins are increasingly commonplace. Bag tagging, however, still resorts to very conventional means with most passengers handing over bags to a ticketing agent in the check-in hall. Off-site bag tagging -- either as print-at-home tags or electronic tag displays integrated (or purchased and attached) onto one's luggage – seem to be on the near horizon. Some cities like Las Vegas, Bangkok, Dubai, Hong Kong, Kuala Lumpur, New Delhi, Chennai, Seoul, and Taipei are currently experimenting with bag drops in city cores. Figure 27 shows what might be common in future airports despite some current regulatory challenges.

A shift to mobile technology is evident. Airlines, for example, are embracing its efficiency so that their personnel are unencumbered by having to sit at a desk. It is now common practice for ticketing agents to carry their enterprise system on a tablet with them. In unexpected situations, mobile employees can deal with customers without making an unpleasant journey even worse by having to direct them to a customer service area. It is easy to foresee a scenario where passengers receive mobile updates and information about delays and other unscheduled circumstances, e.g., "We're sorry your flight has been delayed and you have missed your connection, please proceed to area (such and such) where you will be handed a dossier with your new arrangements, an overnight bag and a voucher for the airport hotel."

Figure 27 The Shift to Off-Airport (HPBT: Home Printed Bag tags / EBT: Electronic bag tags). The images on the right show digital baggage tabs integrated into baggage and an Air New Zealand automated bag-drop kiosk. Source: Air New Zealand.

Improvements like these will help relieve the drudgery and anxiety associated with contemporary air travel. For the airlines, efficiency translates to revenue; for passengers it means less stress; for airports it means greater energy efficiency and better gate utilization. It requires the integration of data which, in turn, results in more accurate predictions of delays and improved service to passengers who have missed their flights.

Technology and biometrics in general will play a major role in future airports. The IATA is promoting a concept developed for more efficient security screening (Figure 28). Rather than requiring all passengers to pass through the same security portal, it is promoting a risk-based approach to security where passengers self-identify the category to which they belong and proceed through an appropriate tunnel with hidden sensors.

Other new and emerging technologies are shown in Figure 29. While the left-hand side is fairly easy to imagine, virtual reality services for passengers or single biometric travel tokens for identity management are gaining significant traction among airports. According to a 2014 survey a third of airports were interested in technologies like AI or wearable services for passengers in the short term; half were looking at implementation or testing within 5-10 years (9).

Figure 28: Technology and Biometrics may significantly change the processing area and its associated anxiety.
Source: IATA-FAST

Figure 29 The percentage of airports anticipating the implementation of emerging technologies.
Source: Airport IT Trends Survey 2014, SITA (106 airports representing 42% of global traffic)

4.1 A Fictional Account of Travel in the Future

Departing passengers would be able to drop their bags off in the city, e.g., at a hotel or train station. They might arrive at the airport via some high-speed transport where, if requiring assistance or directions, they would be met by a robotic attendant in lieu of searching for a help kiosk. Passengers could then proceed through a touchless security aisle into retail spaces (that may be virtual) or into restorative environments with acoustic dampeners and pink noise generators. The airport would be largely silent, with customized messages passed only to those who require them. Automatization at the gate will eliminate line-ups and the aircraft would be boarded through an unmanned portal. For a premium, passengers could even reserve space in the overhead compartments.

The arrivals experience would be similarly automated. Having disembarked, the transfer passenger would go through a touchless security portal. Passengers leaving the airport would have pre-cleared customs through an app on the aircraft seatback. They would walk through security, tracking the progress of their bag on a personal device. The baggage claim may even be replaced by on-demand bag pickup kiosks.

The technology outlined in this chapter will reduce the need for architecture to guide us through a prescribed process and limit where we can go. If so, the airport of the future could run the risk of being even more placeless and indistinct than its contemporary counterpart. In the introduction, I mentioned that in a society where perpetual motion obliterates meaningful places, the architect must strengthen values of identity and stability by preventing everything from unraveling into indistinct flows. In the future identity will recede into data, biometrics and a boarding pass. If airports are to maintain any sensation, they must transition from 'non-place' to the 'third-place.'

▸ REFERENCES

1. **IATA.** *Fact Sheet Industry Statistics.* Montreal: International Air Transport Authority, 2017.

2. **SITA.** *Airport IT Trends Survey, 2014.*

5.0 DESIGN

5.1 Recap of Issues

In the 1960s the high passenger volume brought about by jet travel reduced many airports to uninspired and sterile people-processing centers. This contributed to the largely disengaged and jaded mentality of today's air traveler. As airports grew rapidly in the decades after WWII, gates were pushed further and further afield – tethered to departure halls through an endless series of increasingly utilitarian concourses. The gate and boarding experience became progressively marginal and utilitarian. The design ambition of most airports dissipated long before reaching the gates, which were little more than fixed jetways.

Since the 1980s, the advantages of the stand-alone, midfield (satellite) terminal have become evident. Departure halls, where most of the design aspiration is expended, now account for only a fraction of the time passengers spend in airports. The better part of the passenger experience now occurs in midfield terminals, to which most of the non-processing programs of the airport have migrated. This thesis proposes a satellite terminal as a study of how architecture can rekindle and improve the experience of air travel.

As a standalone aggregation of gates, the satellite terminal has redefined the passenger experience (thanks, in large part, to the people movers that have transformed the way passengers are ferried between processing and waiting areas). This thesis attempts to address the psychological and physical needs of passengers closer to the gates where they spend most of their time. As such, it argues that theatrical interior spaces – replete with gardens and greenery – should not be limited to departure halls through which most passengers hurry anxiously. Satellite terminals flanked by aircraft on all sides, provide an opportunity to reconsider the relationship between the passenger and the plane. To the degree that the actual experience of flying has lost much of its romance (no leg room, meagre snacks, steep tariffs for checked baggage, etc.), the time spent prior to boarding matters more.

While the airport industry is rapidly changing, and security protocols are in a constant state of redefinition, satellite terminals have become sanctuaries. As air travelers today have meaningful choices among airports the industry is becoming increasingly customer-oriented. To gain a competitive advantage, marketers are trying to differentiate their airports by meeting a wider range of their passengers' needs.

In this proposed design, I bring architecture to bear on solving logistical challenges of satellite terminals, including the challenge of segregating various categories of passengers and integrating an increasing array of uses and amenities.

5.2 Setting the Program

The airport is a complex apparatus that is yet to be perfected. After deciding to focus on the design of a mid-field terminal served by a people mover (where check-in, ticketing, security and baggage claim are handled at a landside area), I moved on to defining the program . Several standards proved helpful in sizing various spaces, their overall dimensions and the traffic for each function they serve.

The rhythm of arrivals and departures at some airports will cluster at certain times of day. For example, peak traffic in Sydney is in the early morning, Islamabad's airport is busiest around 3am, and Montreal sees most of its international traffic in the early evening. The airport terminal should be designed for peak hour traffic and not the absolute maximum (e.g. Christmas Eve) (1). In North America, peak hour activity is defined as the traffic in the busiest month divided by the number of days in that month. In Britain, the Standard Busy Rate is the level of traffic during the 30th most busy hour of the year. For the purposes of my design, I used the definition put forth by the International Civil Aviation Organization (ICAO) along with data published by Airports Council International for larger airports (i.e., those serving 25 million passengers per year or more).

Usually, airports are planned using a top-down approach: a regional plan begets a masterplan which then informs individual terminal designs and so forth. As this thesis focuses on the satellite terminal, however, I worked in the opposite direction, namely from the aircraft to the terminal that supports it.

By ICAO standards, each gate sees six aircraft turn-arounds in a 12-hour period. This, combined with the largest aircraft the designed gate is intended to serve, gives the peak passenger load. In his book Airport Systems, Richard de Neufville outlines the space required by different types of airports. In general, this thesis adheres to his recommendations, which result in "an excellent level of service, free-flow and no delays." (1)

Tables 1 and 2 outline the space standards recommended by De Neufville (1) and Brian Edwards (4).

TABLE 1

ACTIVITY	SITUATION	SPACE (m^2 / passenger)	TIME SPENT (in hours)
Waiting and Circulating	Moving Freely	2.7	1 hr
Eating and Shopping	Moving, Sitting	2.1	1.5 hr
Toilets	x	0.3	0.15 hr
Circulation, Building Plant	x	19.1	x
Airline Operational	x	4.8	x

Sizing of the below-ground baggage handling area is based on the following data.

TABLE 2

ACTIVITY	SITUATION	SPACE (m^2 / passenger)	TIME SPENT (in hours)
Baggage Undercroft	Bags separated from their owners	1.5 Less for business travelers but more for vacationers. The height is around 9m for a four-layer handling system	x

5.2.1 Passenger Space

The same space can cater to many passengers staying a short period of time or to fewer staying longer. The earlier passengers check-in the longer they spend shopping and waiting. This is called the Dwell Time. I used the following formula to set the program for my design.

Required Area = Design Load (people/hr) x Space (m2/person) x Dwell Time (hr)

Most airport designers tend to oversize corridors and circulation spaces, so operators can convert them to retail space or storage for various facilities if required.

5.2.2 Restrooms

Calculations for airside restroom locations are typically based on the types of aircraft serving the adjacent concourse. Eight gates of typical narrow-bodies (145 passengers each) can share one restroom module between them (2). For Airbus A380s in an economy-heavy configuration of 615 passengers each, a bathroom module is required for every pair of gates. Arriving passengers typically produce the greatest demand and those facilities must be adequate. The Federal Aviation Authority (FAA) recommends, at least, an equal split between women's and men's fixtures. Each module must also contain a family restroom. Based on a 50%-50% gender mix, in a terminal where 60% of the passengers are transiting, 12-16 fixtures are required for every two wide-body gates.

5.2.3 Areas for Baggage and Mechanical Systems

While a satellite terminal requires less undercroft space for these systems than the main processing area, the design needs to incorporate space for the following:

1. HVAC
2. Water and sewer pipelines
3. Electric substations and transformers
4. Telecommunication lines
5. Elevators and escalators
6. Rights of ways for future people movers
7. Egress

Areas accommodating these services need to be easily reconfigurable.
At this early stage of the design, I did not require a more detailed breakdown. If this project were to be developed further, however, more detailed studies would need to be undertaken. For this reason, I have erred on the side of caution, especially regarding the mechanical undercroft and commercial spaces .

5.3 Gate Module Size and Flexibility

Based on current and foreseeable (i.e., design phase) aircraft types, I produced the following list of gate sizes with their corresponding traffic (See Figure 30). Aircraft wingspan increases by an average of 15m as we move up through each category, this became the basis of a 15m grid upon which modules are designed.

Airport facilities need to be adaptable because the mix of traffic at any terminal varies over the course of a year and because the terminals are upgraded infrequently. Given a growth rate of between 5% to 7%, most airports only undergo improvements once a decade (1).

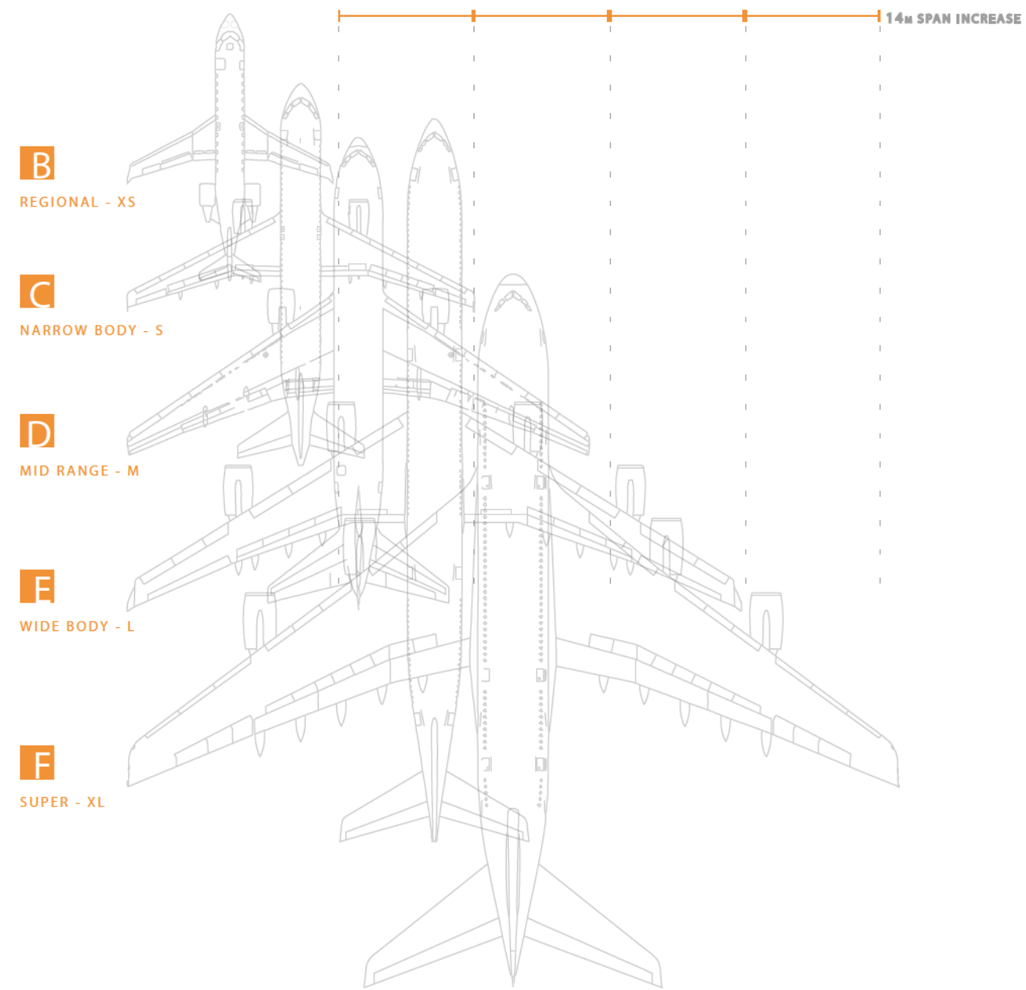


Figure 30: Illustration of ICAO Airplane Design Codes and the average wingspan of each category. Source: ICAO Annex 14, Table 1.1.

Each gate has been designed to be able to support either two smaller aircraft or one wide-bodied plane (see Figure 31). This results in a design peak of 500 passengers for a segment of the terminal with gates on both sides. Since all aircraft are extremely unlikely to arrive or depart simultaneously, a shared waiting space is the most efficient. The number of passengers waiting for a flight follows a normal distribution curve. This means that a 500-passenger design peak requires combined waiting spaces for only 250 passengers.

This concept was used in Zurich Kloten's (LSZH) satellite terminal, where 4 gates share waiting spaces for 190 people (Figure 32). Consequently, the terminal isn't dominated by seating and more area remains open for other activities. The design tries to engage passengers and encourage them to spend time outside of designated waiting areas. A clear, linear arrangement is easily legible and allows passengers to keep their gate in sight while shopping and eating. I have taken a similar approach in my proposed design.

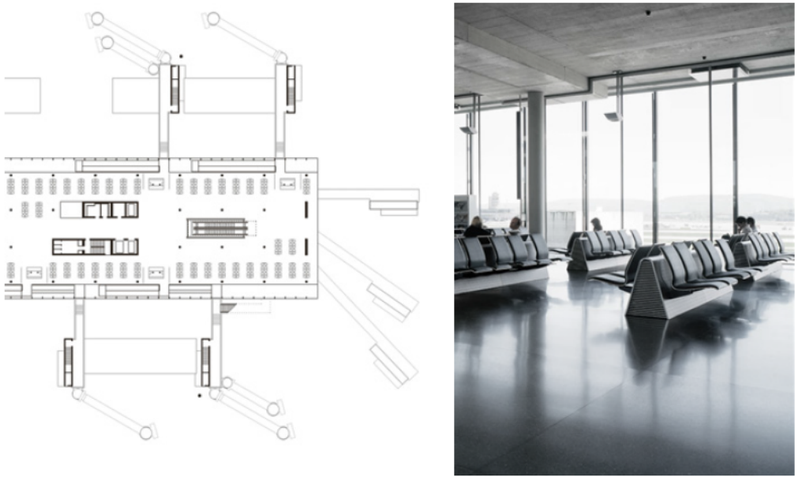


Figure 32 An image and a departure-level plan of the satellite Terminal E at Zurich (LSZH) showing a service module and waiting area shared between multiple gates. This part of the building can accommodate 4 widebodies or up to 7 narrow-body aircraft. Source: Divisaire/AGPS 2001.

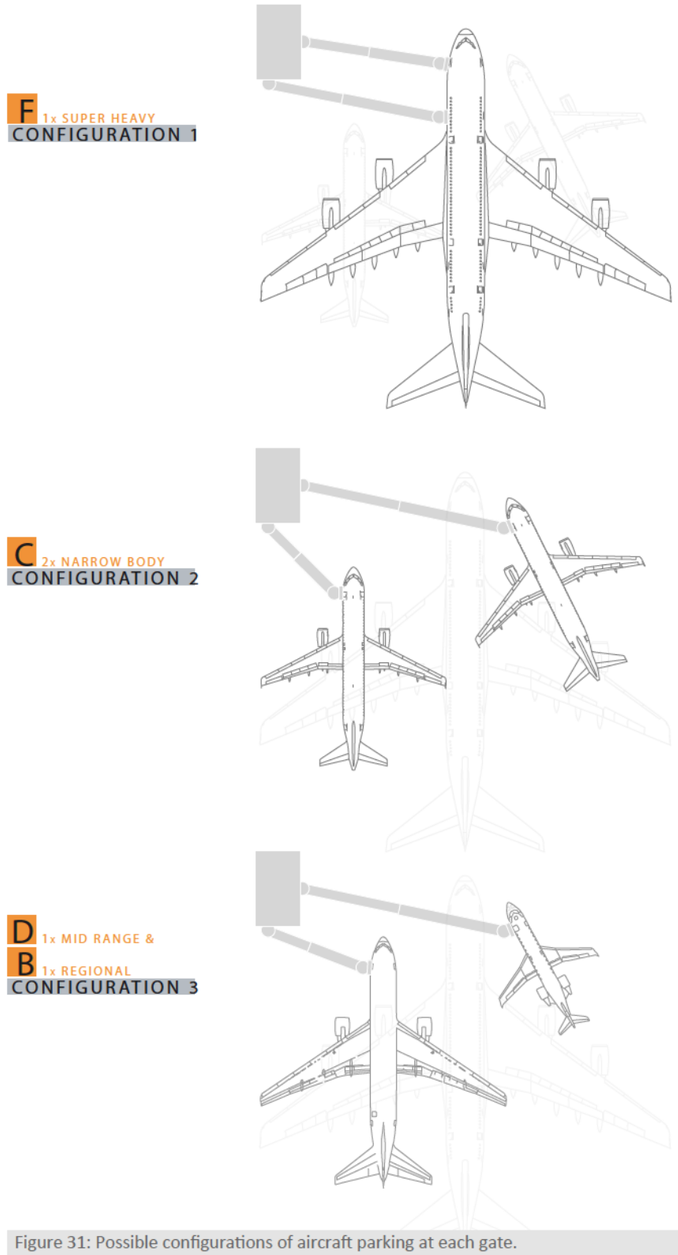


Figure 31: Possible configurations of aircraft parking at each gate.

5.4 Research Through Design

As discussed above, airports are trending towards centralized processing facilities (i.e., landside terminals) served by a series of linear satellite terminals. This configuration offers greater efficiency in aircraft taxi operations, which is fundamentally important to airlines but also to passengers through trickle-down cost savings. Another reason for this trend is reliable and cheaper transporter technology (trains, moving walkways, etc.) making midfield terminals more cost effective. Finally, this configuration offers the ability to adapt to evolving traffic types and to shifts in international or transfer passenger volumes.

The linear terminal must simultaneously accomplish more goals than ever before because airport operators are looking to enhance non-aviation related. As such, design considerations have shifted from the utilitarian to the carefully orchestrated and experiential. Whether it is restaurants, retail, restrooms or gates, an airport's physical design must make it easy for passengers to find what they need. The terminal should also display art and offer secondary services like conference rooms and chapels. Increasingly, passengers expect provision for quiet areas in which to nap, read or conduct business as well as amenities like massage booths, salons and recliner lounges (3). For logistical and security reasons, the bulk of these services should be available airside, in the satellite terminal.

BASIC TYPOLOGY

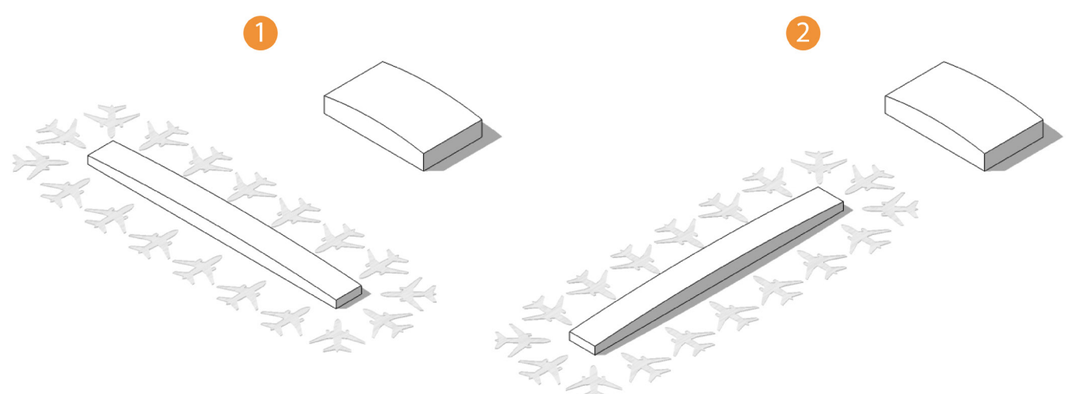


Figure 33

POSSIBLE EXPANSION

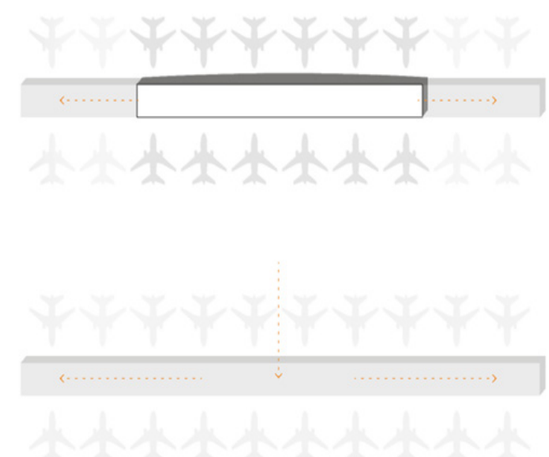


Figure 34

In a conventional gate area, circulation and travellators (or moving walkways) are flanked by generic waiting halls furnished with parallel rows of attached seating. As commercial spaces are often far afield (e.g., aggregated at junctions of concourses), passengers are often disinclined to leave the gate area, especially when this means dragging their carry-on luggage and hand baggage along with them. Early in the design process, I extended the commercial, food and drink amenities along the spine of the satellite terminal (Step 1 in Figure 35), dropping them down a level from the departure gates and circulation. As departure areas are, in effect, organized as mezzanines above the retail area below, it is possible to quickly see what stores and restaurant offerings are available (from above) and keep an eye on one's gate area (from below). While this is not the optimal design for conventional retail spaces like shopping malls, it is apposite in this linear building.

A 2007 study in the Journal of Services Marketing found that passengers prefer soothing spaces with soft music or other relaxing, biophilic atmospheres. The same study also verified the benefit of art or stimulating exhibits for passengers to peruse as they wait. Building on this, the next design iteration placed restorative areas along the building (Step 2 in Figure 35). These take the form of green spaces; some of which drop down to engage with restaurants on the level below (See Figure 38). While others continue upward, connecting to outdoor terraces from which one can watch planes. Some of these gardens are open to the air while others are enclosed and can be used to pre-purify incoming air. Especially on the west side of the terminal, these gardens act as natural sun shading devices to moderate temperatures within. Gates, gardens and service area are configured along the departures mezzanine like Morse-Code in a dot and dash configuration.

The design proposed in this thesis tries to reduce travel anxiety and allow passengers to relish the airport experience. It was also important to offer as much natural light through windows and skylights as possible. The windows also reinforce the passenger-plane connection and provide views of aircraft on the apron and runways.

I used section to explore and elucidate the muddled overlap of arrivals, departures, transfers, waiting and shopping. While bulky security apparatuses and government controls aren't an issue in the satellite terminal, passenger flow segregation and clarity of movement had to be taken into consideration. Spaces also had to be accessible to differently-abled passengers. The sectional exploration allows for a concourse with wide traffic lanes and moving walkways as well as an arrivals experience that is not buried under the building (Step 3 in Figure 35).

This solution for dealing with arrivals is already used (at least partially) in airports like Toronto (CYUL), Charles de Gaulle (LFPG), Dubai (OMDB) and Doha (OTBD). Passengers are kept separate while still fully aware and a part of the terminal experience. Upon arrival, transit passengers get an overview of the waiting, departures and retail areas below. Bridges that connect the jetways to the arrival-level circulation are angled towards the center of the satellite where escalators connect to an automated people mover below. Placing retail on the lowest level -- where arrivals would conventionally have been -- made the shopping and entertainment area adaptable and with dedicated routes for the movement of goods.

The final step is the design of an envelope that can be adjusted to the local climate and culture (Step 4 in Figure 35).

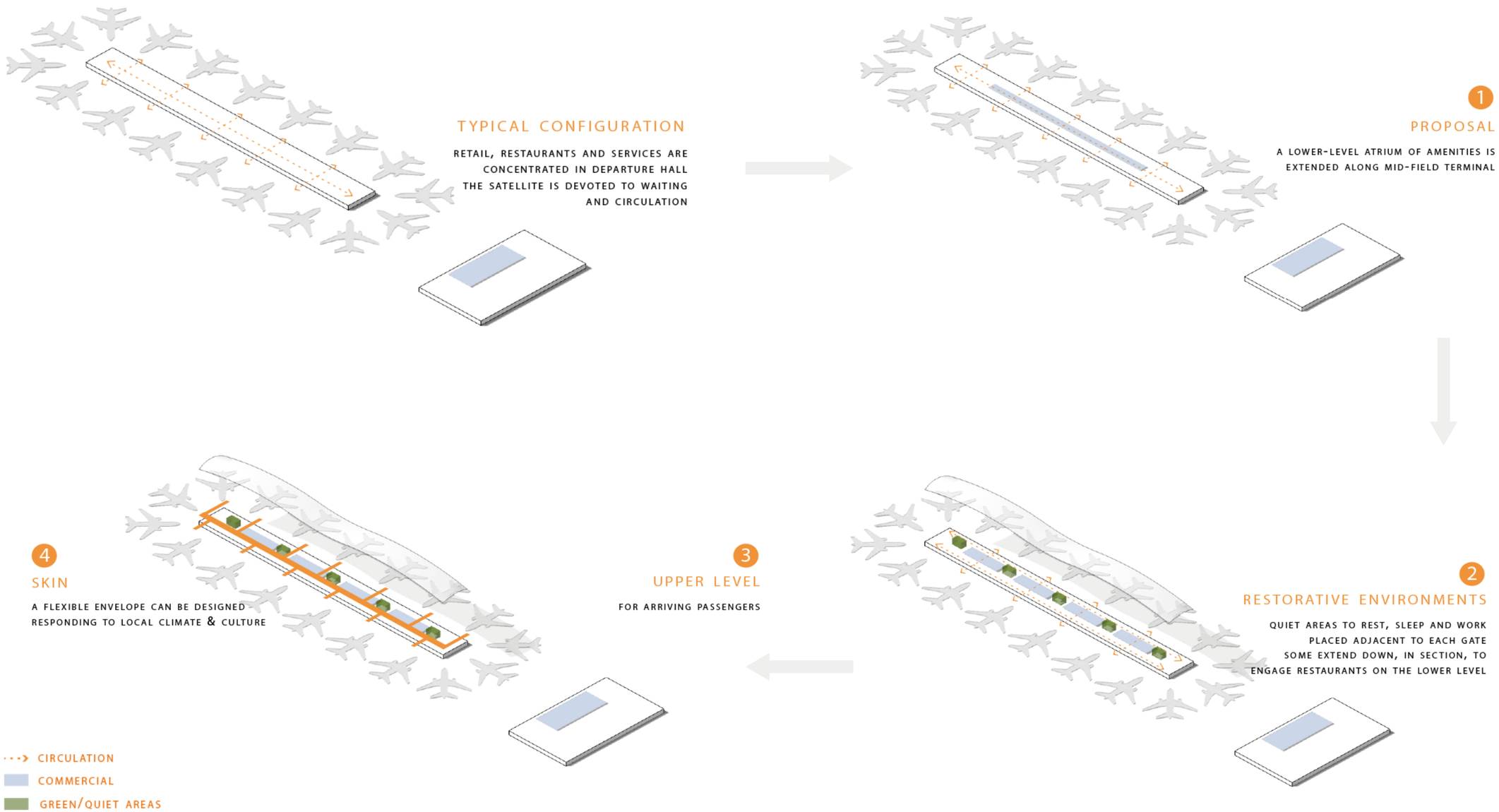

TYPICAL CONFIGURATION
RETAIL, RESTAURANTS AND SERVICES ARE CONCENTRATED IN DEPARTURE HALL
THE SATELLITE IS DEVOTED TO WAITING AND CIRCULATION
1
PROPOSAL
A LOWER-LEVEL ATRIUM OF AMENITIES IS EXTENDED ALONG MID-FIELD TERMINAL
2
RESTORATIVE ENVIRONMENTS
QUIET AREAS TO REST, SLEEP AND WORK PLACED ADJACENT TO EACH GATE
SOME EXTEND DOWN, IN SECTION, TO ENGAGE RESTAURANTS ON THE LOWER LEVEL
3
UPPER LEVEL
FOR ARRIVING PASSENGERS
4
SKIN
A FLEXIBLE ENVELOPE CAN BE DESIGNED RESPONDING TO LOCAL CLIMATE & CULTURE
CIRCULATION
COMMERCIAL
GREEN/QUIET AREAS

Figure 35

The experience of an airport is much more than functionality. It cannot be measured by simplistic parameters like walk distances and numbers of seats. A TU Delft study conducted at Amsterdam Schiphol (EHAM) airport confirmed what most designers intrinsically know (18) namely, that passengers clearly preferred terminal environments designed to feel spacious, bright, warm and relaxing. Most subjects favored a curvilinear roof and a light-colored material palette. They were attracted to green space and the sense of comfort it provides. Notably, passengers weighted the impact of architectural elements more heavily than lighting or decoration.

The precursor to the satellite terminal was the holding room and waiting area. This in-between moment should reduce stress and not add to it. Every part of the building offers glimpses of the surroundings or of the spacious central atrium dominated by activity. A duality emerged where the core of the terminal was public and similar to conventional retail spaces but moving up and outward, the spaces become private and focus on the surroundings (Figure 38). To accentuate this duality I placed natural, calming zones at the transition. They receive passengers from the commercial plaza and prepare them for the flight ahead. They can take the form of gardens, as mentioned above, or water features and quiet, isolated seating. Contingent on climate, they could be open-air or enclosed.

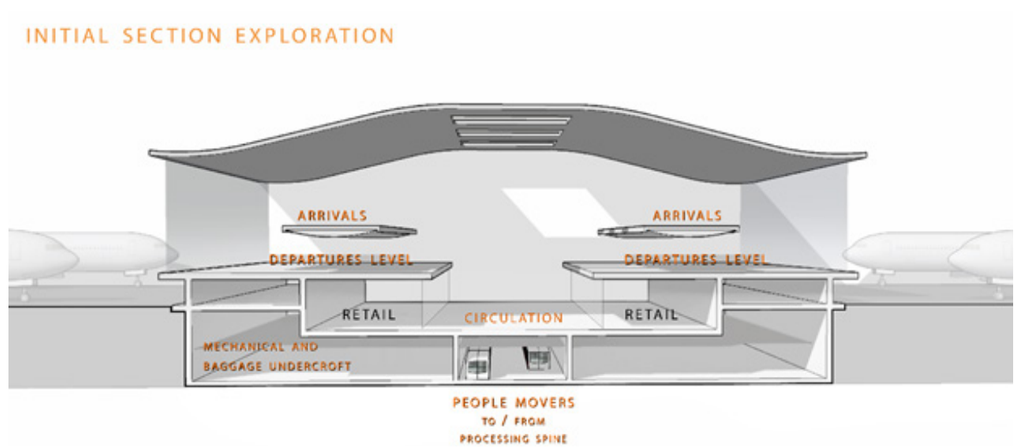
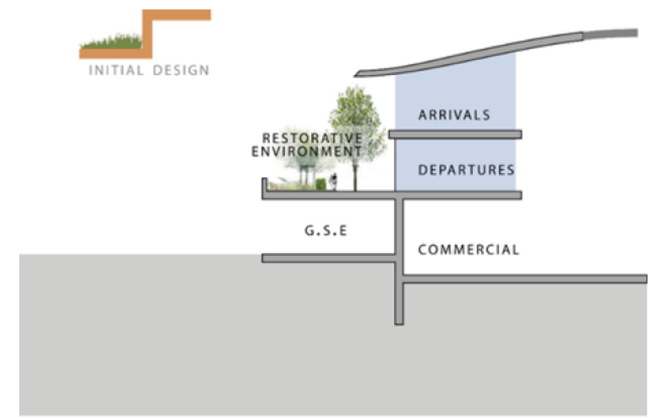


Figure 36

Reversing the initial design had the practical advantage of reducing the noise and security concerns that come with balconies overlooking the apron. More importantly, it defined the gate as a relaxing, natural and introspective experience complementary to the more social and lively aspects associated with the retail level. A secondary circulation spine, dominated by the view of the aircraft on one side and the garden on the other, helps prepare the passenger for flight.

Figure 38 shows how arriving passengers walk up a ramp that frames the aircraft that just carried them. Then they cross above and through the restorative environment and into the arrivals mezzanine. Here, if not in a rush, they can view the airport or head straight to security clearance.



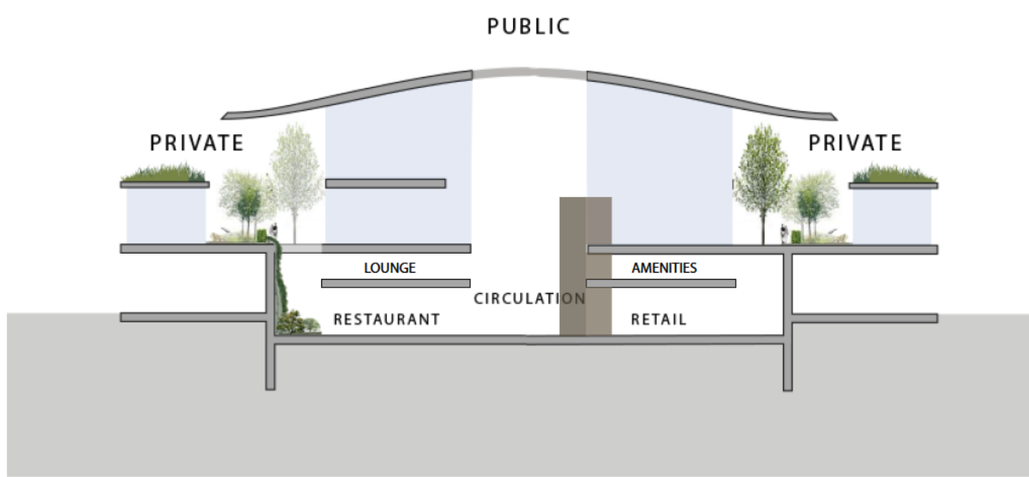


Figure 38: The duality between a public core and private gardens

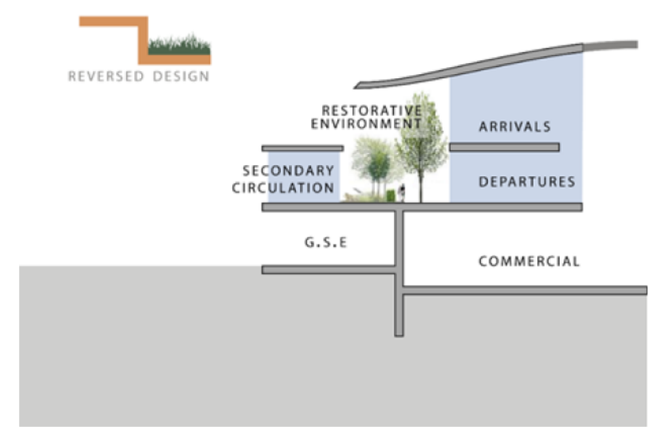


Figure 37

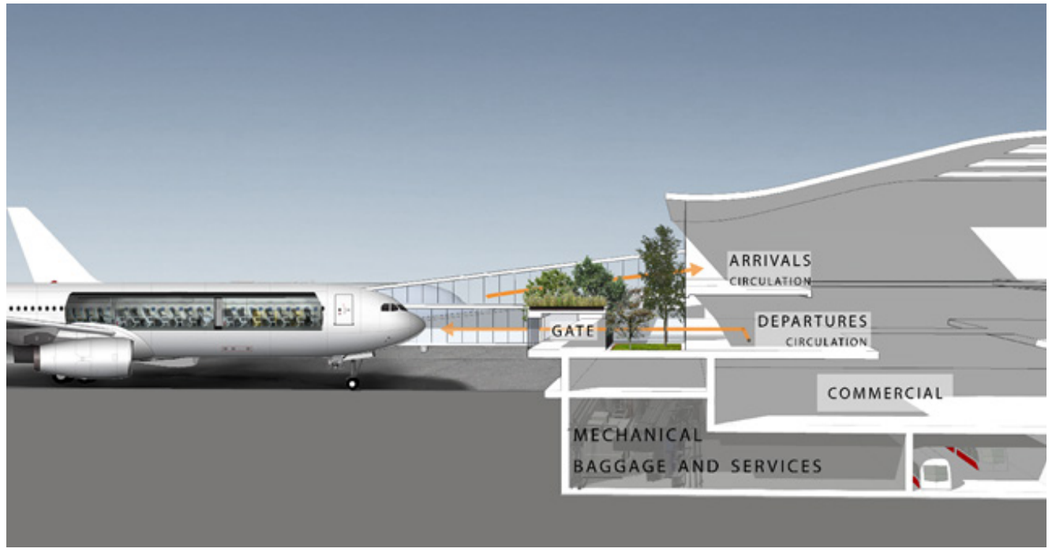


Figure 39

Figure 40: an early impression of what the gate may look like at the departures level (Figure 47 shows a more developed iteration)

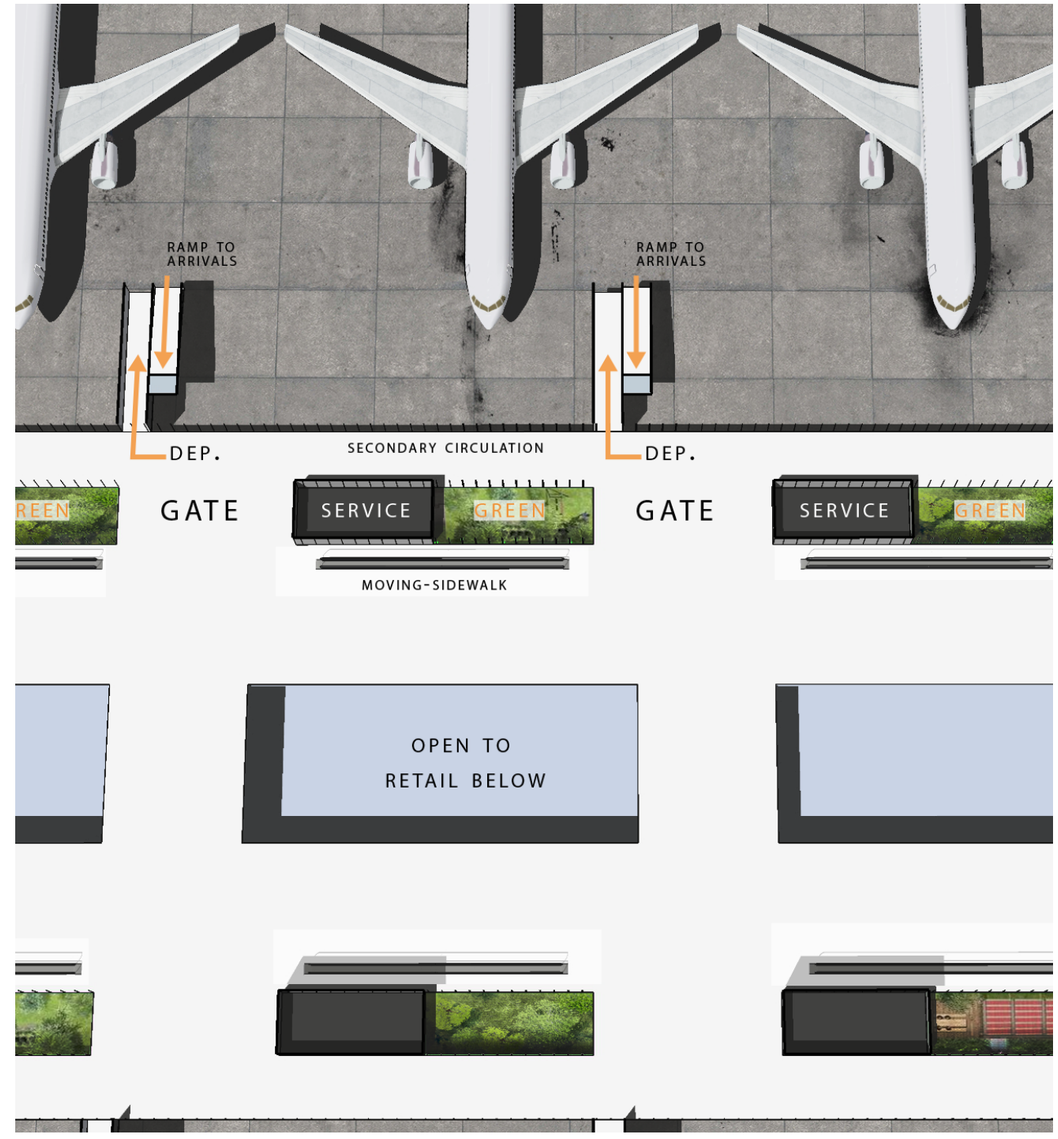


Figure 41 Concept diagram of the primary and secondary circulation spaces on the departures level. Service cores containing bathrooms, offices and mechanical rooms abut the garden at each gate. Compare to Figure 41.

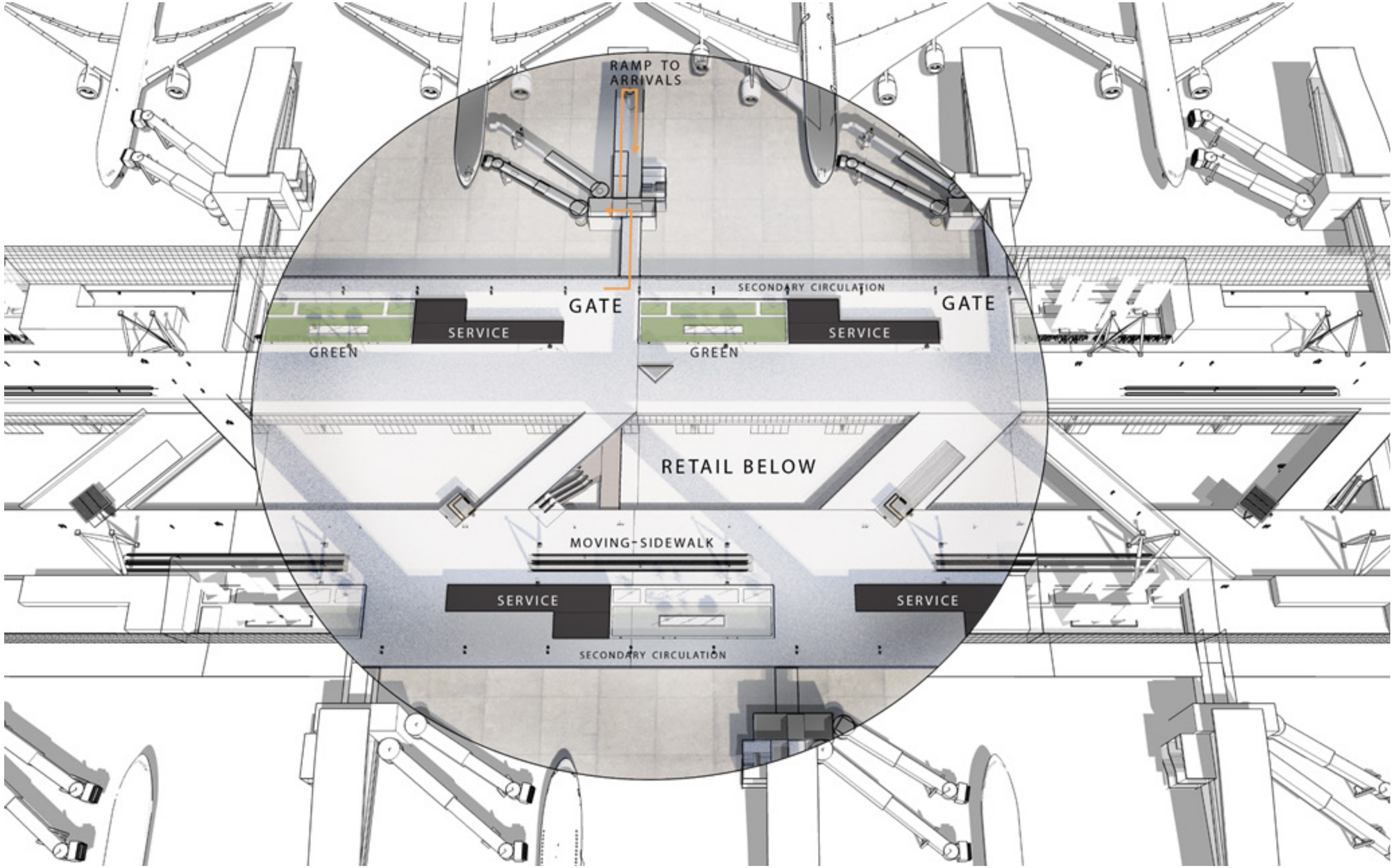


Figure 42: The final design of the departures level.

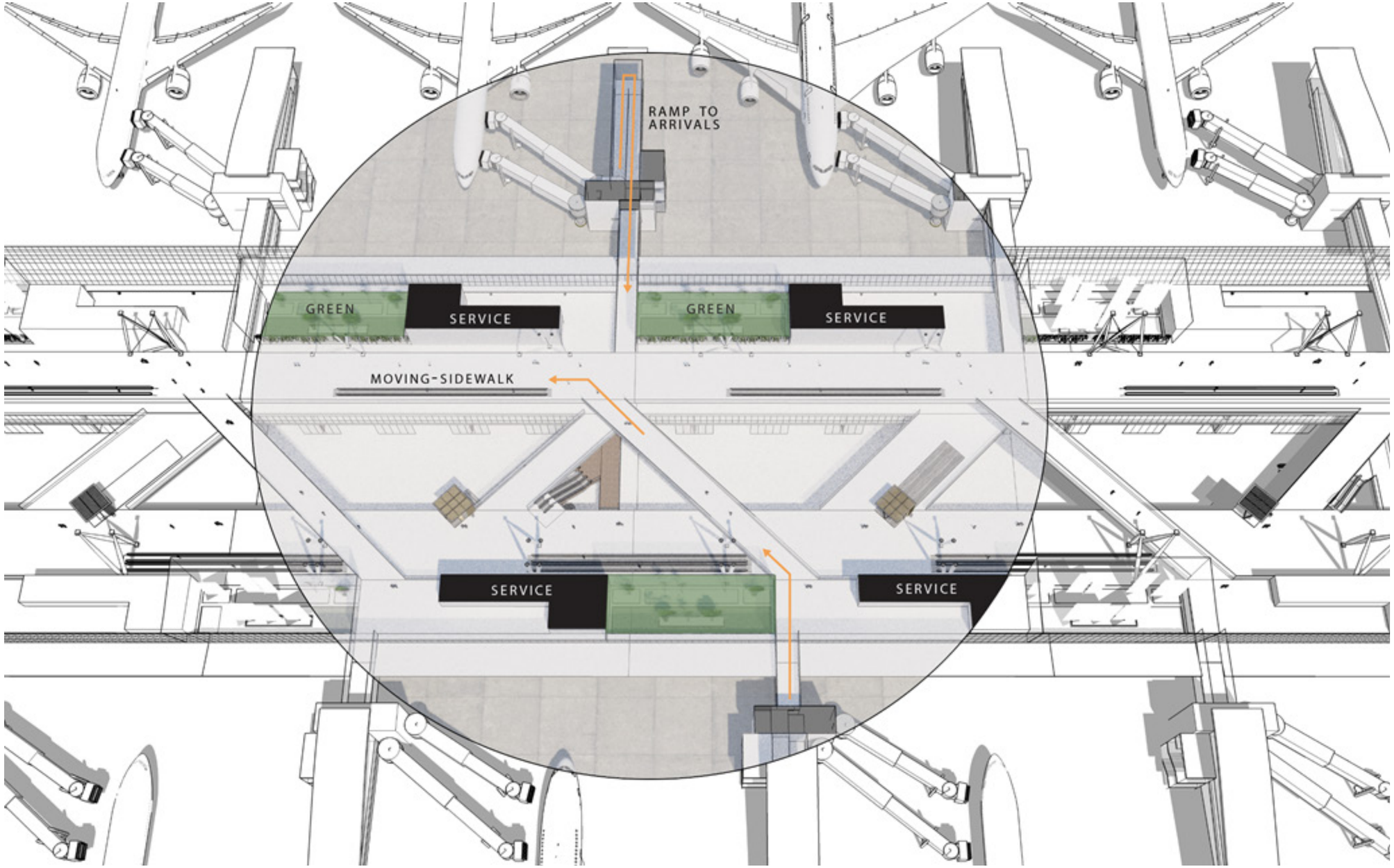
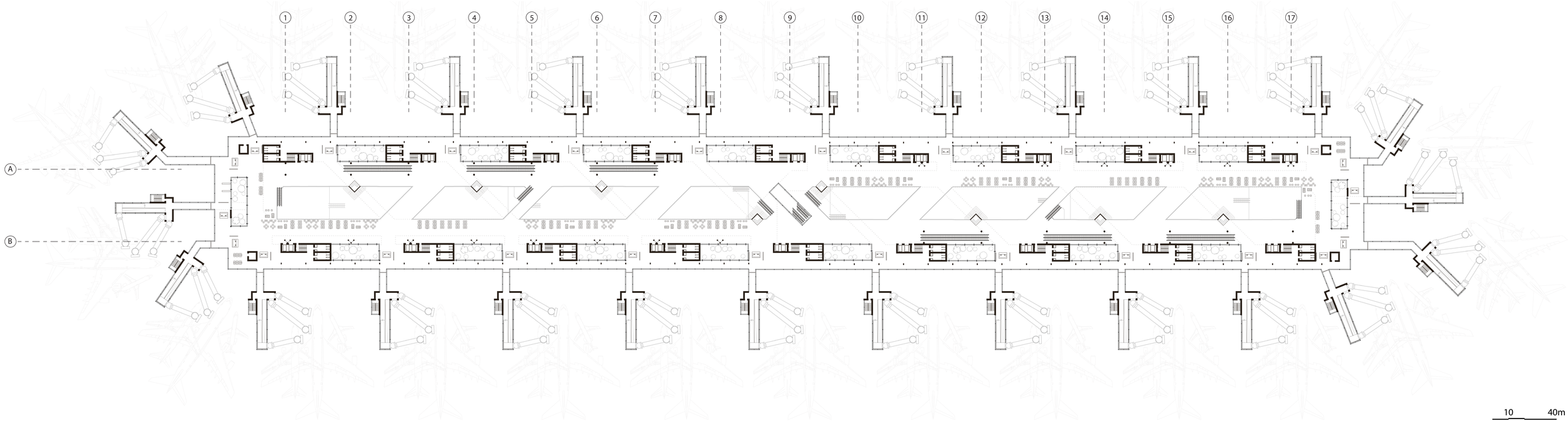
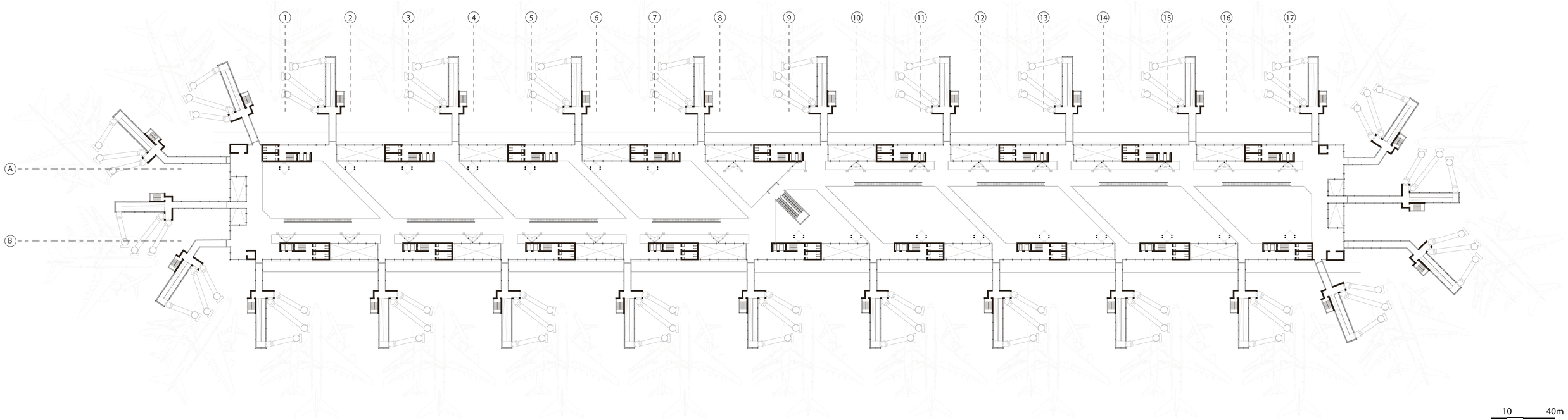


Figure 43: View showing the final design of the arrivals level



A1 DEPARTURES FLOOR PLAN



A2 ARRIVALS FLOOR PLAN

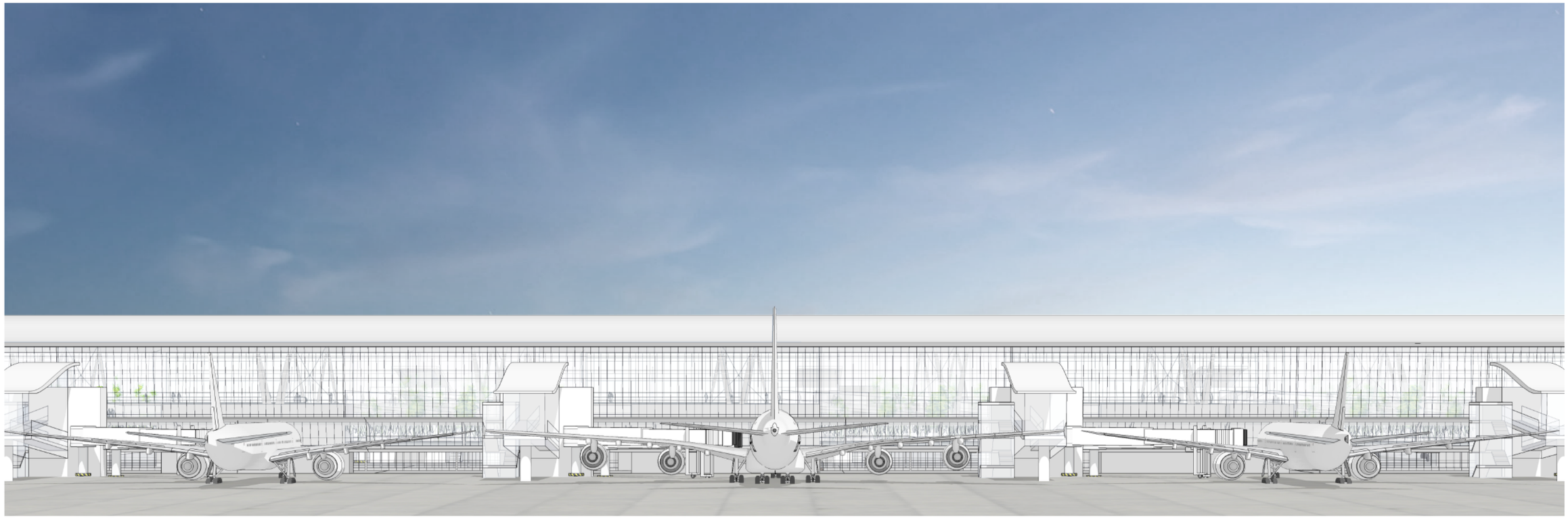


Figure 44: Elevation showing an assembly of three gate modules

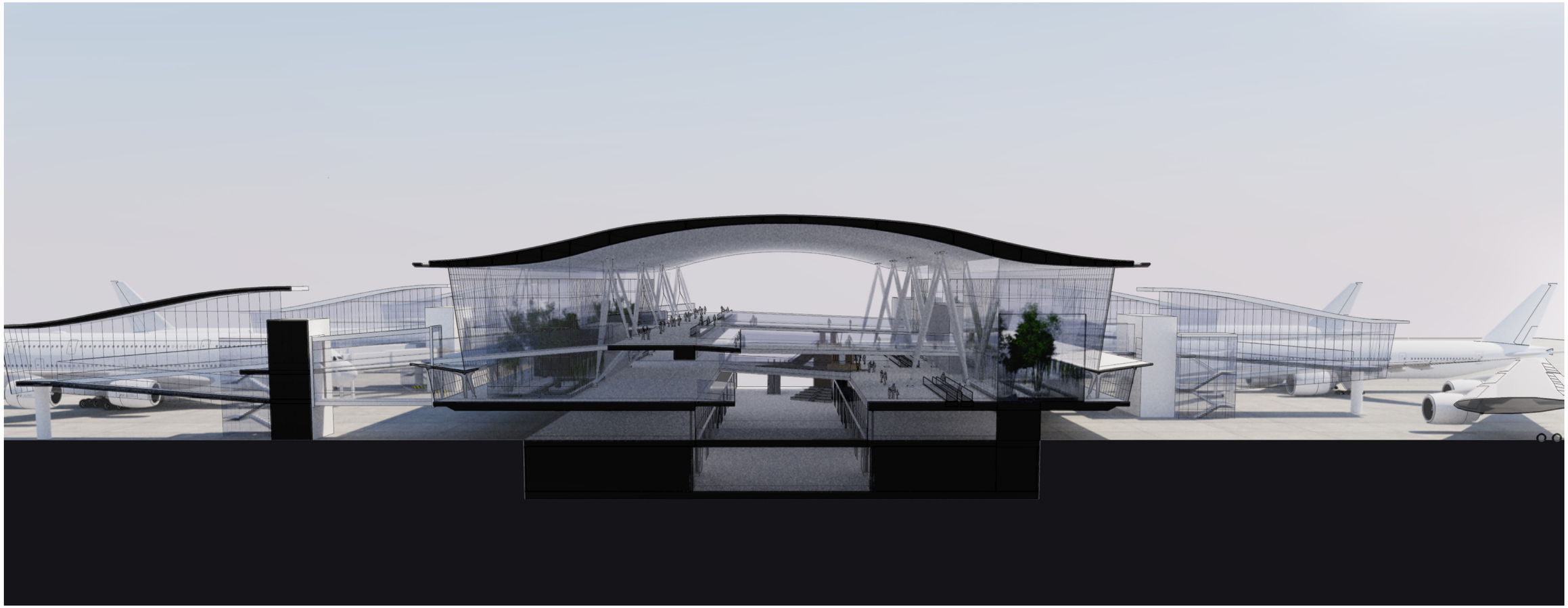
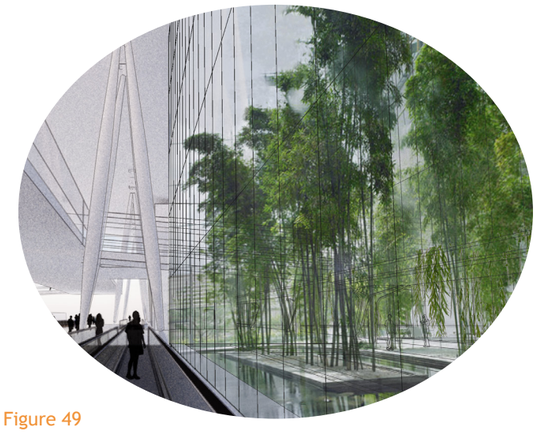


Figure 45: Rendered section through a ramp in the gate annex (far left).



▸ See Figure 49

▸ See Figure 48

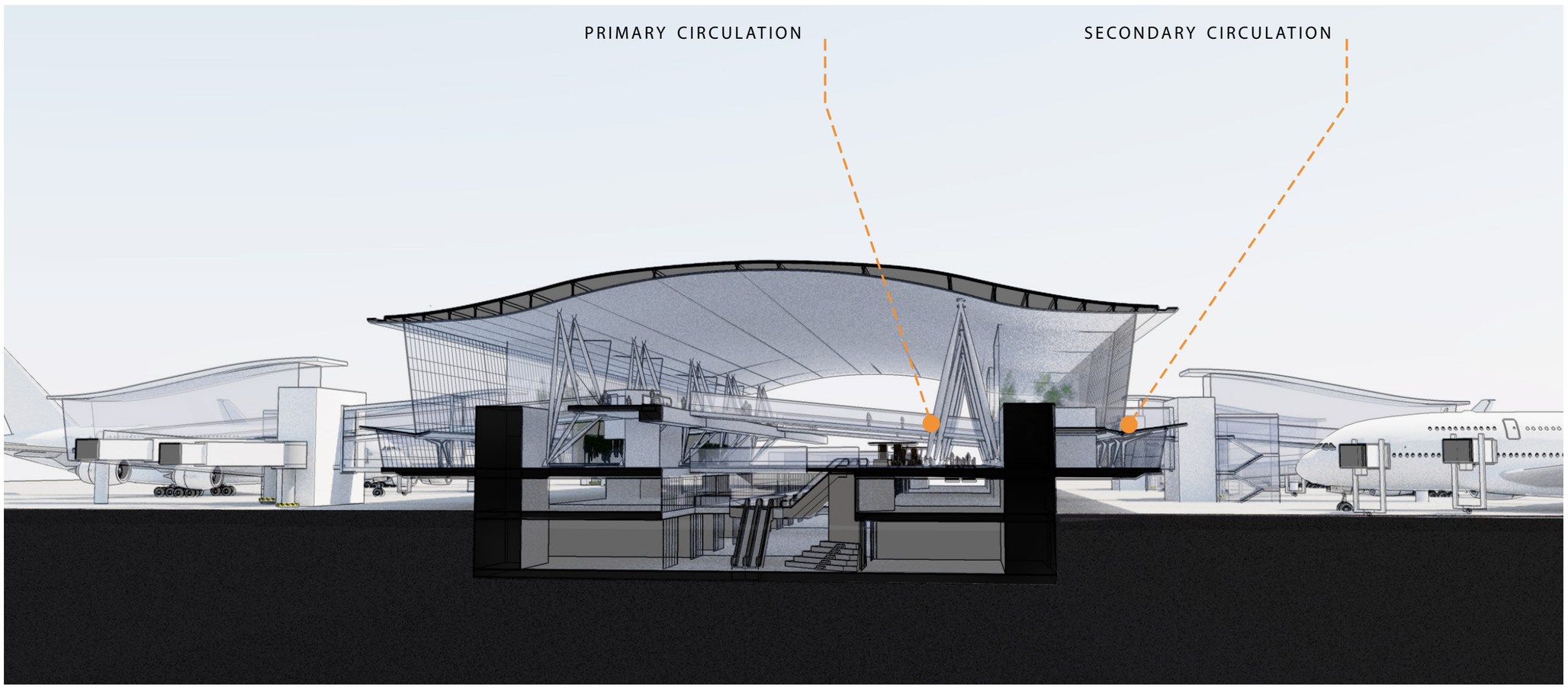


Figure 46: Rendered section showing service cores and circulation between retial and departure levels

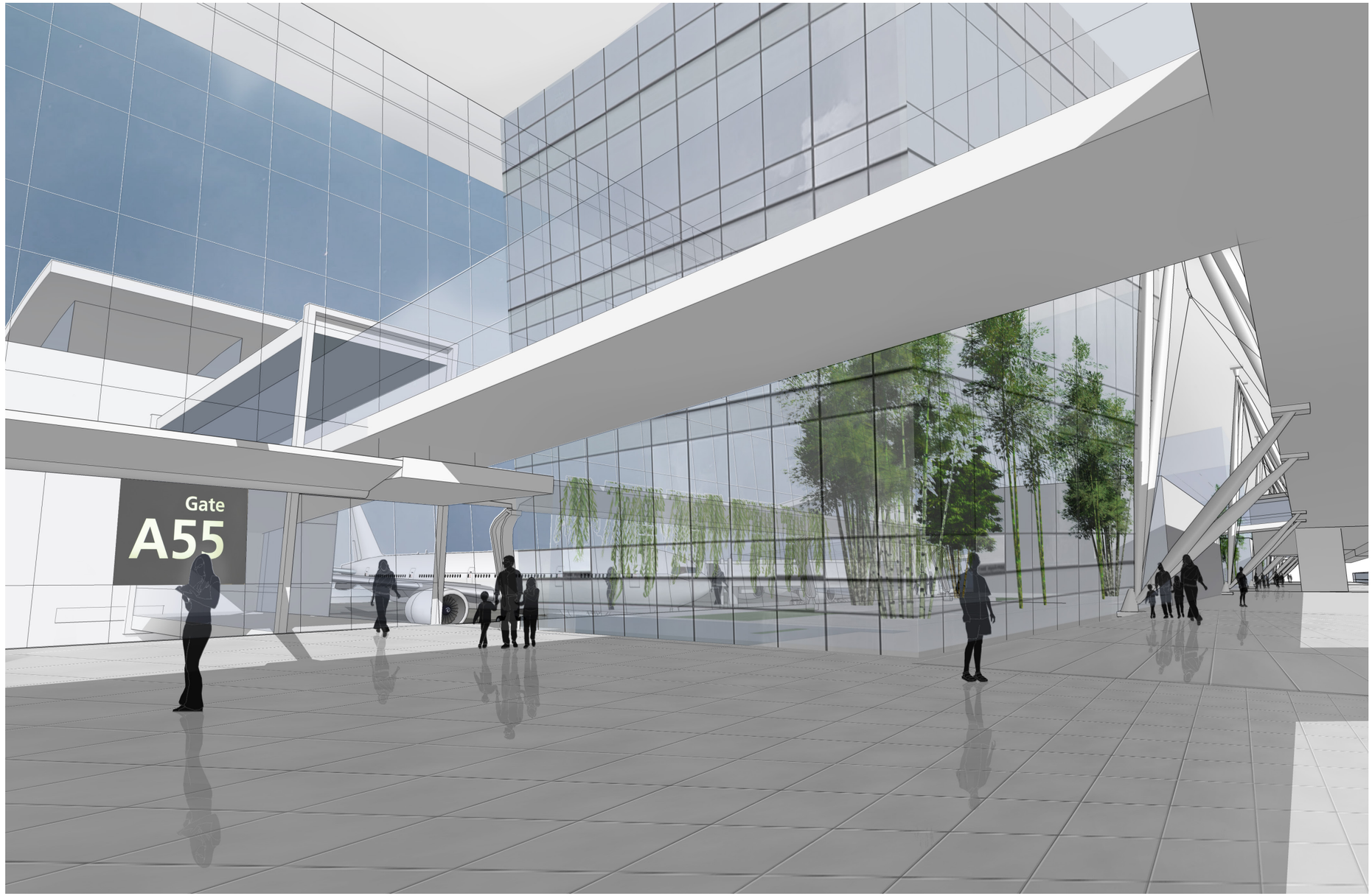


Figure 47: Looking towards a garden at the departures level with the arrivals mezzanine visible above.

Figure 48: Looking down secondary circulation corridor with restorative gardens on one side and aircraft visible on the other.

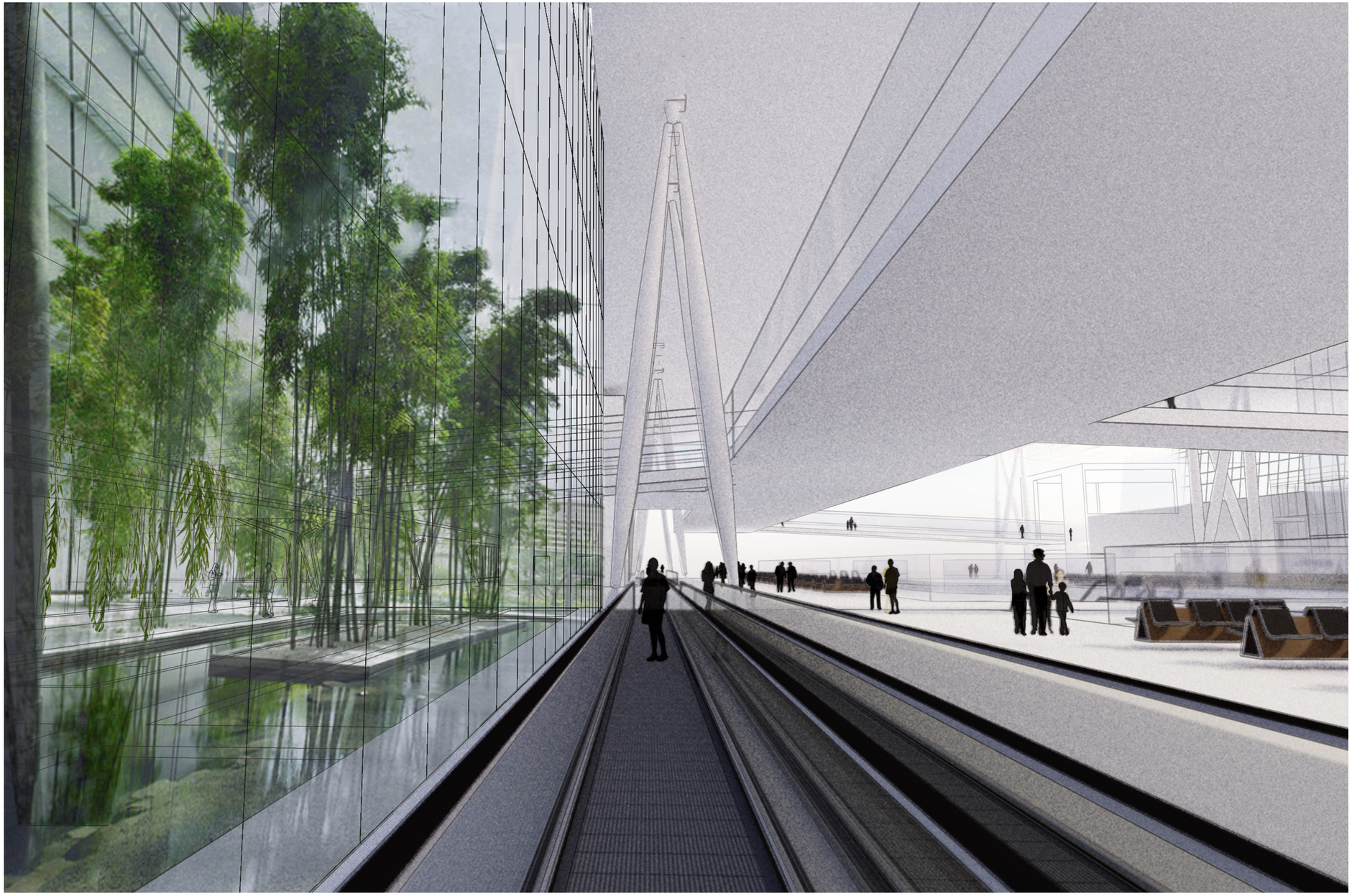


Figure 49: Main circulation on the departures level showing how the structure and green spaces help direct movement.

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6.0 CONCLUSION

The International Air Transport Association (IATA) expects 7.2 billion passengers to travel by air in 2035. This prediction represents a near doubling of the 4 billion people who travelled in 2016. Accordingly, airports around the world (especially in the Asia Pacific region) are in the planning stages for new terminal buildings that will significantly define the future experience of flight.

6.1 Lessons Learned

As discussed in Chapter 2, the entire airport terminal is, truly, a building defined by modernity. Lacking direct precedents, however, airports have evolved from temporary structures like tents, hangars and sheds. By the 1960s the typology of airport buildings was more or less set: an assembly comprising a rudimentary passenger building flanked by carparks and the occasional hotel and office building on the landside and an apron for aircraft on the other. In the 21st century, however, the design of airports has matured significantly. Just as evolution adapts a species into a form best suited to the prevailing conditions so too has the passenger terminal transformed to accommodate a spate of different functions and characteristics.

While not all airports have evolved to the same level of sophistication, it is possible to identify key trends, notably centralized processing concourses supporting multifunctional satellite terminals that address an increasing diversity of human activities. These gate concourses have become functionally diverse (and programmatically ambiguous), accommodating everything from travel to leisure, retail to fitness, conferences to family reunions, churches to planespotting decks. The simple passenger terminal of the 20th century has given way to a diverse collection of buildings and functions, tantamount in complexity to the cities these airports serve.

In fact, the airport has become so large that it can no longer be a singular architectural object but instead a mega structure where activities inside are corralled into distinct hamlets connected by vast swaths of circulation space. The more functions diversify, the more logical it becomes to divide and accommodate different uses in different buildings. Consequently, the megastructure of the airport terminal has split into three individual parts: the transportation hub on the landside, the processing concourse in-between and the satellite terminal on the airside. Even the latter risks being so large that it cannot readily be comprehended. So familiar urban elements like streets, malls and gardens must be deployed to enable passengers to locate and orient themselves. In my design the structural columns, beams and trusses are used to further establish a hierarchy and provide a sense of direction to support movement through the terminal.

Psychologically the airport terminal must provide stimulation for some and tranquility for others. But the rationality of movement combined with the intrinsic linear form of a satellite terminal can overwhelm the design (as it does in so many poor examples). In my proposal the circulation was tempered by tranquil spaces to provide contrast between voluminous and low, solid and void, indoors and outdoors, light and shade, natural (gardens) and built elements. The planting in the terminal's many green spaces also acts as a purifier of interior air and as a baffle to noise from the apron. These restorative gardens divide public from more private routes through the terminal, noisy areas from quiet ones and retail from the act of boarding.

The design of the satellite terminal must address the technical and logistical stipulations of airlines while responding to demands from the airport authority or from retail and commercial interests. In the segregation of passenger flows (arriving, departing, post immigration, prescreened, etc.) for operational security, there is an inherent conflict between commercial agenda of retailers as well as the passengers own psychological need to be in touch with nature.

The design proposed in this thesis attempts to strike a balance between legibility and variability by maximizing light and interior space while using structure to guide navigation. Submerging shops, restaurants, hotels, fitness areas and airline lounges allowed for a robust range of commercial uses without compromising the legibility of the whole.

▸ 6.2 Moving Forward

The design of this satellite terminal is only a fragment of the overall design of the aerotropolis – which in turn is a microcosm of the challenges posed by global standardization and placelessness. I have already noted that the impact of an airport extends far beyond the chain-link fences that surround them. The Masterplan that structures and integrates adjoining areas and which involves, multiple disciplines and complex analyses was excepted from the scope of my thesis but would be essential to real-world applications.

The more orthodox way of designing an airport would have been to define and research a site, begin from the landside connections, moving onto the departure and arrival halls and then finally designing the gate area to match the former. Instead I focused on the airside connection and made the case that all airports, regardless of location, are defined at the gate area by the airplanes they serve. The site, whether it used to be a desert or boreal forest is standardized into flat aprons and taxiways that adhere to strict regulations and share a predictability. Based on this, I designed a building that would be adaptable, wherever it was.

Now, having focused on strategies for the gate area and satellite terminal, the design of the landside concourse along with the challenges of parking, and connections to other modes of transportation, warrants further attention. The main advantage of this will be the ability to shape passenger experience from start to finish. Designing the processing concourse will also influence the design of the connection in the satellite terminal to the Automated People Mover (APM). But Beyond the point of entry and exit, I do not think the conclusions I drew about the gates or the satellite terminal would be much different.

Moving forward with the design of the satellite, I would finesse certain aspects, like the design of the curtain walls, the design and differentiation of seating areas as well as the design of totemic retail elements that reach up and connect between commercial and departure levels. Going forward, I would explore a single-loaded concourse where aircraft only connect to one side. Though it would retain major design elements and the spirit of the current proposal, this variation could be utilized in places where a conventional satellite terminal is unfeasible. I would also further develop the retail level, delineating areas for bars and restaurants into which the gardens drop.

The logical next step is to test how this design might be adapted and applied to existing airports around the world that are seeking ways to expand. Based on a case by case basis, specific elements like the end-pieces or the length of the building can be adjusted in response demand or to the available space. The curtain wall system, too, could be articulated based on local conditions. Sun shading devises and double skins could be deployed to address heat loss and gain; or the pre-heating/cooling of air (which the gardens are also designed to do). Local flora and fauna could be showcased in the gardens, which could also be designed to provide sun shading – especially on west-facing facades (in the northern hemisphere).

Committing to design a standard terminal suitable for a wide range of airports necessitated that the building be able to adapt in size. This led me to focus on gate modules that could repeatedly dovetail into one another. In the future, I would like to review any redundancies that may have resulted from modularity, and define a phased construction strategy where certain service modules would be omitted initially and only added when the building begins to reach its full passenger load.

According to the IATA's forecasts, China will overtake the US as the world's largest aviation market in less than two decades and India will displace the United Kingdom for third place in 8 years. Though most older airports in the US, Canada and Europe face countless constraints to new development and tend to focus on piecemeal renovations, most of the developing world (which over the past 10 years has doubled its share in global traffic) is embarking on ambitious airport 'megaprojects'. In the process of researching this thesis I came across many proposals where the gate area, despite being a linchpin of the experience of flight, remains an unimaginative non-place.

My strength as a designer has been to think from the perspective of the passenger and emplace these non-places. I believe the design proposed in this thesis can be adapted in hundreds of different ways to enrich the gate experience at almost any airport that aspires to become an international hub. Before it is too late, these burgeoning airport terminals can benefit from some of the lessons learned in the exploration of this thesis.

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