

# TAN SON NHAT Intl AIRPORT

Re-designing passenger travel experience.

**/\* a Research upon airline passenger  
experience**

**<context: aviation, Narita International Airport>**



by  
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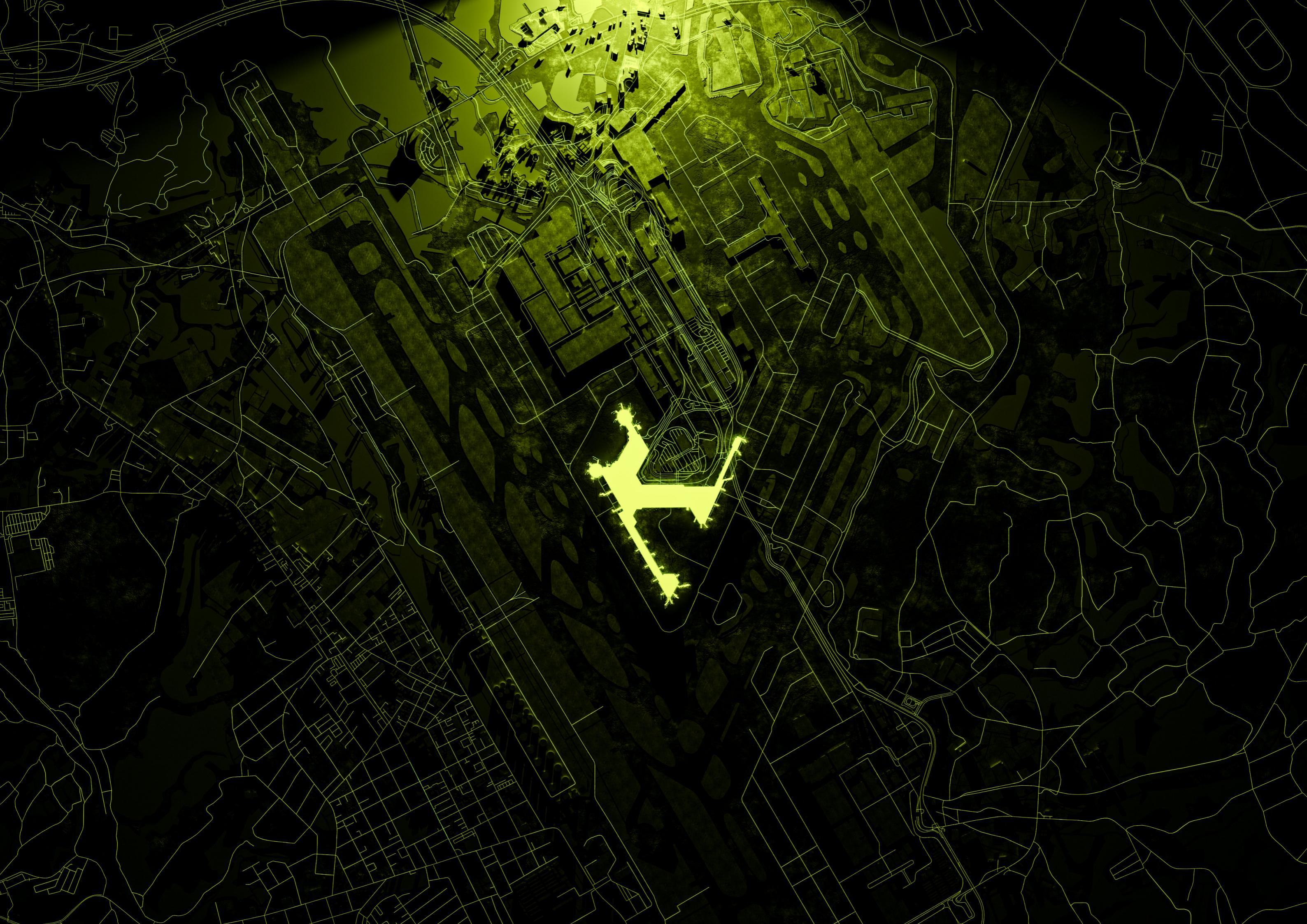
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**\_April 2023\_**  
 Fargo, North Dakota, USA

*\*An architectural research and design project  
submitted to the Department of Architecture and Landscape Architecture.\**

*\_In Partial Fulfillment of the Requirements  
for the Degree of Master of Architecture".*



# Table of Content



Table of Figures	1
Abstract	4
Introduction	8
Site and Context	10
Methodology	16
Simulation	18
Analysis	52
Summary	58
Implication	62

# Table of Content



Where ?	78
Site Analysis	84
Why ?	102
Design & Concept	114

# TABLE OF FIGURES



14	Figure 01   Narita International Airport Site Plan
21	Figure 02   Narita International Airport Isometric Diagram
22	Figure 03   AnyLogic Algorithm_Pedestrian Sources
24	Figure 04   AnyLogic Algorithm_Pedestrian Entry
26	Figure 05   AnyLogic Algorithm_Pedestrian Entry Split
28	Figure 06   AnyLogic Algorithm_Check-in Counters
30	Figure 07   AnyLogic Algorithm_Pedestrian Level Change
32	Figure 08   AnyLogic Algorithm_Security Check
34	Figure 09   AnyLogic Algorithm_Attractions
36	Figure 10   AnyLogic Algorithm_Gates
38	Figure 11   AnyLogic Algorithm_Time Measure Start
40	Figure 12   AnyLogic Algorithm_Time Measure End
44	Figure 13   Simulation Data <6 Hours> _ East wing Check-in 4th floor Pedestrian Flow Histogram
44	Figure 14   Simulation Data <6 Hours> _ West wing Check-in 4th floor Pedestrian Flow Histogram
45	Figure 15   Simulation Data <6 Hours> _ 4th floor Pedestrian Flow Plot Chart
44	Figure 16   Simulation Data <6 Hours> _ East wing Check-in 3rd floor Pedestrian Flow Histogram
44	Figure 17   Simulation Data <6 Hours> _ West wing Check-in 3rd floor Pedestrian Flow Histogram
45	Figure 18   Simulation Data <6 Hours> _ 3rd floor Pedestrian Flow Plot Chart
46	Figure 19   Simulation Data <6 Hours> _ 4th Floor Pedestrian Density Heatmap
47	Figure 20   Simulation Data <6 Hours> _ 3rd Floor Pedestrian Density Heatmap

# TABLE OF FIGURES



48	Figure 21   Simulation Data <12 Hours> _ East wing Check-in 4th floor Pedestrian Flow Histogram
48	Figure 22   Simulation Data <12 Hours> _ West wing Check-in 4th floor Pedestrian Flow Histogram
49	Figure 23   Simulation Data <12 Hours> _ 4th floor Pedestrian Flow Plot Chart
48	Figure 24   Simulation Data <12 Hours> _ East wing Check-in 3rdfloor Pedestrian Flow Histogram
48	Figure 25   Simulation Data <12 Hours> _ West wing Check-in 3rd floor Pedestrian Flow Histogram
49	Figure 26   Simulation Data <12 Hours> _ 3rd floor Pedestrian Flow Plot Chart
50	Figure 27   Simulation Data <12 Hours> _ 4th Floor Pedestrian Density Heatmap
51	Figure 28   Simulation Data <12 Hours> _ 3rd Floor Pedestrian Density Heatmap
85	Figure 29   Tan Son Nhat Intl Airport _ Domestic Terminal
87	Figure 30   Tan Son Nhat Intl Airport _ Intl Terminal
89	Figure 31   Tan Son Nhat Intl Airport _ Circulation
91	Figure 32   Tan Son Nhat Intl Airport _ Parking
93	Figure 33   Tan Son Nhat Intl Airport _ Terminal 3
95	Figure 34   Tan Son Nhat Intl Airport _ Wind Analysis
97	Figure 35   Tan Son Nhat Intl Airport _ Administration
99	Figure 35   Tan Son Nhat Intl Airport _ Utililies
100	Figure 36   Tan Son Nhat Intl Airport _ Floorplan
101	Figure 37   Tan Son Nhat Intl Airport _ Floorplan
104	Figure 38   Typical Airport Flow Diagram
107	Figure 39   Visitor at Tan Son Nhat Intl Airport

# TABLE OF FIGURES



48	Figure 40   Visitor at Tan Son Nhat Intl Airport
48	Figure 41   Tan Son Nhat Intl Flow Diagram
49	Figure 42   Expand & Connect
48	Figure 43   Unison
48	Figure 44   Concept
49	Figure 45   Concept
50	Figure 46   Concept
51	Figure 47   Concept
85	Figure 48   Concept
87	Figure 49   Concept
89	Figure 50   Concept
91	Figure 51   Re-designed Tan Son Nhat Intl Airport
93	Figure 52   Axonometric Program Diagram
95	Figure 53   Re-designed Tan Son Nhat Intl Airport Site Plan
97	Figure 54   Re-designed Tan Son Nhat Intl Airport
99	Figure 55   Re-designed Tan Son Nhat Intl Airport 2nd Floor Plan
100	Figure 56   Re-designed Tan Son Nhat Intl Airport 2nd Floor Plan Performance Analysis
101	Figure 57   Re-designed Tan Son Nhat Intl Airport _ Check-in Hall
104	Figure 58   Re-designed Tan Son Nhat Intl Airport _ Visitor Hall
107	Figure 59   Re-designed Tan Son Nhat Intl Airport 1st Floor Plan



# TABLE OF FIGURES



48	Figure 60   Re-designed Tan Son Nhat Intl Airport 1st Floor Plan Performance Analysis
48	Figure 61   Re-designed Tan Son Nhat Intl Airport _ Departure Hall
49	Figure 62   Re-designed Tan Son Nhat Intl Airport _ Immigration Hall
48	Figure 63   Re-designed Tan Son Nhat Intl Airport Ground Floor Plan
48	Figure 64   Re-designed Tan Son Nhat Intl Airport Section 1A
49	Figure 65   Re-designed Tan Son Nhat Intl Airport Section 2A
50	Figure 66   Re-designed Tan Son Nhat Intl Airport Axonometric Flow Diaram
51	Figure 67   Re-designed Tan Son Nhat Intl Airport Axonometric Flow Diaram
85	Figure 68   Re-designed Tan Son Nhat Intl Airport Axonometric Flow Diaram
87	Figure 69   Re-designed Tan Son Nhat Intl Airport Axonometric Flow Diaram
89	Figure 70   Re-designed Tan Son Nhat Intl Airport Axonometric Flow Diaram
91	Figure 71   Re-designed Tan Son Nhat Intl Airport Axonometric Structure Diaram
93	Figure 72   Re-designed Tan Son Nhat Intl Airport Axonometric Structure Diaram
95	Figure 73   Re-designed Tan Son Nhat Intl Airport MEP
97	Figure 74   Re-designed Tan Son Nhat Intl Airport MEP
99	Figure 75   Re-designed Tan Son Nhat Intl Airport
100	Figure 76   Re-designed Tan Son Nhat Intl Airport
101	Figure 77   Re-designed Tan Son Nhat Intl Airport
104	Figure 78   Re-designed Tan Son Nhat Intl Airport
107	Figure 79   Visitor at Tan Son Nhat Intl Airport

*A*bs

# trac



Think back to your last trip on a plane. Was it a nightmare of horror, anxiety, and stress? While aviation travel has brought unimaginable advancements to our lives, it's far from perfect. And if you've ever been to an airport in Vietnam, you know it's a whole other level of "extra." You won't be going alone – your entire family, in-laws, and even distant cousins will join you. It's not just an issue of architecture, but a cultural challenge that requires attention.

That's why this project aim to solve the problems I've encountered countless times at this airport. I'm redesigning the passenger experience, with a vision that goes beyond just the passengers themselves. It's about expanding our thinking to include everyone – from passenger to visitor – and creating a new paradigm for airport travel that addresses the unique challenges of Vietnam.

# Introduction

/\* Air travel has been the fattest and safest travel in these recent years. It also outweighs other forms of transportation mean when compared side to side. Nevertheless, when talking about air travel, instant images flooding people's minds are about confusing directions, horrifying security, and long lines.


When looking into the matter, one cannot pinpoint just one element since it includes the entire system and must be examined carefully.

This research intends to look at passenger experiences when travelling via commercial aviation through the lens of modern technology. The research will look and analyze a typical passenger's experience when travelling via commercial aviation.

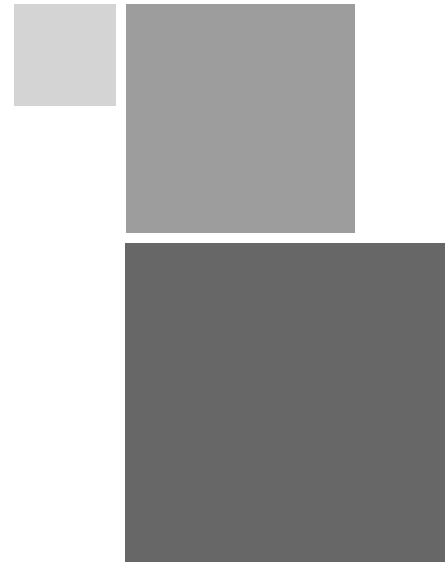
The logo for Narita Airport, featuring the word "Narita" in a stylized, pixelated font.The logo for Narita Airport, featuring the word "Airport" in a stylized, pixelated font.

/\* Narita is the busiest airport in Japan for international passenger and cargo traffic. In 2018, Narita had 33.4 million international passengers and 2.2 million tonnes of international cargo. In 2018, Narita was also the second-busiest airport in Japan in terms of aircraft movements (after Haneda Airport in Tokyo) and the tenth-busiest air freight hub in the world.

/\* Its 4,000-meter (13,123 ft) main runway shares the record for the longest runway in Japan with the second runway at Kansai International Airport in Osaka. Narita serves as the main international hub of Japan Airlines, All Nippon Airways and Nippon Cargo Airlines, and as a hub for low-cost carriers Jetstar Japan and Peach.



/\* Check-in is processed on the fourth floor, and departures and immigration control are on the third floor. Arriving passengers clear immigration on the second floor, then claim their baggage and clear customs on the first floor. Most shops and restaurants are located on the fourth floor of the Central Building.



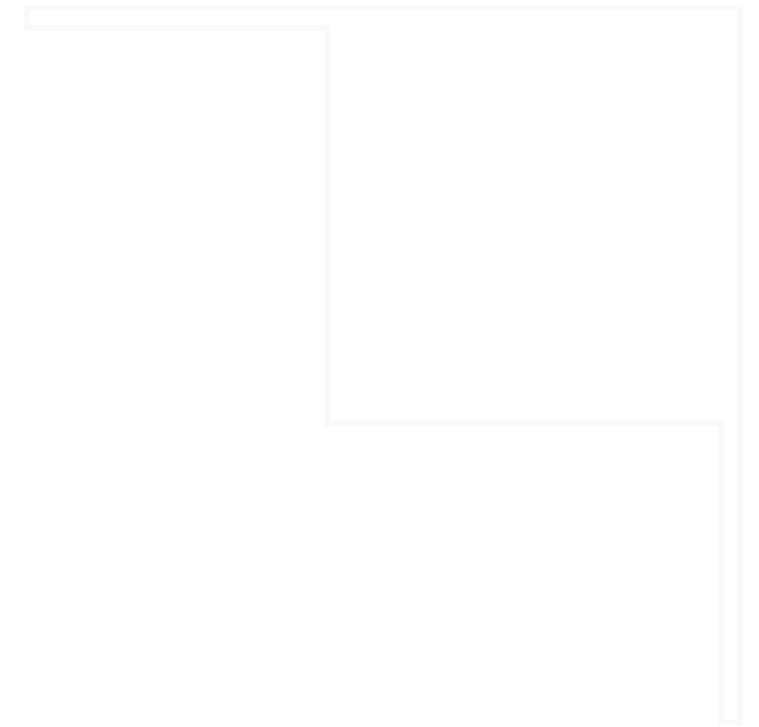
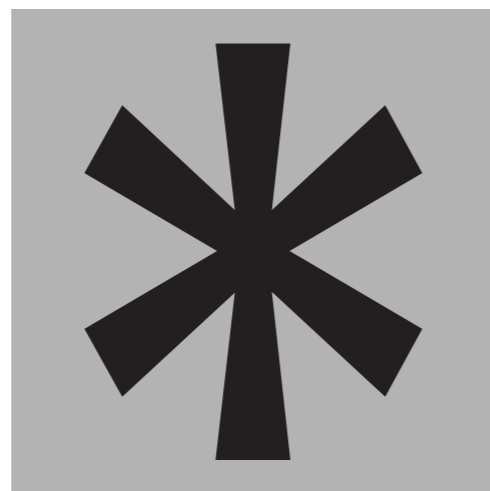
/\* Terminal 1 uses a satellite terminal design divided into a North Wing, Central Building, and a South Wing. Two circular satellites, Satellites 1 (gates 11-18) and 2 (gates 21-24), are connected to the North Wing. Satellites 3 and 4 (gates 26-38 and gates 41-47) compose a linear concourse connected to the Central Building. Finally, satellite 5 (gates 51-58) is connected to the South Wing. The terminal has a floor space of 463,000 m<sup>2</sup> (4,980,000 sq ft) and is equipped with 40 gates.



# Methodology

/\* Regarding highly designed airports, Tokyo International Airport is among the top, whether it is of its form or function.

The study will encompass a typical airline passenger experience travelling through Narita International Airport.



/\* The schematic layout and operating system of Narita International airport will be analyzed. In junction with that, modern technology and simulation software will be used to visualize the data and translate that into designs.





/\* AnyLogic is a multimethod simulation modelling tool developed by The AnyLogic Company (former XJ Technologies). It supports agent-based, discrete event, and system dynamics simulation methodologies. AnyLogic is used to simulate: markets and competition, healthcare, manufacturing, supply chains and logistics, retail, business processes, social and ecosystem dynamics, defence project and asset management, pedestrian dynamics and road traffic, IT, and aerospace.

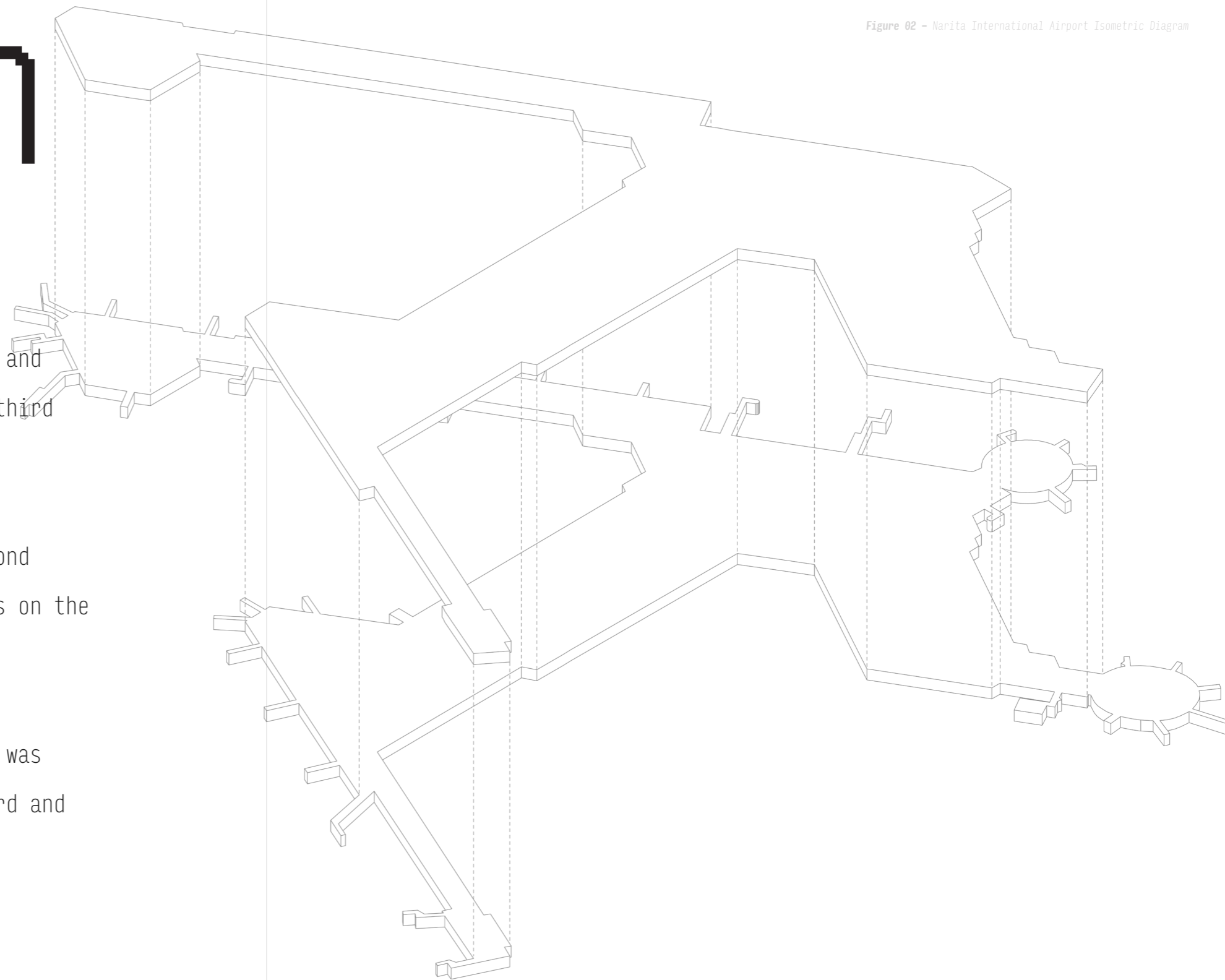
/\* The ability to analyze the model as it runs sets simulation modelling apart from other methods, such as those using Excel or linear programming. By inspecting processes and interacting with a simulation model in action, understanding and trust are quickly built.

# Re-creation

/\* The check-in process occurs on the fourth floor, and departures and immigration control occur on the third floor.

Arriving passengers clear immigration on the second floor, then claim their baggage and clear customs on the first floor.

With that information, Narita airport Terminal 1 was recreated in the 3D spaces, specifically the third and fourth floors of Terminal 1.



/\* WITH THE FLOOR PLAN RECREATED WITHIN THE 3D SPACE, THE FUNCTION WAS PROGRAMMED TO MATCH CLOSELY WITH NARITA AIRPORT.

DIFFERENT AGENTS, SIMULATION NODES ALONG WITH DIFFRENT TOOLS WAS USED TO PROGRAM THESE FUNCTIONS.

# AnyLogic

# Algorithm

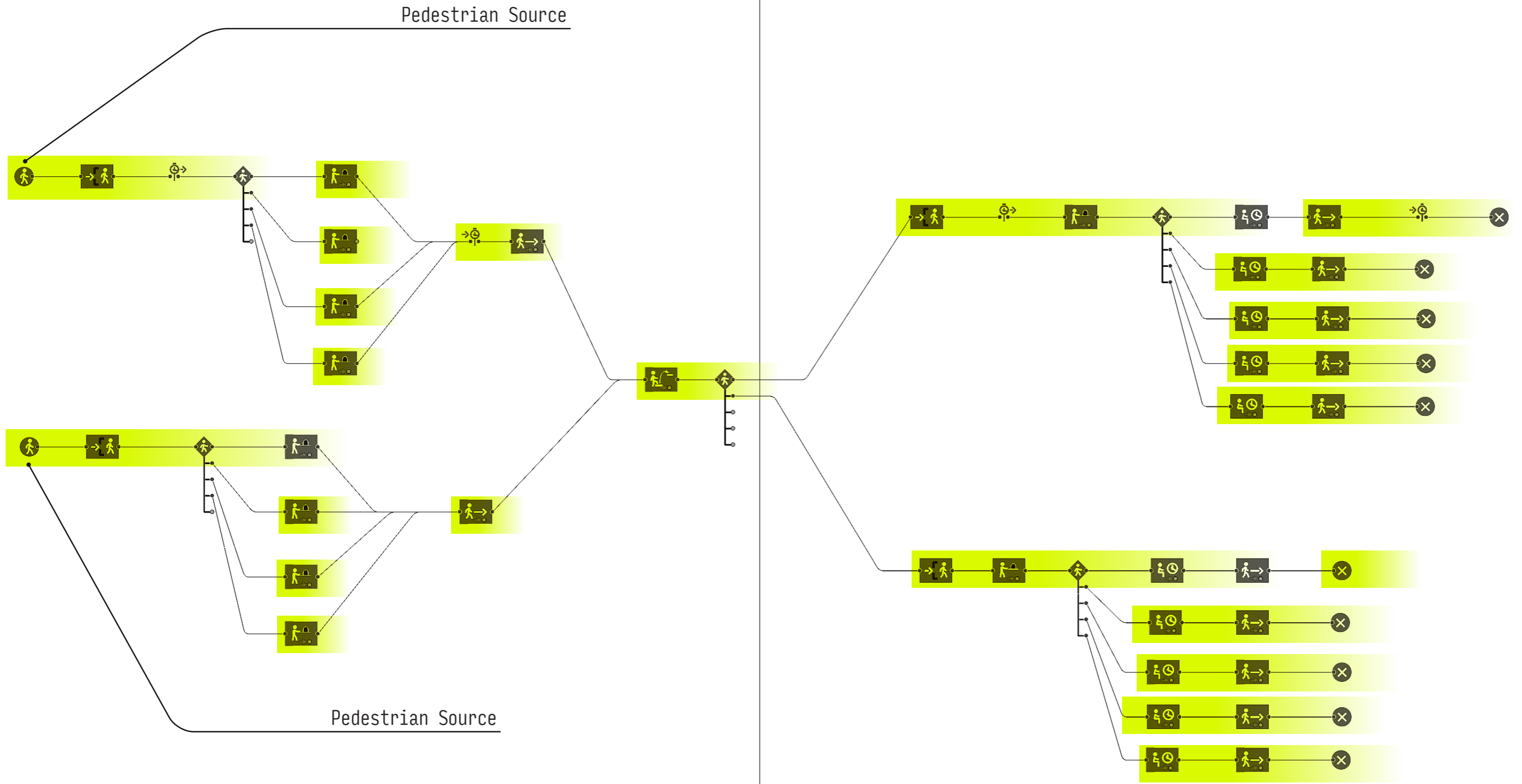


Figure 03 - AnyLogic Algorithm\_Pedestrian Sources

# Algorithm

# AnyLogic

# AnyLogic

# Algorithm

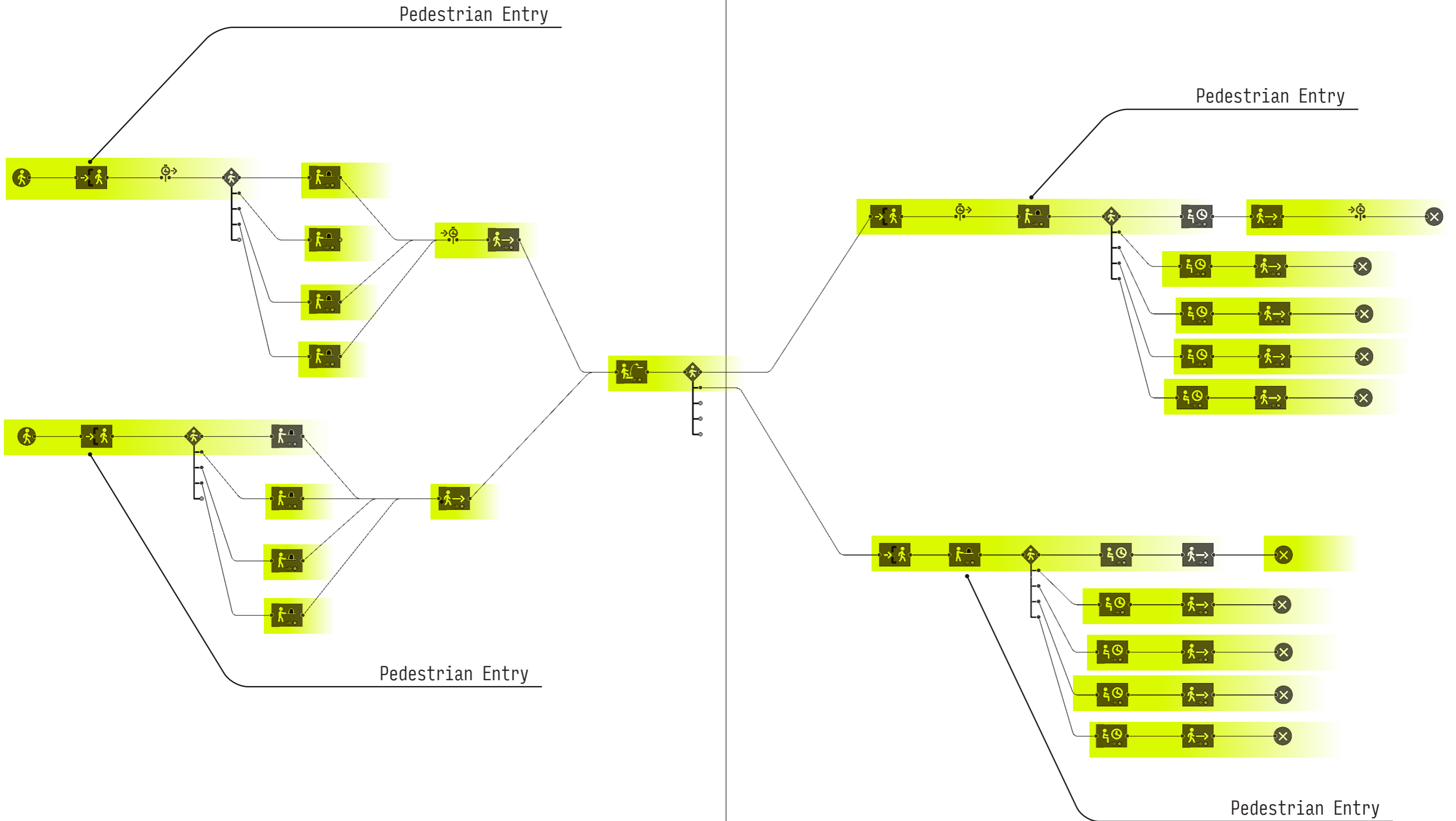


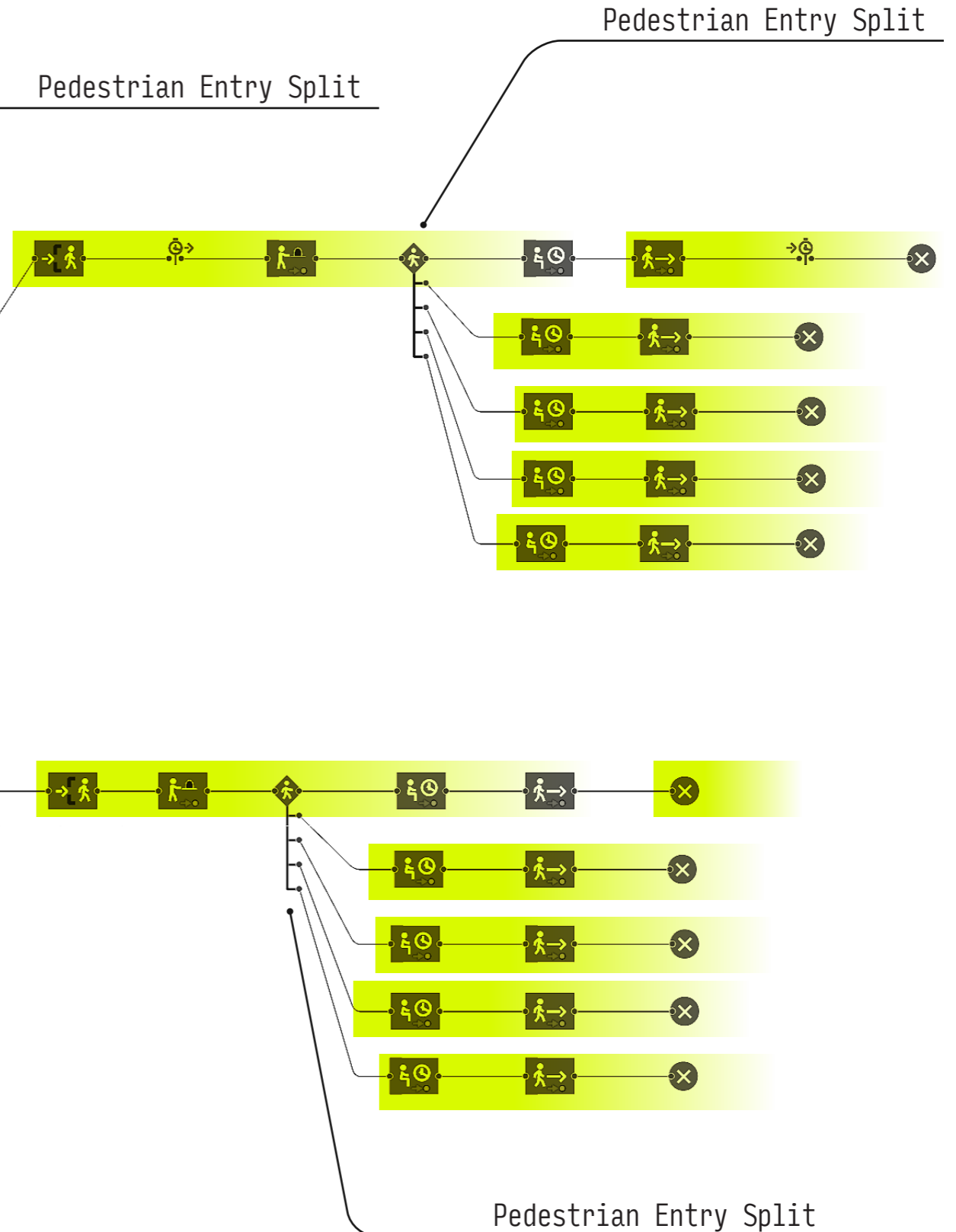
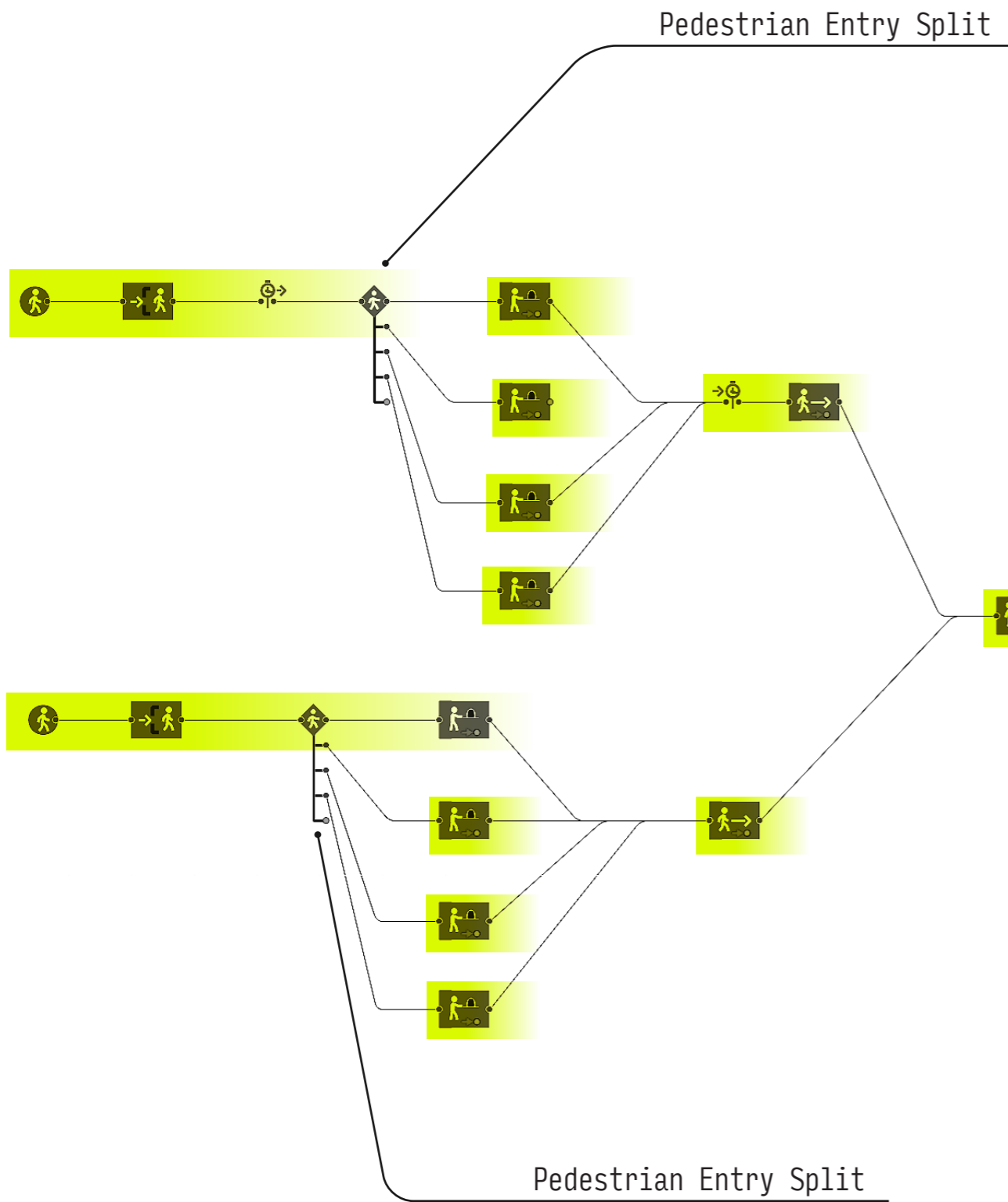
Figure 04 - AnyLogic Algorithm\_Pedestrian Entry

# Algorithm

# AnyLogic

# AnyLogic

# Algorithm



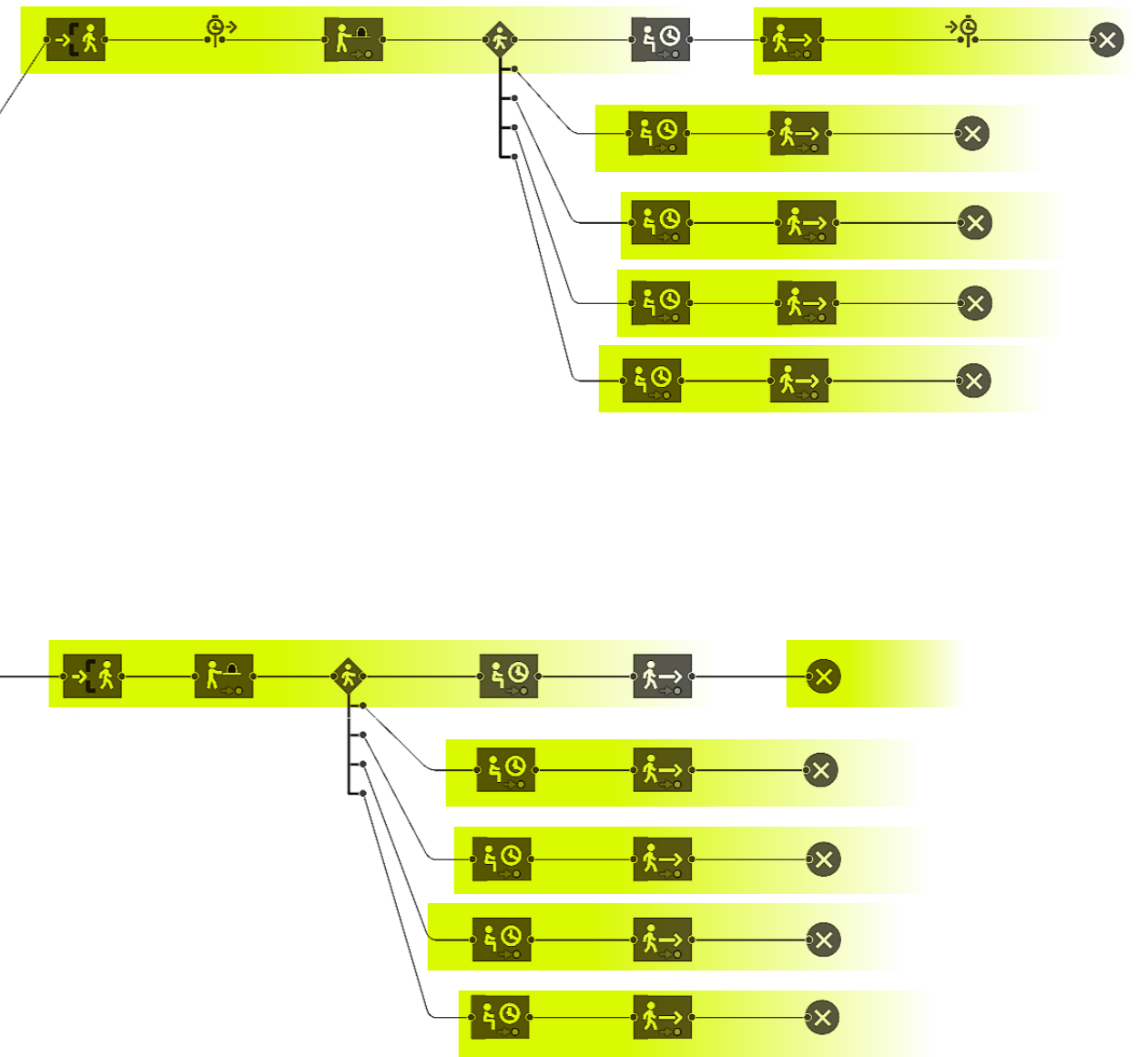
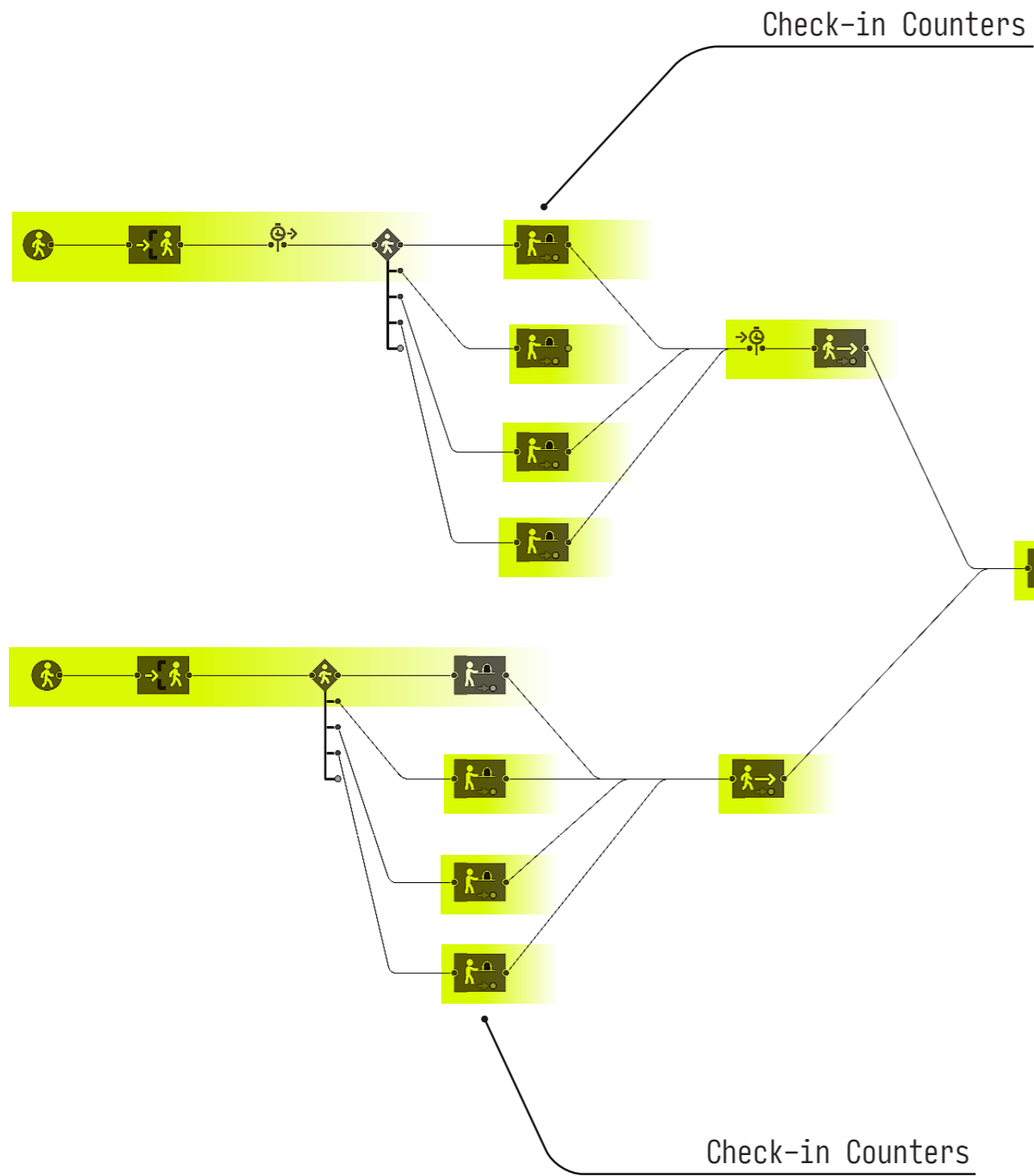
# Algorithm

# AnyLogic

Figure 05 - AnyLogic Algorithm\_Pedestrian Entry Split

# AnyLogic

# Algorithm



# Algorithm

# AnyLogic

Figure 06 - AnyLogic Algorithm\_Check-in Counters

# AnyLogic

# Algorithm

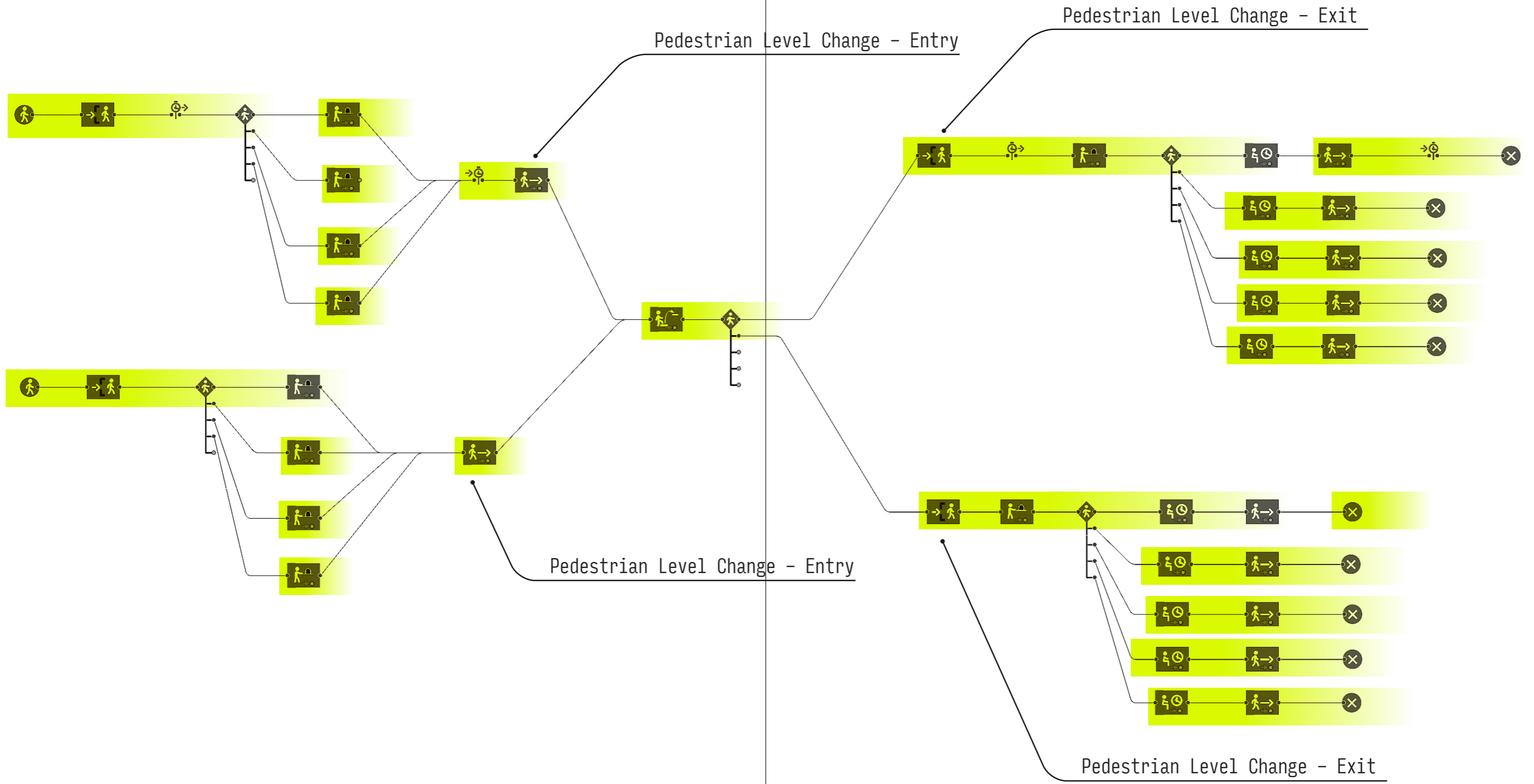


Figure 07 - AnyLogic Algorithm\_Pedestrian Level Change

# Algorithm

# AnyLogic

# AnyLogic

# Algorithm

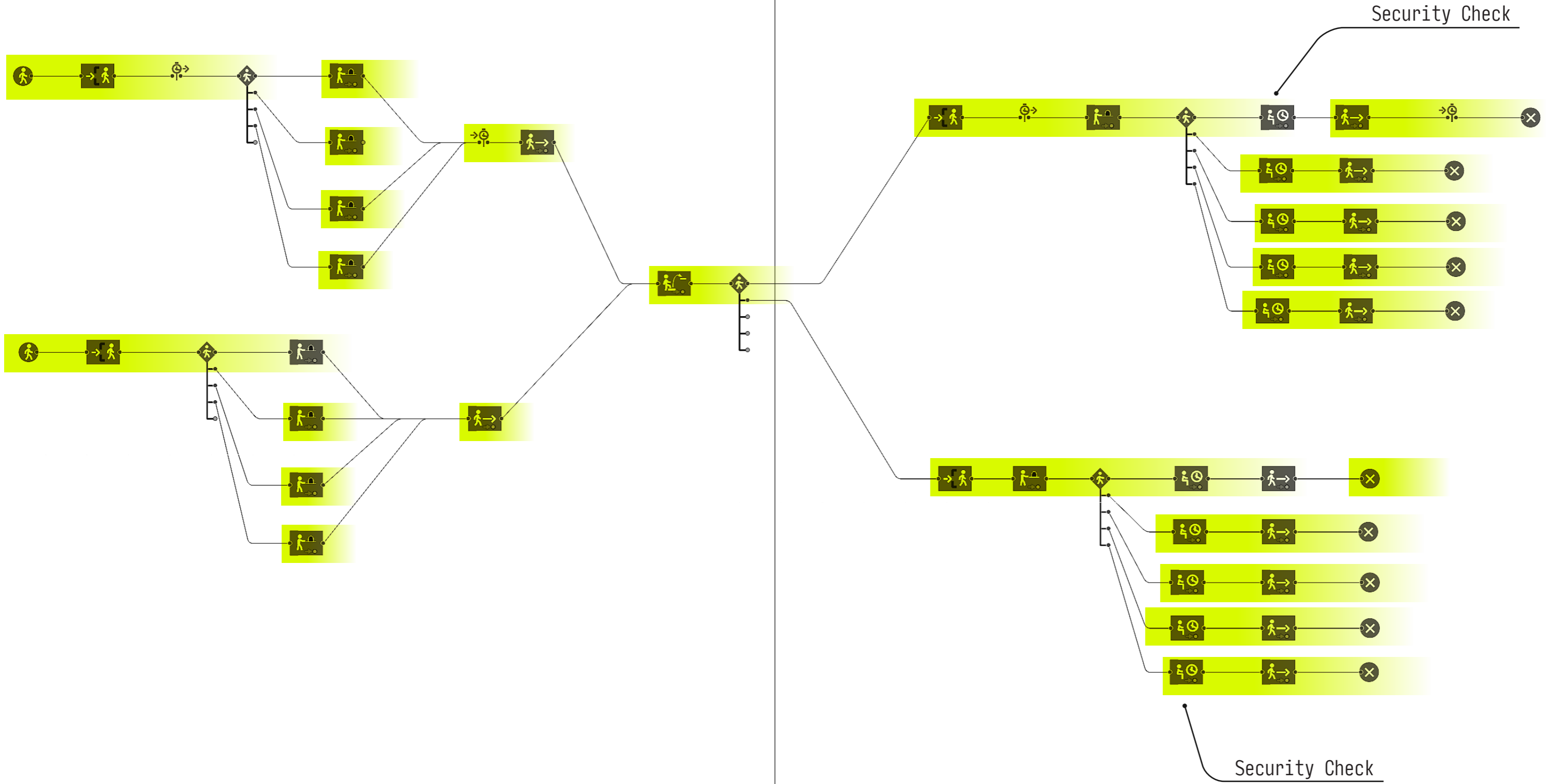


Figure 08 - AnyLogic Algorithm\_Security Check

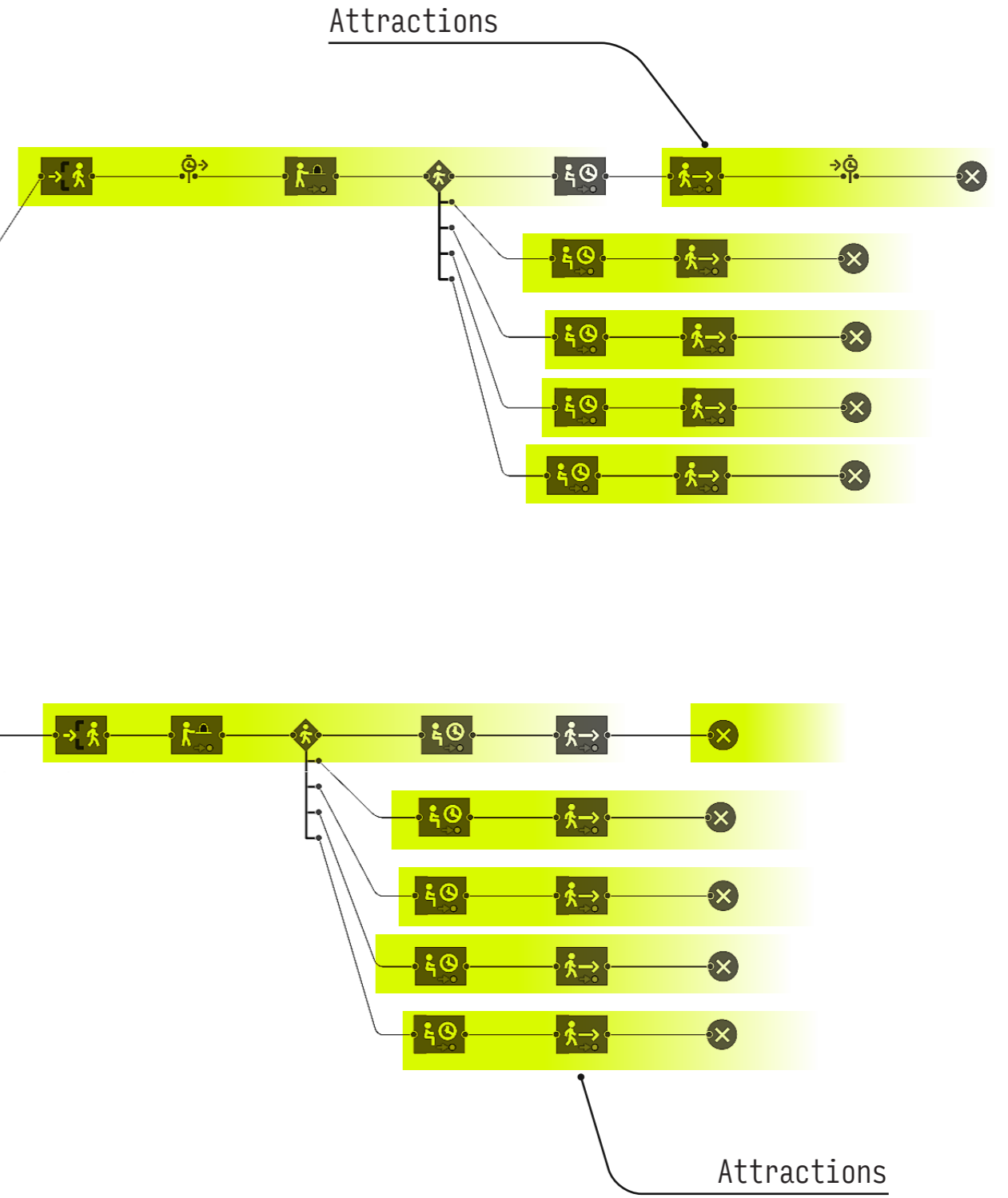
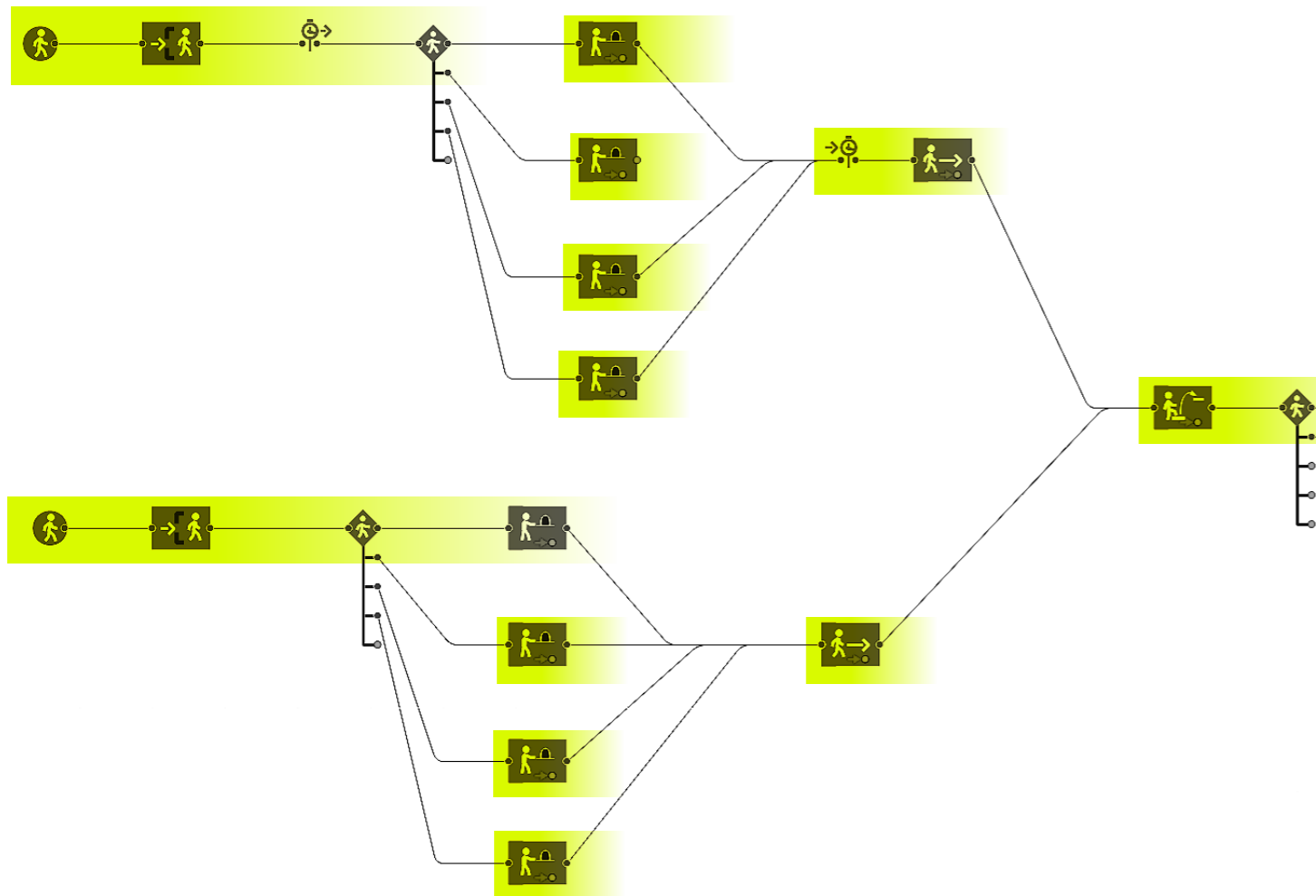
# Algorithm

# AnyLogic



# AnyLogic

# Algorithm



# Algorithm

# AnyLogic

Figure 09 - AnyLogic Algorithm\_Attractions

# AnyLogic

# Algorithm

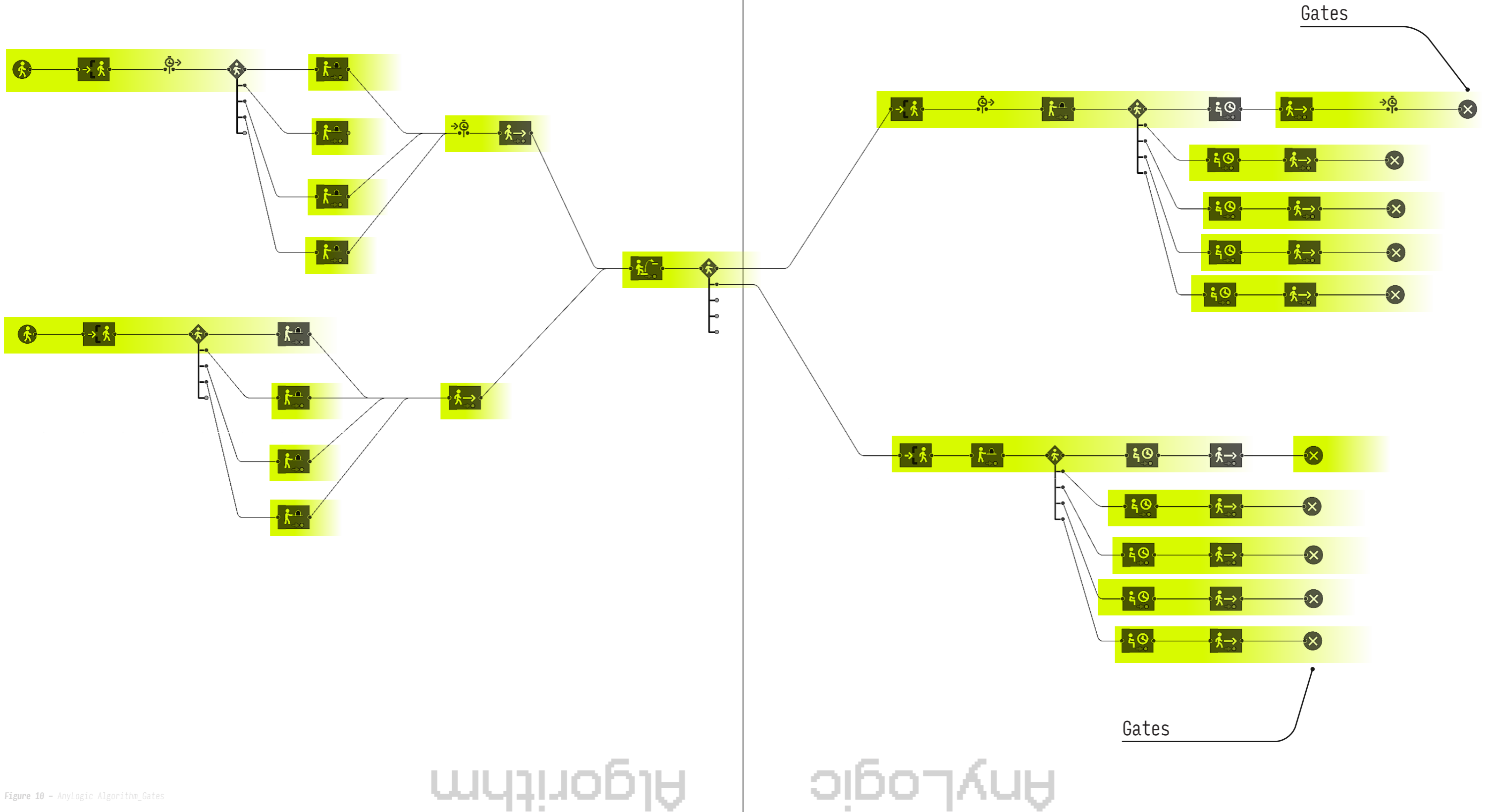
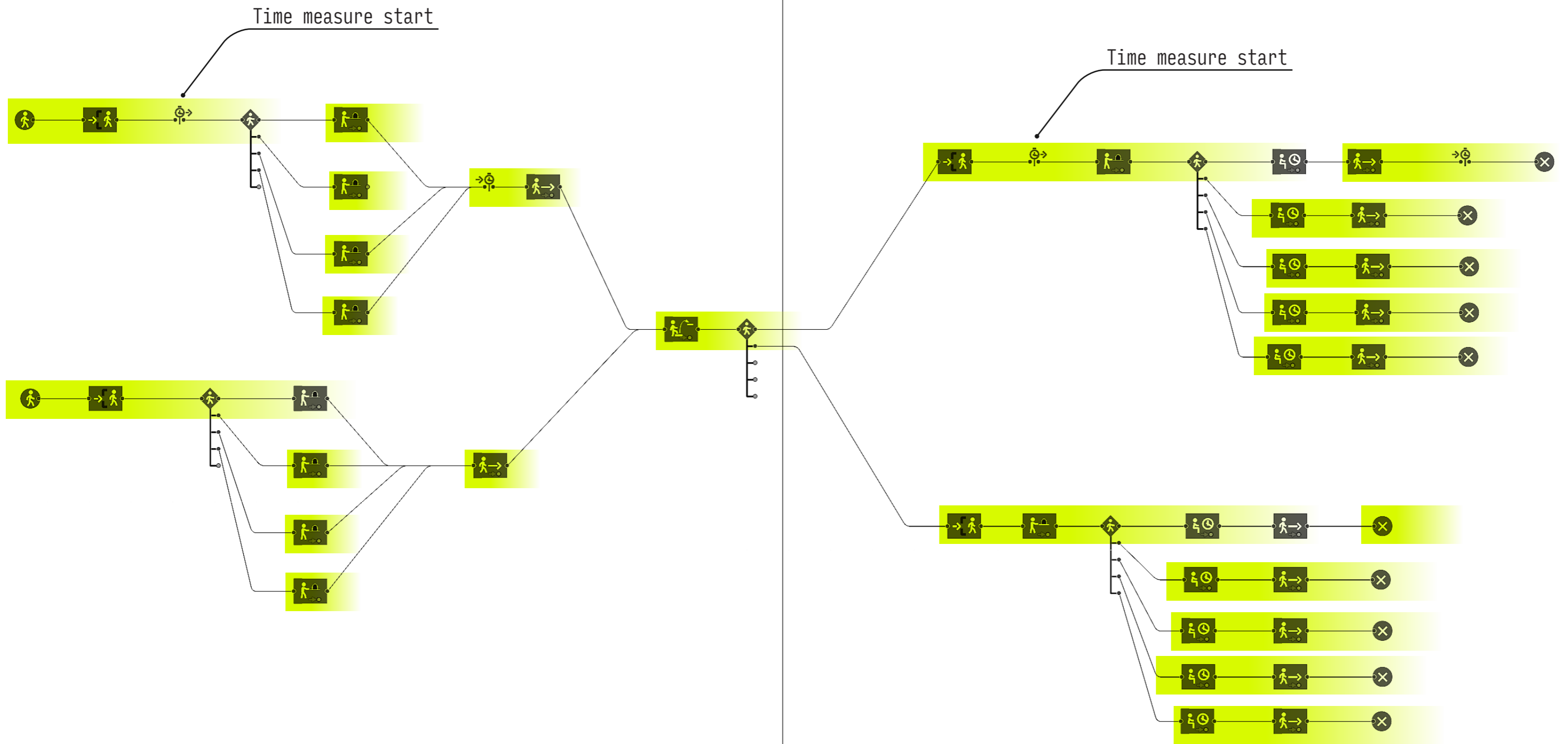


Figure 10 - AnyLogic Algorithm\_Gates

# AnyLogic

# Algorithm



# Algorithm

# AnyLogic

Figure 11 - AnyLogic Algorithm\_Time Measure Start

# AnyLogic

# Algorithm

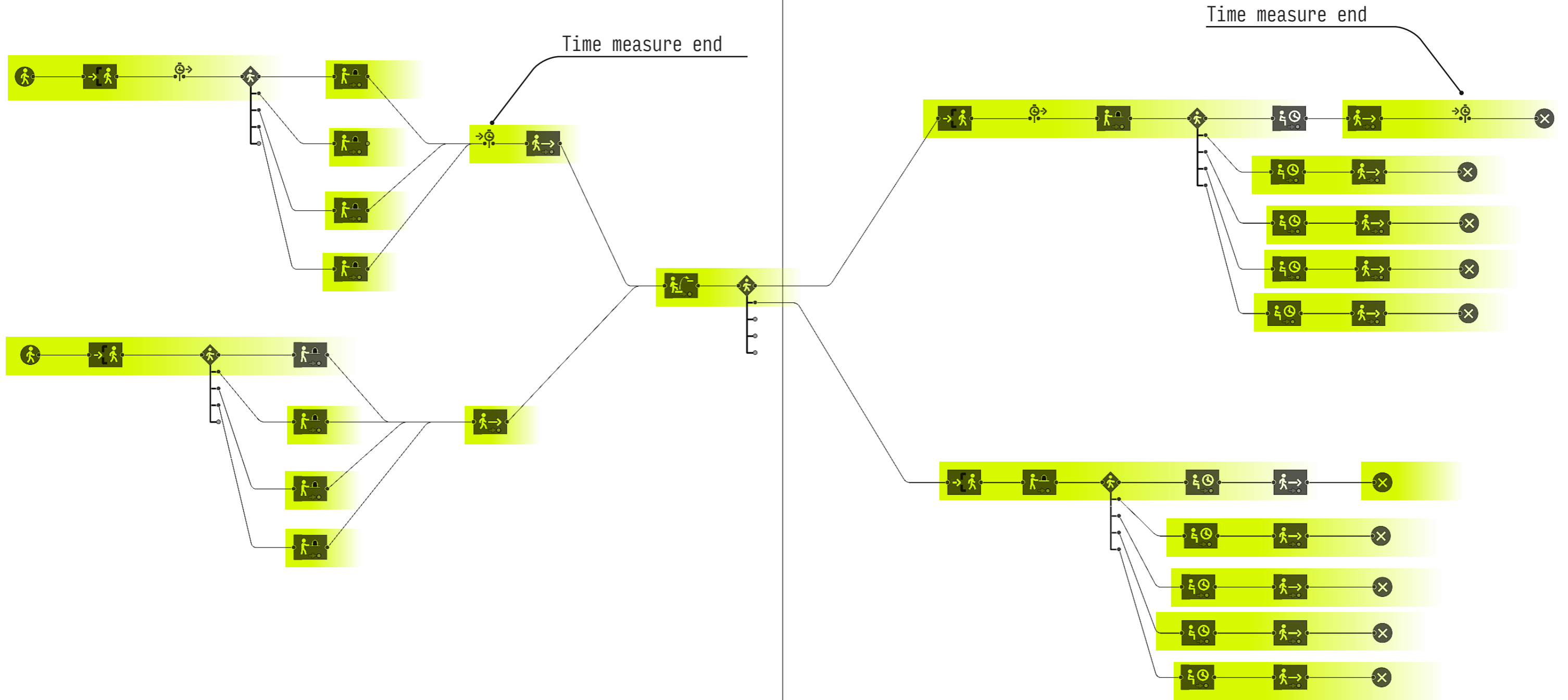


Figure 12 - AnyLogic Algorithm\_Time Measure End

# Algorithm

# AnyLogic

# Simulation

The Narita Airport Model was simulated for two period of time in order to capture the system with different level of details.

**6 Hours**

**12 Hours**

This way, one can differentiate the performance of one system more easily. The shorter time period can show the fast-moving or sudden changes within the system. In contrast, the longer time period can show the overall picture of the system.

One minute will be simulated in the airport model for every real-time second.



# 6 Hours

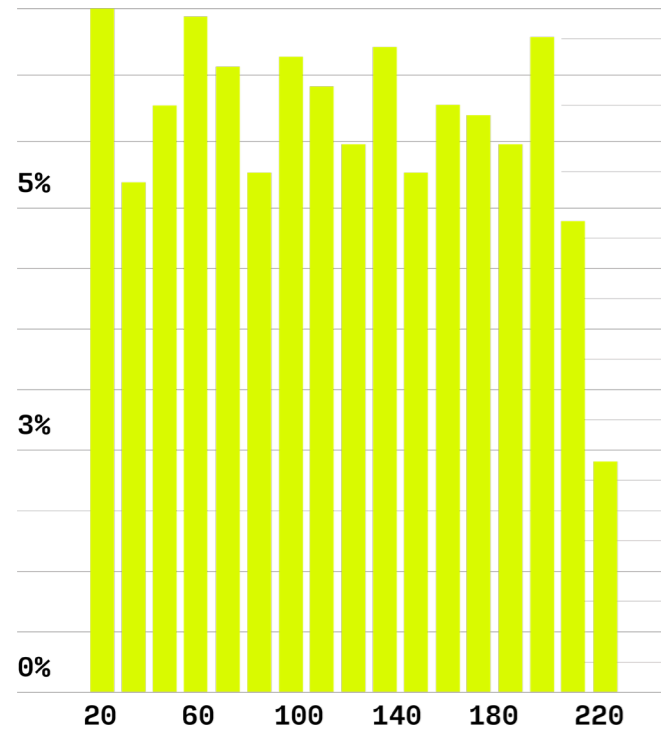


Figure 13 - East wing Check-in 4th floor Histogram

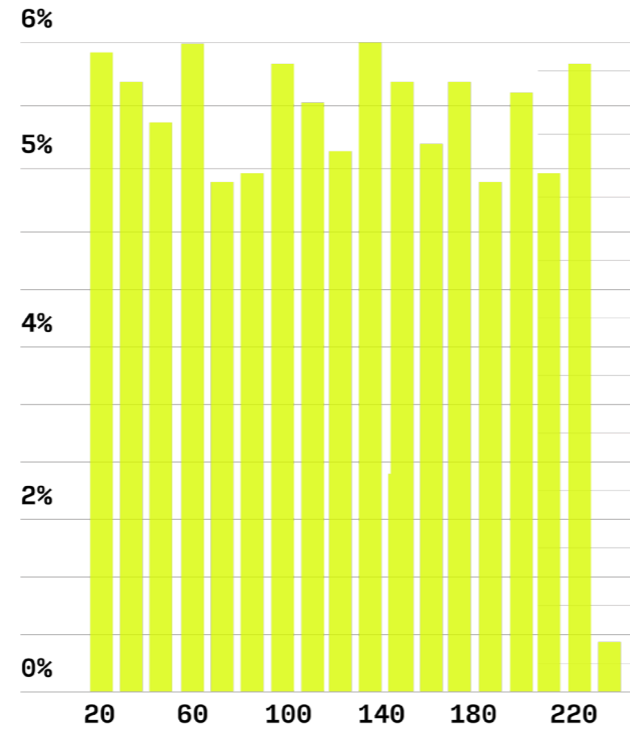


Figure 14 - West wing Check-in 4th floor Histogram

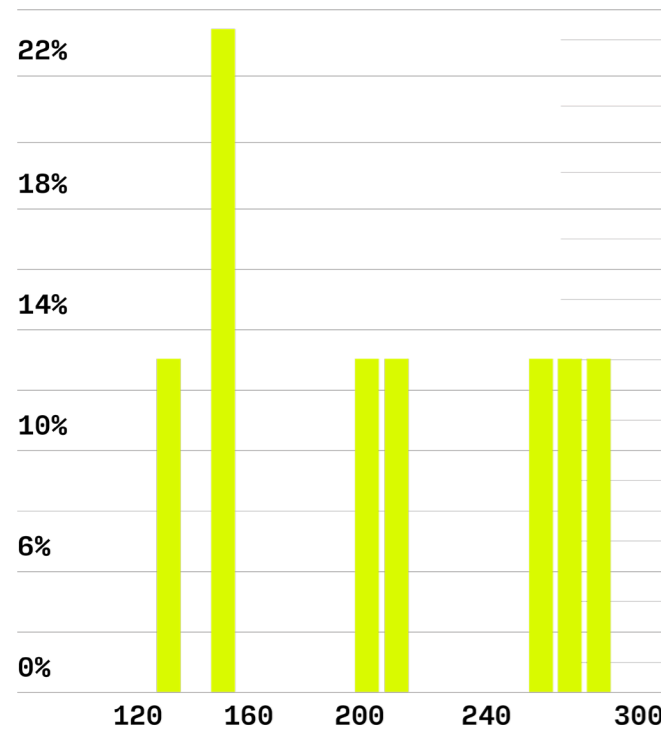


Figure 16 - East wing Check-in 3rd floor Histogram

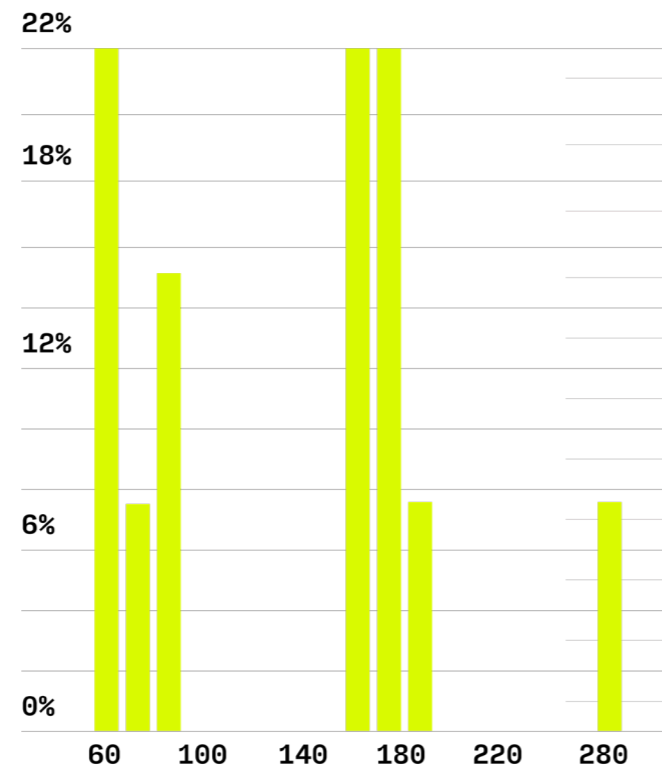


Figure 17 - West wing Check-in 3rd floor Histogram

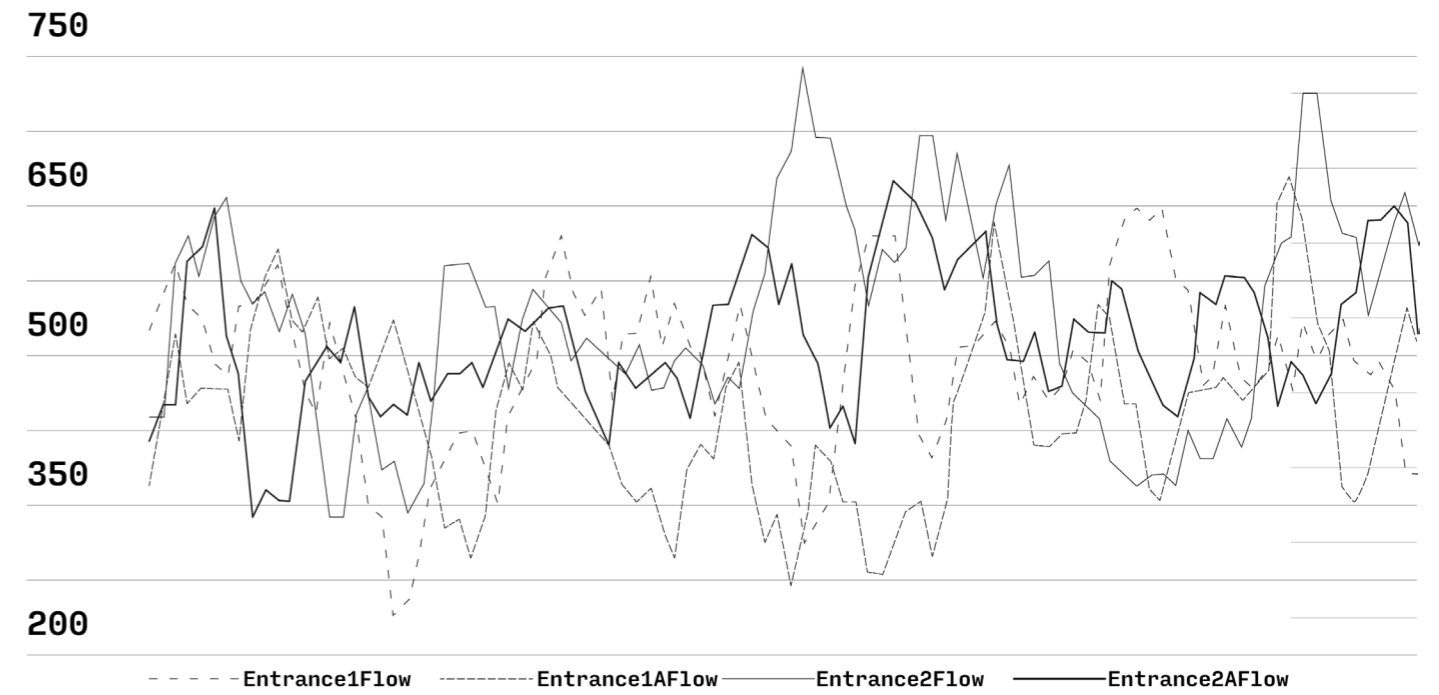


Figure 15 - 4th floor Pedestrian Flow Plot Chart

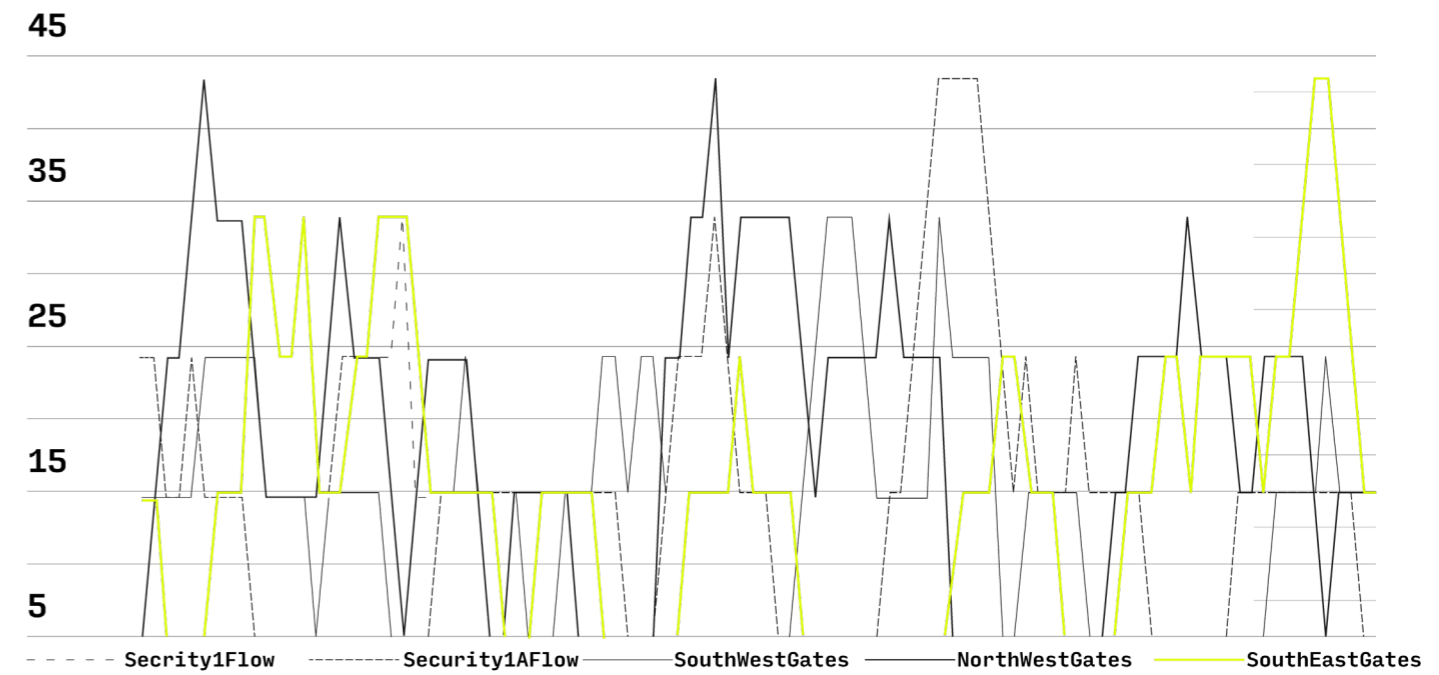


Figure 18 - 3rd floor Pedestrian Flow Plot Chart

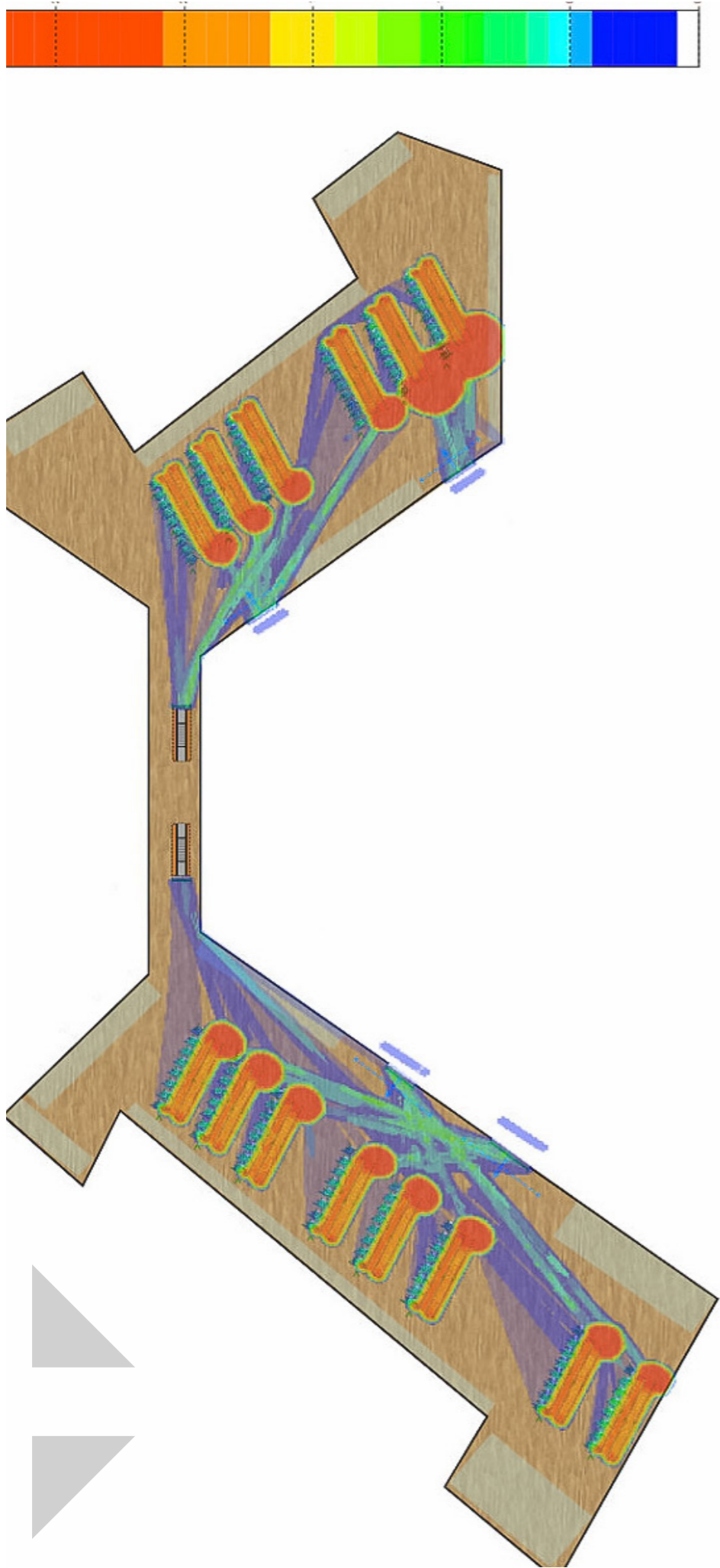
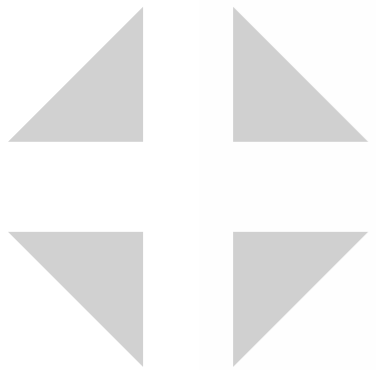


Figure 19 - 4th Floor Pedestrian Density Heatmap

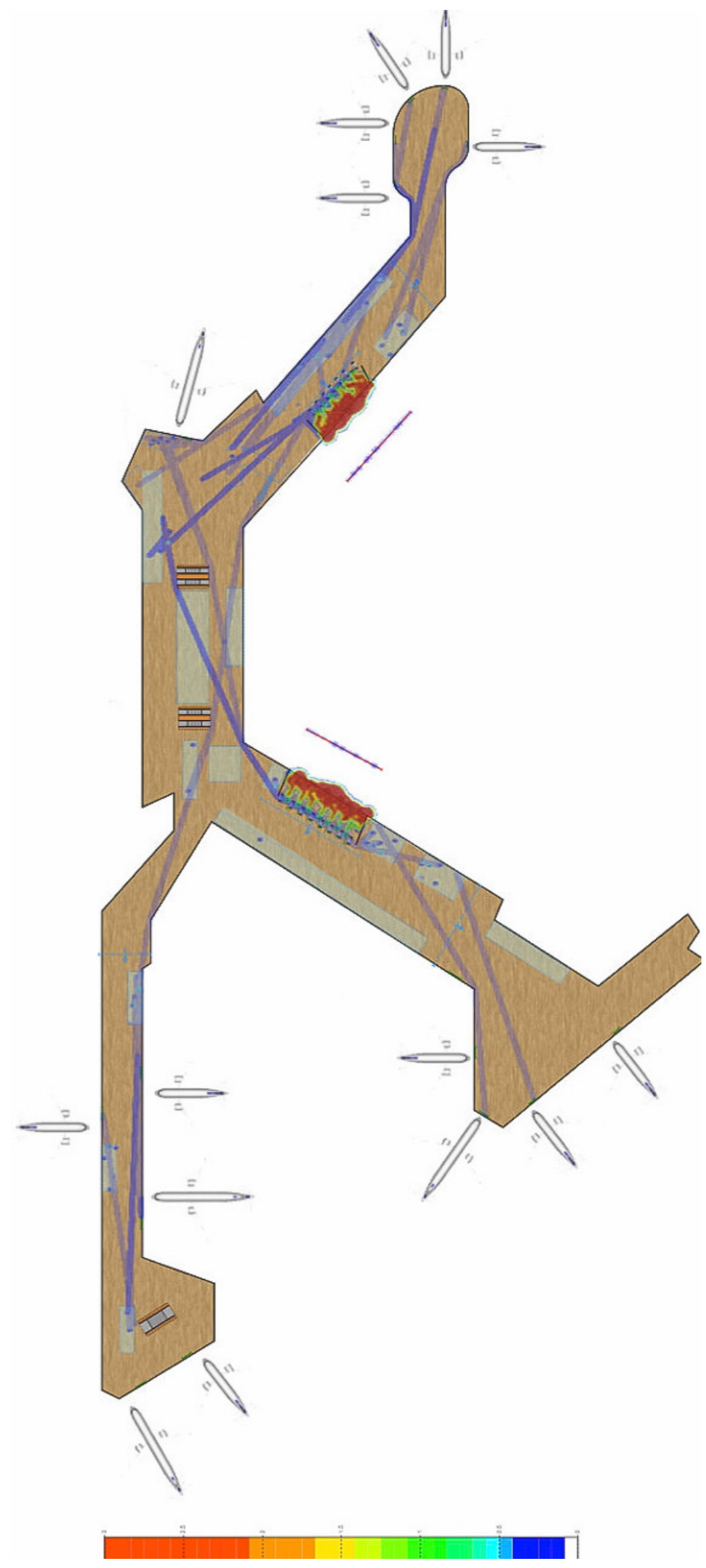


Figure 20 - 3rd Floor Pedestrian Density Heatmap

# 12 Hours

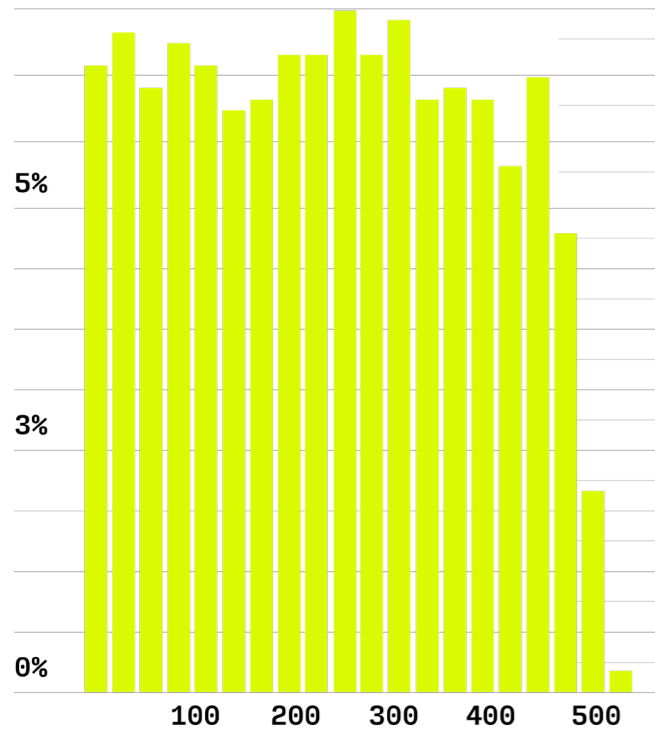


Figure 21 - East wing Check-in 4th floor Histogram

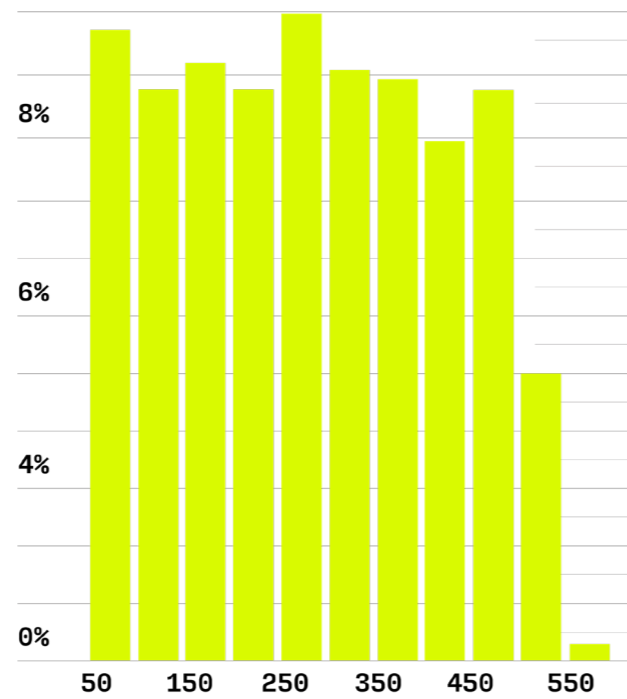


Figure 22 - West wing Check-in 4th floor Histogram

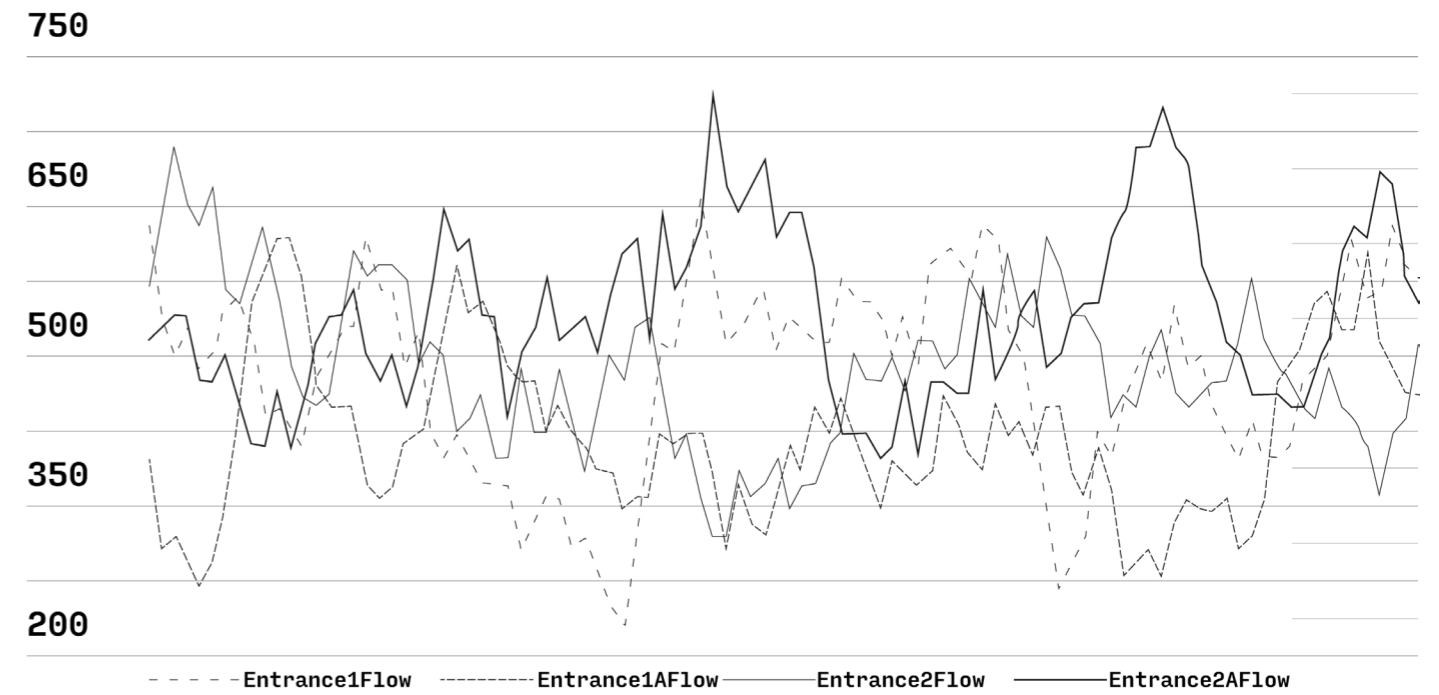


Figure 23 - 4th floor Pedestrian Flow Plot Chart

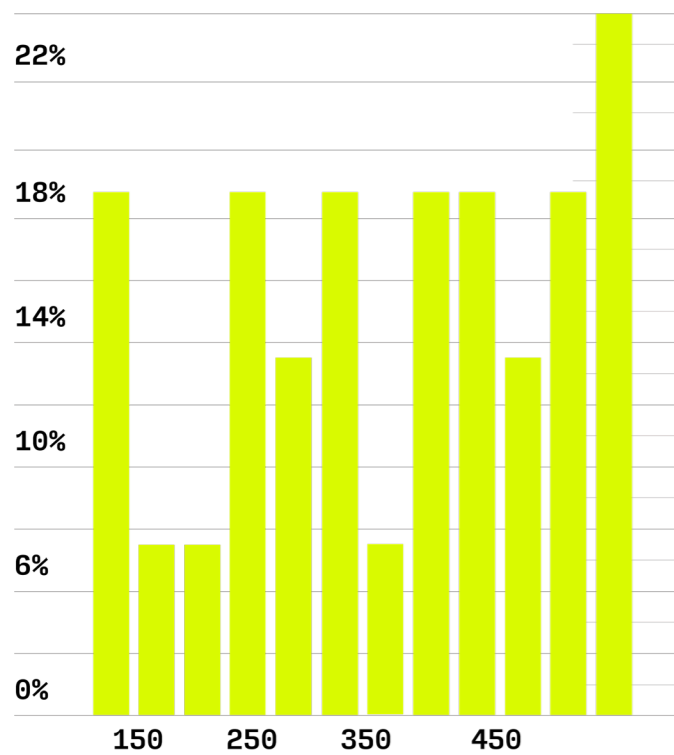


Figure 24 - East wing Check-in 3rd floor Histogram

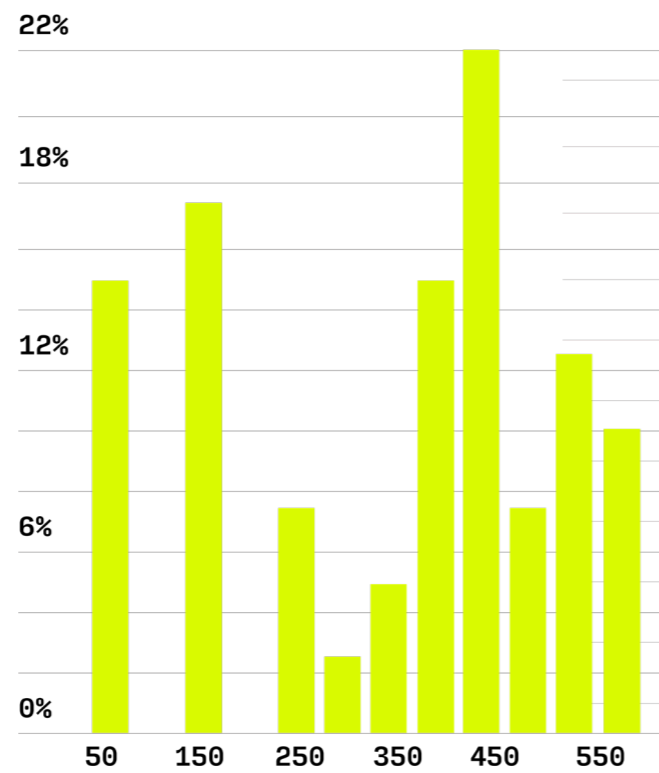


Figure 25 - West wing Check-in 3rd floor Histogram

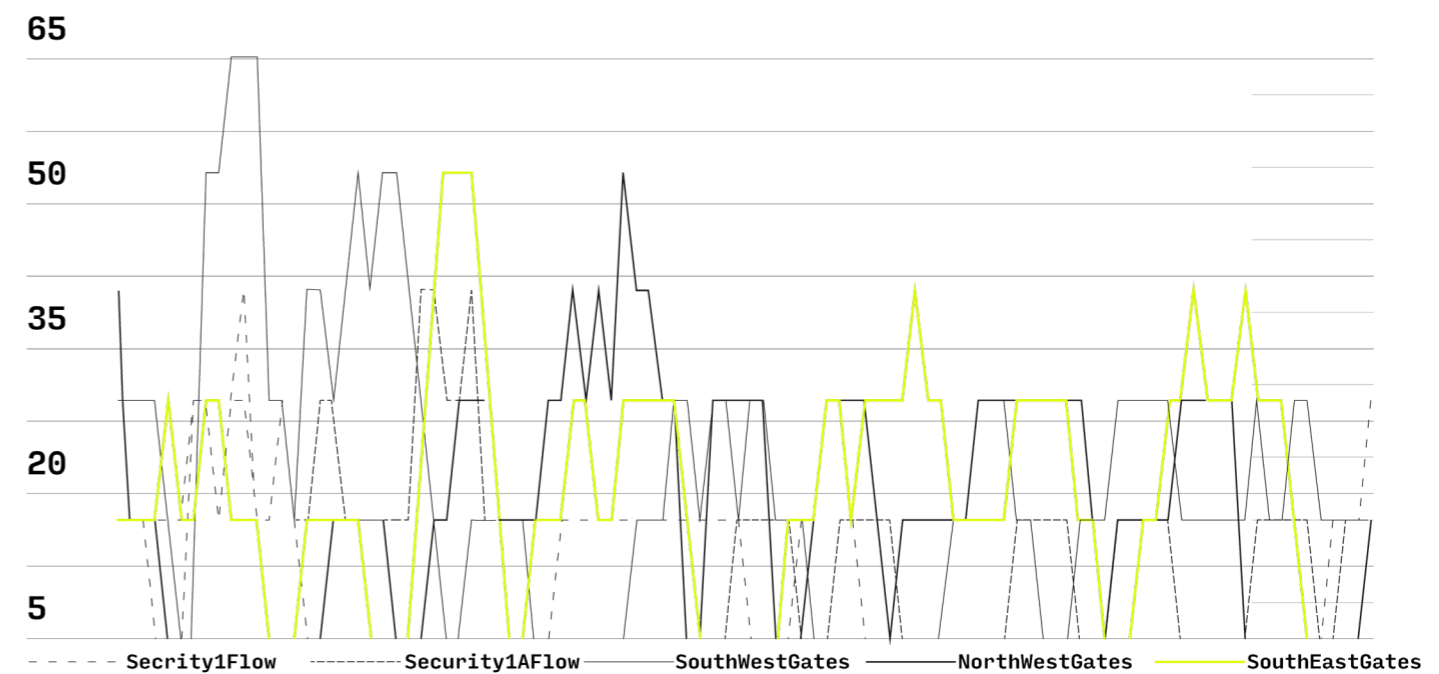


Figure 26 - 3rd floor Pedestrian Flow Histogram



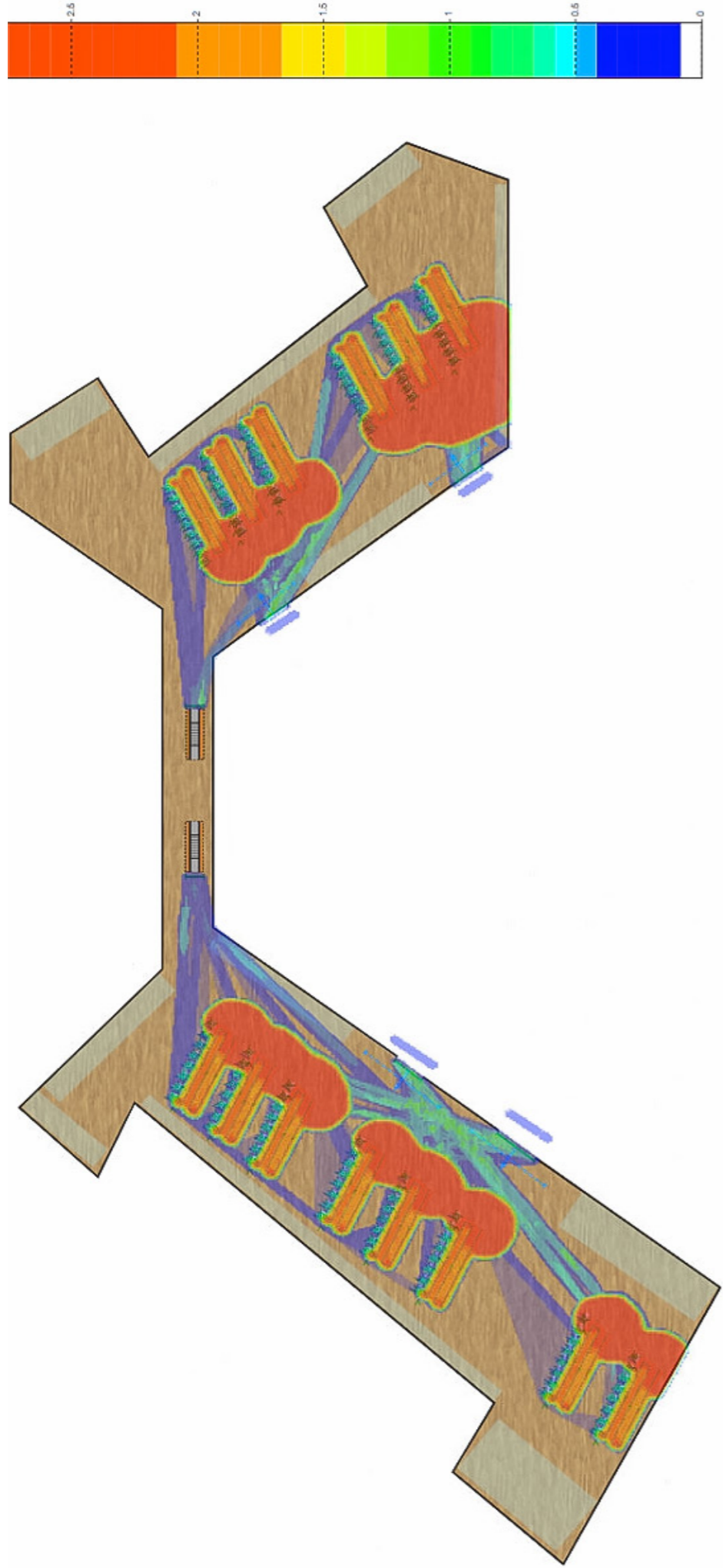


Figure 27 - 4th Floor Pedestrian Density Heatmap

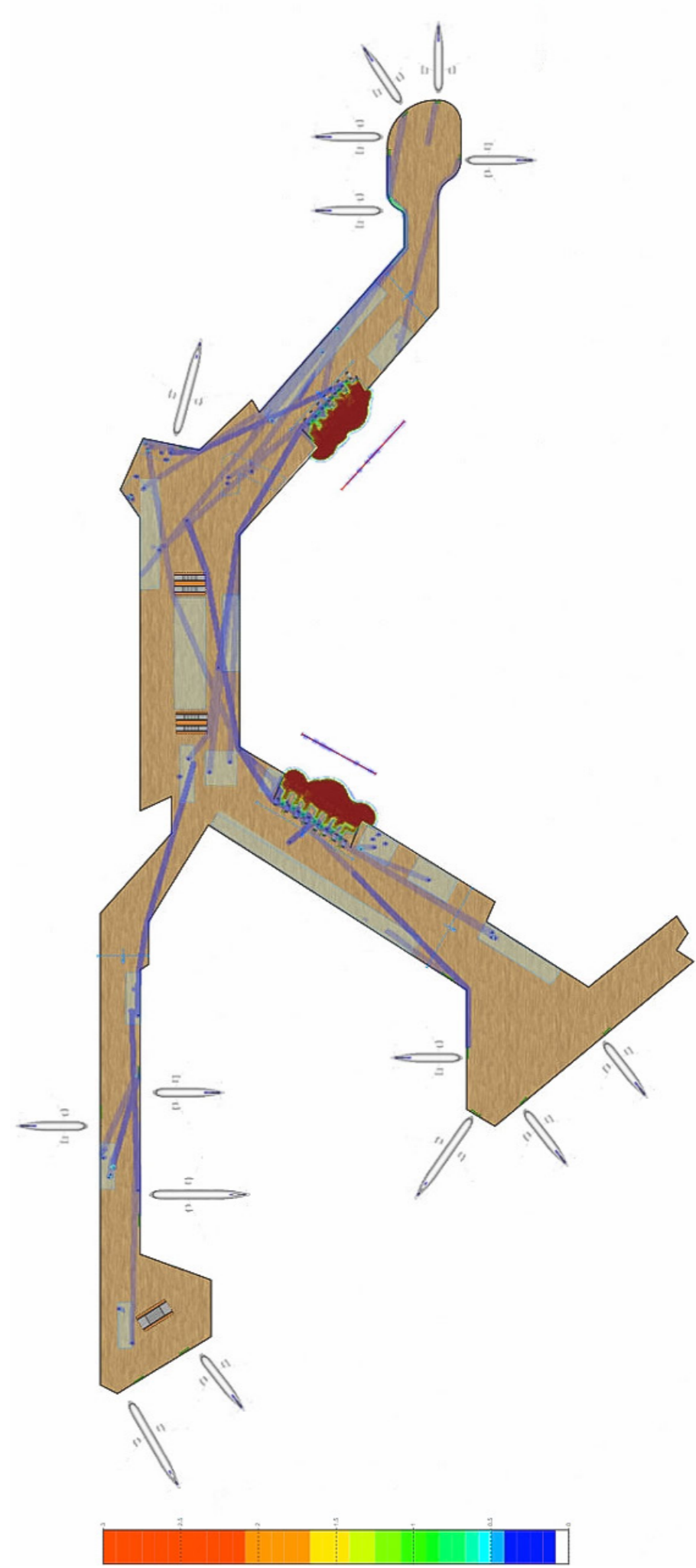
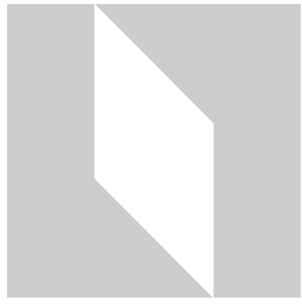


Figure 28 - 3rd Floor Pedestrian Density Heatmap



# Analysis

/\* Looking at Narita Airport's schematic layout, it is clear that Narita Airport wants to separate its function into different levels.

The advantage is that it creates much space for that specific program to function well and not interfere with each other.

However, this could be confusing from a typical passenger's perspective. The distance from one checkpoint to another seems far and hard to reach.

/\* The result from the simulation re-ensured the problem that it has. Passenger, when they enter entrances, crosses each other paths. When the density is not high, it does not cause many problems. However, when passenger density is high, people start to bump into each other and cause inconvenience.



---

/\* The other problem that can be seen is the passenger density at the check-in counter on the 4th floor and the security screening on the 3rd floor. At the time of the research, Narita airport does not imply a wide use of automation machines for this procedure. As a result, the manual labour involved in these processes is still quite high. One needs to interact and exchange when checking in and getting tickets at the counters through the long serpentine line.

/\* The security screening process is constricted in a relatively small area compared to the airport's size. This confined space makes the security screening process difficult and lengthy. As reflected on the passenger density heatmap (Figures 19-20, 27-28) and the plateau on the flow statistic plot chart (Figures 18, 26), the queue for this process is lengthy and not smooth.

---

# SUMMARY



/\* In summary, Narita International Airport proved why it is one of the top airports in the world. The number of annual passengers it serves makes it very efficient and laid out. Nevertheless, with that being said, it still has some kinks within the system.

It needs more transparency for airline passengers travelling. The fact that passengers must travel from floor to floor to get to another checkpoint causes confusion and anxiety in travelling.

Areas such as check-in counters and security screening are common choke points for that floor. With human labour still in charge of most of the process, it takes much space to do it well.

Automation can be used to optimize this process and bring more efficiency into the process chain. Security screenings are the biggest problem, according to this simulation data. In addition, the queue and process time are lengthy, slowing the experience for a typical passenger. These areas need to increase in size and open up to keep up with the demands. However, an increase in size would not solve the problem when it happens again down the road.

Again, automation can help out this process and make this more efficient. A change in the operating system can also improve this, such as screening via cameras and pre-check-in for domestic passengers.



Implementation



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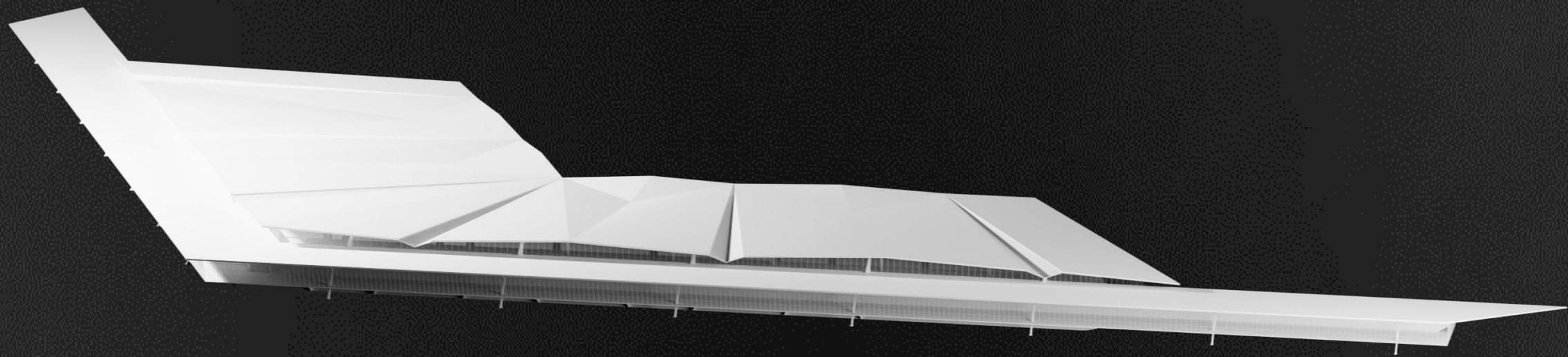
These simulation data are not guaranteed 100% accuracy, but it informs what is working and what is not.

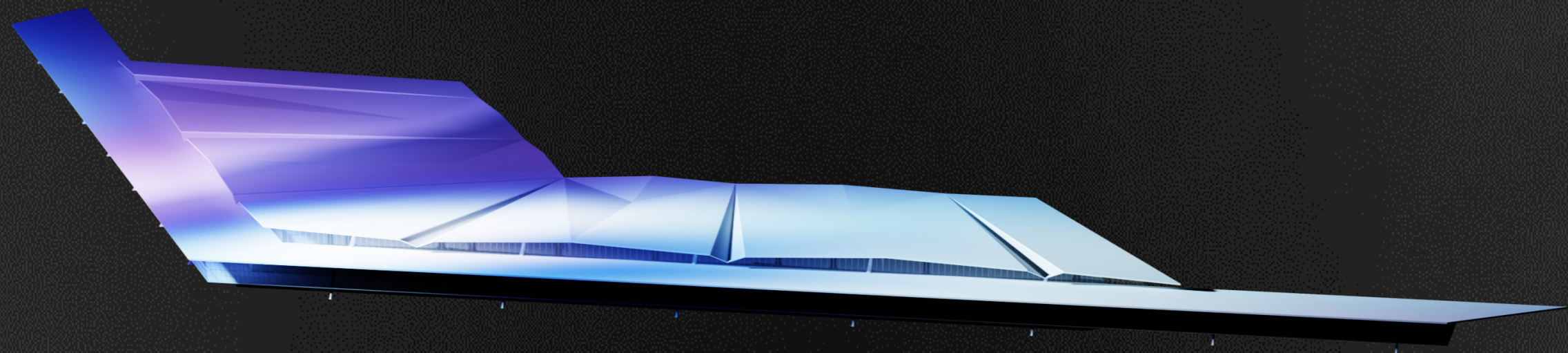
These are the important key ideas when looking at this research.

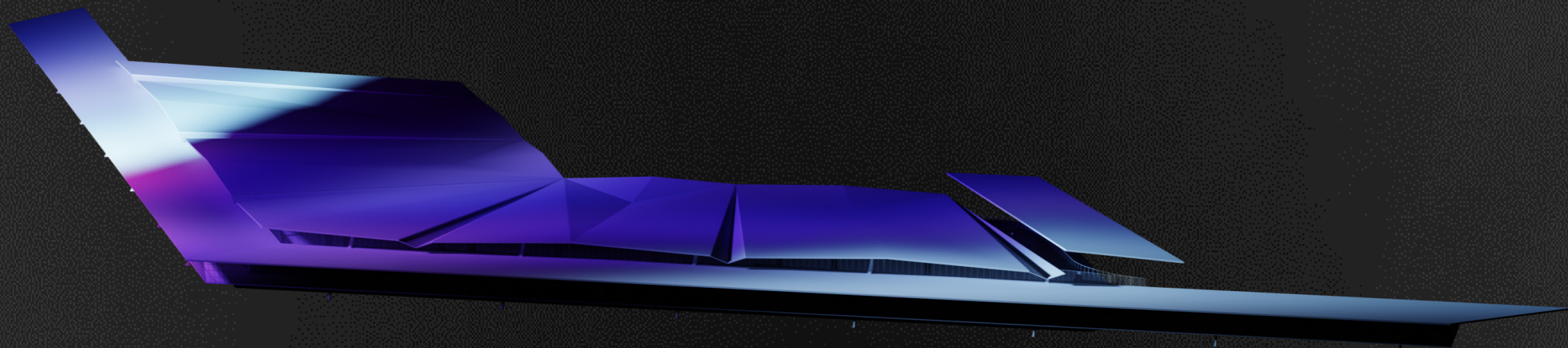
Heading into the thesis design project, armed with this knowledge and data, would not only help inform better design choices. For example, floor plans can be quickly formed and re-created within the software. In addition, the system performance can be simulated and tweaked on the spot.

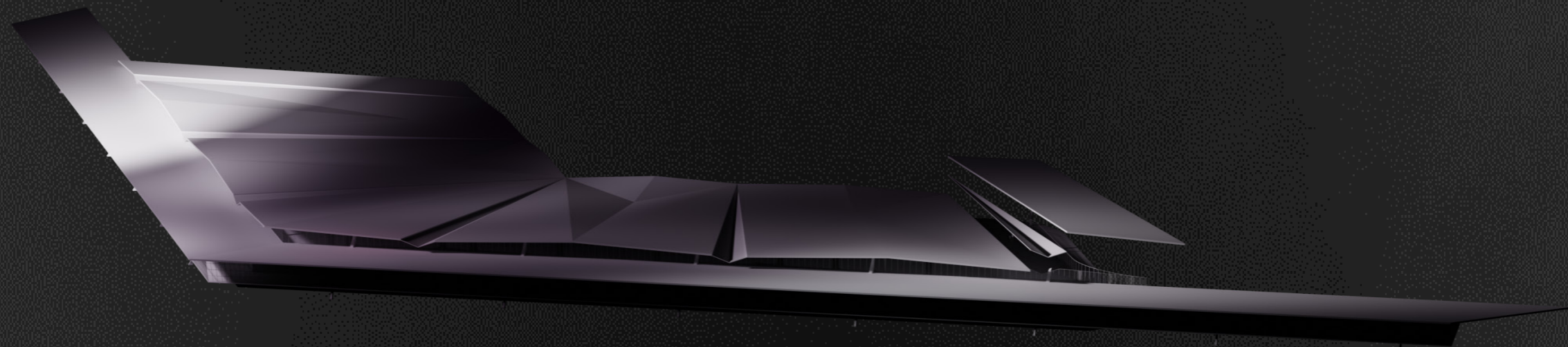
The more understanding one can get from the data, better design choices can be made down the road.

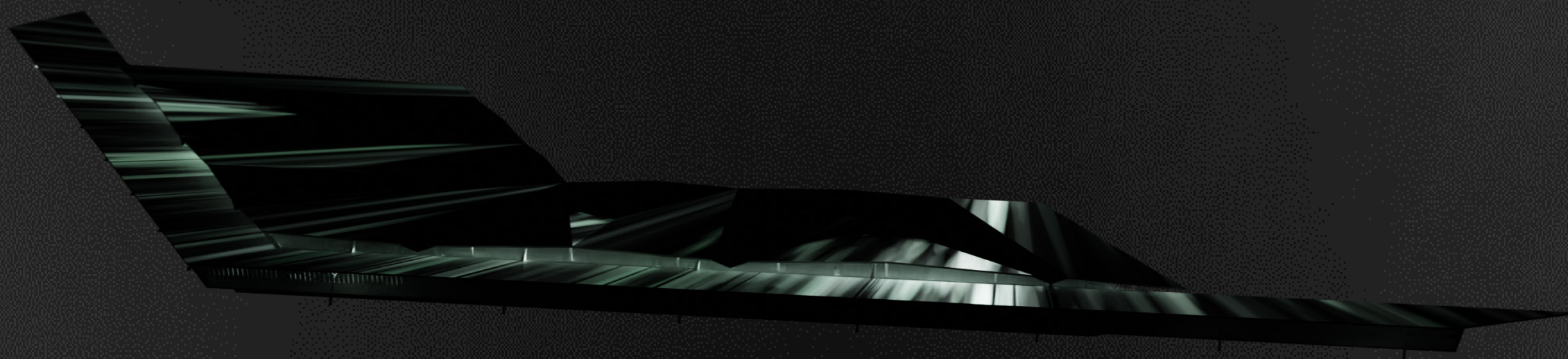


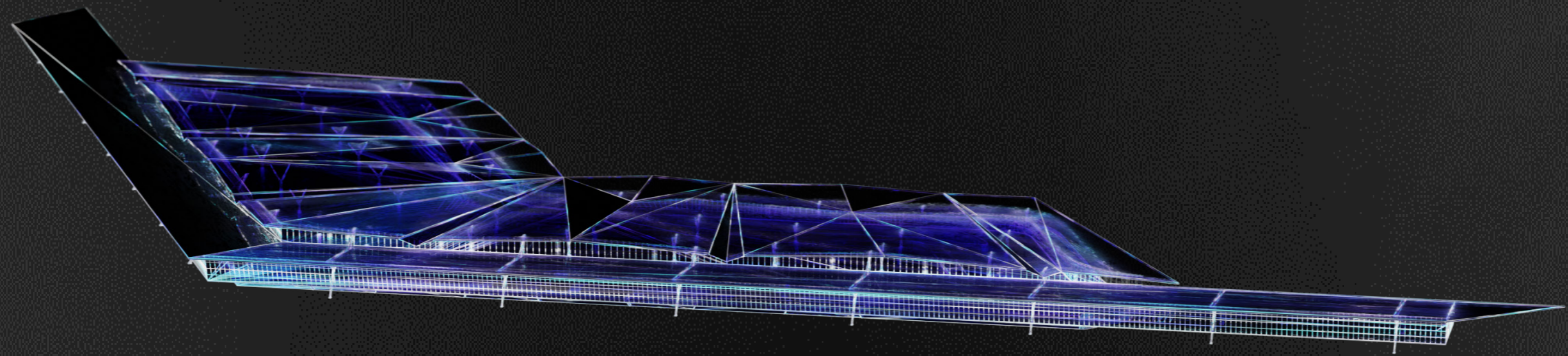












**Where?**




A satellite view of the Earth from space, showing the Eastern Hemisphere. The Indian Ocean is on the left, and the Asian continent is on the right. A yellow rectangular box highlights the location of Vietnam in Southeast Asia. The text 'HO CHI MINH' and 'Viet Nam' is overlaid on the left side of the image.

**HO CHI MINH**

**Viet Nam**





Ho Chi Minh City located in the South region and is the largest city in Viet Nam. It has the population of 9 million. It is a major economic center of country. It hosted many large tech, financial, and even architecture firm from all around the world.

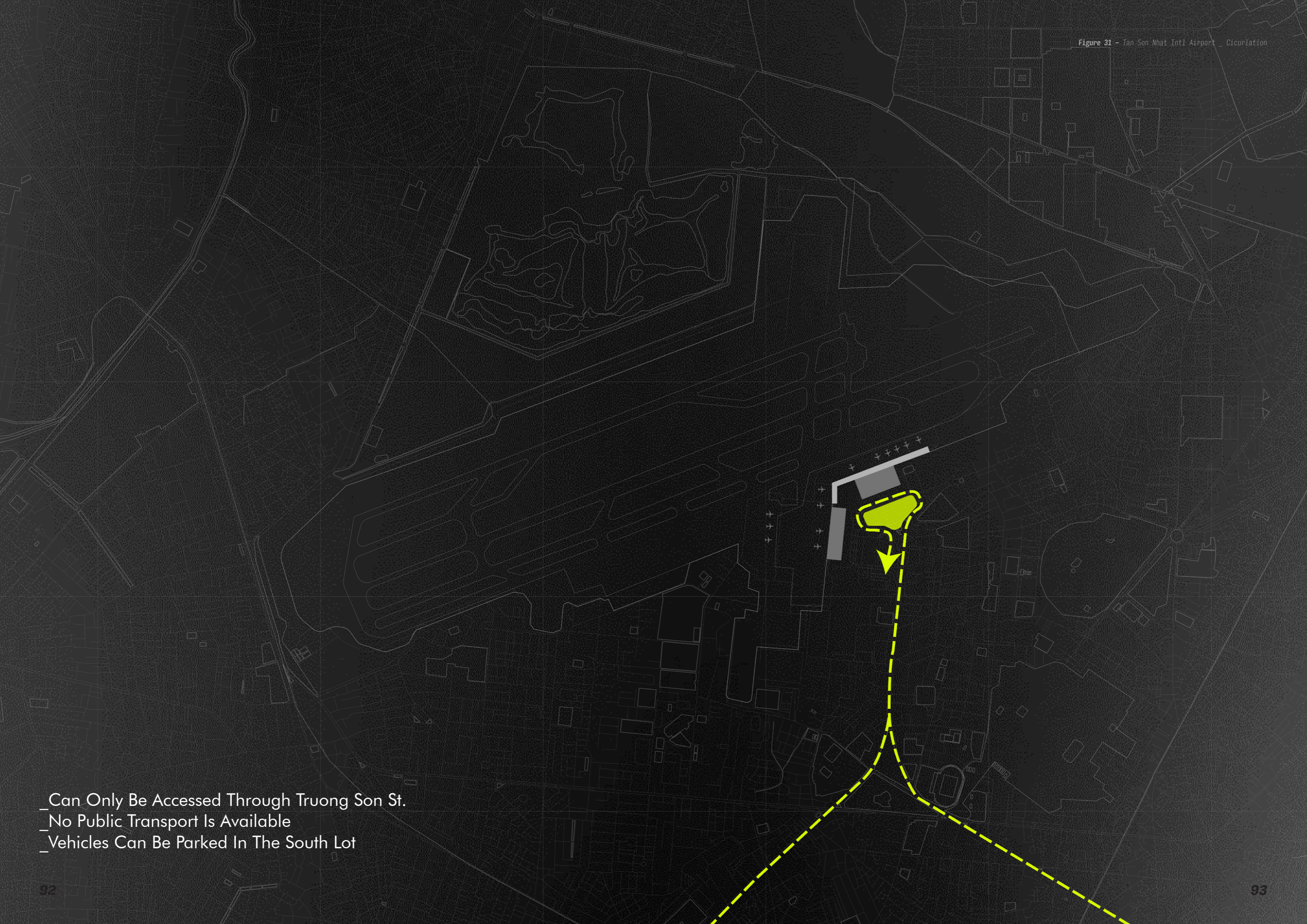
The city architecture is still very much influenced by the French colonial and you still see lots of well-preserved buildings dated back to the 1900s. And in the center of it is the Tan Son Nhat Intl Airport.



Tan Son Nhat Airport was originally built in 1930s by the French. The Domestic Terminal was the original building and later expanded. The airport was used exclusively by the military, and later opened to the public 1975. Currently serving approximately 15 million passengers a year.



The International Terminal opened in 2007. Currently serving approximately 10 million passengers a year.



- \_ Can Only Be Accessed Through Truong Son St.
- \_ No Public Transport Is Available
- \_ Vehicles Can Be Parked In The South Lot



Motorcycles have to be parked in the South West lot opposite of the Domestic Terminal



Both Terminal are deemed too small for its capacity. New T3 are in discussion to ease the relief on both terminal. But again, still in discussion



Site has great solar potential from previous research. However, Wind analysis showing the runway is sitting crosswind and not position for the best efficiency



Administration Facilities are currently placed in between two Terminals





While Utility Facilities are currently placed at the East of the Site.

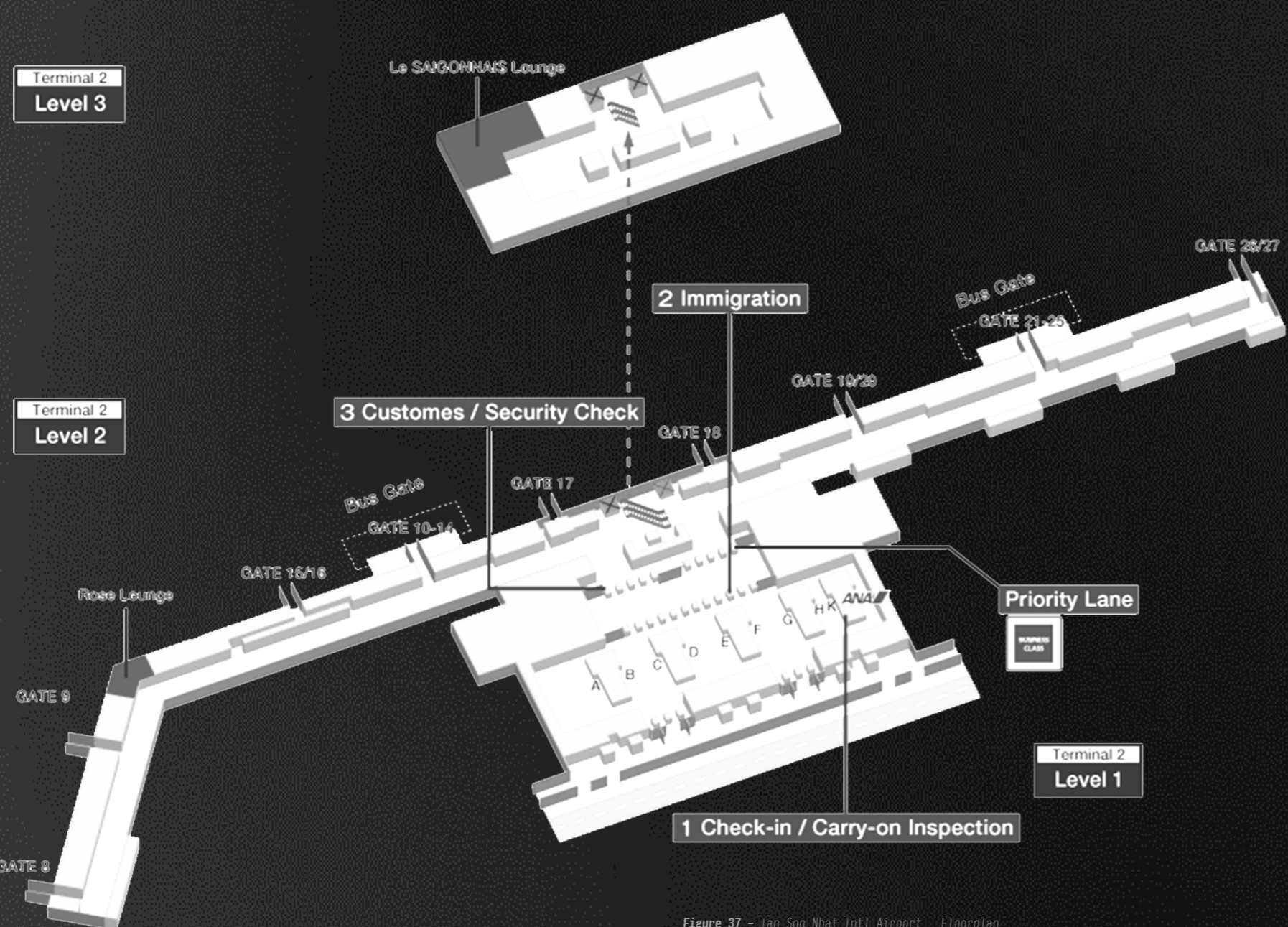


Figure 37 - Tan Son Nhat Intl Airport \_ Floorplan

Here're the current floorplan of the airport. The 3rd level host a lounge and handful of restaurants while the main operation happens at the 2nd floor where the checkin, security are at. Passengers when complete with the procedure go through a long hall way to get to their final gates.

Arriving passengers go through a hall way behind the departure hall to get to the immigration, then finally baggage claim at the ground floor.

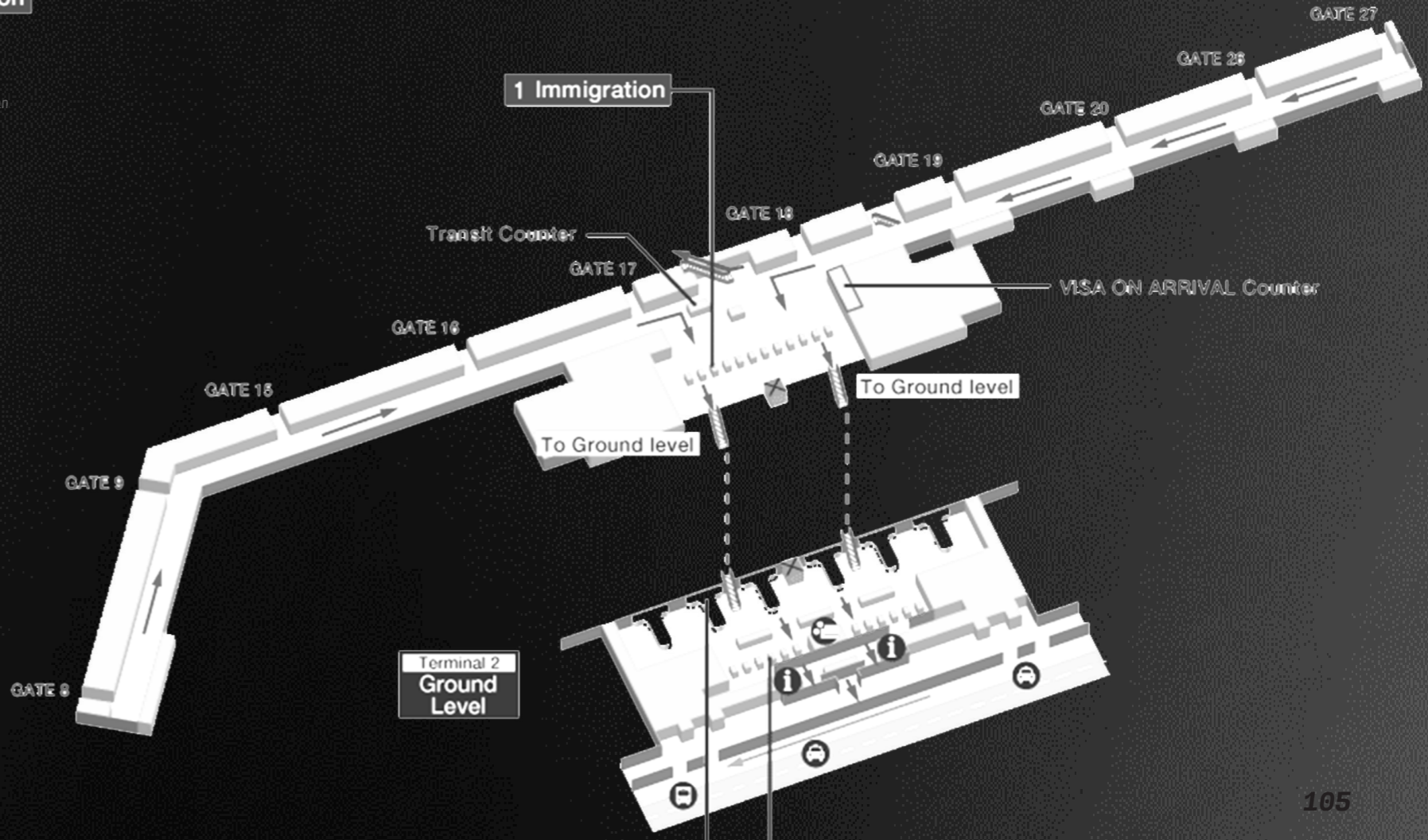
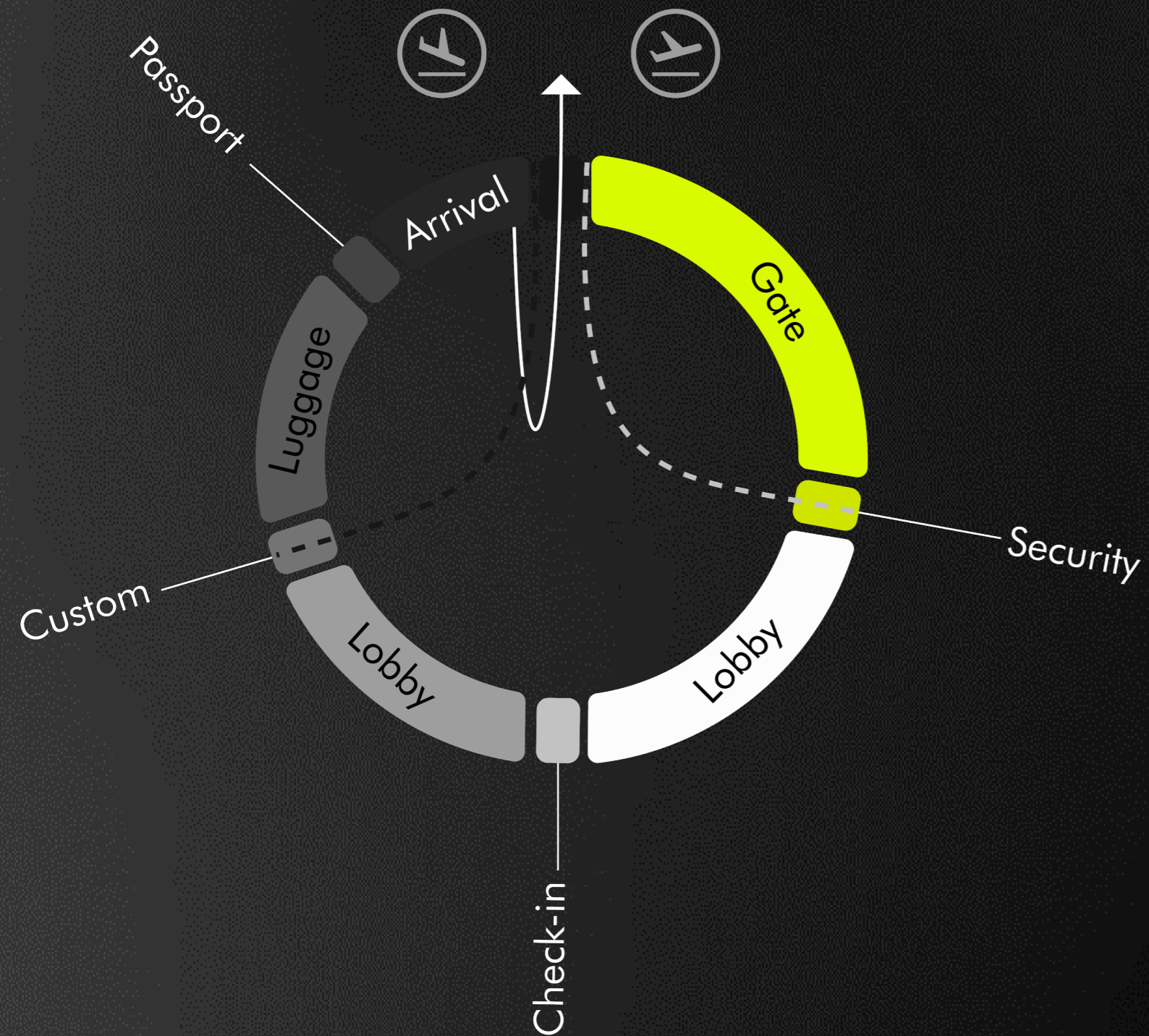


Figure 38 - Tan Son Nhat Intl Airport \_ Floorplan

so...

What is so special about this?



The Domestic Terminal currently serving approx. 15 millions passenger per year. the Intl Terminal currently serving approx. 10 millions passenger per year. The sq footage of both terminal combined are still less then Terminal 1 of MSP Intl Airport. It is holding back the performance and capability of the airport.

2nd When you look at this diagram, showing a typical flow from a typical airport in the US. Passenger checkin then security then gates. Passenger arrival, go get luggage then leaves. Cycles repeats.

But if you have ever been to Tan Son Nhat Airport, you will know it is a whole level of "extra." You won't be going alone - your entire family, in-laws, and even your distant cousins will join you. And you will go there 5 hours early "just to make sure."

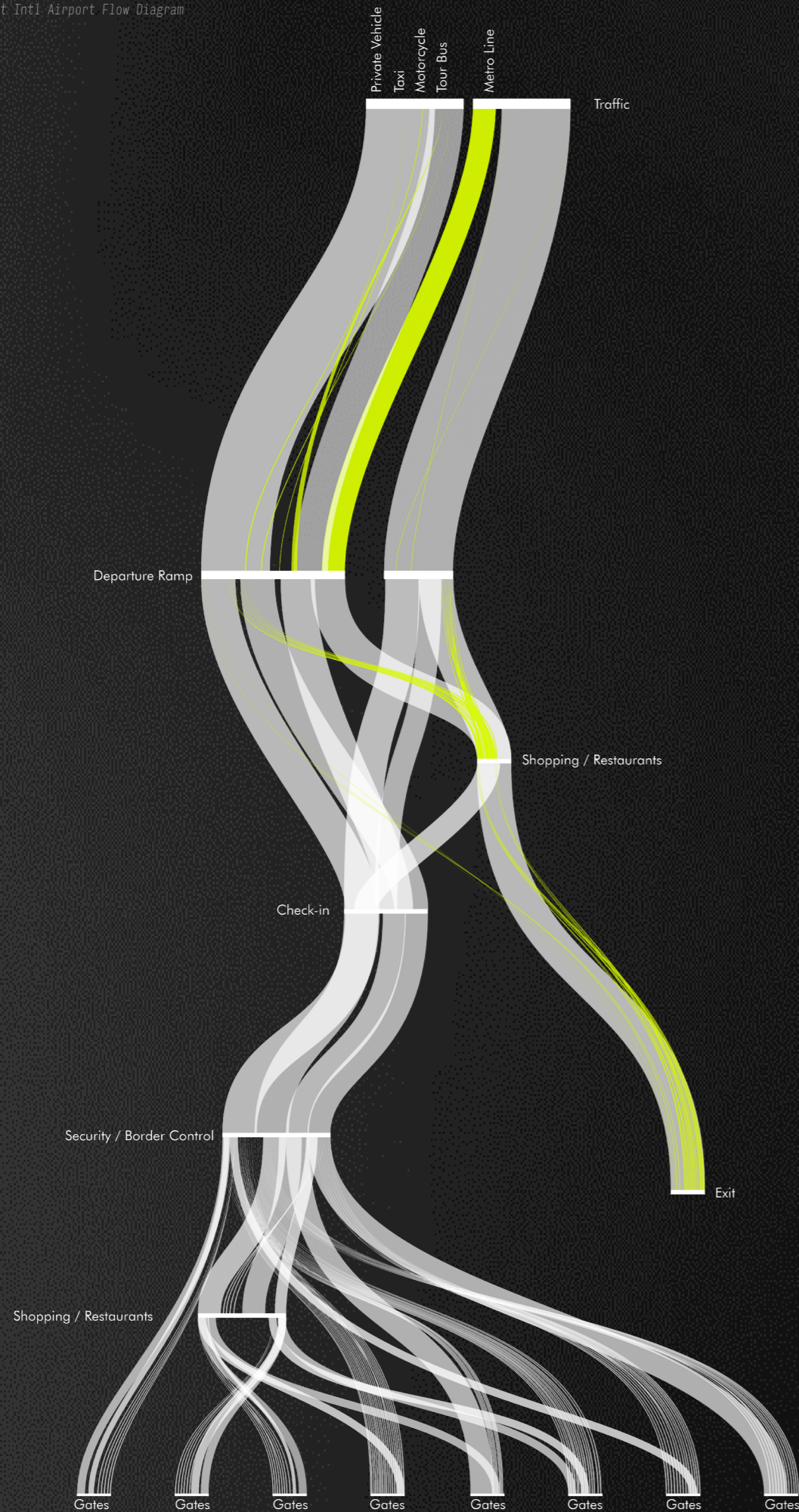


But if you have ever been to Tan Son Nhat Airport, you will know it is a whole level of “extra.” You won’t be going alone - your entire family, in-laws, and even your distant cousins will join you. And you will go there 5 hours early “just to make sure”



And with how Tan Son Nhat airport is operating, family members aren't allow to come along for the checkin procedures and have to wait outside. Additionally, there are limited seating, and amenities to accommodate for the visitor. Resulting people sitting on the floor and causing congestion among entry ways.

Figure 43 - Tan Son Nhat Intl Airport Flow Diagram



So this a more accurate representation of a passenger flow through the airport. Visitor and passenger spend their time while waiting on the floor or at the limited amenities, and only until passenger has gone through all procedure, that's when visitor will leave. Because in Asian culture in general and Viet Nam in specific, we value friends and family, and are not shy away from travel long distances and spend time at the airport before they leave. It has been like that for many generations. That's why... ==>

More than just a  
spatial problem

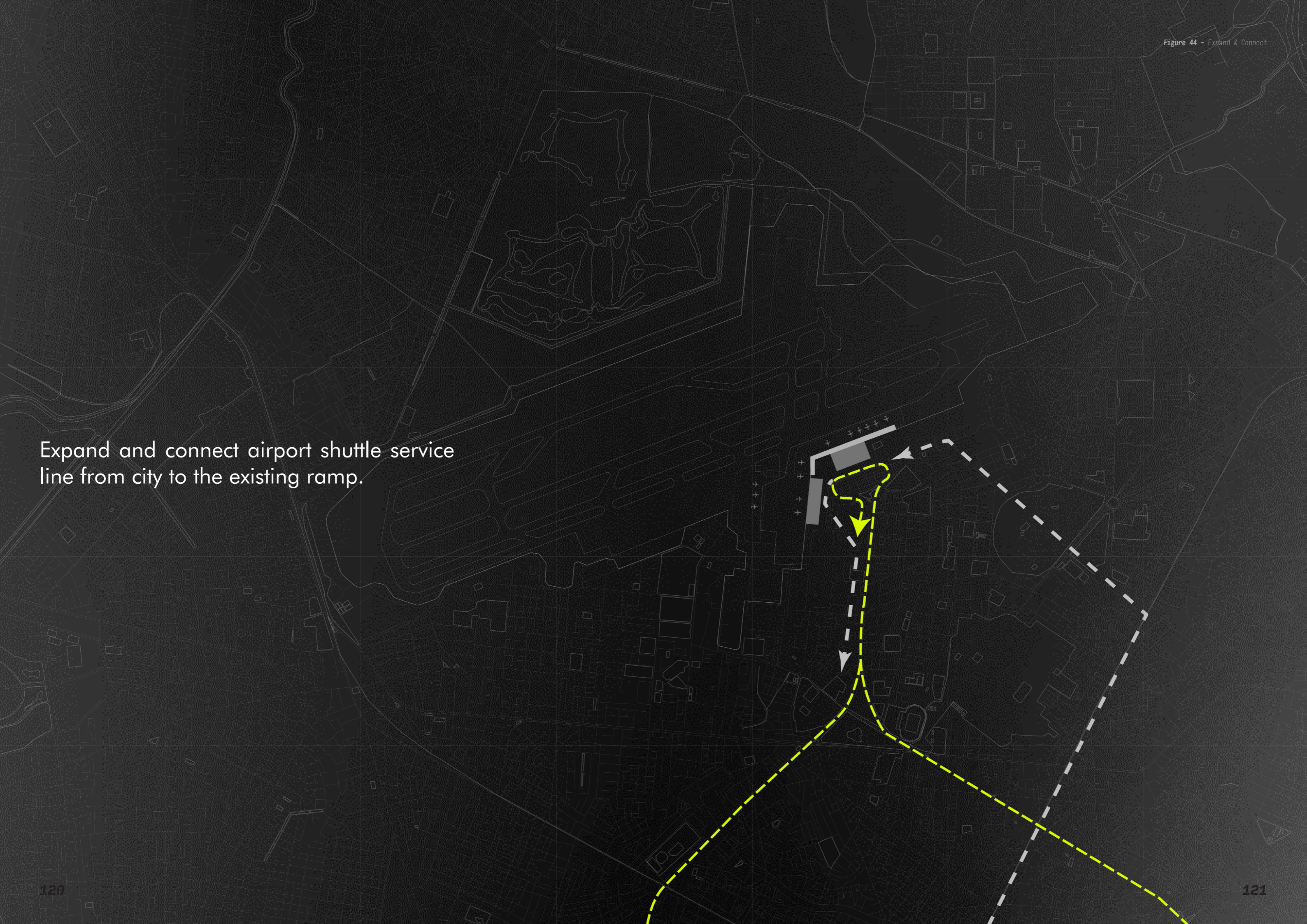
It's cultural



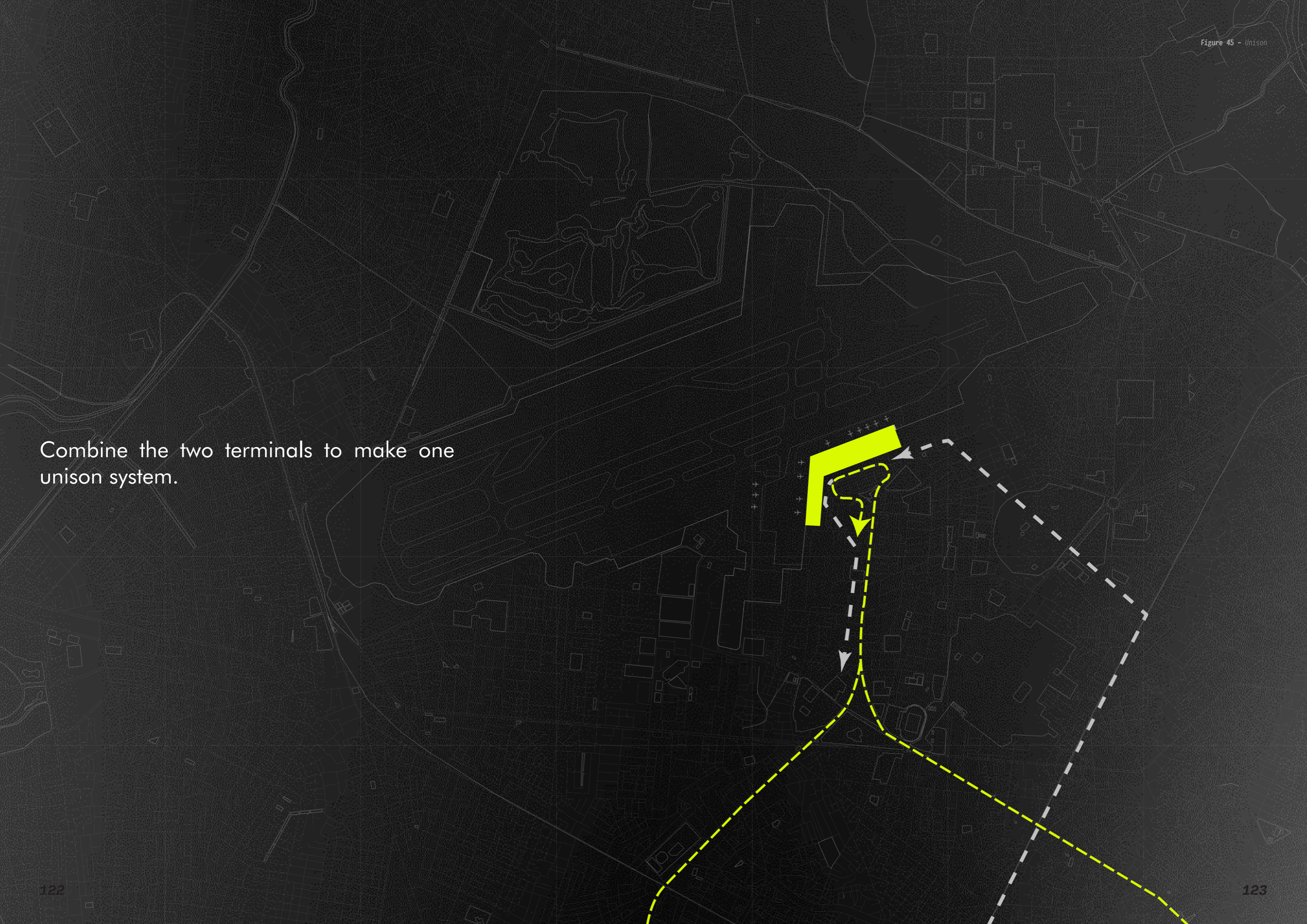


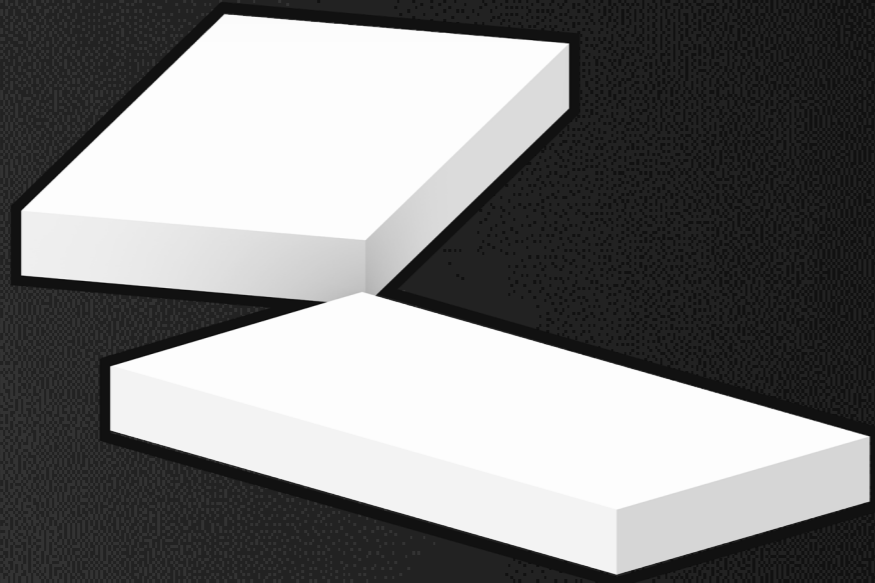
# Proposed Solutions

Expand and connect airport shuttle service line from city to the existing ramp.

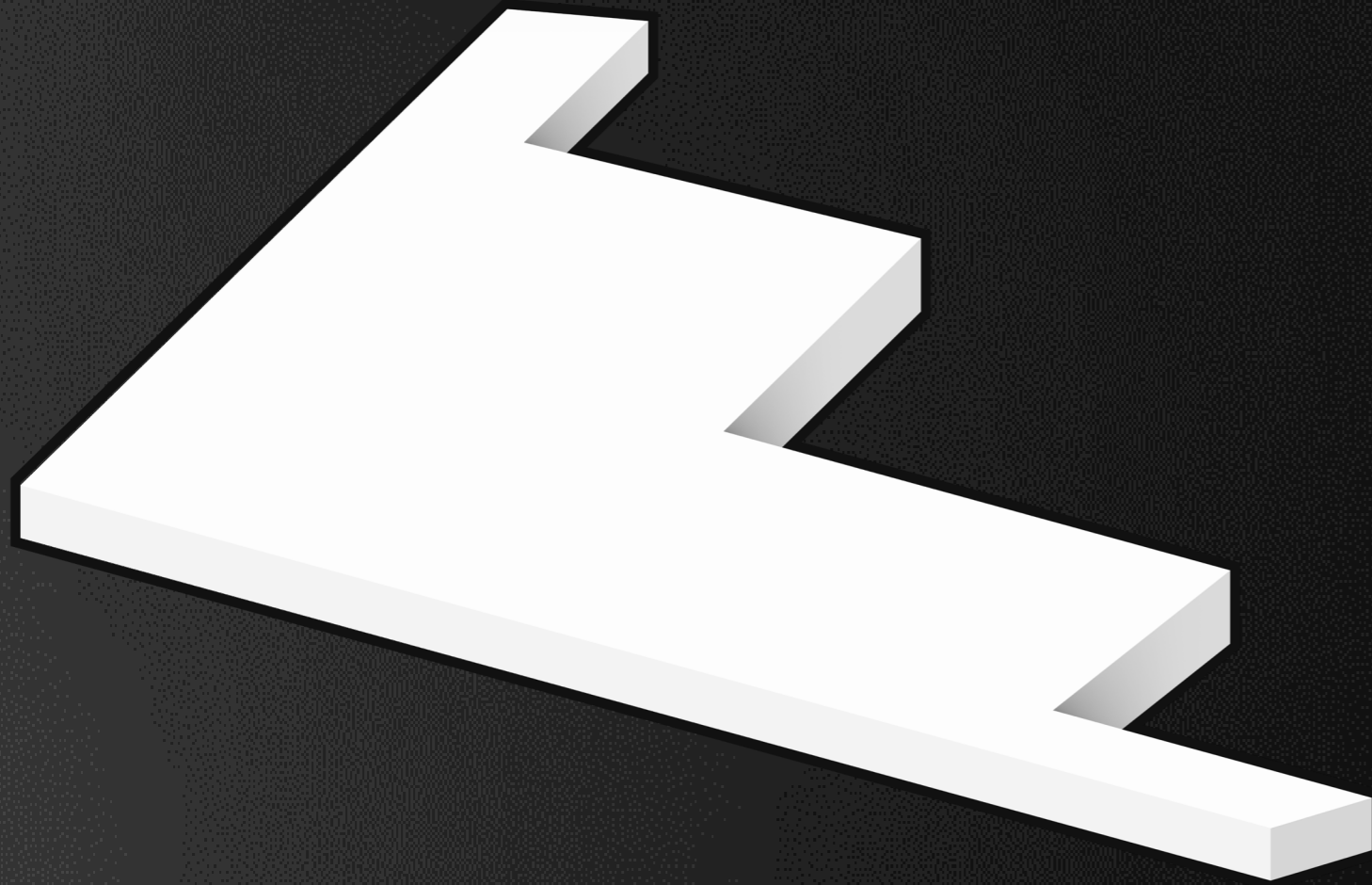


Combine the two terminals to make one unison system.

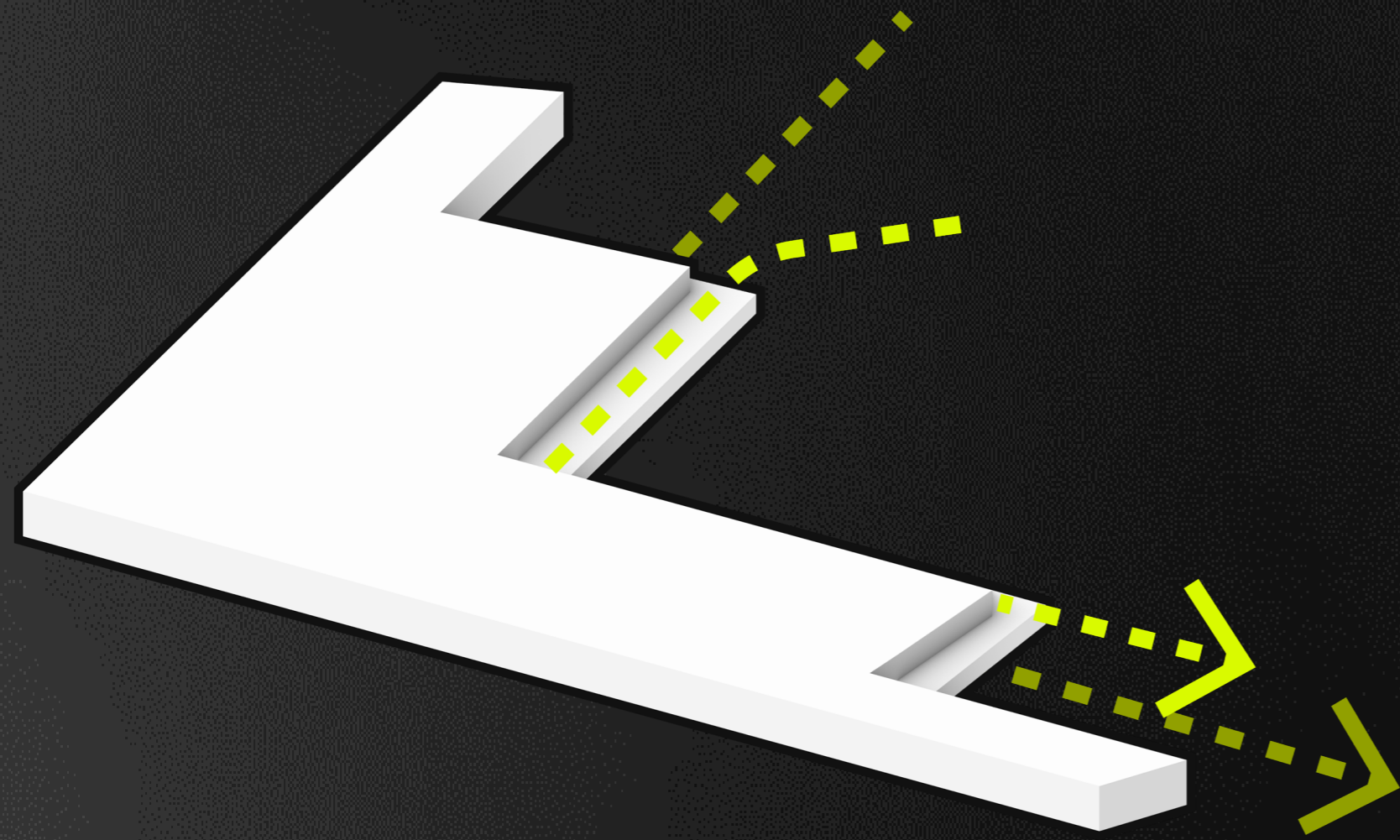




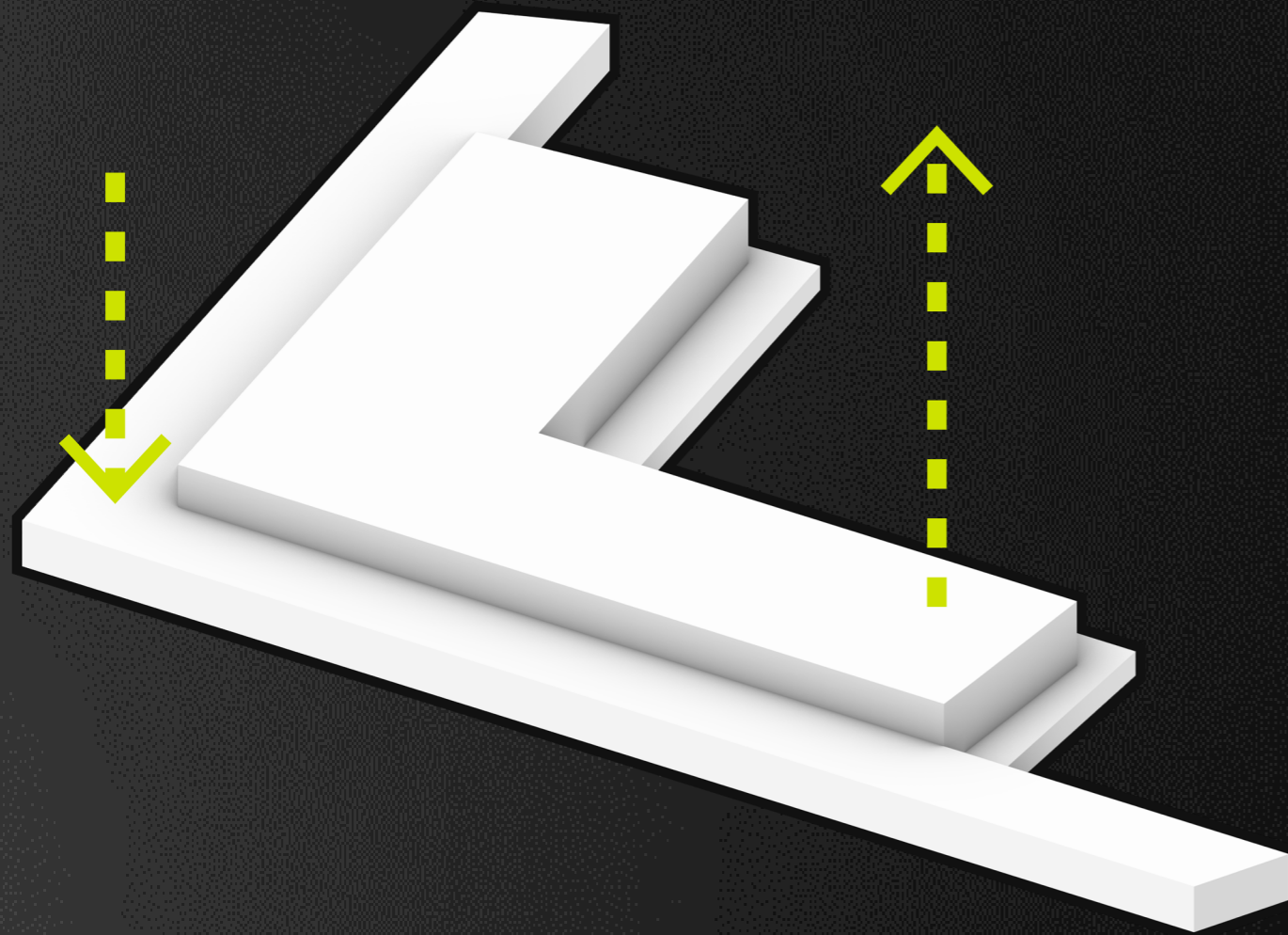
Define the masses of the both terminals.



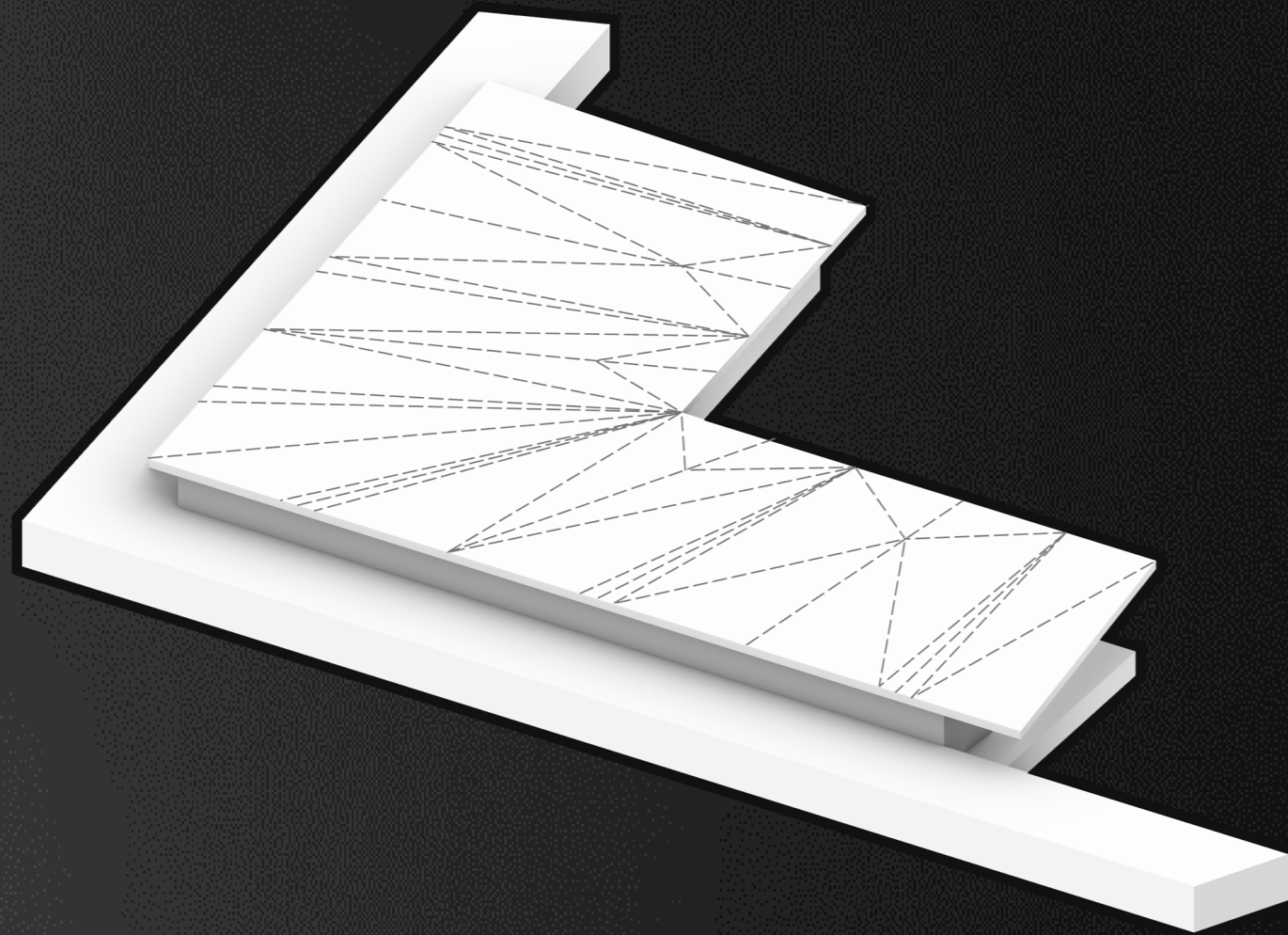
Combine and extend the mass of both terminal in a harmonious way, ensuring the efficiency of its functions.



Cutaway to create space for the extension ramp for the metro line. Maintaining a sense of fluidity and connectivity.

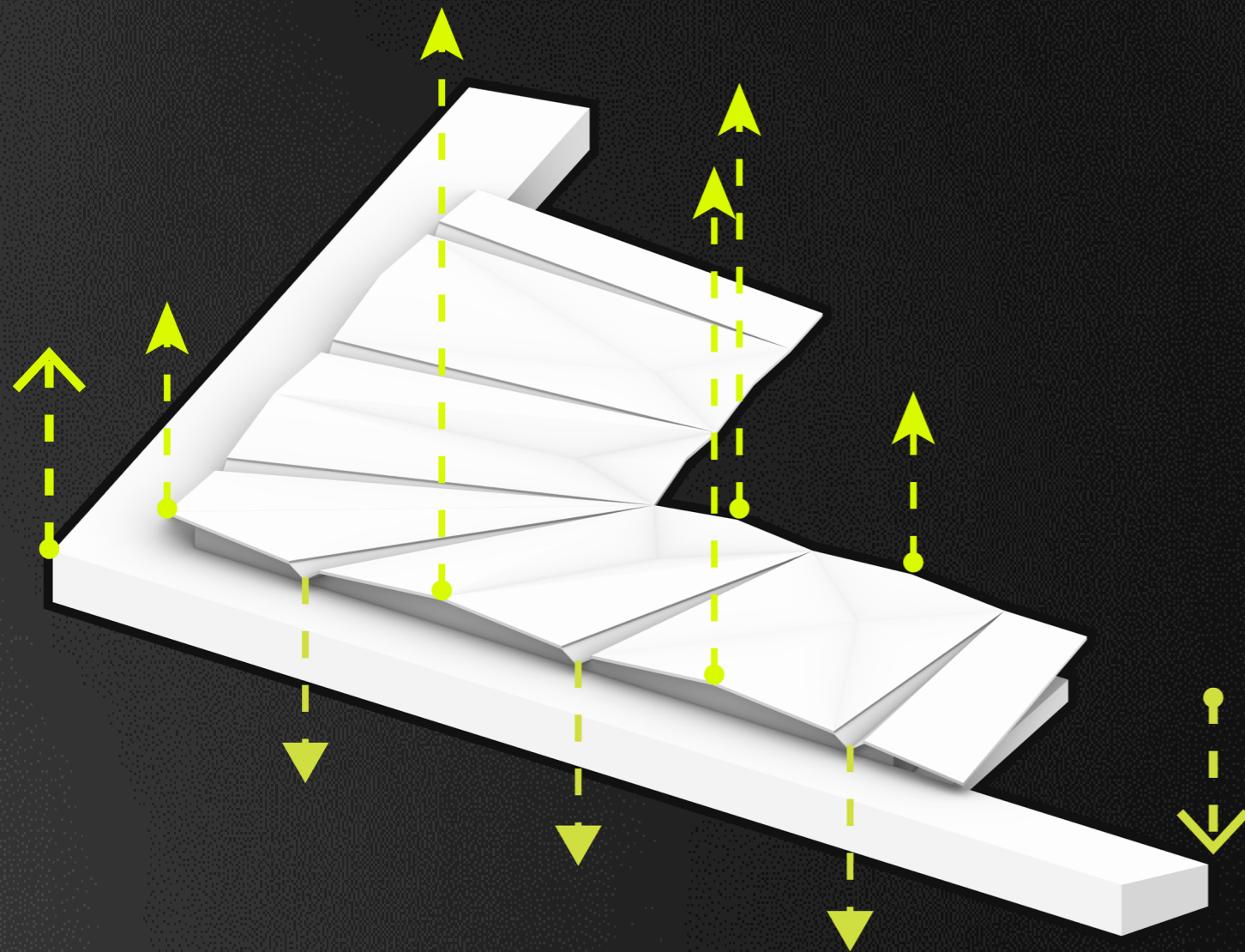


Curate distinct spaces within the terminals. Shaping them to accommodate their designated functions.

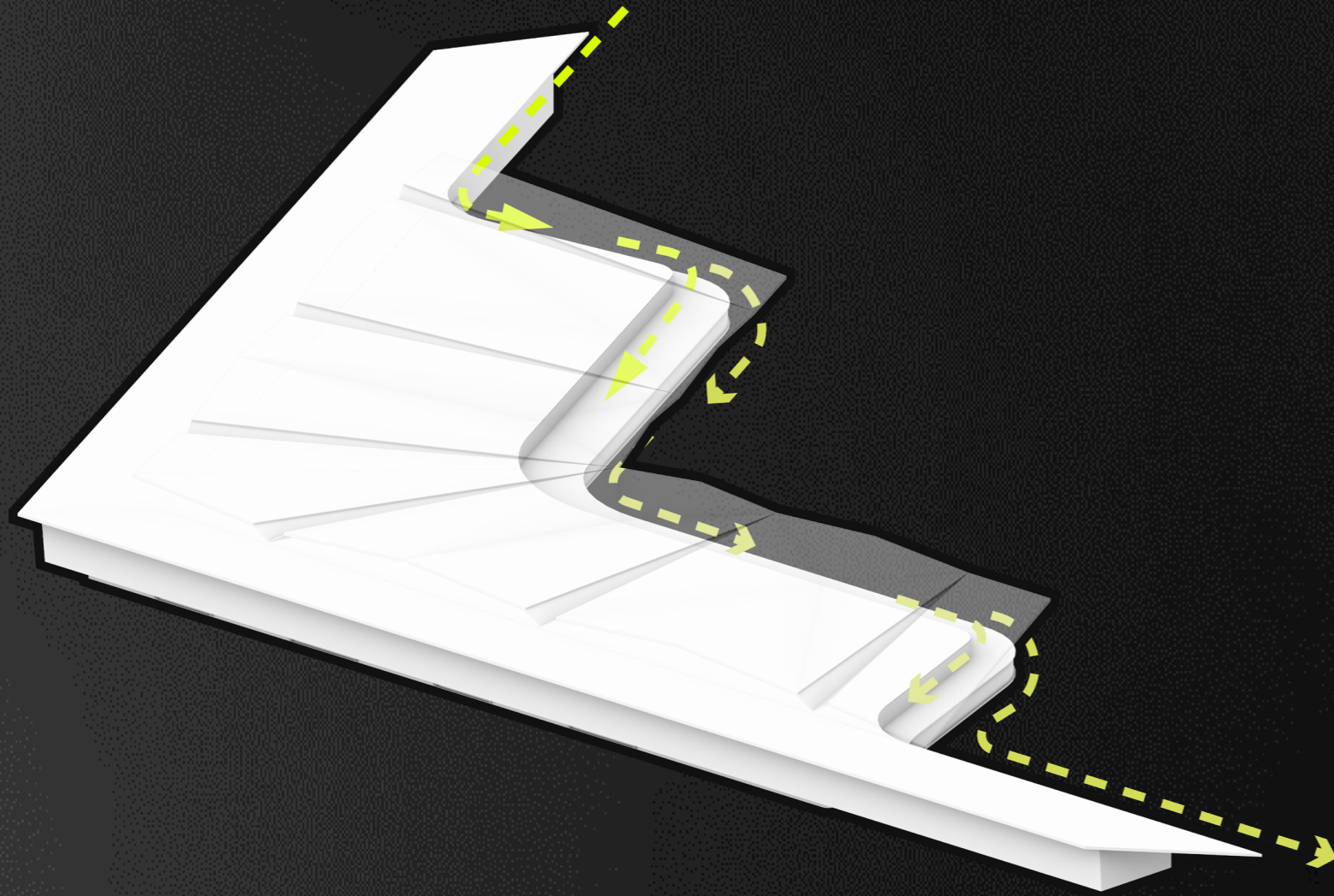


Divide the domain of the roof structures into unique different segments. Enhancing the overall visual appeal and spatial experience of the terminals.

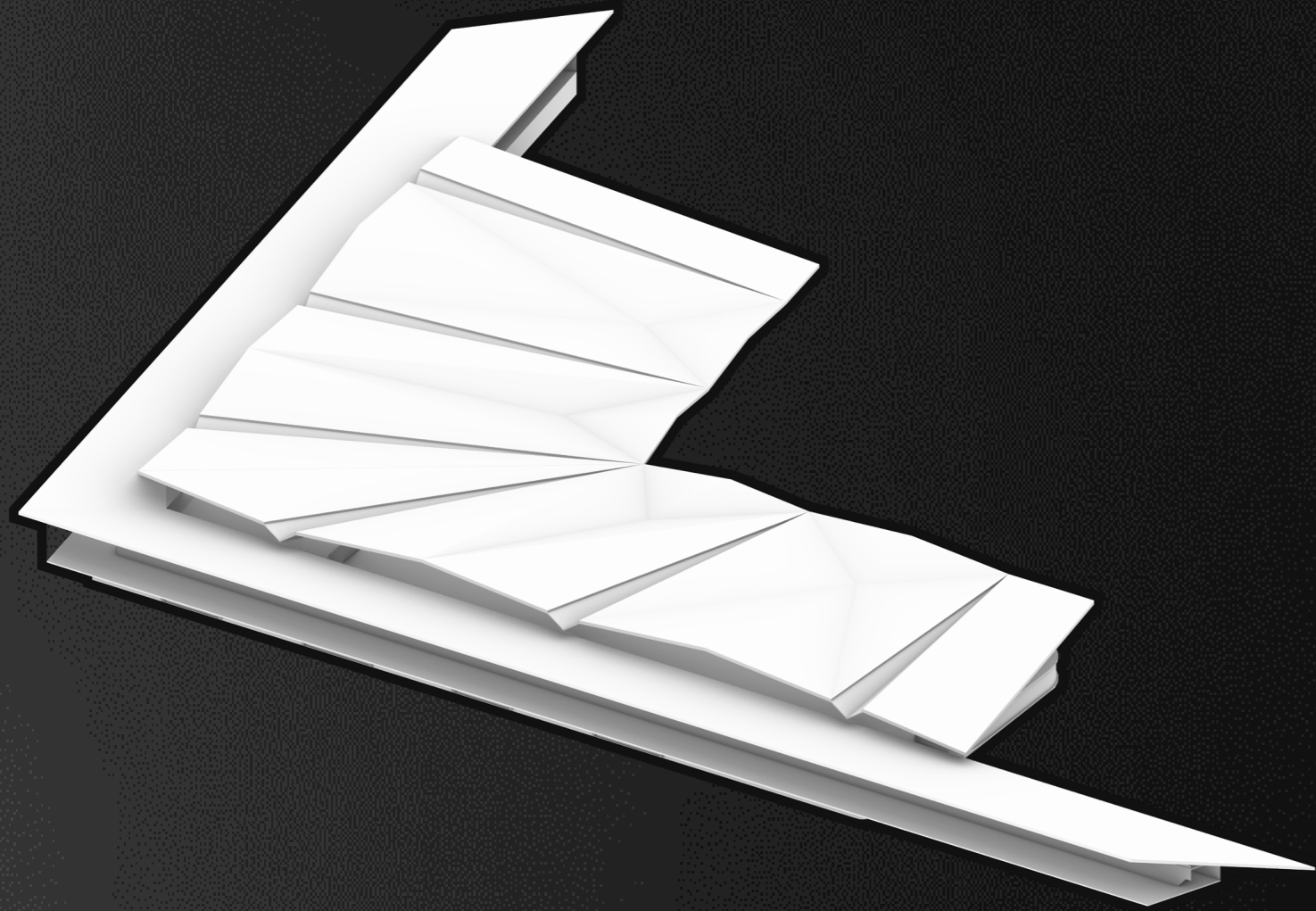




Manipulate points to create variations in height, allowing an abundance of natural light to permeate through the spaces.



Beveling the corner to seamlessly transition between spaces, creating a cohesive and uniform design language.



Provide a sense of transparency through the use of materials while also providing a view of the surrounding landscape.

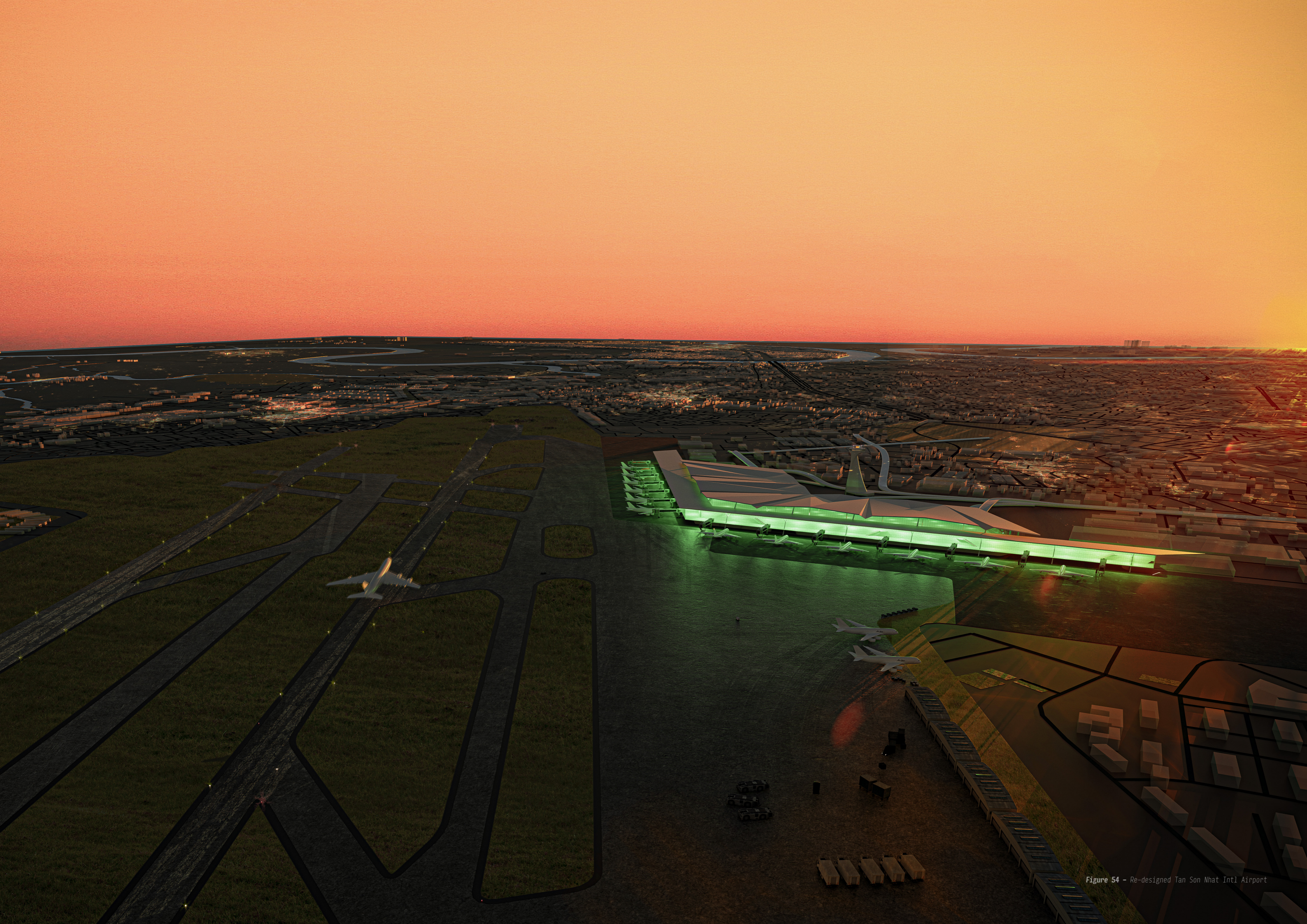


Figure 54 - Re-designed Tan Son Nhat Intl Airport



The size of each words represent its important and the space it occupied within the building.

- 1 Air Control Tower
- 2 South Parking Lot
- 3 South West Parking Lot
- 4 Entrance Ramp from Truong Son St.
- 5 Entrance Ramp from Metro Line
- 6 Exit Ramp

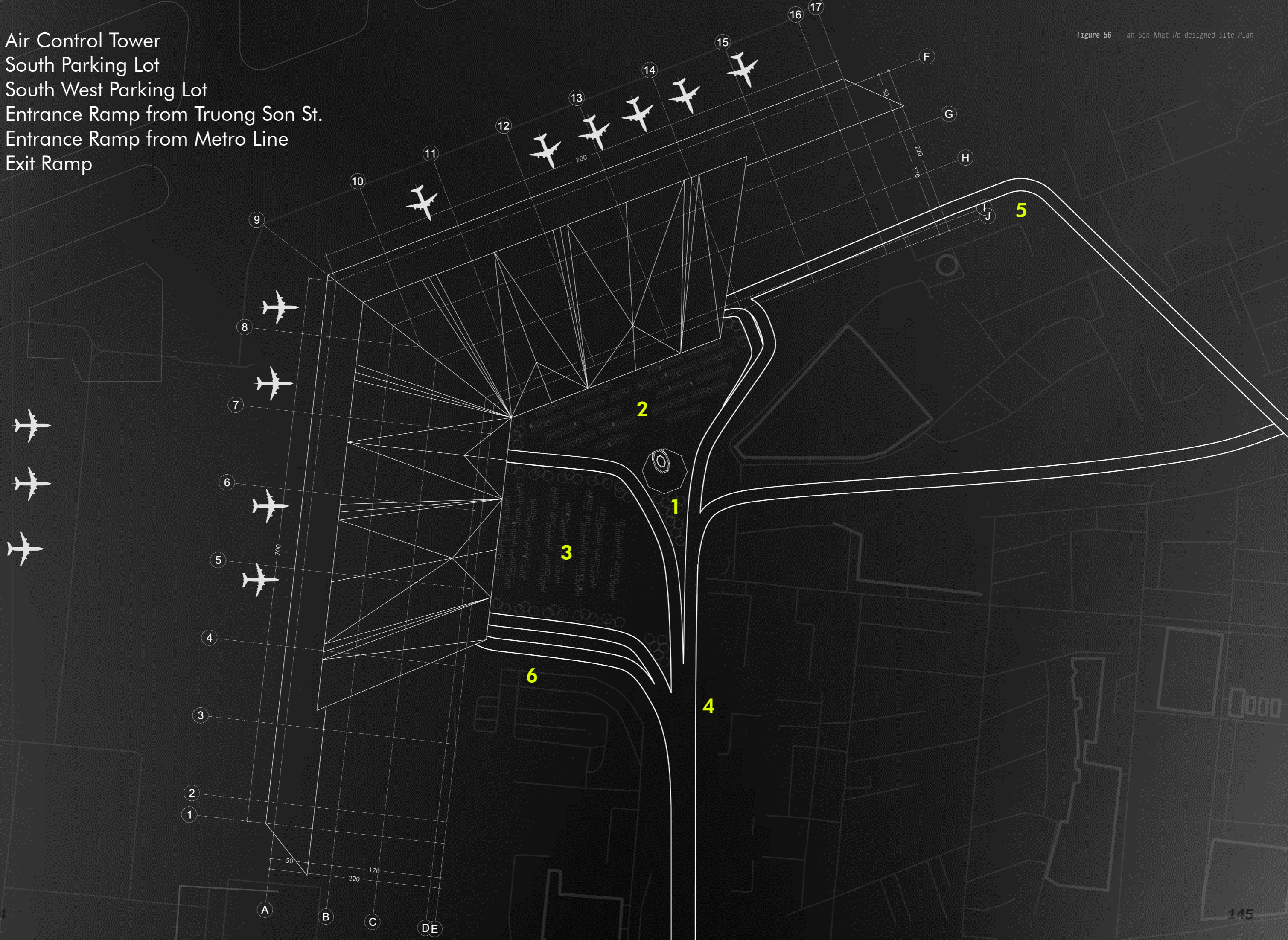




Figure 57 - Re-designed Tan Son Nhat Intl Airport







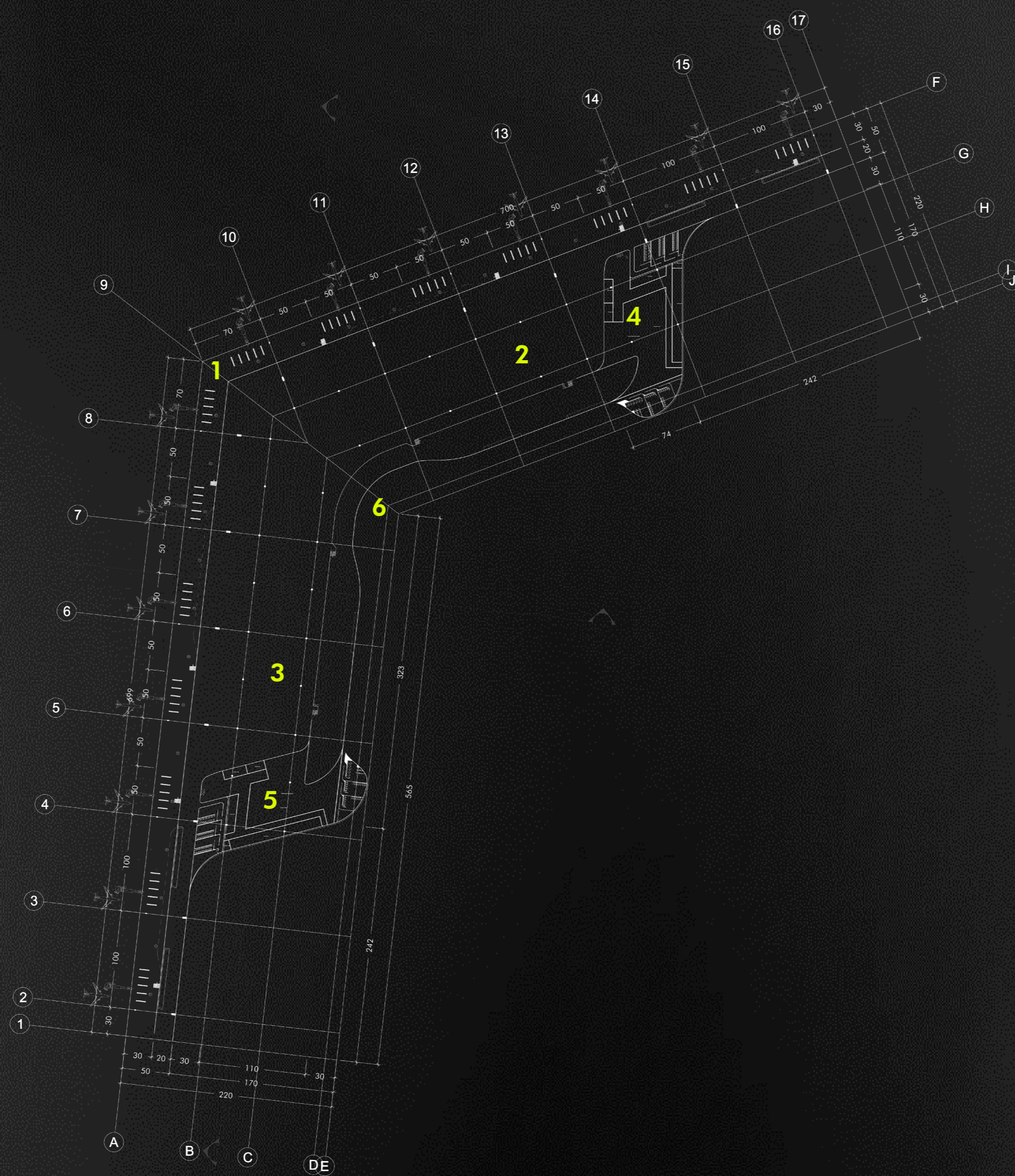


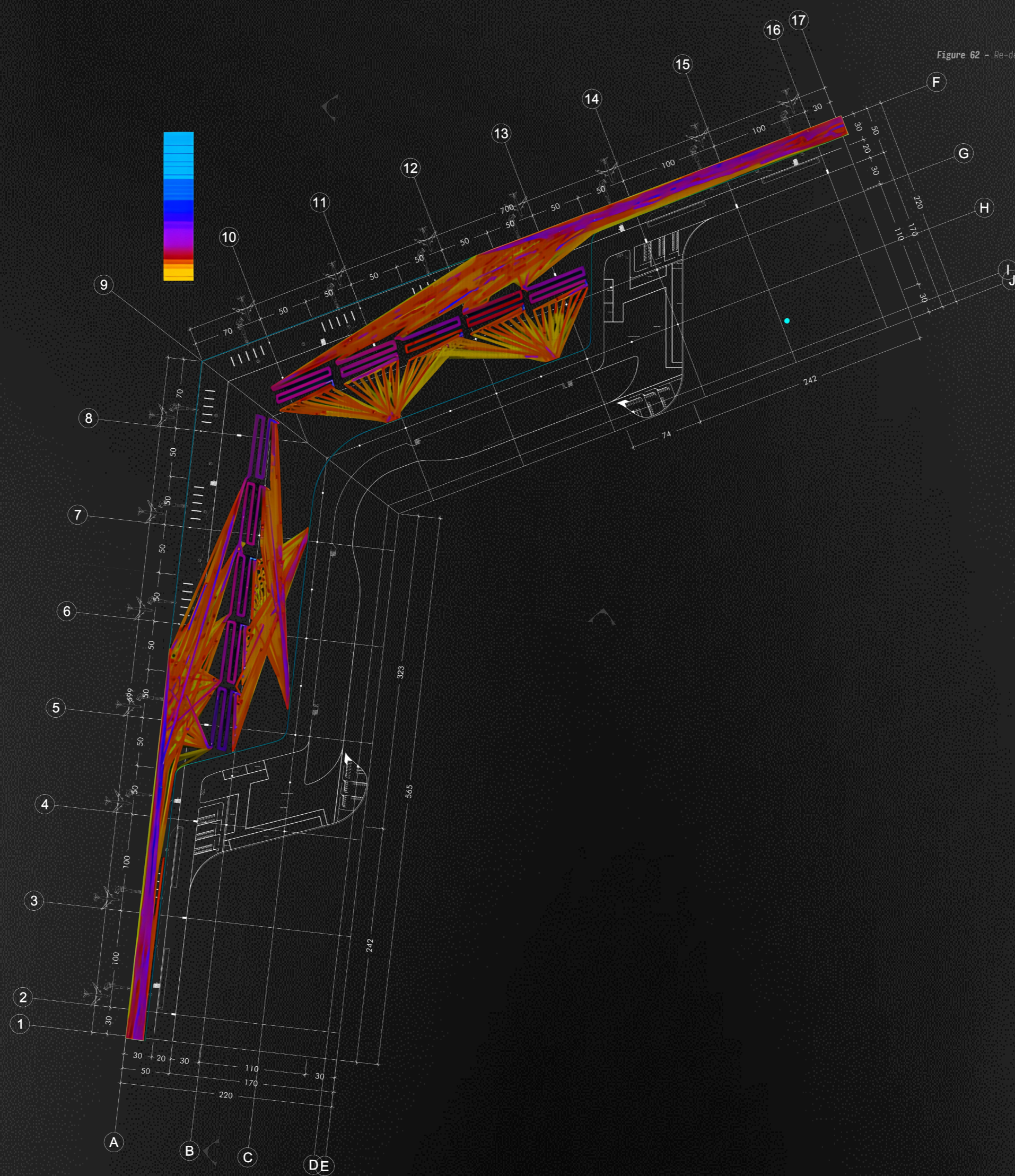
Figure 61 - Re-designed Tan Son Nhat Intl Airport - Visitor Hall



- 1** Arrival Hall
- 2-3** Immigration
- 4-5** MEP
- 6** Visitor Area

Figure 62 - Re-designed Tan Son Nhat Intl Airport 1st Floor Plan







Natural light comes from the clear stories that were created by the moving roof structure. Different shades of white were chosen to promote cleanliness while more natural earth tones were chosen and combined with the green spaces to create a more relax and contrast look overall.

The Visitor area designed to be fun and more relax and junction with tall glass window making the space feel large and open. With seating throughout the spaces, fun and youthful pieces that people can interact with. Additionally is more amenities including shops, restaurants to spend their time here

Departure Hall with its high ceiling create bright and open space. Seating can be combined with vegetation to allow passenger to interact with and create a difference experience.

Immigration area materials choices promote a clean and professional while the lighting added some warmth to the space. The baggage claim area meant to be minimalistic with little to no intricate detail

Figure 63 - Re-designed Tan Son Nhat Intl Airport \_ Departure Hall

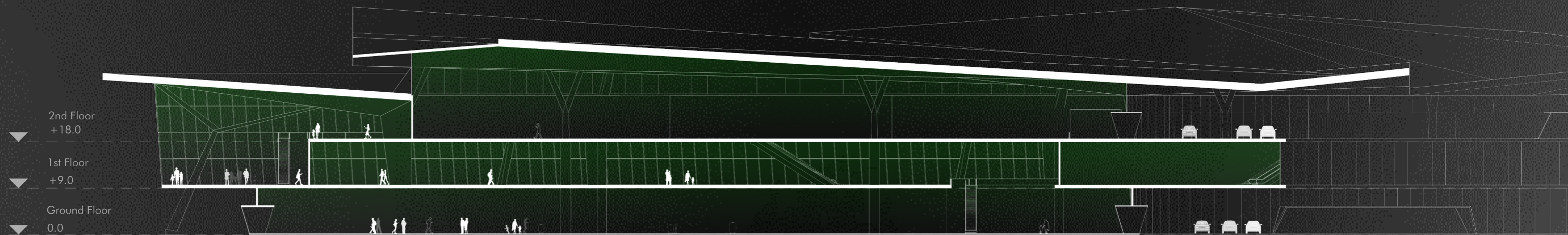
Figure 64 - Re-designed Tan Son Nhat Intl Airport - Immigration Hall





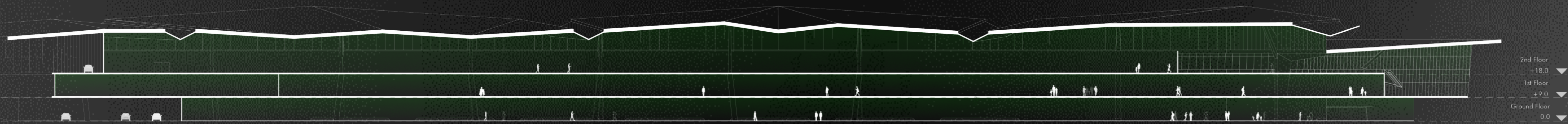


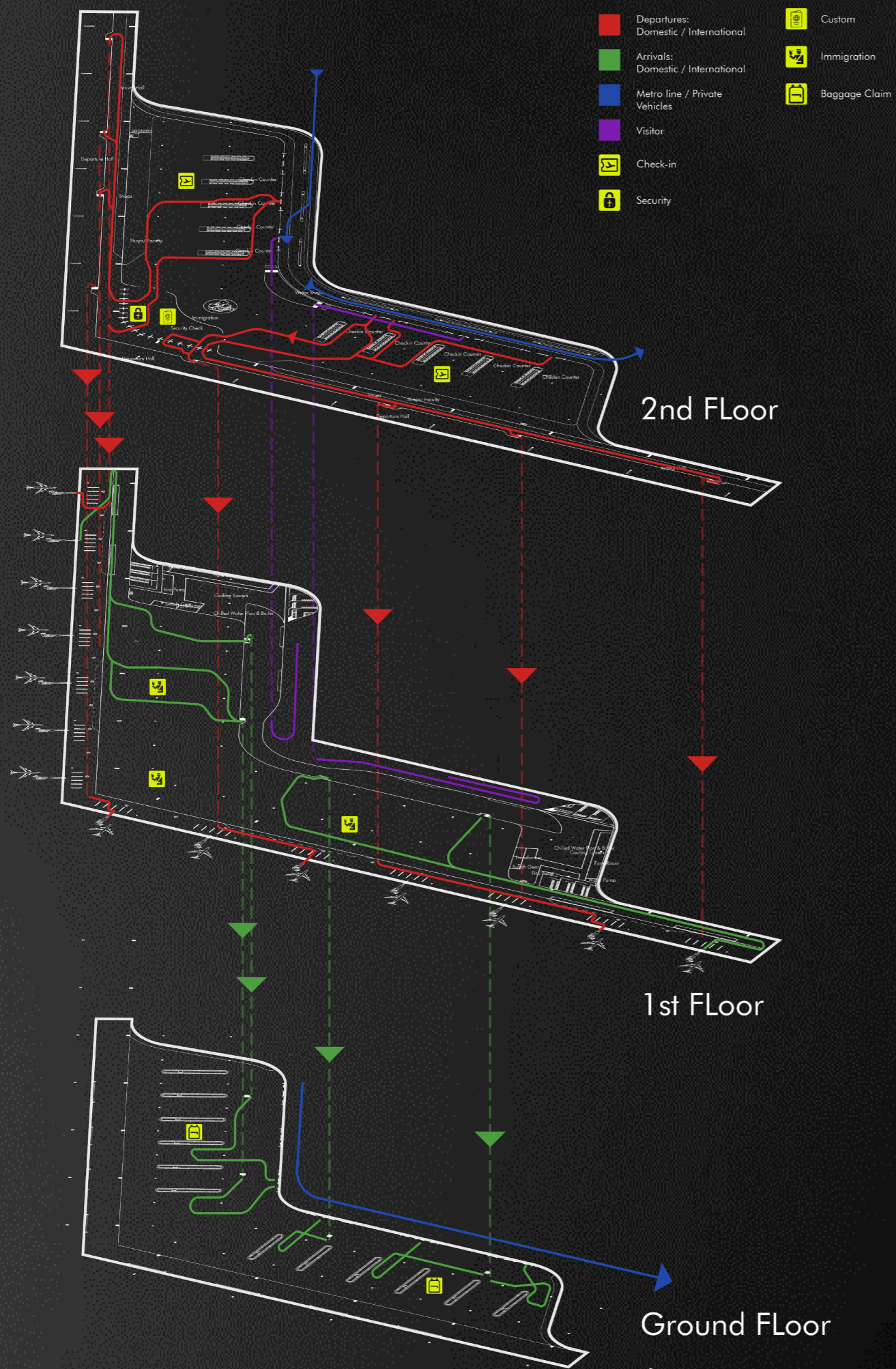




- 1** Vehicle Drop-off
- 2** Check-in Hall
- 3** Security
- 4** Departure Hall
- 5** Arrival Hall

- 6** Immigration Hall
- 7** Visitor Hall
- 8** Baggage Claim
- 9** Vehicle Pick-up





This diagram show every passenger flow throughout the airport.

Blue represent the incoming traffic either to drop-off or pick-up passenger

Red represents the departure passenger and the procedure such as check-in, security they need to pass before they get to the gates

Green represent the arriving passenger, going through the immigration process, and heading down to the baggage claim area.

And the visitor area that can be accessed by everyone.

Figure 70 - Axonometric Flow Diagram

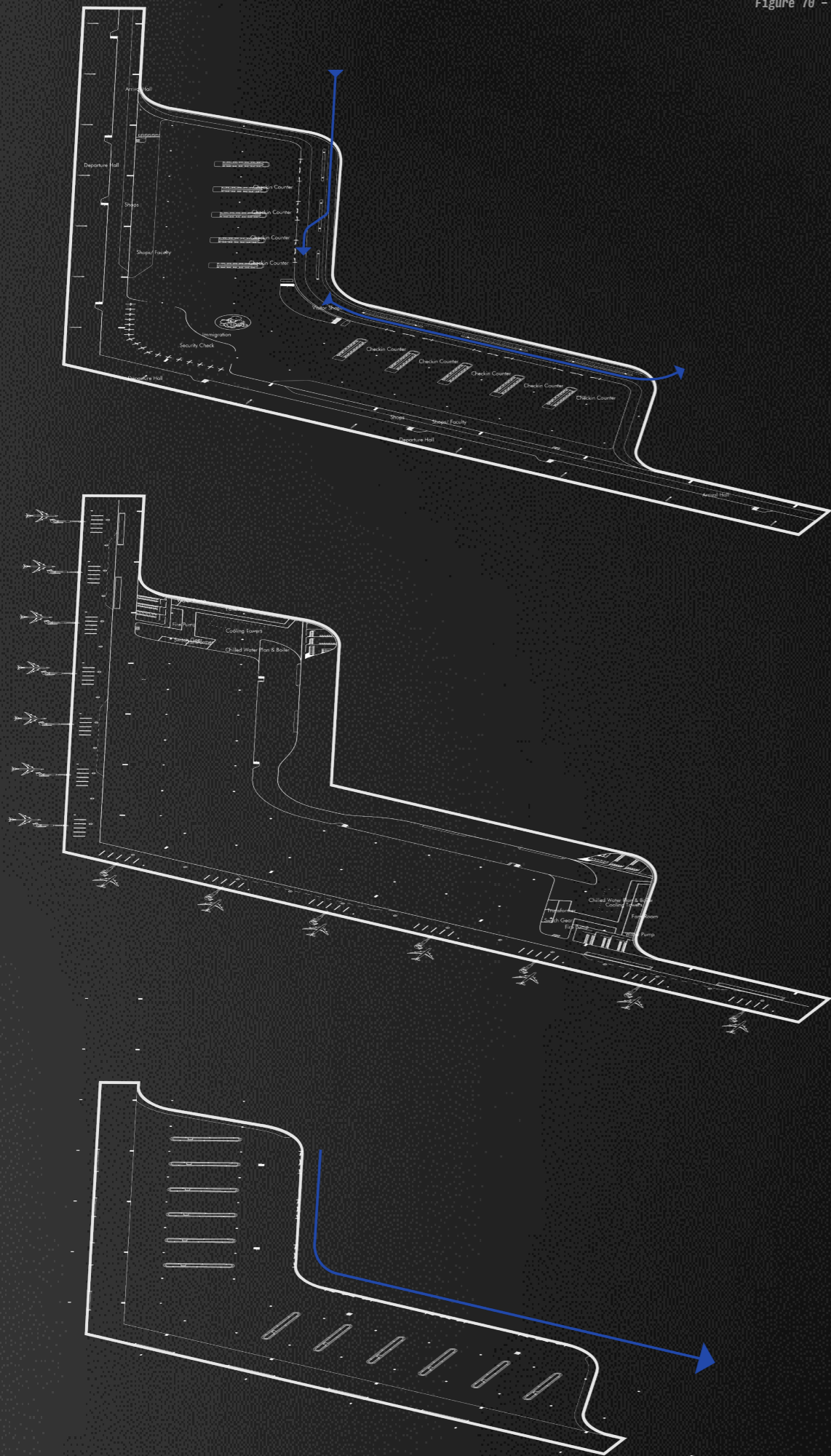


Figure 71 - Axonometric Flow Diagram

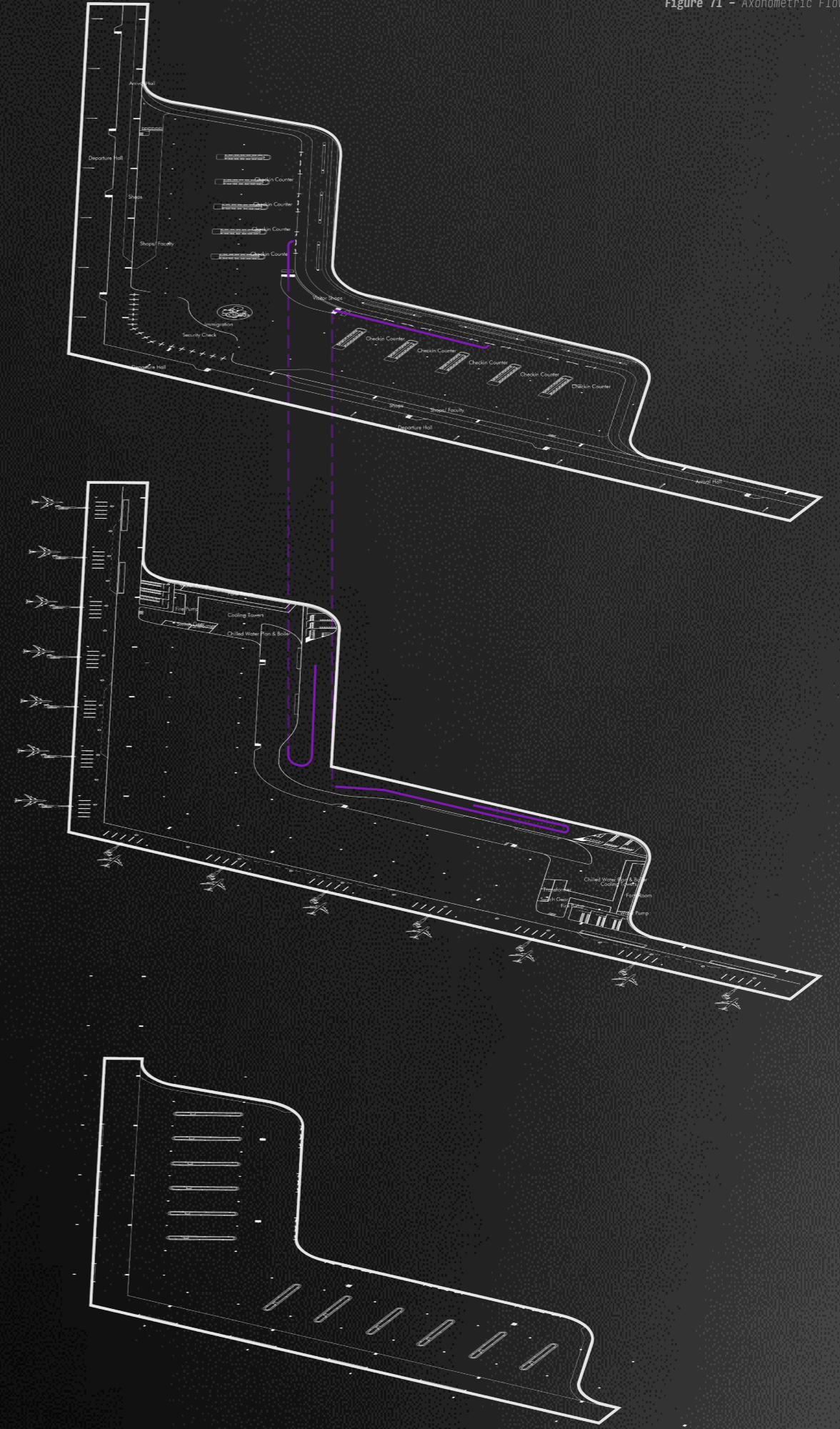


Figure 72 - Axonometric Flow Diagram

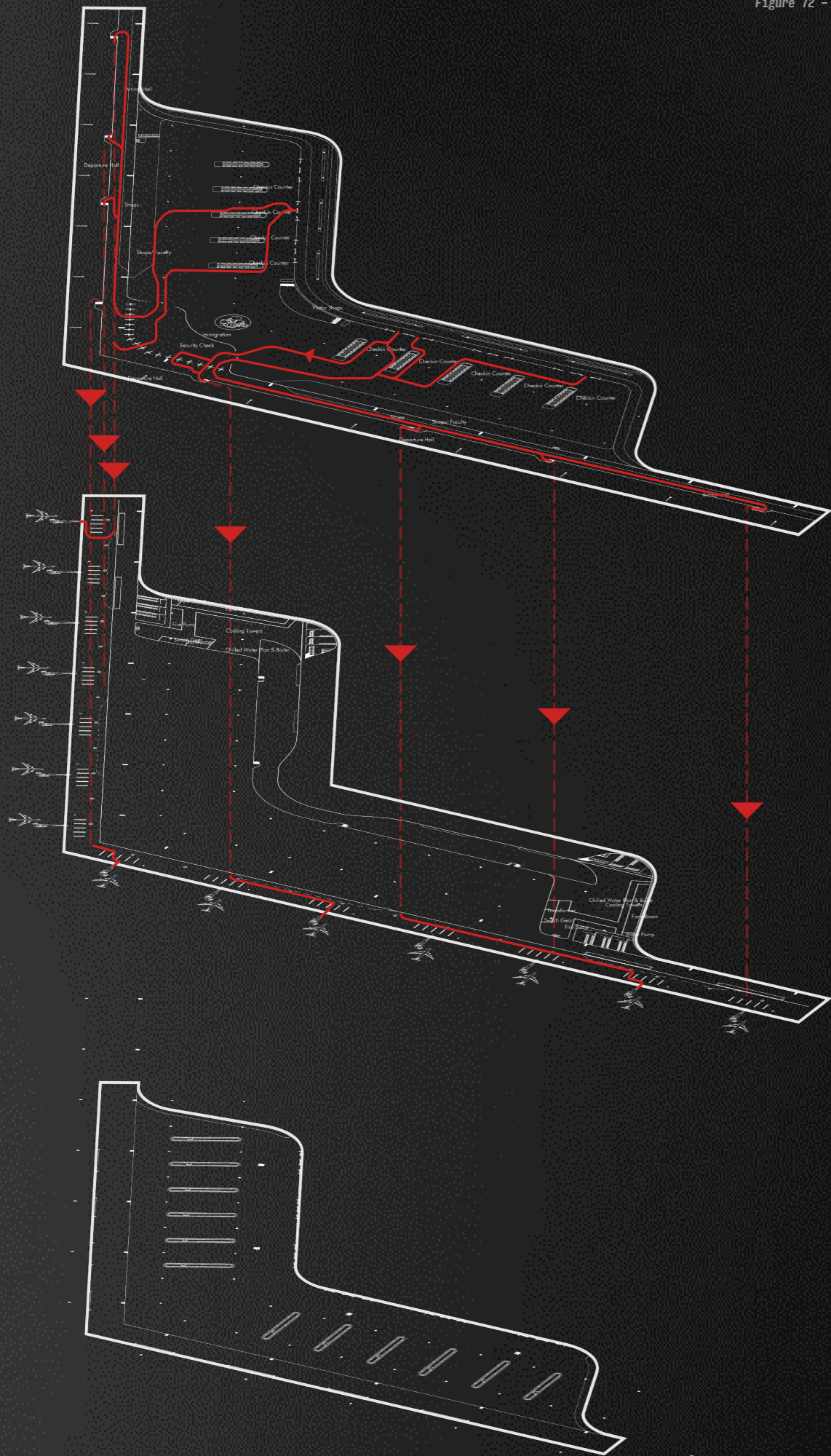
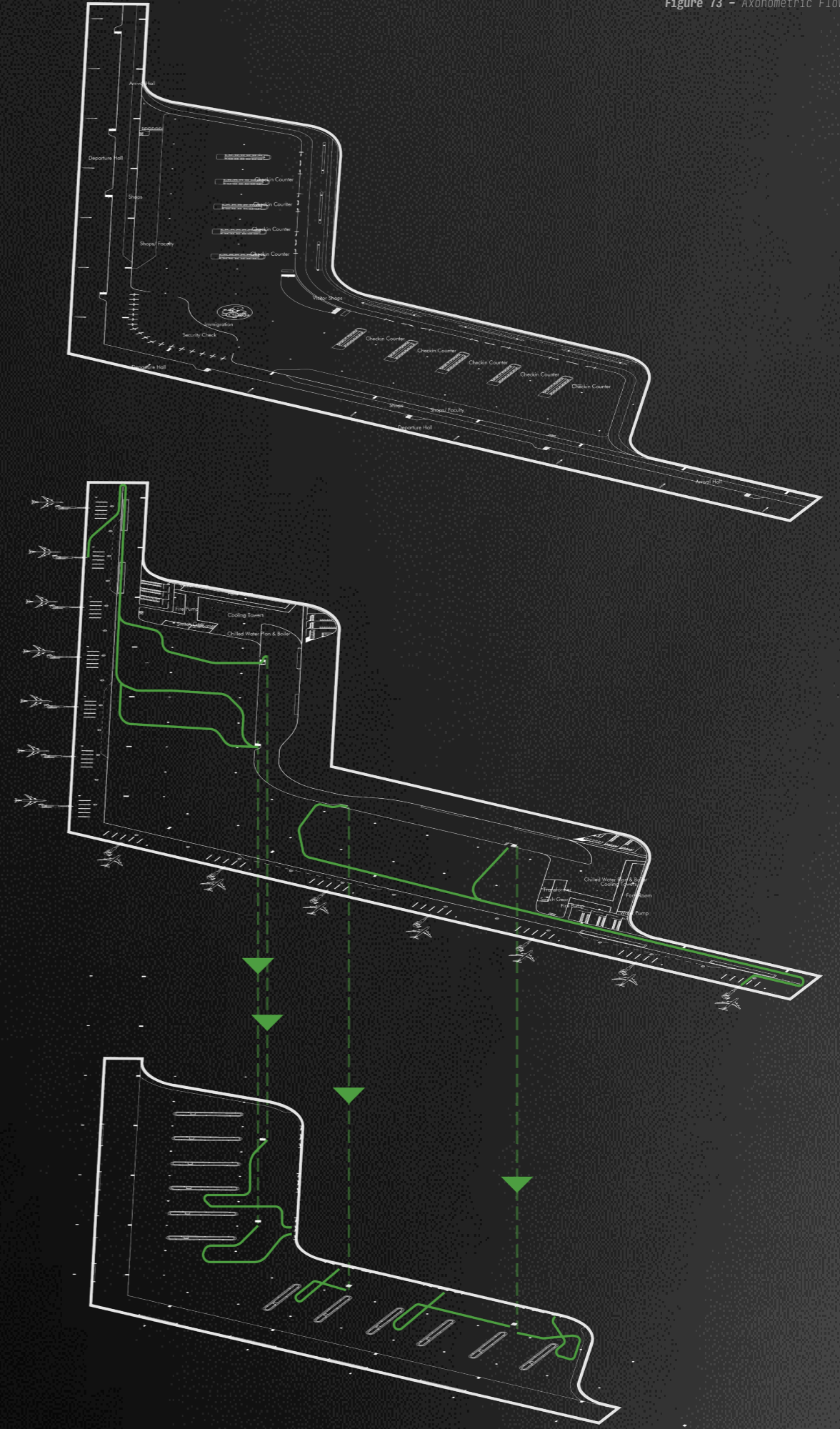
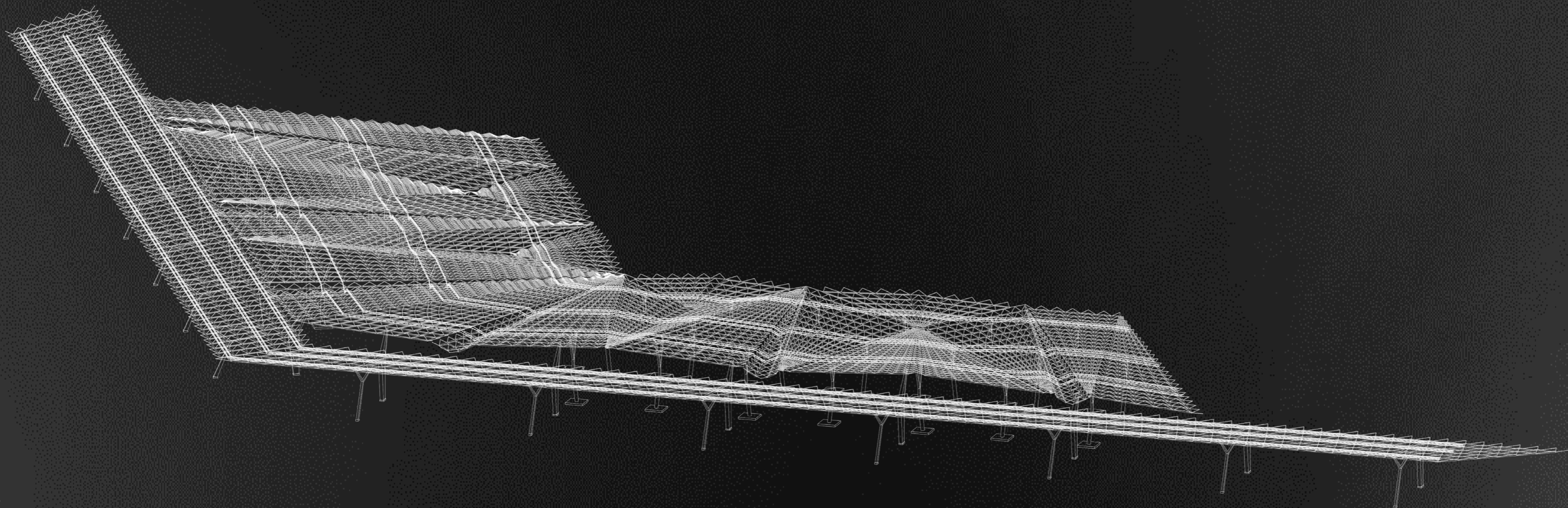
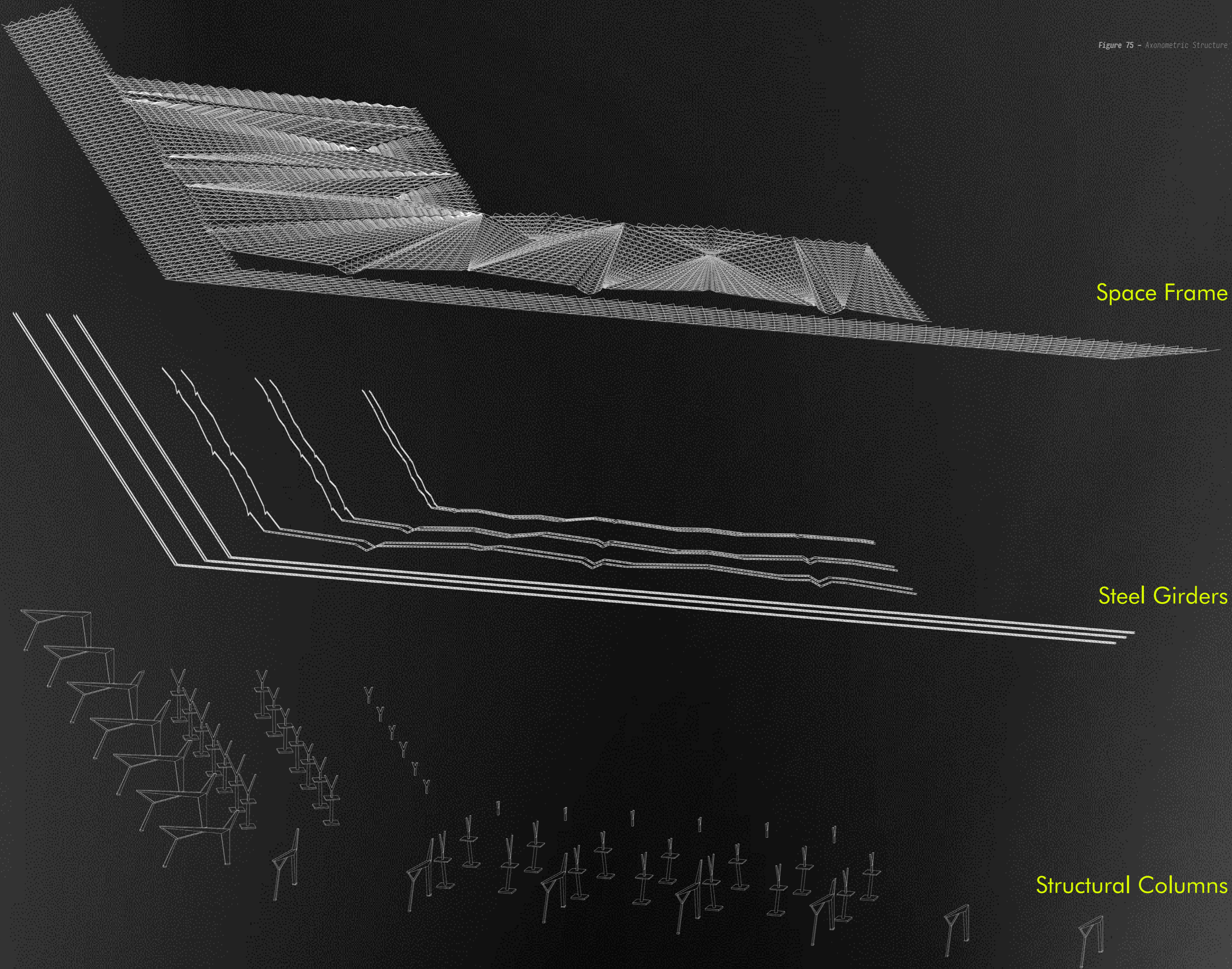


Figure 73 - Axonometric Flow Diagram







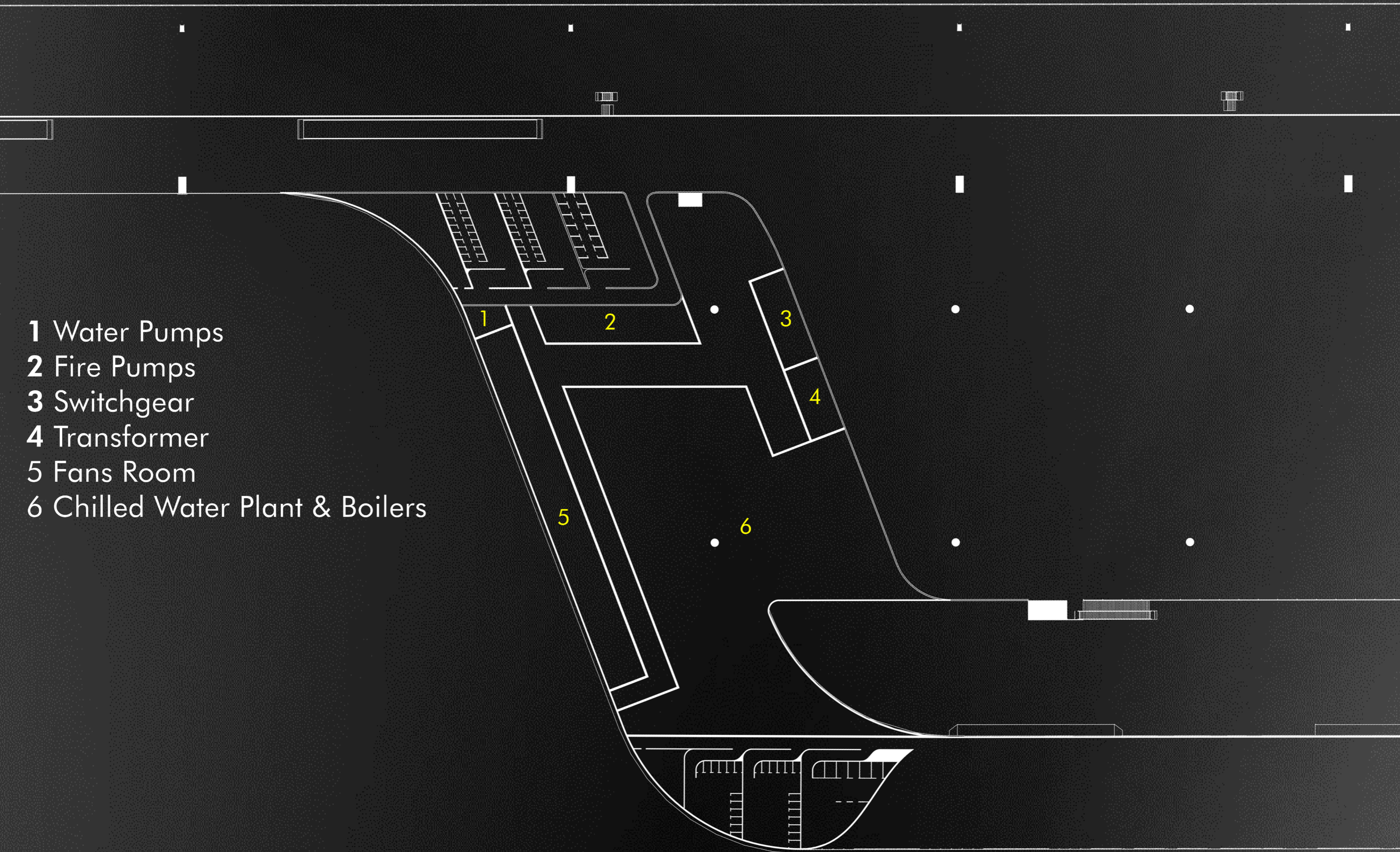
Space Frame

Steel Girders

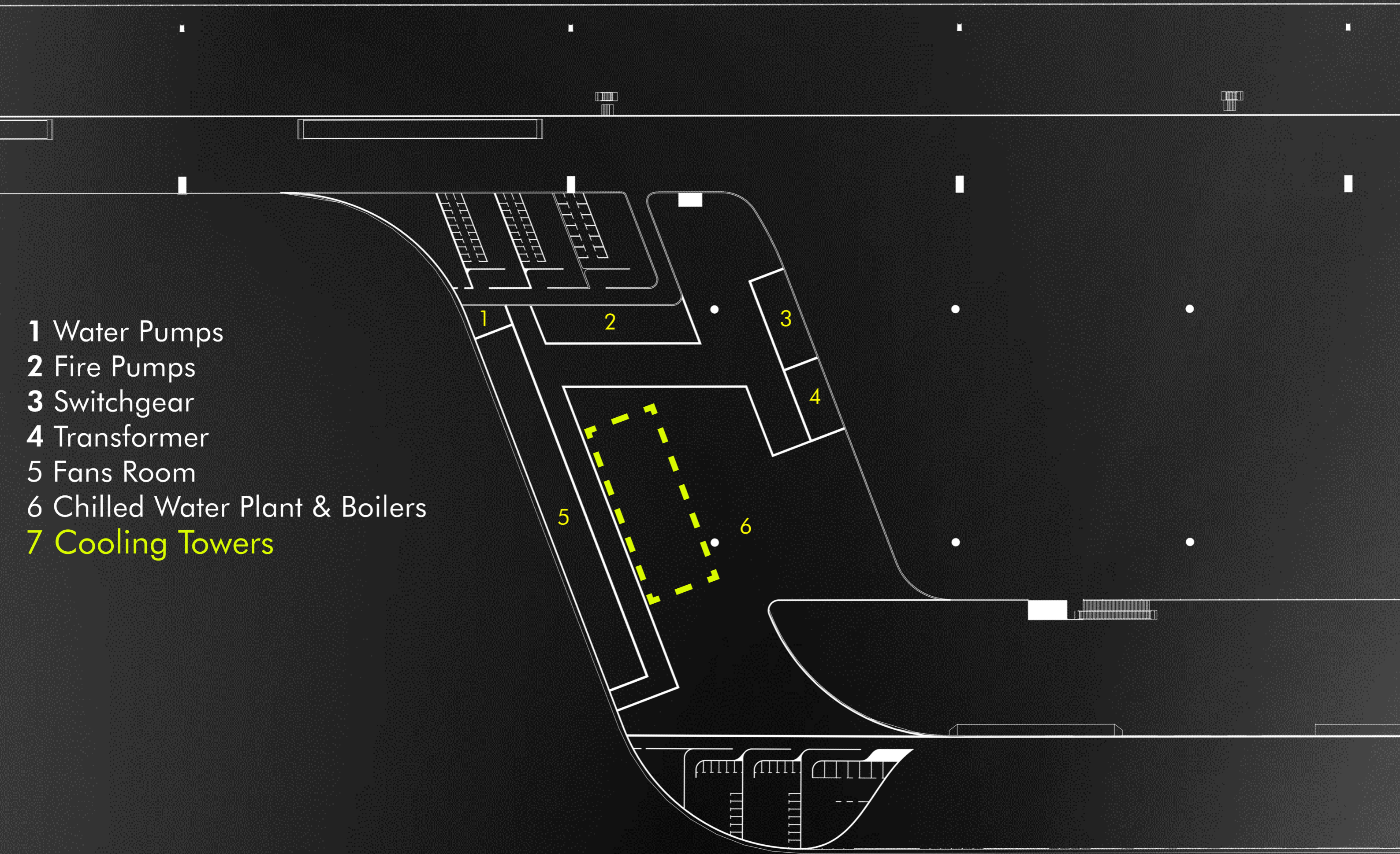
Structural Columns



- 1 Water Pumps
- 2 Fire Pumps
- 3 Switchgear
- 4 Transformer
- 5 Fans Room
- 6 Chilled Water Plant & Boilers



- 1 Water Pumps
- 2 Fire Pumps
- 3 Switchgear
- 4 Transformer
- 5 Fans Room
- 6 Chilled Water Plant & Boilers
- 7 Cooling Towers



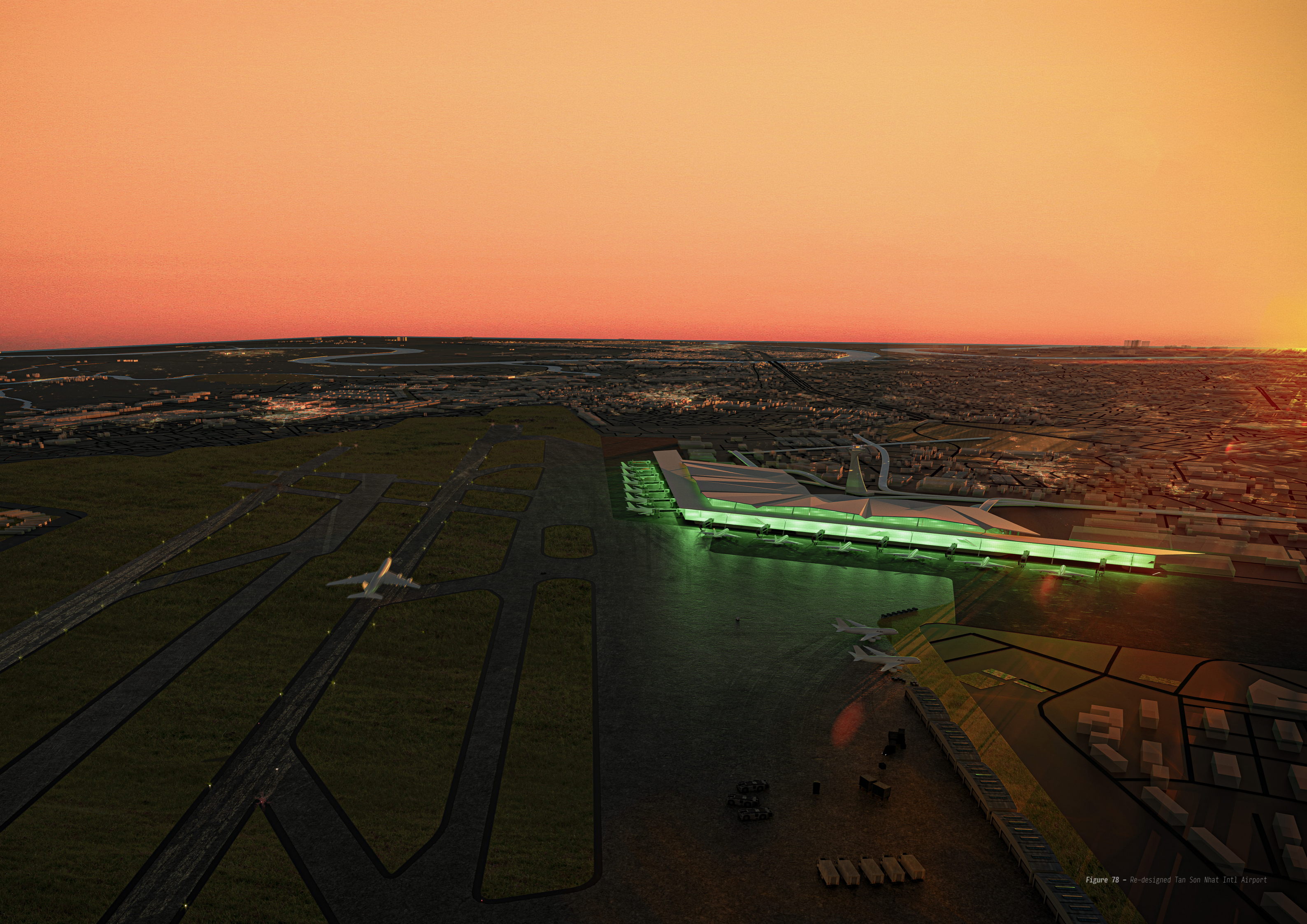


Figure 78 - Re-designed Tan Son Nhat Intl Airport

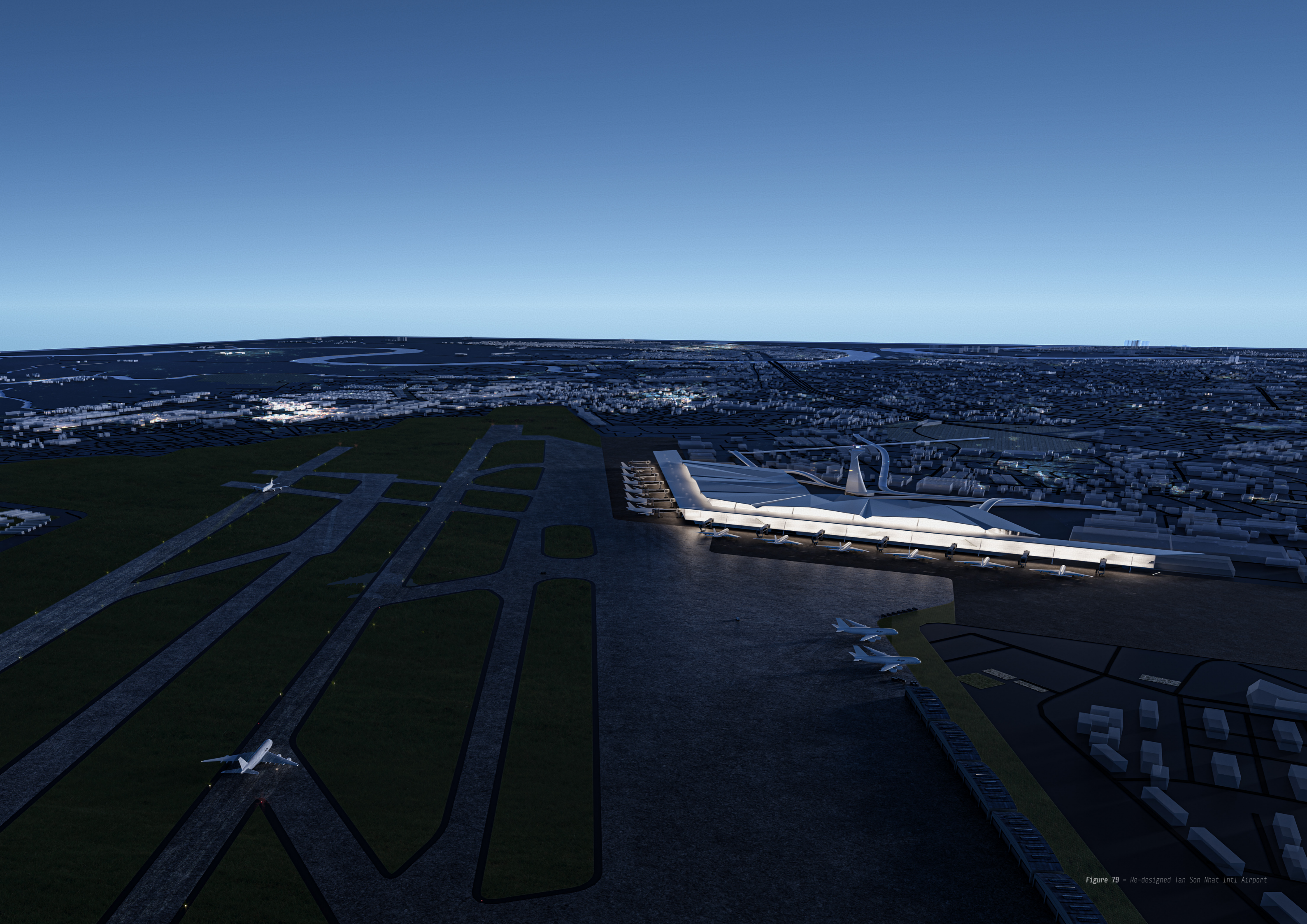


Figure 79 - Re-designed Tan Son Nhat Intl Airport

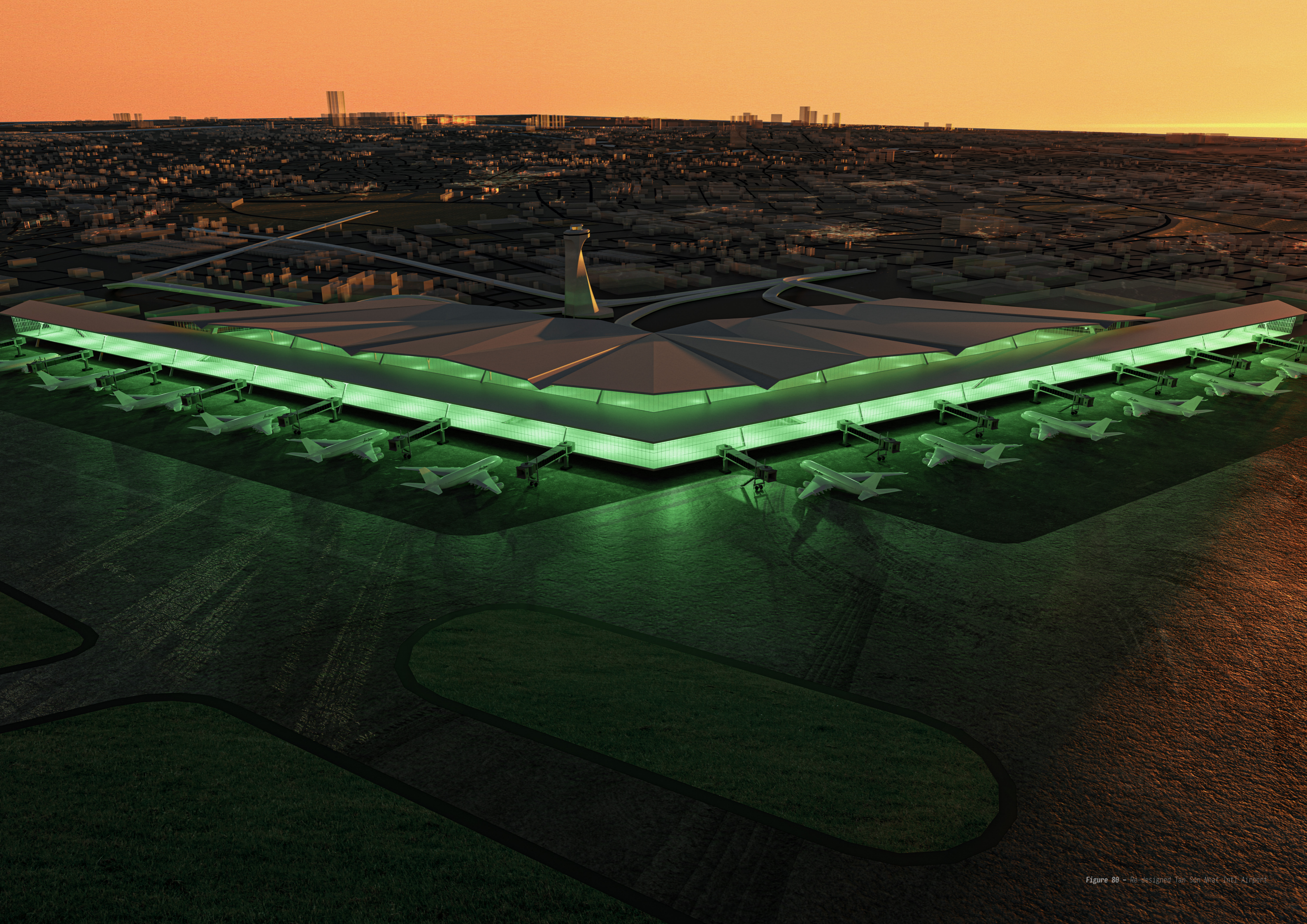


Figure 80 - Re-designed Tan Son Nhat Intl Airport

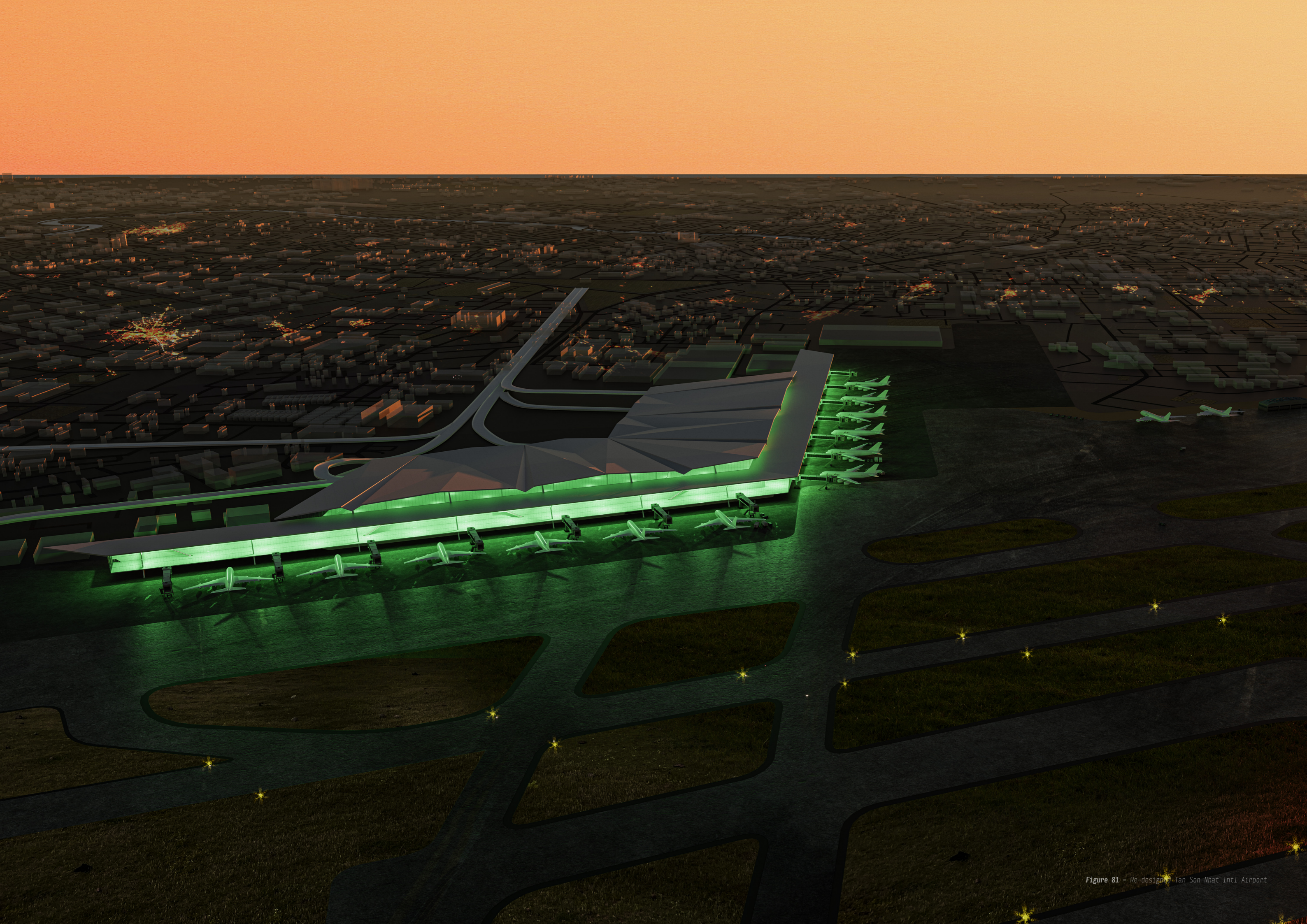


Figure 81 - Re-designed Tan Son Nhat Intl Airport

# Previous Experience

- \_2ND YEAR\_**  
 FALL 2019: MILT YERGENS  
 Project: River Oaks House  
 Project: Boat House  
 SPRING 2020: EMILY GUO  
 Project: Dwelling House  
 Project: Mixed Used  
 Project: Faculty Apartment - Sevens Loft

- \_3RD YEAR\_**  
 FALL 2020: REGIN SCHWAEN  
 Project: Inclination  
 Project: Spiral with floating green terraces  
 SPRING 2021: CINDY URNESS  
 Project: Healthcare Clinic

- \_4TH YEAR\_**  
 FALL 2021: AMAR HUSSEIN  
 Project: Highrise Capstone - The Steps  
 SPRING 2022: AMAR HUSSEIN  
 Project: Marvin Competition  
 Project: Urban Design - Bal Laguna

- \_5TH YEAR\_**  
 FALL 2022: GANAPATHY MAHALINGAM  
 Project: THESIS RESEARCH  
 SPRING 2022: GANAPATHY MAHALINGAM  
 Project: DESIGN THESIS

### Where?

Tan Son Nhat Intl Airport was originally built in the 1930s. At first, it was only the Domestic Terminal. Later in 1975, it opened to the public. The Domestic Terminal serves approximately 15 million passengers per year. The International Terminal currently serves approximately 10 million passengers per year. Amidst the urban sprawl, the site has very minimal vegetation for barriers. The two runways align from SW to NE, posing a constant threat of crosswinds.

### Forms Exploration

Define the masses of both terminals.  
 Combine and extend the mass of both terminal in a harmonious way, ensuring the efficiency of its functions.  
 Cutaway to create space for the extension ramp for the metro line. Maintaining a sense of fluidity and connectivity.  
 Curve the mass of the terminal to create a sense of transparency through the use of materials while also providing a breathtaking view of the surrounding landscape.

More than just a spatial problem  
**It's cultural**  
 If you have ever been to an airport in Viet Nam, specifically Tan Son Nhat Airport, you will know it is a whole level of "extra." You won't be going alone - your entire family, in-laws, and even your distant cousins will join you. Where is the space allotted for them? It's not just a spatial problem, but a cultural challenge that requires more attention.

Divide the domain of the roof structures into unique different segments. Enhancing the overall visual appeal and spatial experience of the terminals.  
 Manipulate points to create variations in height, allowing an abundance of natural light to permeate through the spaces.  
 Beveling the corner to seamlessly transition between spaces, creating a cohesive and uniform design language.

### Assessment

**Strength**  
 Nestled in the heart of Ho Chi Minh city, Tan Son Nhat International Airport reigns supreme as the nation's busiest airport, playing a pivotal role in the country's economy and transportation industry. Boasting a prime economic, political, and geographical position. Its a prime location with close and convenient travel distance is a key factor.

**Weakness**  
 The airport's exclusive access point is through Truong Son St., resulting in significant congestion on this route. Additionally, there is no public transportation available for commuters. Vehicles, such as cars or four buses, are required to park in the South Parking lot, while motorcycles must be parked in the South West lot, opposite the Domestic Terminal. Furthermore, the terminals were built at different times, resulting in them functioning as two separate buildings. This means that domestic passengers who need to transit to an international flight must travel outside and go through the entire process again, and vice versa. This issue not only impacts the passenger experience but also has a significant economic impact on the airport, as it cannot effectively serve a larger number of people. It's a pressing challenge that needs to be addressed.

**Opportunity**  
 Tan Son Nhat Airport is an iconic landmark for the city and a foundation for the economy. But the outdated facilities hinder the airport's performance and create a less-than-ideal experience for passengers and visitors. With that in mind, it has many potentials to be great. Improving the performance of the passenger is essential when re-designing the airport. Enhance the experience through architecture, and provide a sense of guidance and transparency. Also, emphasizing and thinking for the visitor, the family members that go along to wish goodbye. It's an important part of the culture and needs to be addressed accordingly.

### AnyLogic Performance Analysis Model

After the architectural design was finalized, the floor plan was recreated in AnyLogic software, a powerful tool used for simulating and testing the performance of complex systems. In this case, the software was utilized to model and analyze the passenger flow within the designed space. The simulation included various processes that mirror real-life scenarios, such as passenger check-in, custom and security clearance, and gate navigation. Similarly, arriving passengers were also simulated to go through processes like arrival, immigration and custom. Based on the simulation results, necessary modifications were made to the design to optimize the flow rate, ensuring smooth passenger movement. Additionally, consideration was given to the appropriate placement of other functions and structures to avoid any hindrance to the passenger flow.

### Program Diagram



## TAN SON NHAT Intl AIRPORT

Re-designing passenger travel experience.

