
TAN SON NHAT Intl AIRPORT
Re-designing passenger travel experience.

/* a Research upon airline passenger experience

<context: aviation, Narita International Airport>

by
_Ly Truong Phuc Dang___

_Dr. Ganapathy Mahalingam___
Primary Thesis Advisor

_Stephen Wischer___
Thesis Committee Chair

_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 C0ntent

TABLE OF FIGURES

TABLE OF FIGURES

TABLE OF FIGURES

TABLE OF FIGURES

Abs

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.

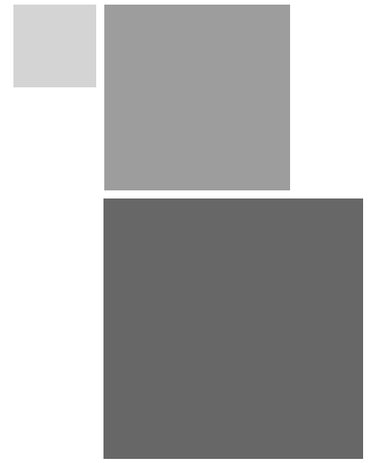
This research intends to look at passenger experiences when travelling via commercial aviation through the lens of modern technology. The research will look and analyze a typical passenger’s experiencewhen travelling via commercial aviation.

Narita Airport

/* 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 de-
    partures 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.
```

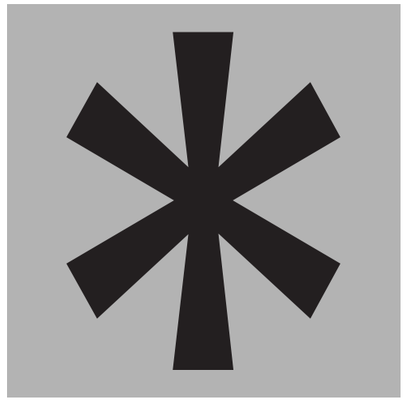
```
/*  Terminal 1 uses a satellite terminal design di-
    vided into a North Wing, Central Building, and a
    South Wing. Two circular satellites, Satellites 1
    (gates 11-18) and 2 (gates 21-24), are connect-
    ed to the North Wing. Satellites 3 and 4 (gates
    26-38 and gates 41-47) compose a linear concourse
    connected to the Central Building. Finally, sat-
    ellite 5 (gates 51-58) is connected to the South
    Wing. The terminal has a floor space of 463,000 m2
    (4,980,000 sq ft) and is equipped with 40 gates.
```

Figure 01 – Narita International Airport Site Plan

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

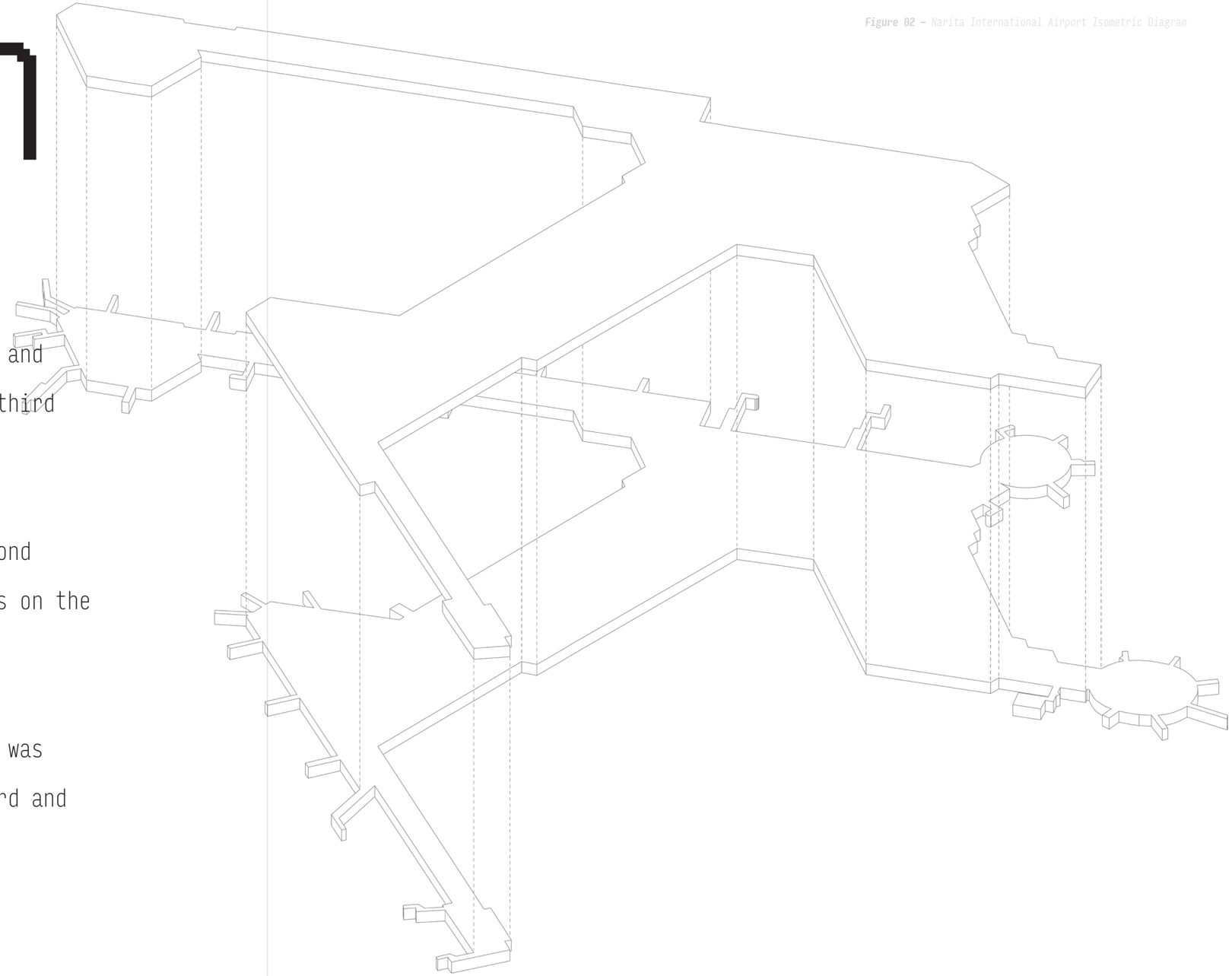


Figure 02 – Narita International Airport Isometric Diagram

/* 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

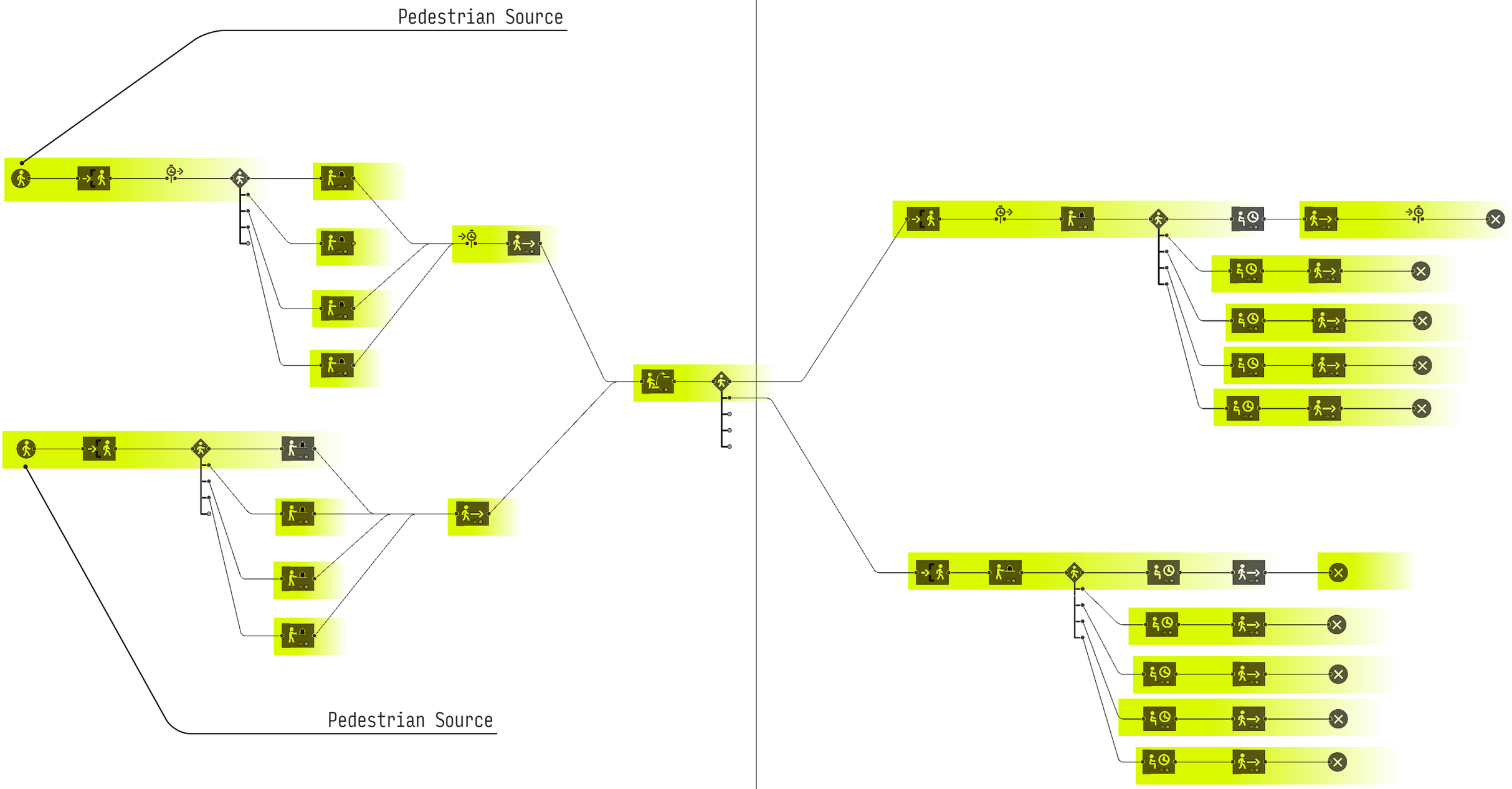


Figure 03 – AnyLogic Algorithm_Pedestrian Sources

Algorithm

AnyLogic

AnyLogic

Algorithm

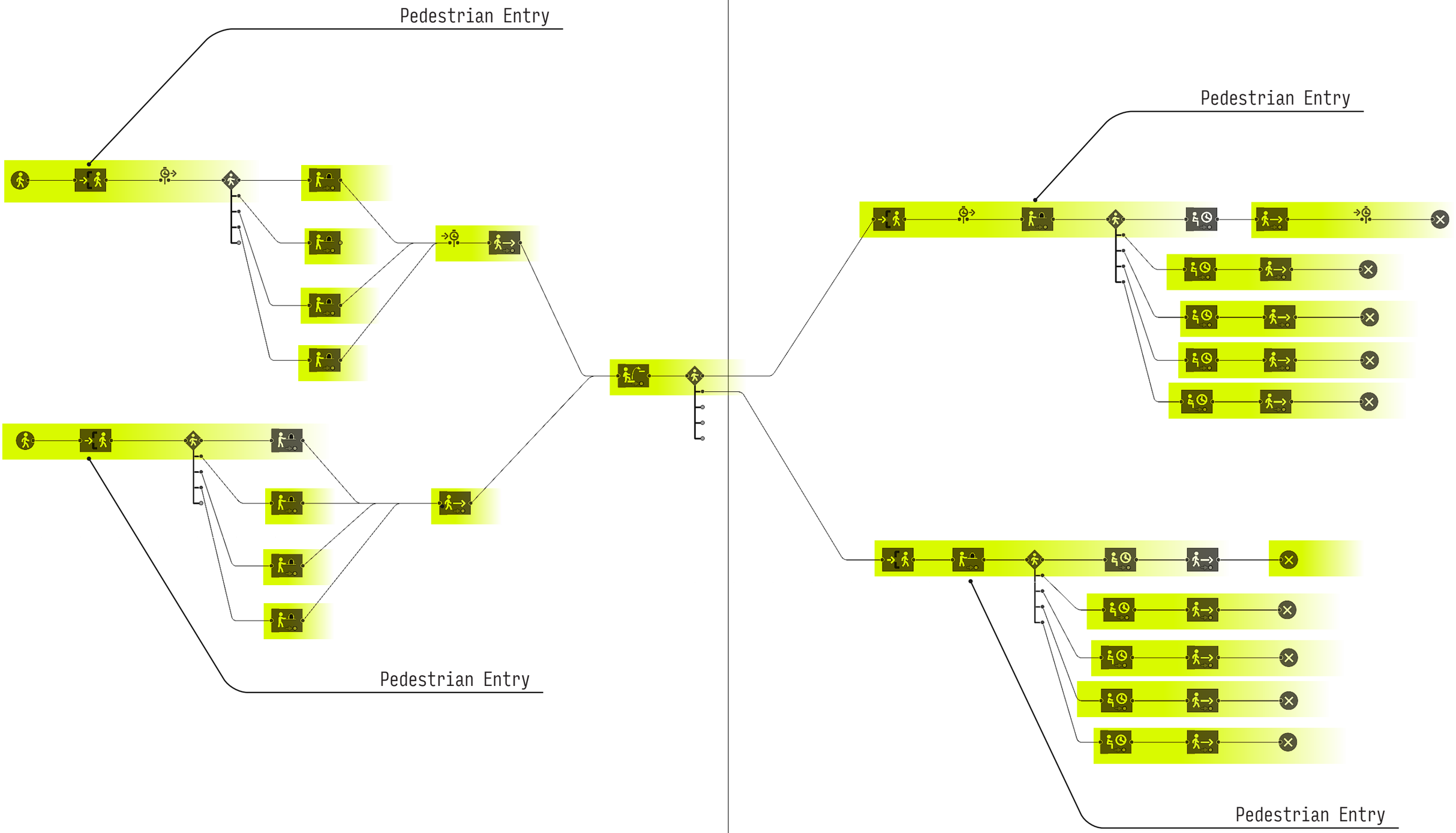


Figure 04 – AnyLogic Algorithm_Pedestrian Entry

AnyLogic

Algorithm

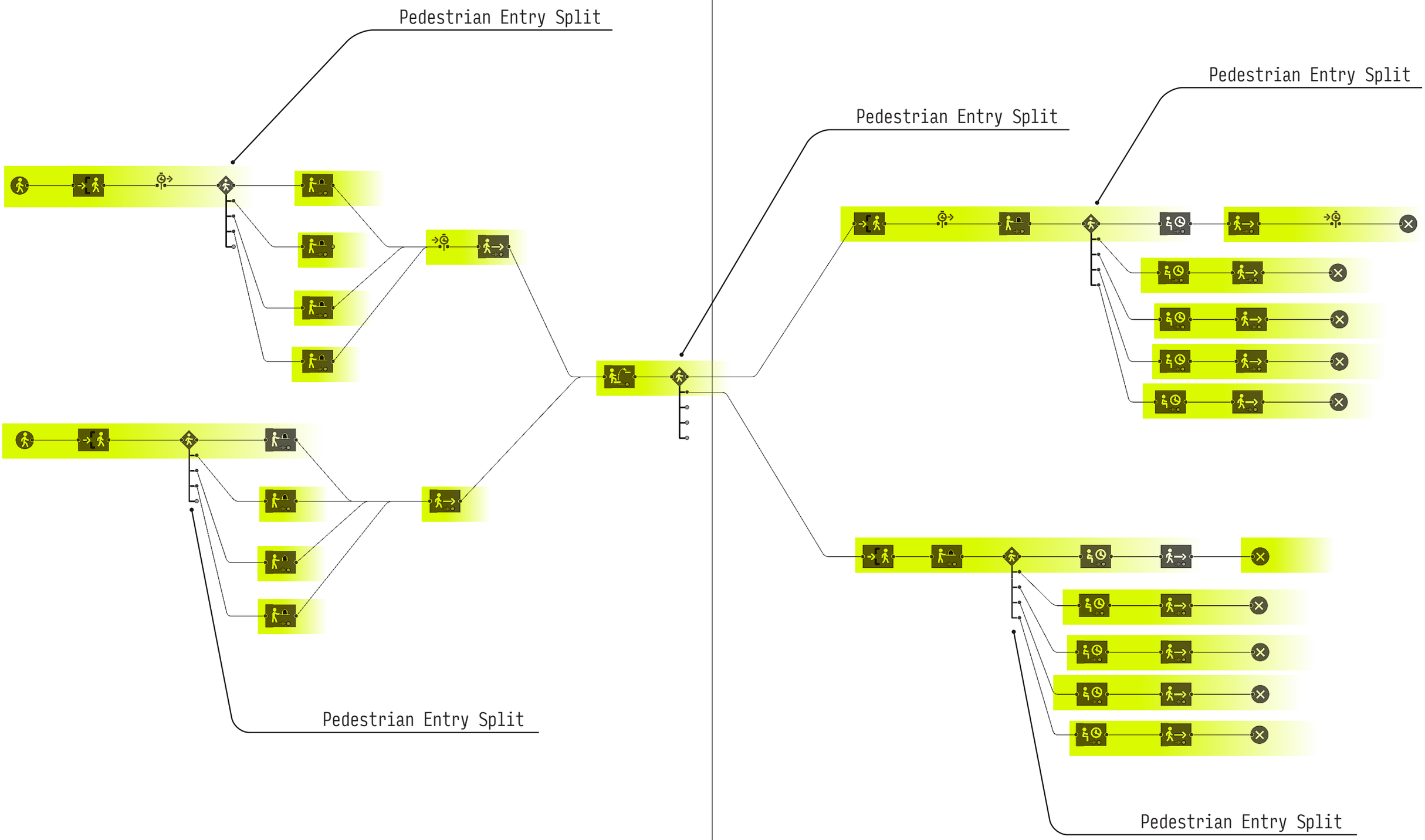


Figure 05 – AnyLogic Algorithm_Pedestrian Entry Split

Algorithm

AnyLogic

AnyLogic

Algorithm

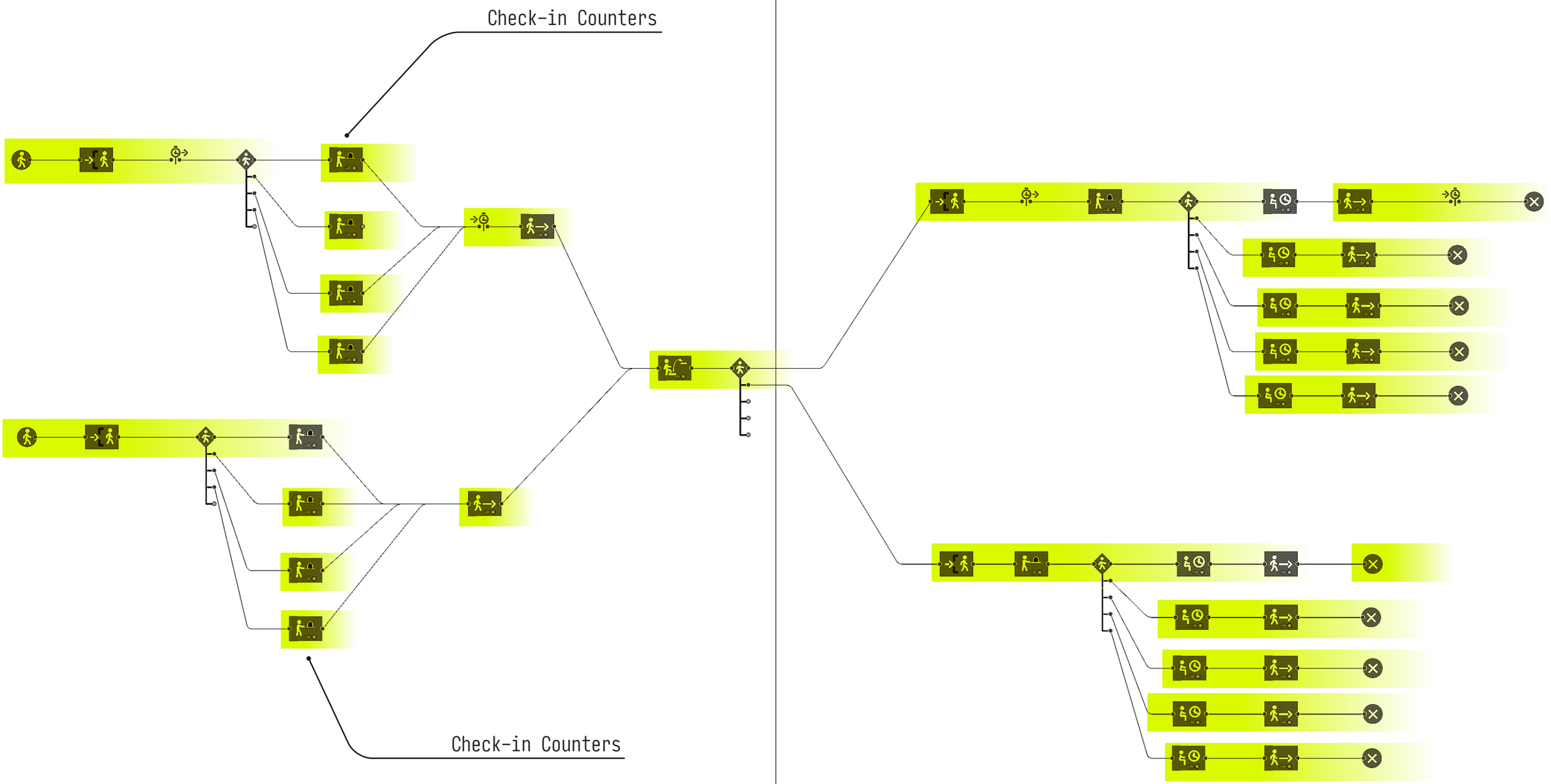


Figure 06 – AnyLogic Algorithm_Check-in Counters

Algorithm

AnyLogic

AnyLogic Algorithm

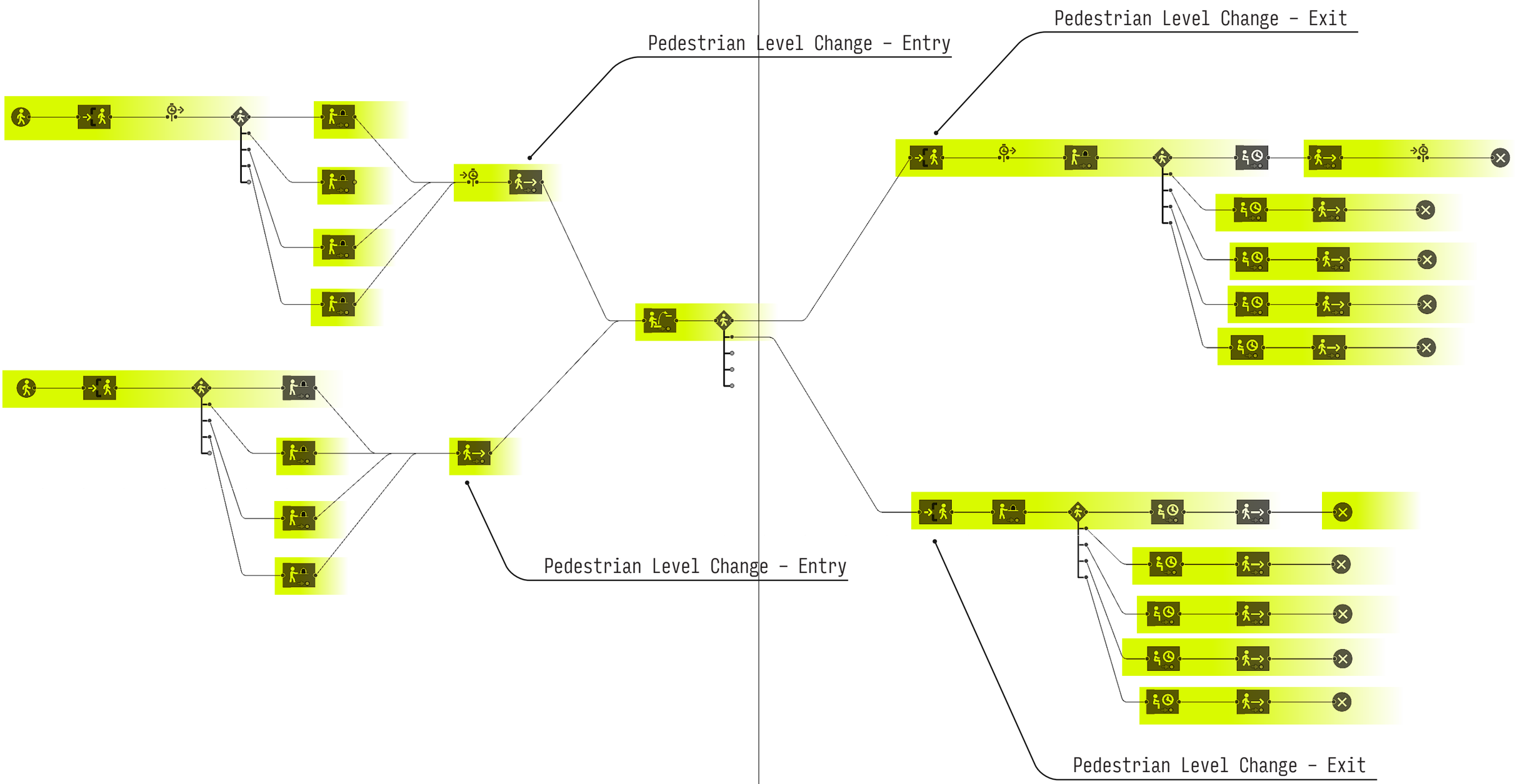


Figure 07 – AnyLogic Algorithm_Pedestrian Level Change

Algorithm AnyLogic

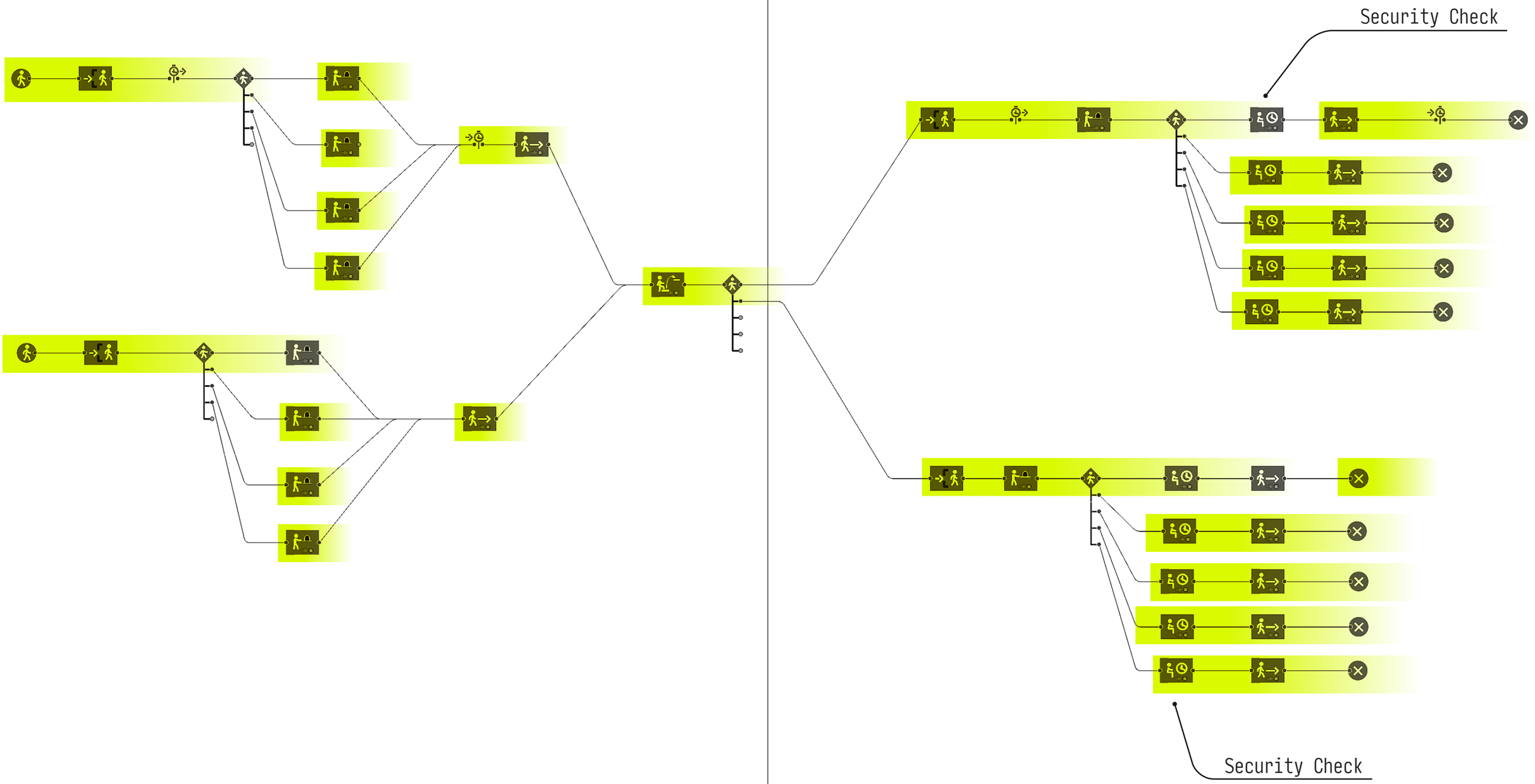


Figure 08 – AnyLogic Algorithm_Security Check

Algorithm AnyLogic

AnyLogic Algorithm

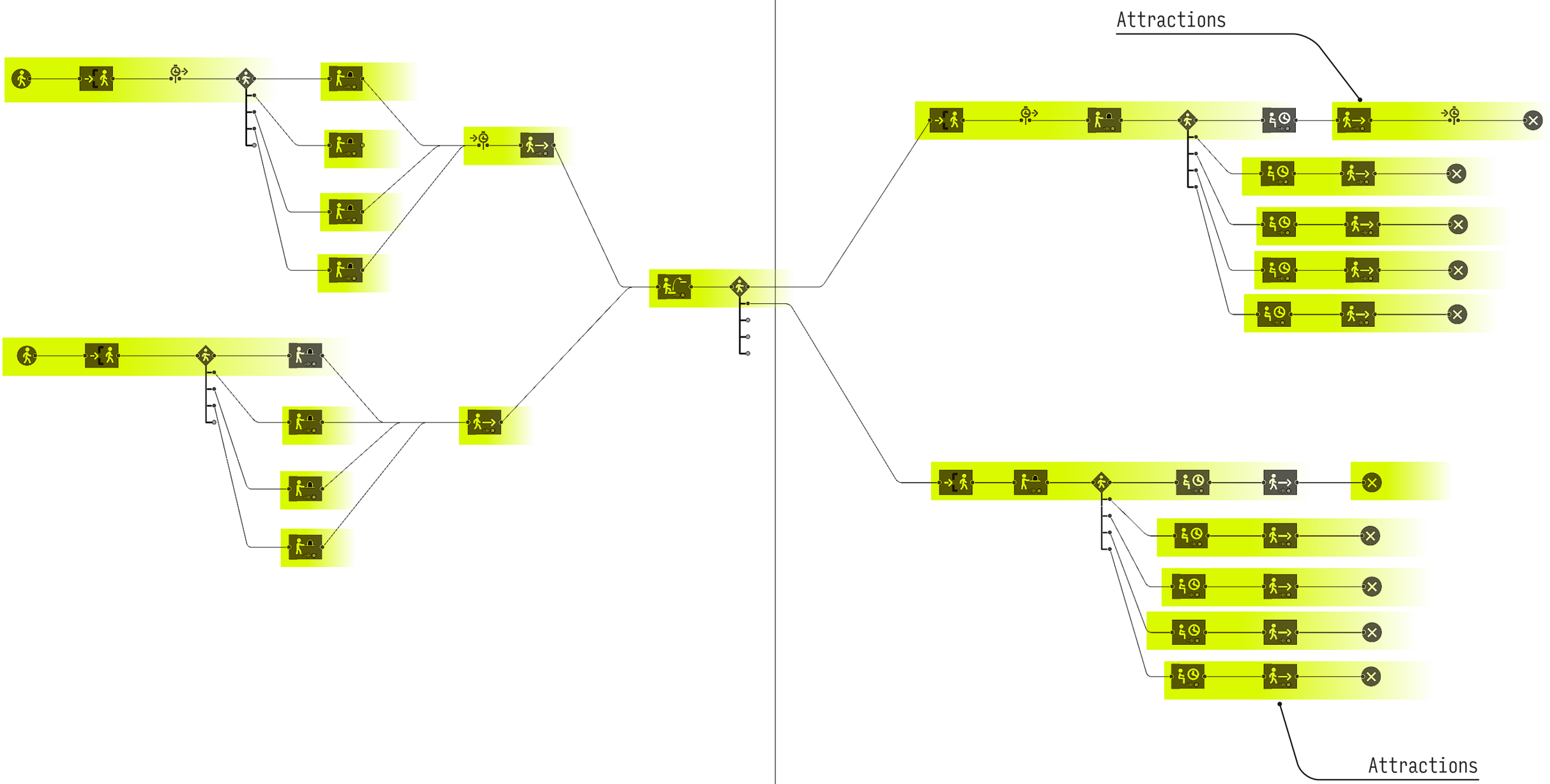


Figure 09 – AnyLogic Algorithm_Attractions

AnyLogic

Algorithm

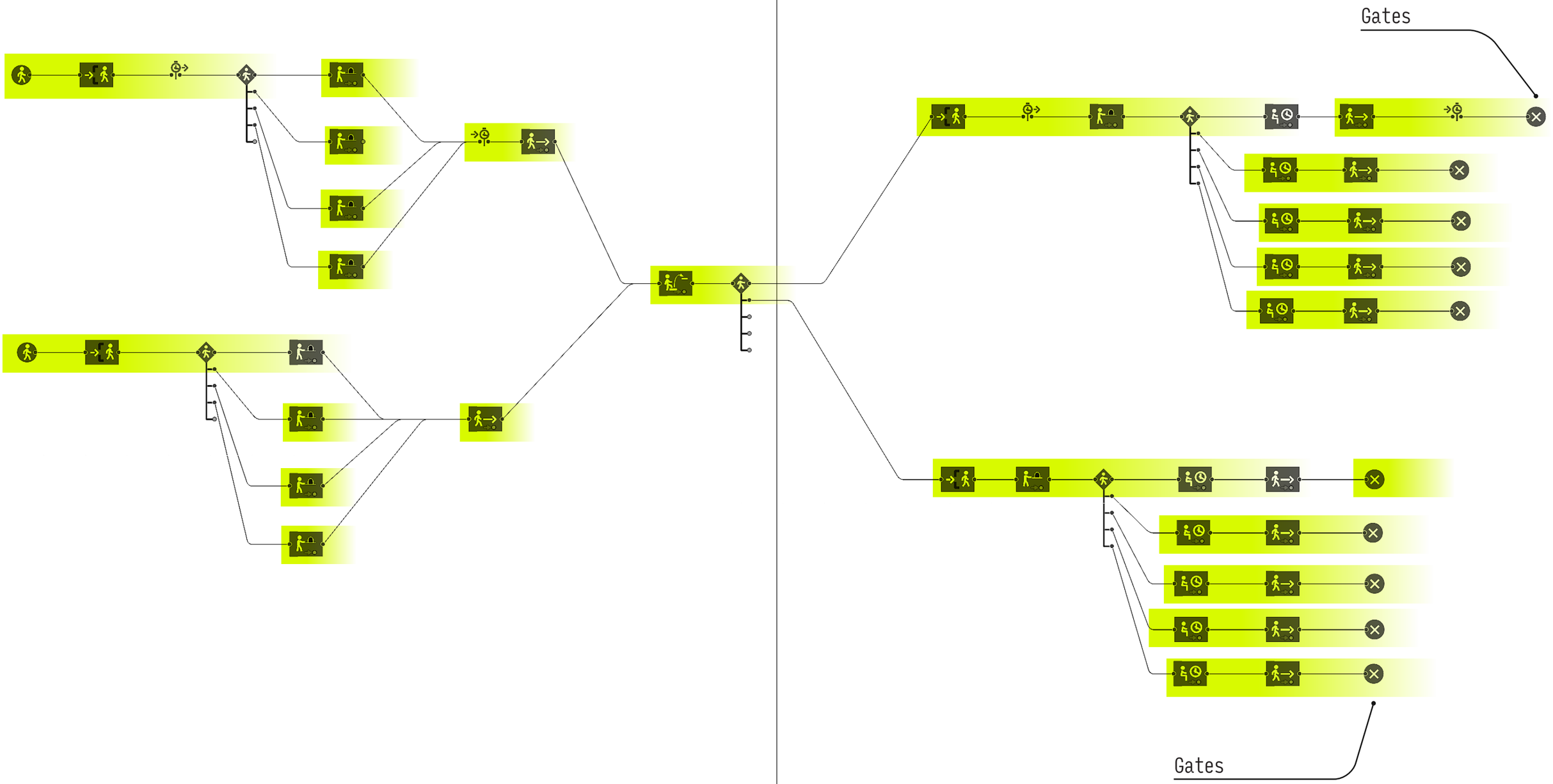


Figure 10 – AnyLogic Algorithm_Gates

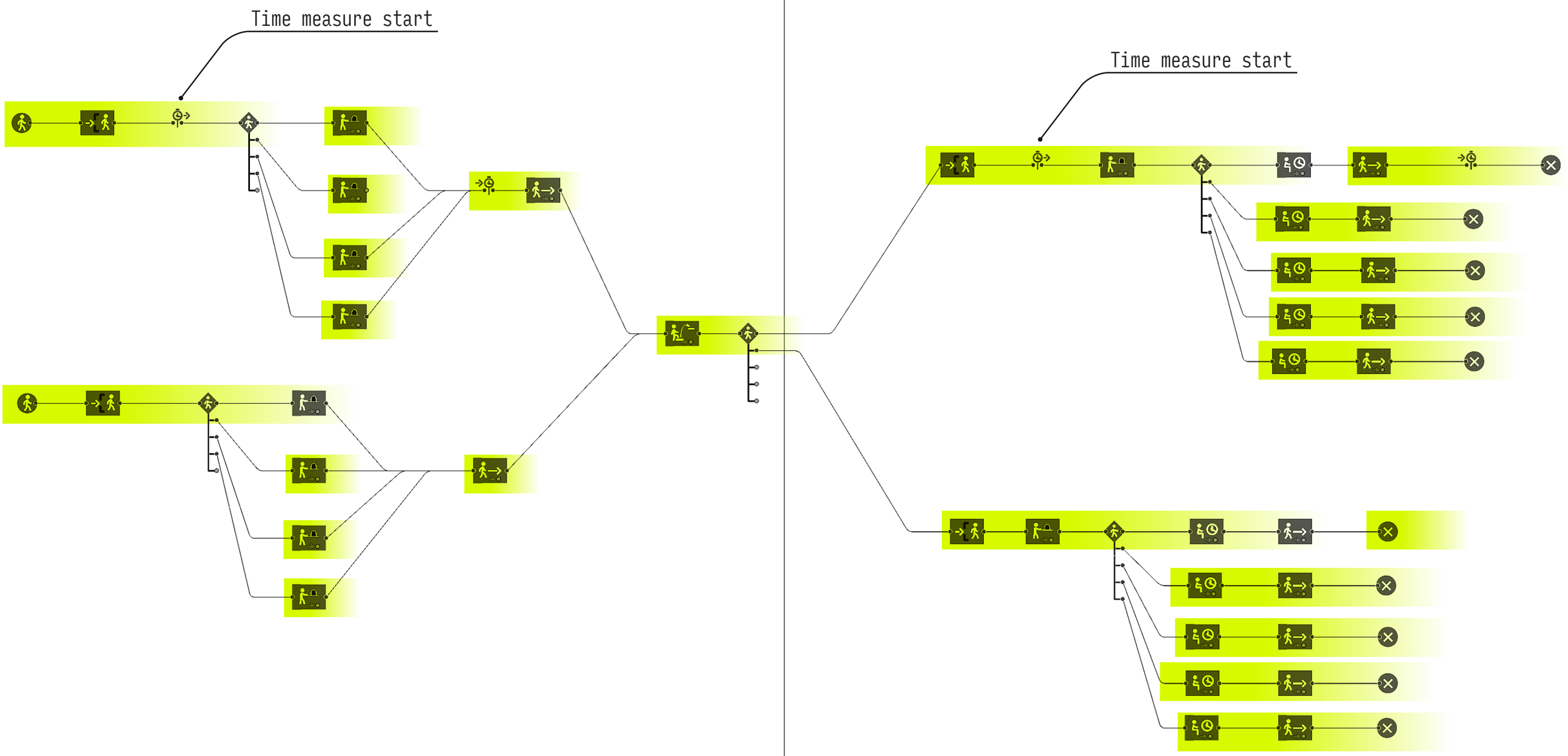
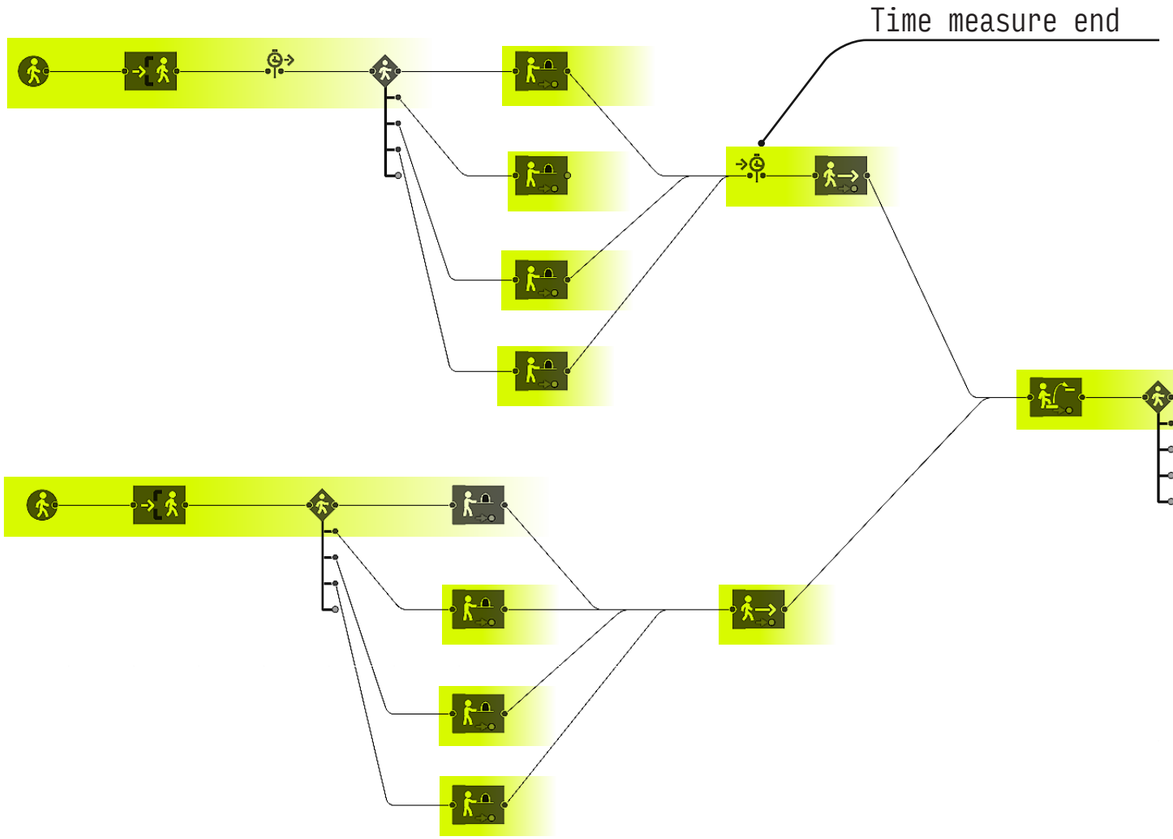


Figure 11 – AnyLogic Algorithm_Time Measure Start

Algorithm AnyLogic



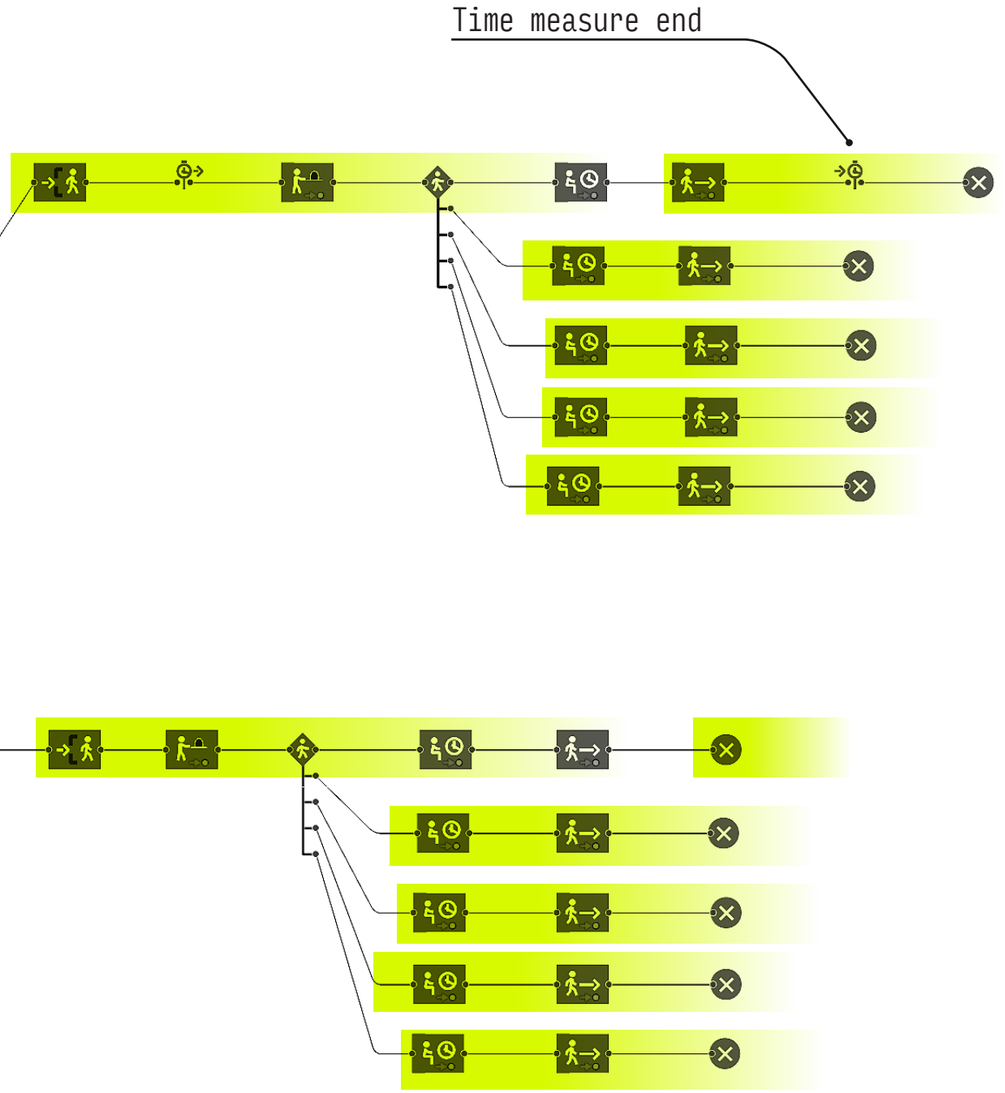


Figure 12 – AnyLogic Algorithm_Time Measure End

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

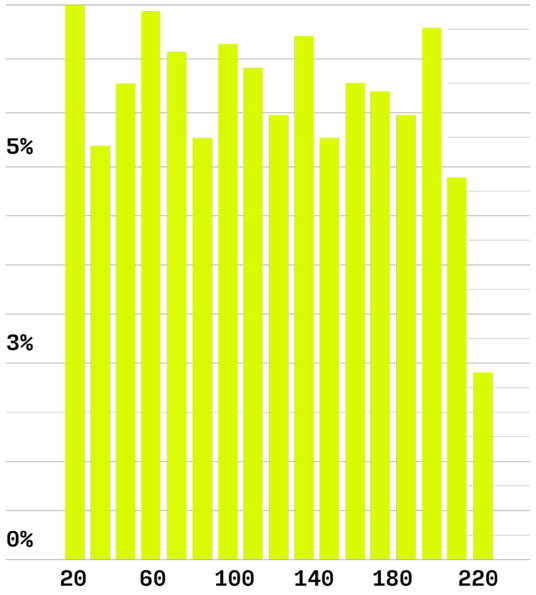


Figure 13 – *East wing Check-in 4th floor Histogram*

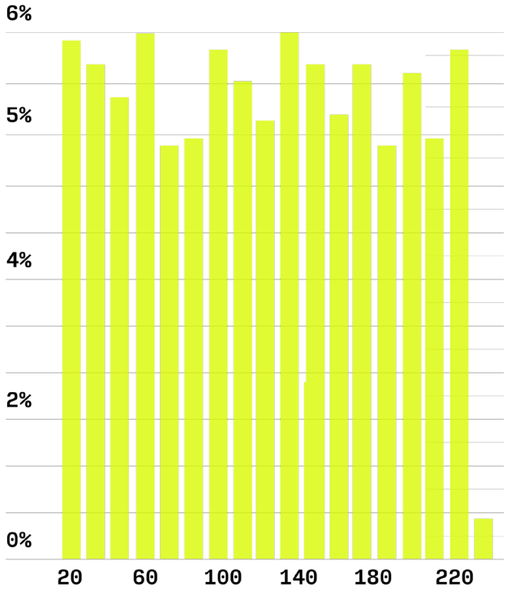


Figure 14 – *West wing Check-in 4th floor Histogram*

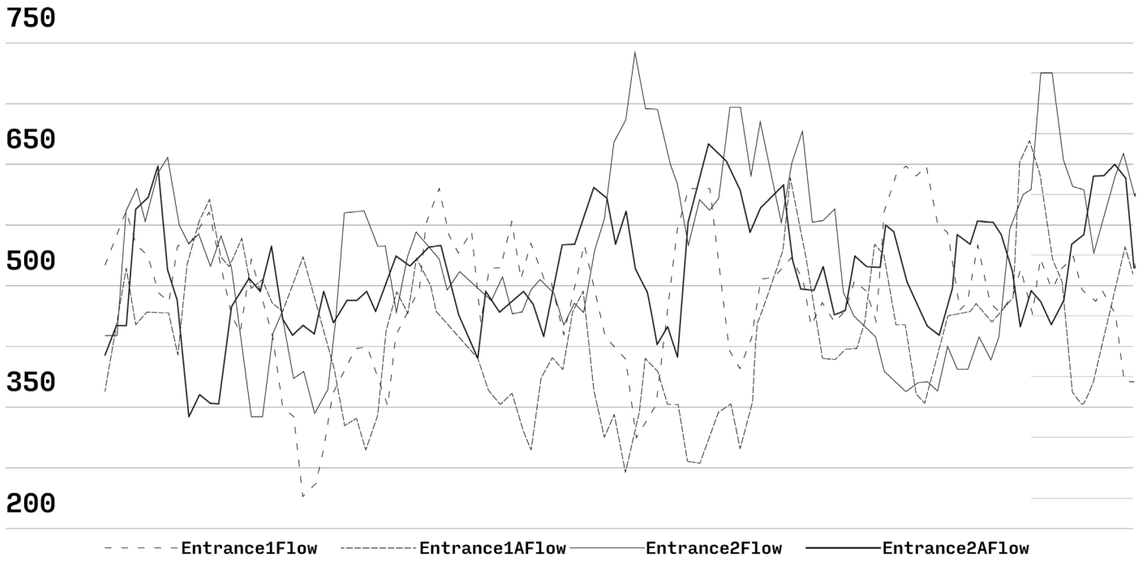


Figure 15 – *4th floor Pedestrian Flow Plot Chart*

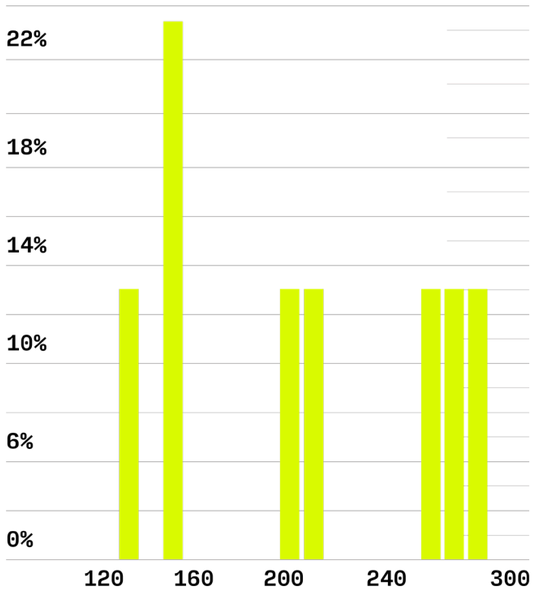


Figure 16 – *East wing Check-in 3rd floor Histogram*

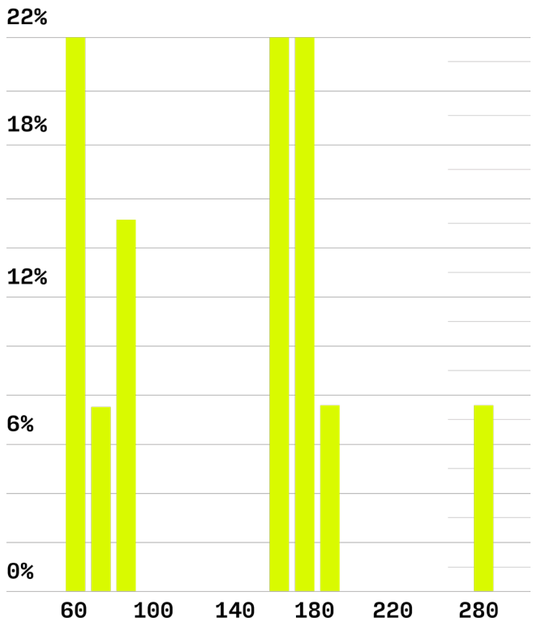


Figure 17 – *West wing Check-in 3rd floor Histogram*

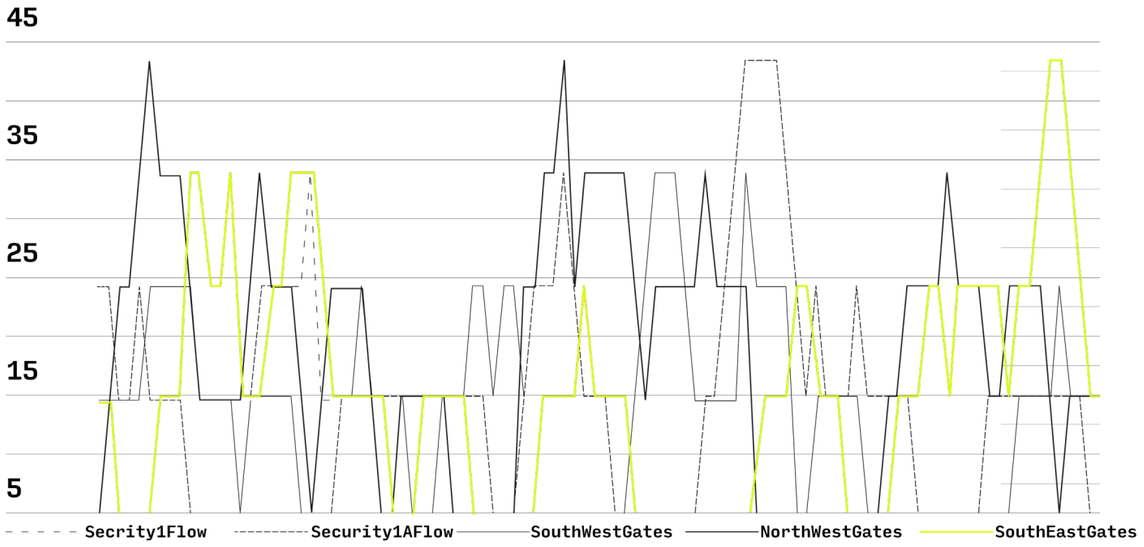


Figure 18 – *3rd floor Pedestrian Flow Plot Chart*

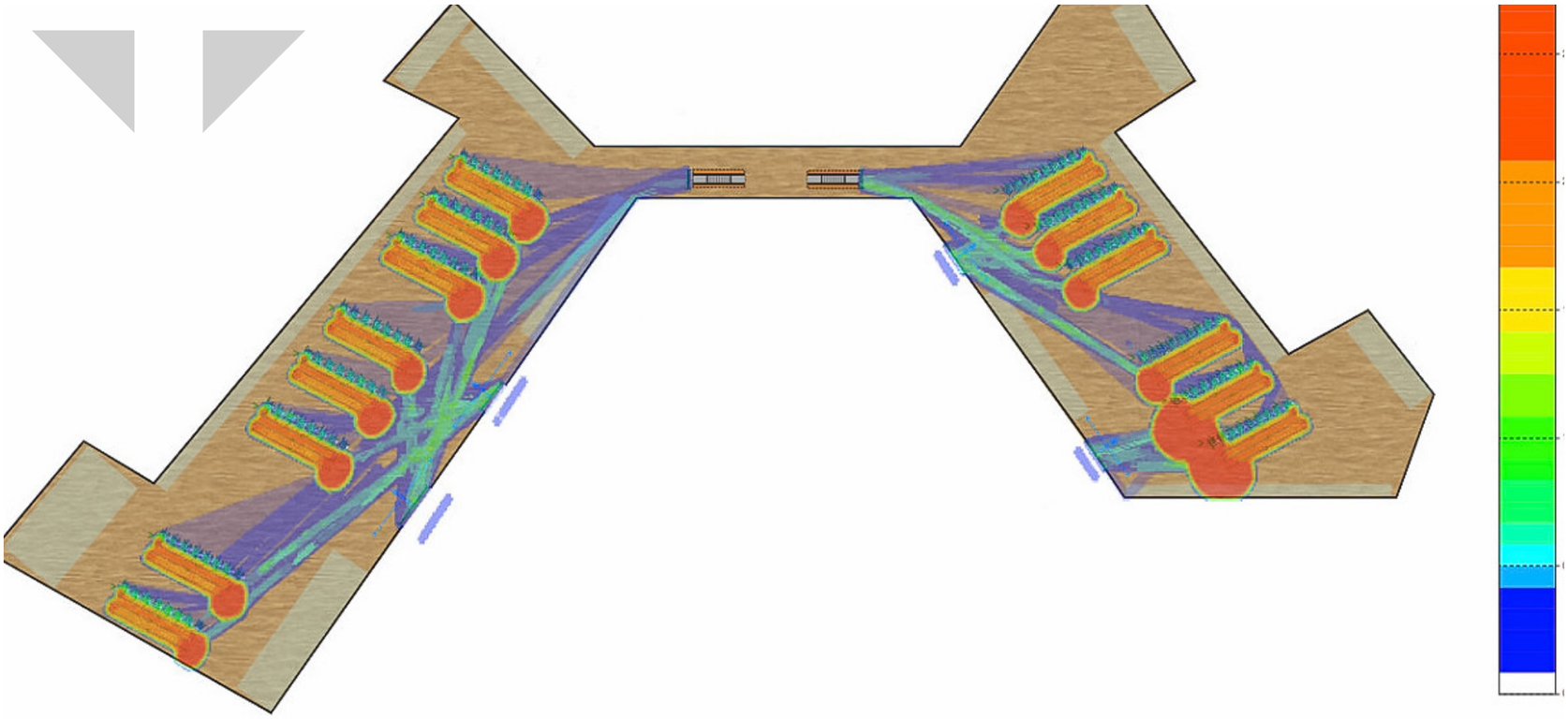


Figure 19 – *4th Floor Pedestrian Density Heatmap*

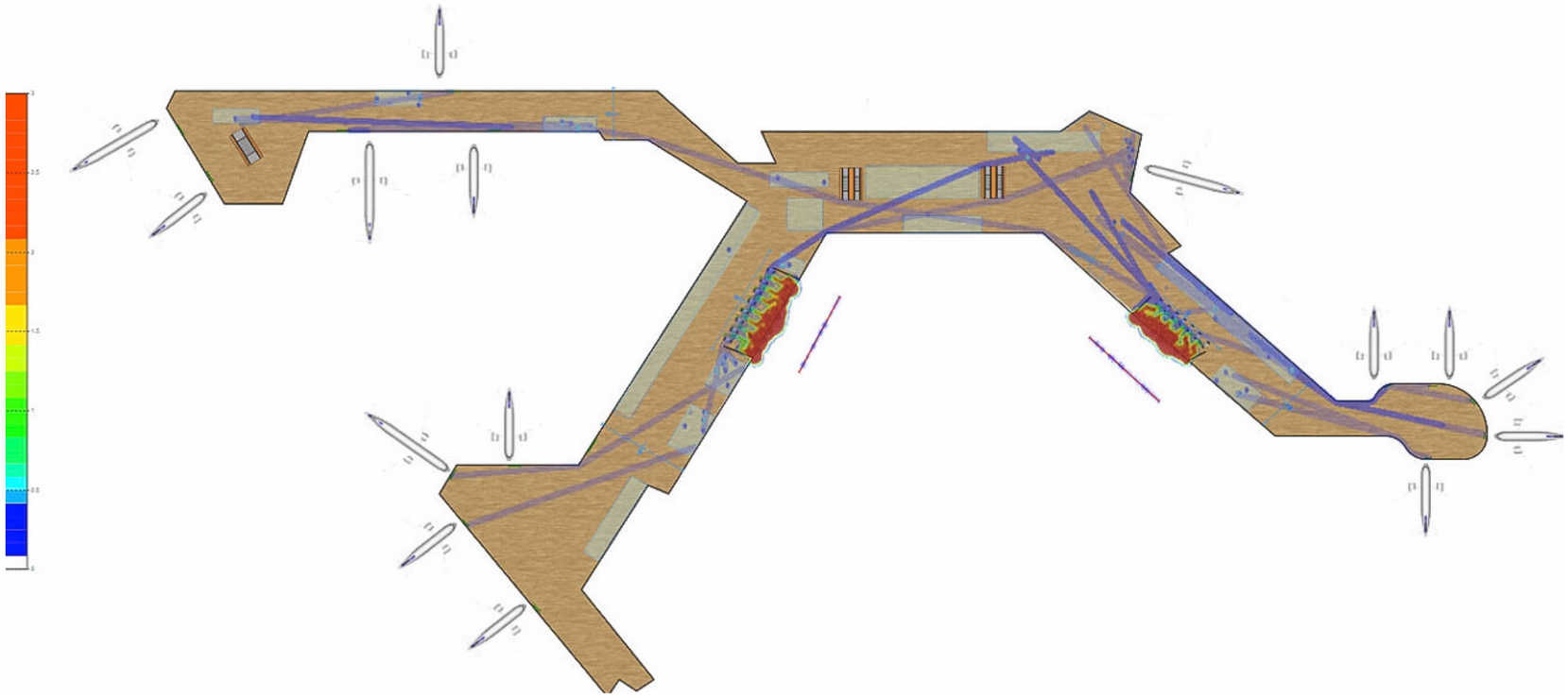


Figure 20 – *3rd Floor Pedestrian Density Heatmap*

12 Hours

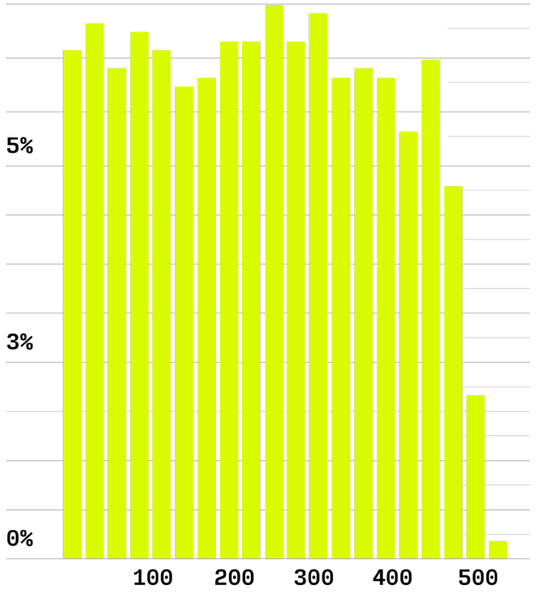


Figure 21 – East wing Check-in 4th floor Histogram

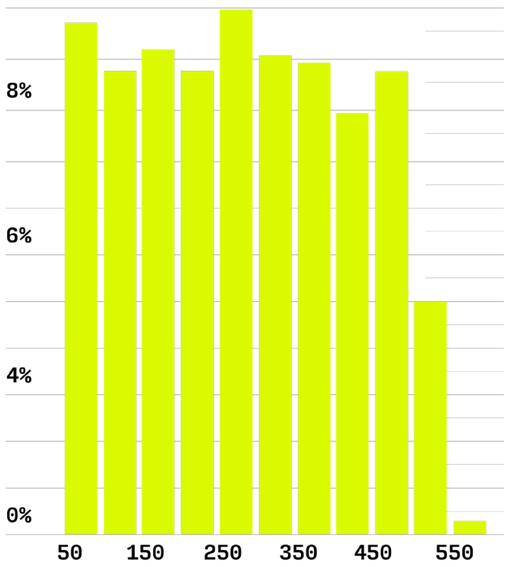


Figure 22 – West wing Check-in 4th floor Histogram

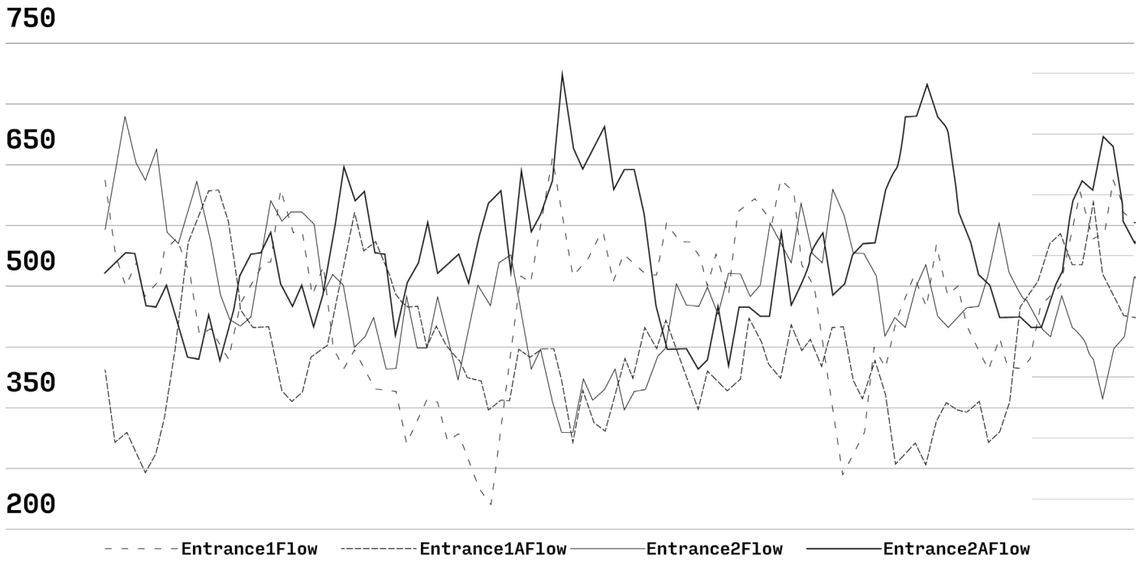


Figure 23 – 4th floor Pedestrian Flow Plot Chart

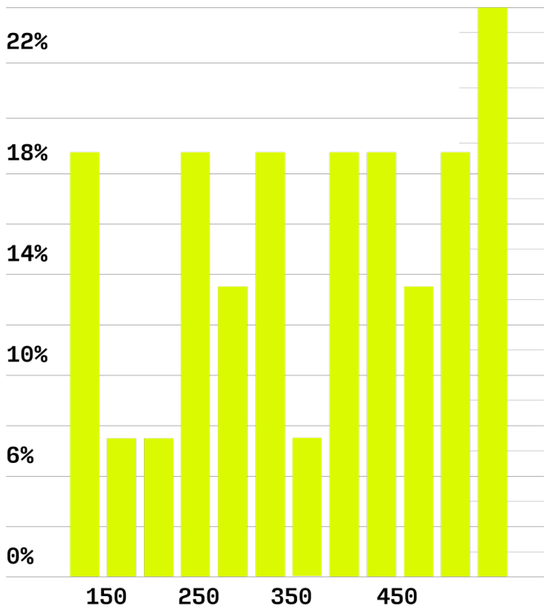


Figure 24 – East wing Check-in 3rd floor Histogram

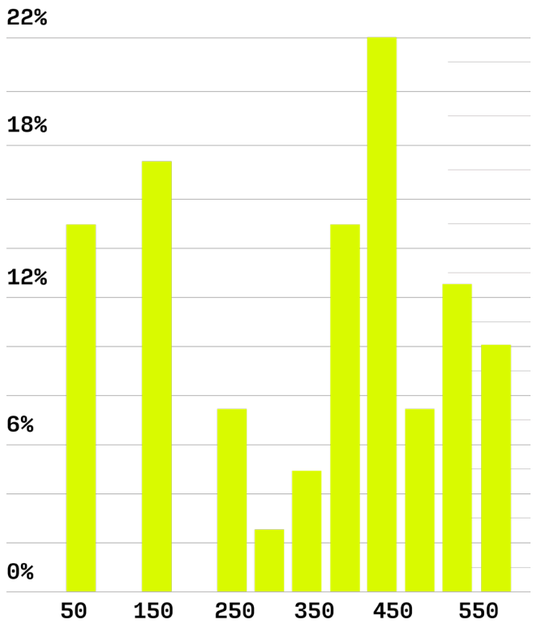


Figure 25 – West wing Check-in 3rd floor Histogram

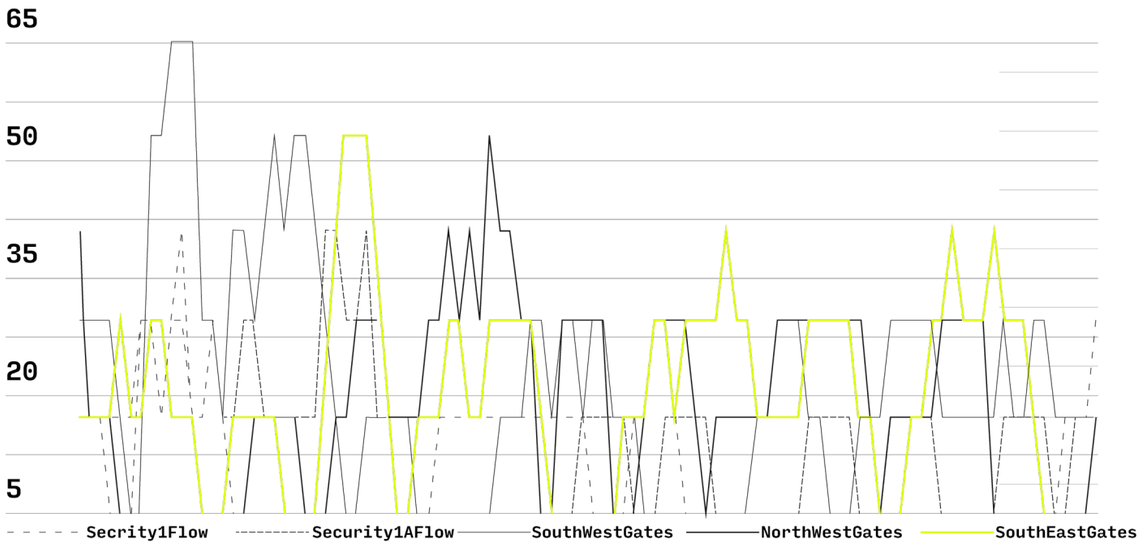


Figure 26 – 3rd floor Pedestrian Flow Histogram

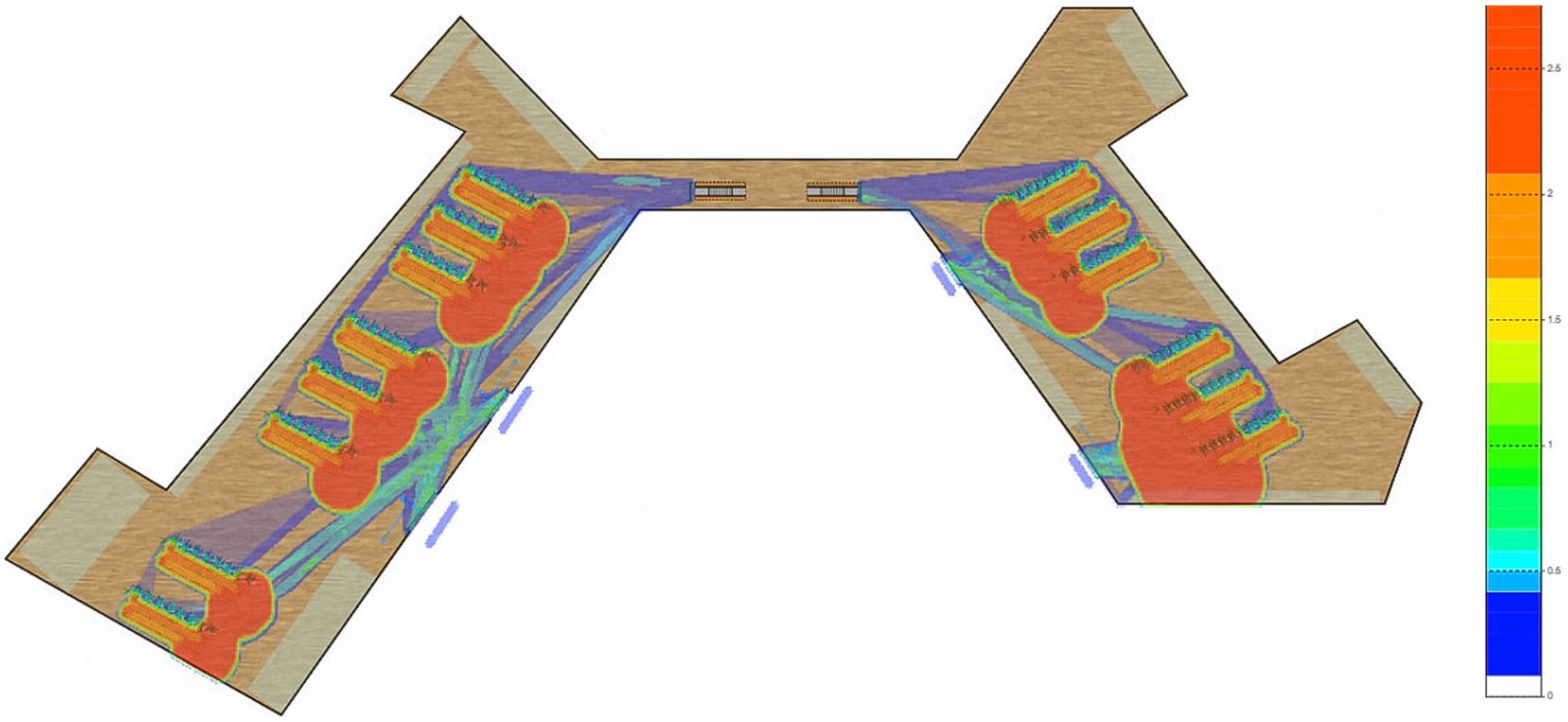


Figure 27 – *4th Floor Pedestrian Density Heatmap*

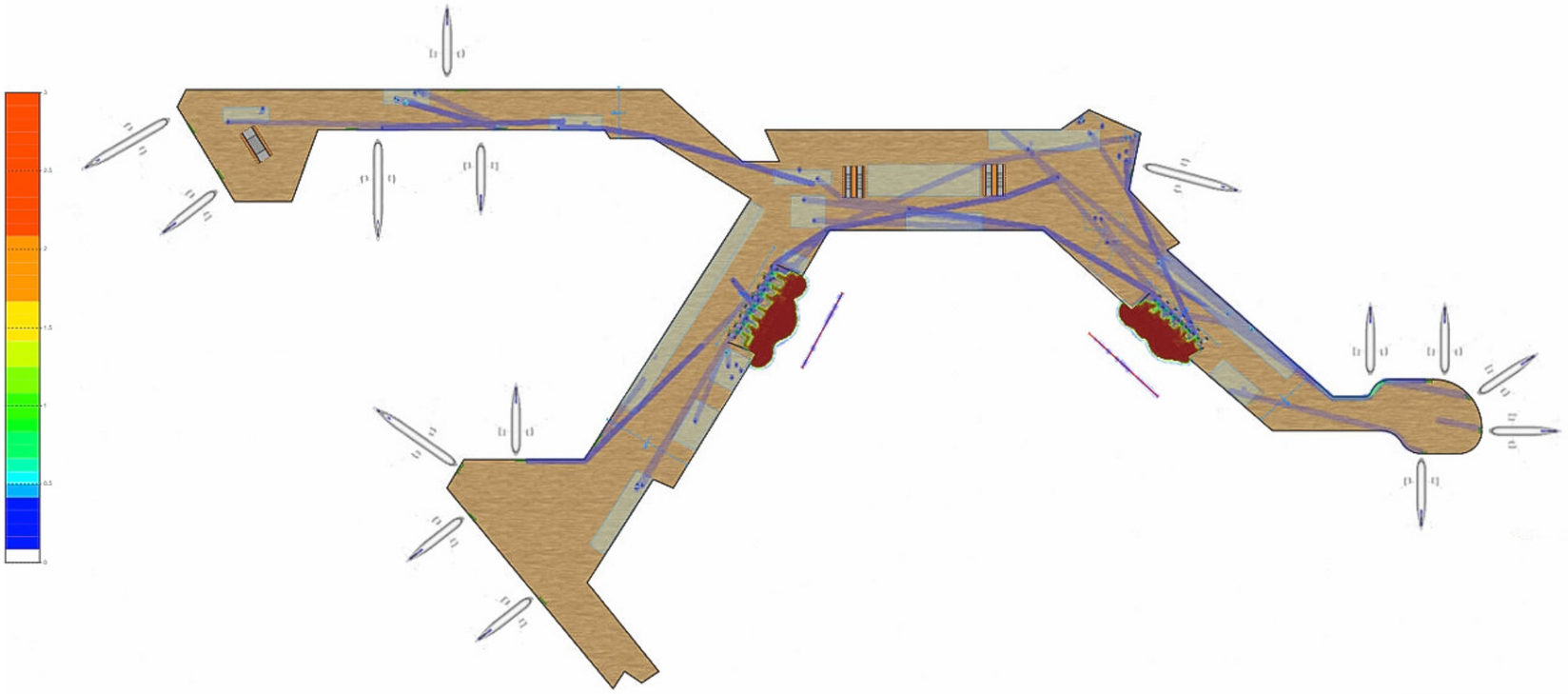


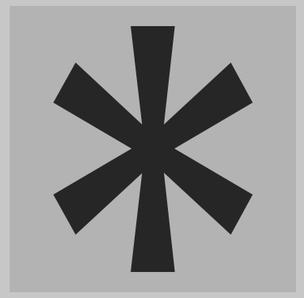
Figure 28 – *3rd Floor Pedestrian Density Heatmap*

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.

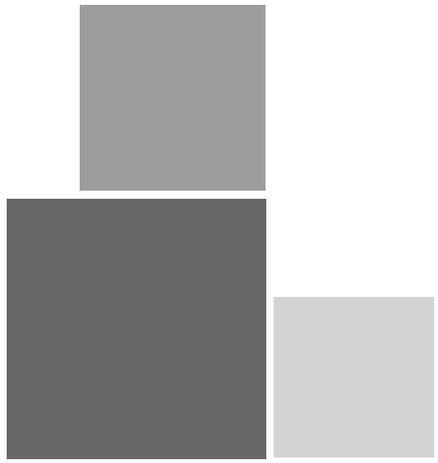
It needs more transparency for airline passengers travelling. The fact that passengers must travel from floor to floor to get to another checkpoint causes confusion and anxiety in travelling.

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.

Implication

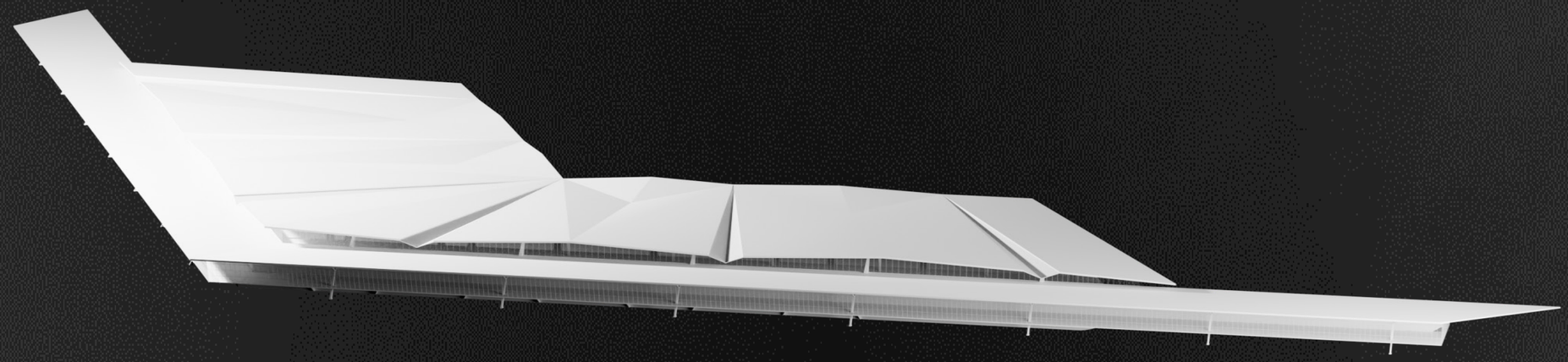


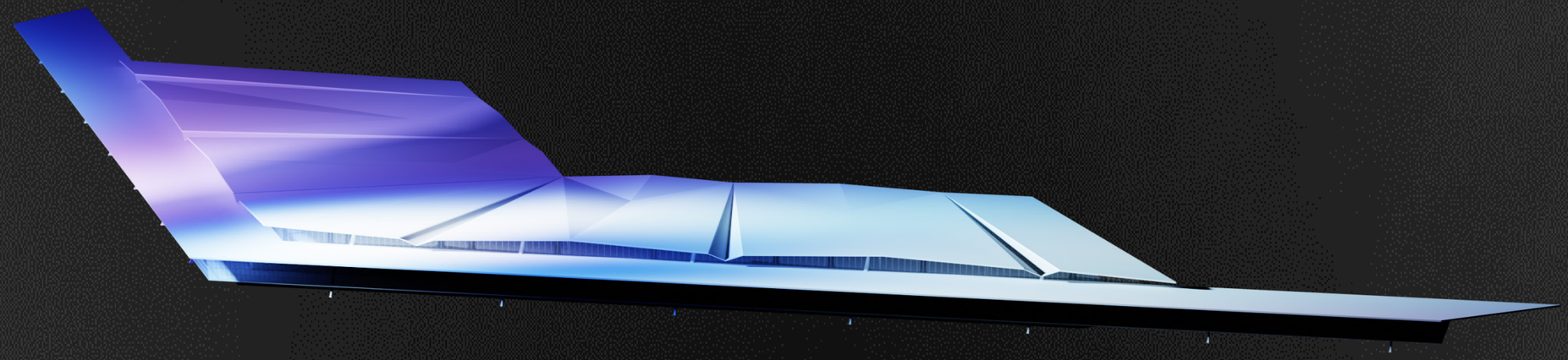
These simulation data are not guaranteed 100% accuracy, but it informs what is working and what is not.

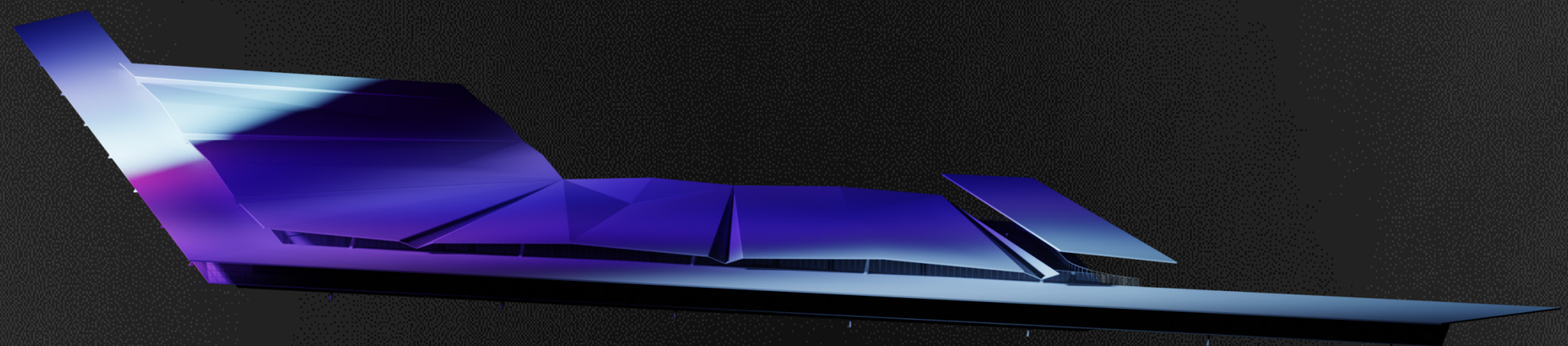
These are the important key ideas when looking at this research.

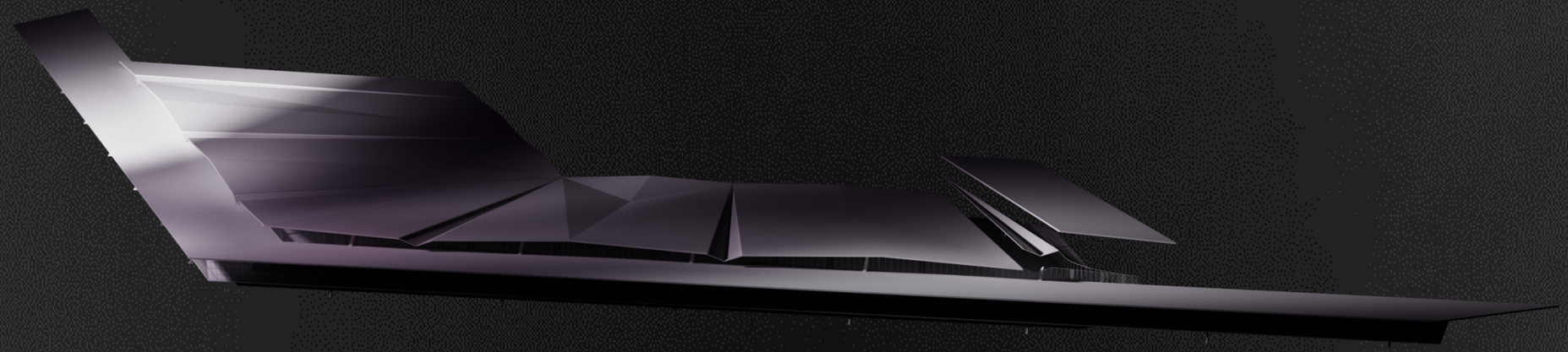
Heading into the thesis design project, armed with this knowledge and data, would not only help inform better design choices. For example, floor plans can be quickly formed and re-created within the software. In addition, the system performance can be simulated and tweaked on the spot.

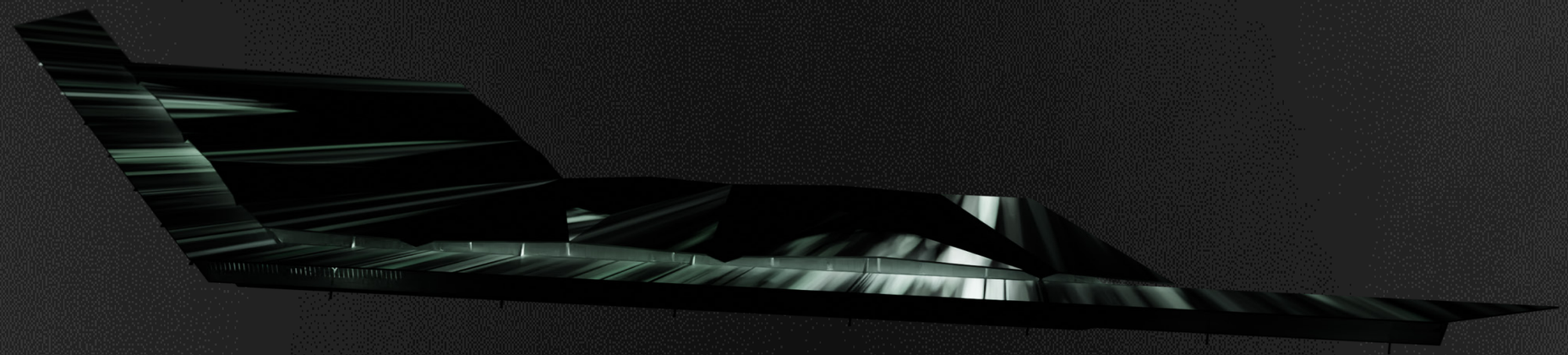
The more understanding one can get from the data, better design choices can be made down the road.

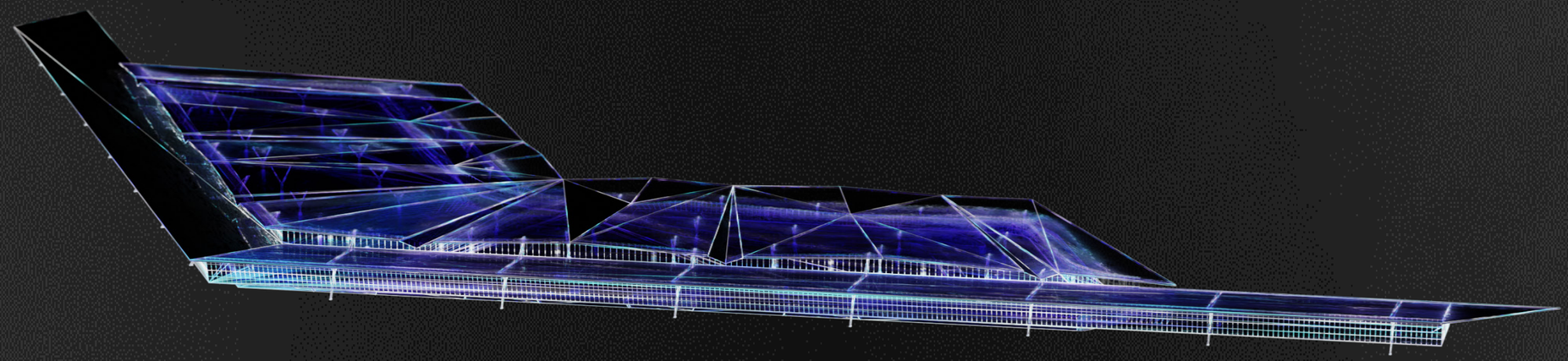








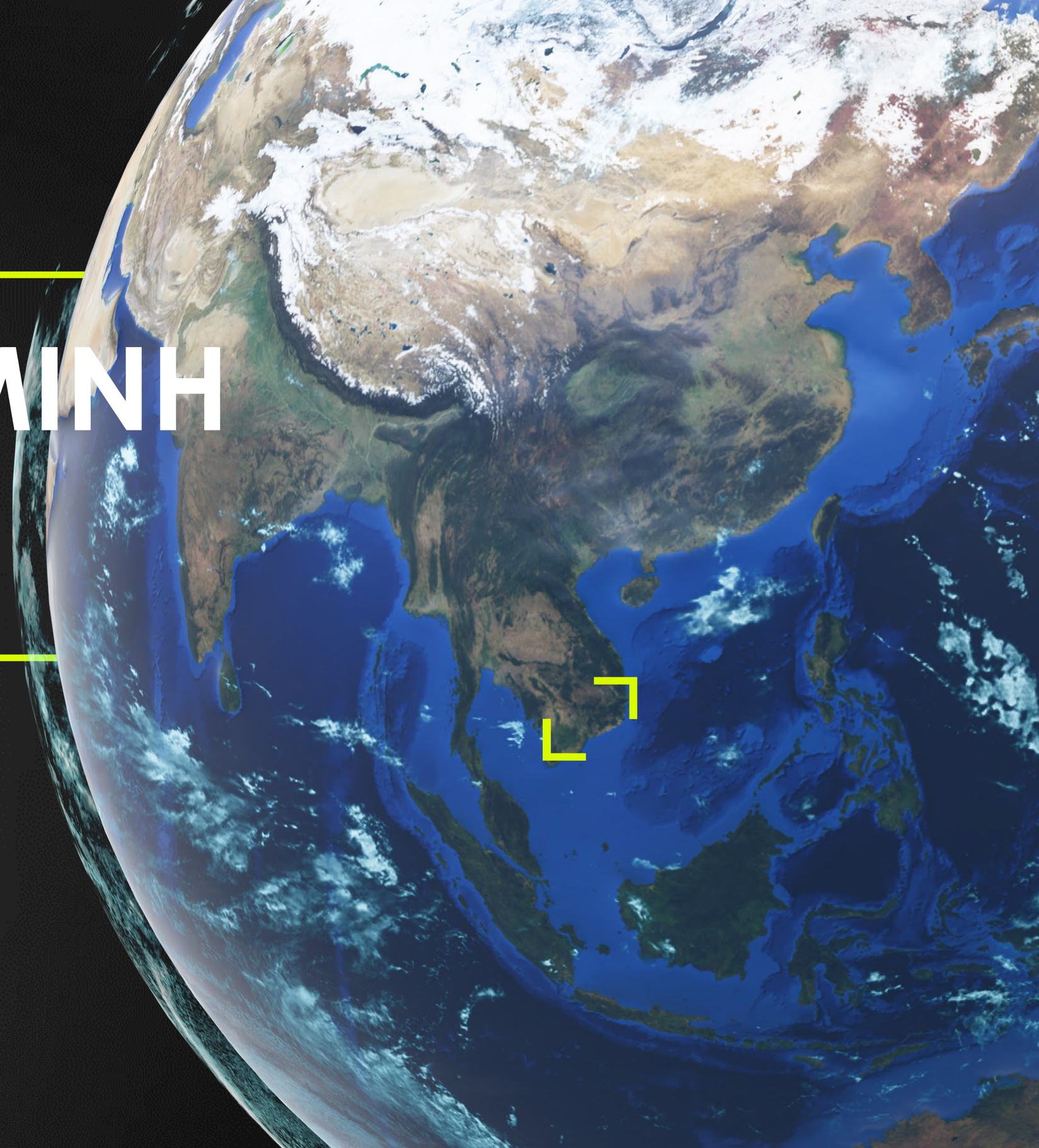




Where?

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 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.

Figure 29 –

Tan Son Nhat Aiport 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.

Figure 30 – Tan Son Nhat Intl Airport _ International Terminal

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

Figure 31 – *Tan Son Nhat Intl Airport _ Cicurlation*

_Can Only Be Accessed Through Truong Son St.
_No Public Transport Is Available
_Vehicles Can Be Parked In The South Lot

Figure 32 – Tan Son Nhat Intl Airport _ Parking

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

Figure 33 – Tan Son Nhat Intl Airport _ Terminal 3

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

Figure 34 – Tan Son Nhat Intl Airport _ Wind Analysis

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

Figure 35 – Tan Son Nhat Intl Airport _ Administration

Administration Facilities are currently placed in between two Terminals

Figure 36 – Tan Son Nhat Intl Airport _ Utilities

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

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.

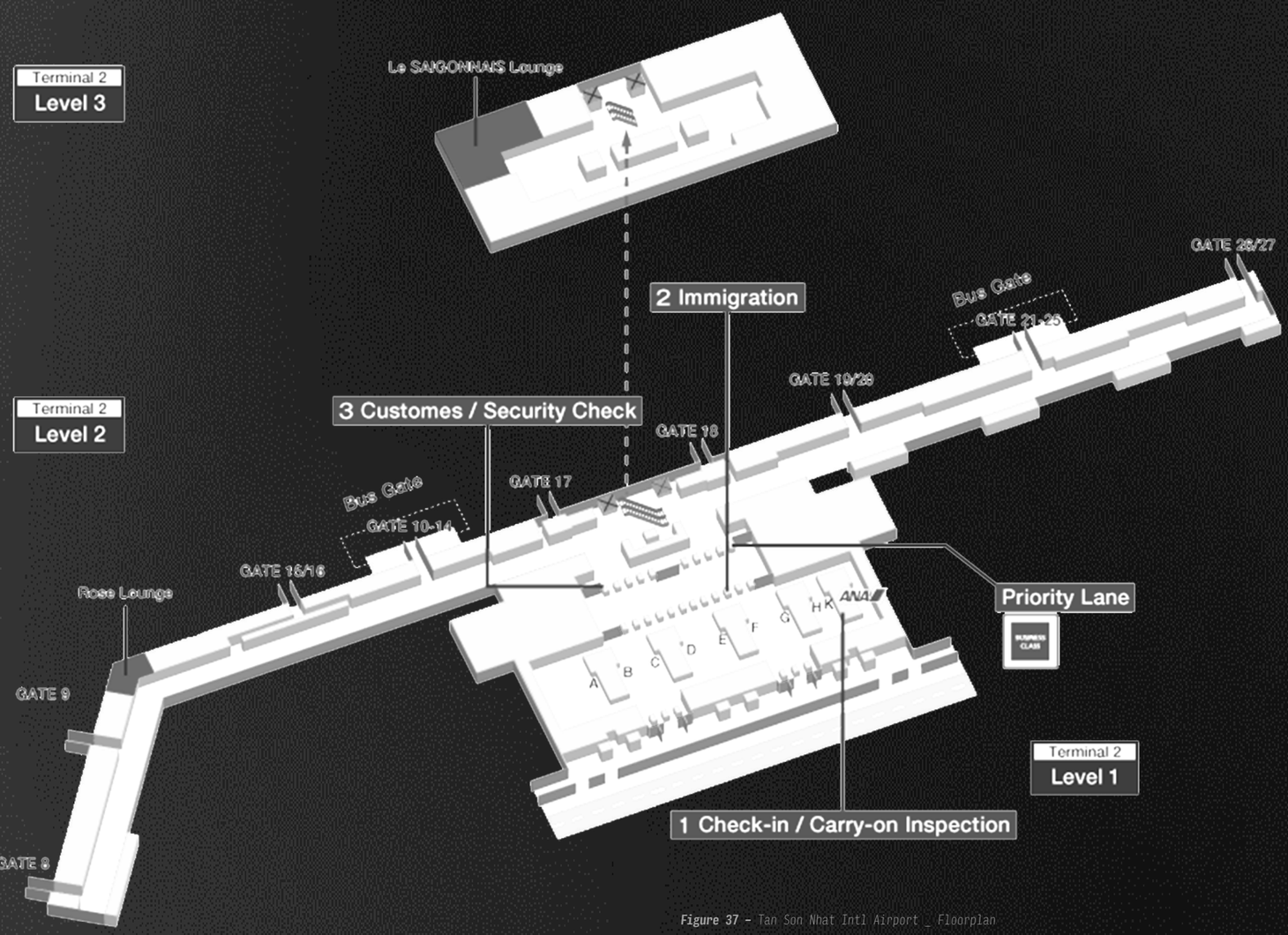


Figure 37 – Tan Son Nhat Intl Airport _ Floorplan

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

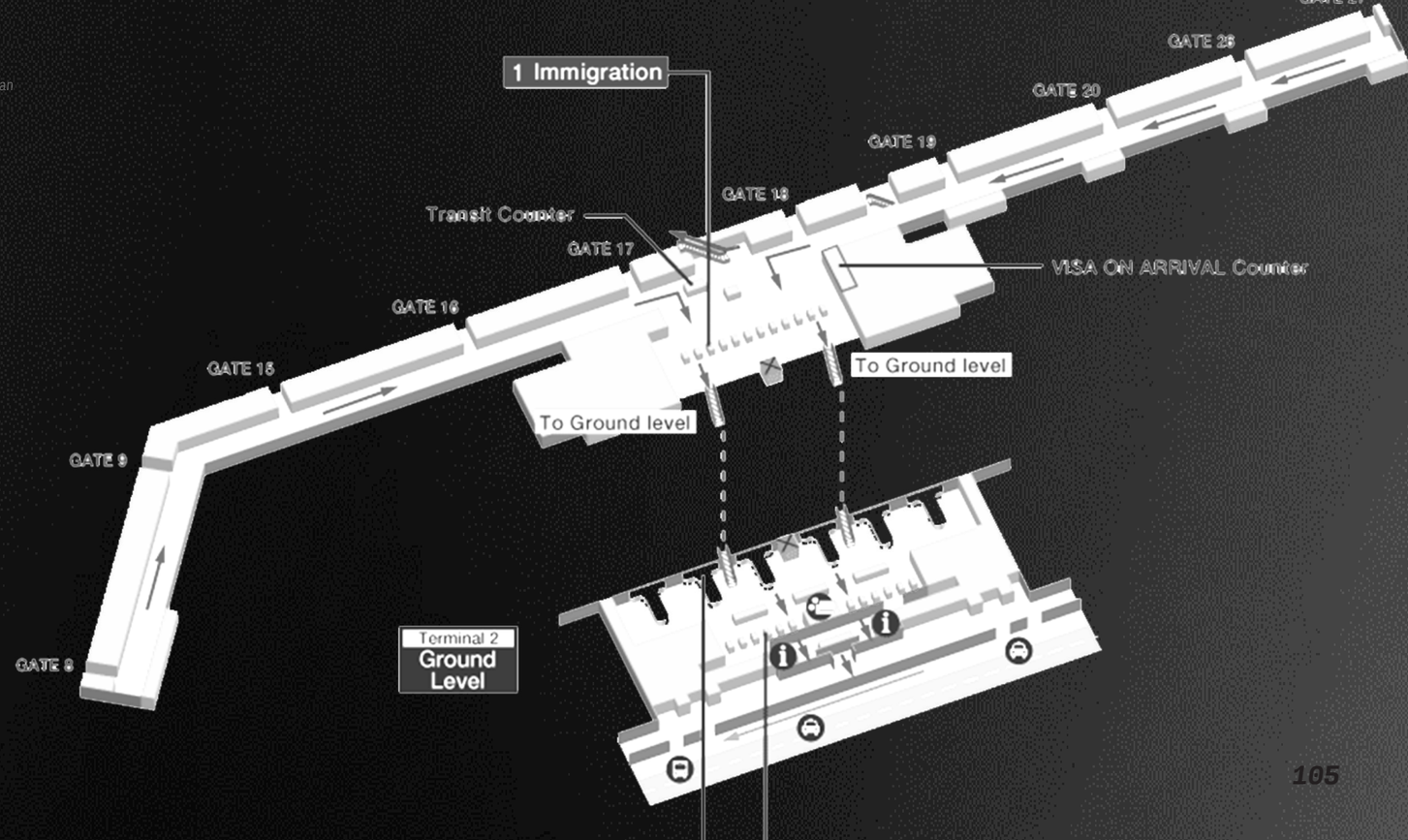
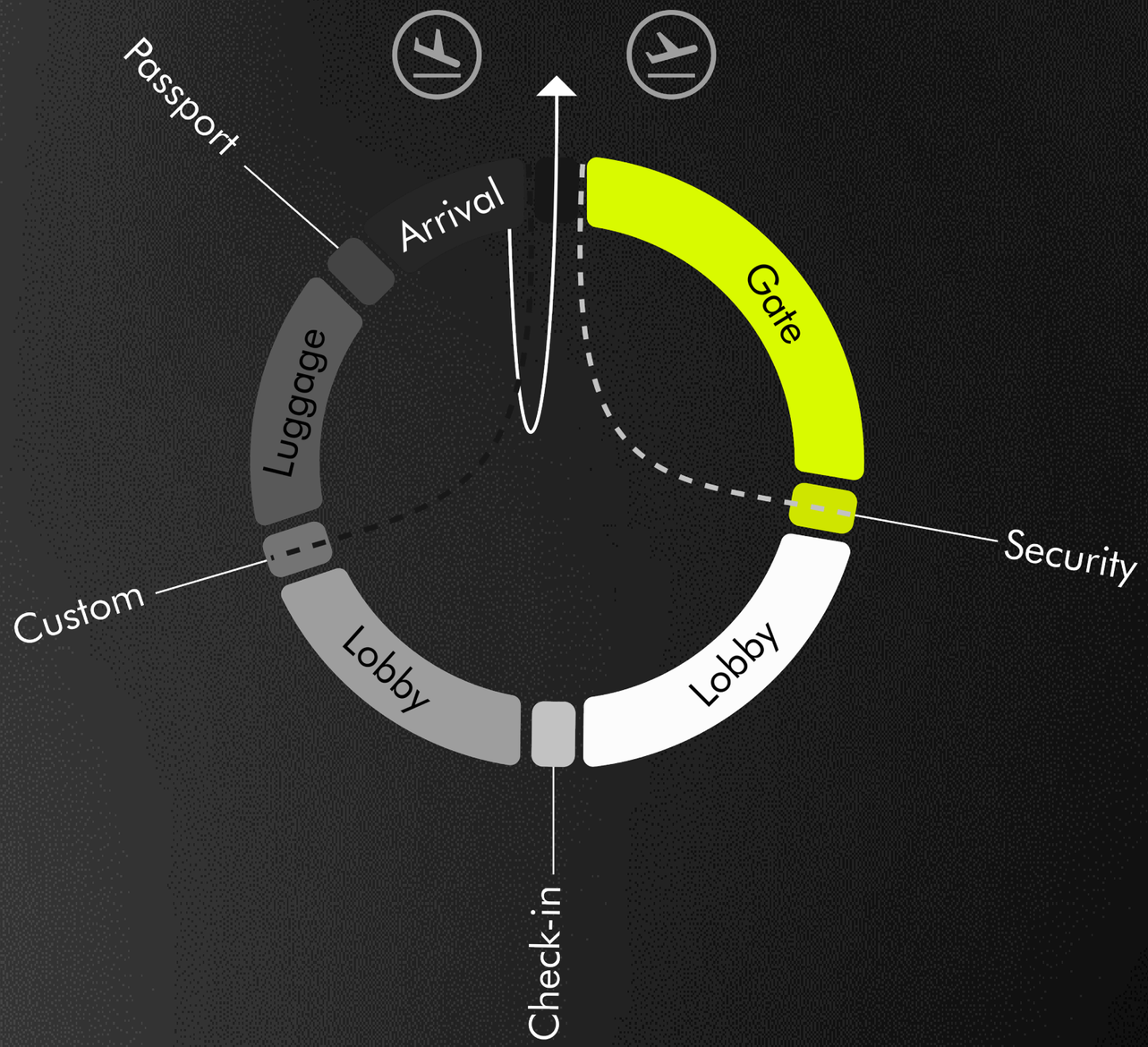


Figure 38 – Tan Son Nhat Intl Airport _ Floorplan

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."

Figure 39 - Typical Airport Flow Diagram

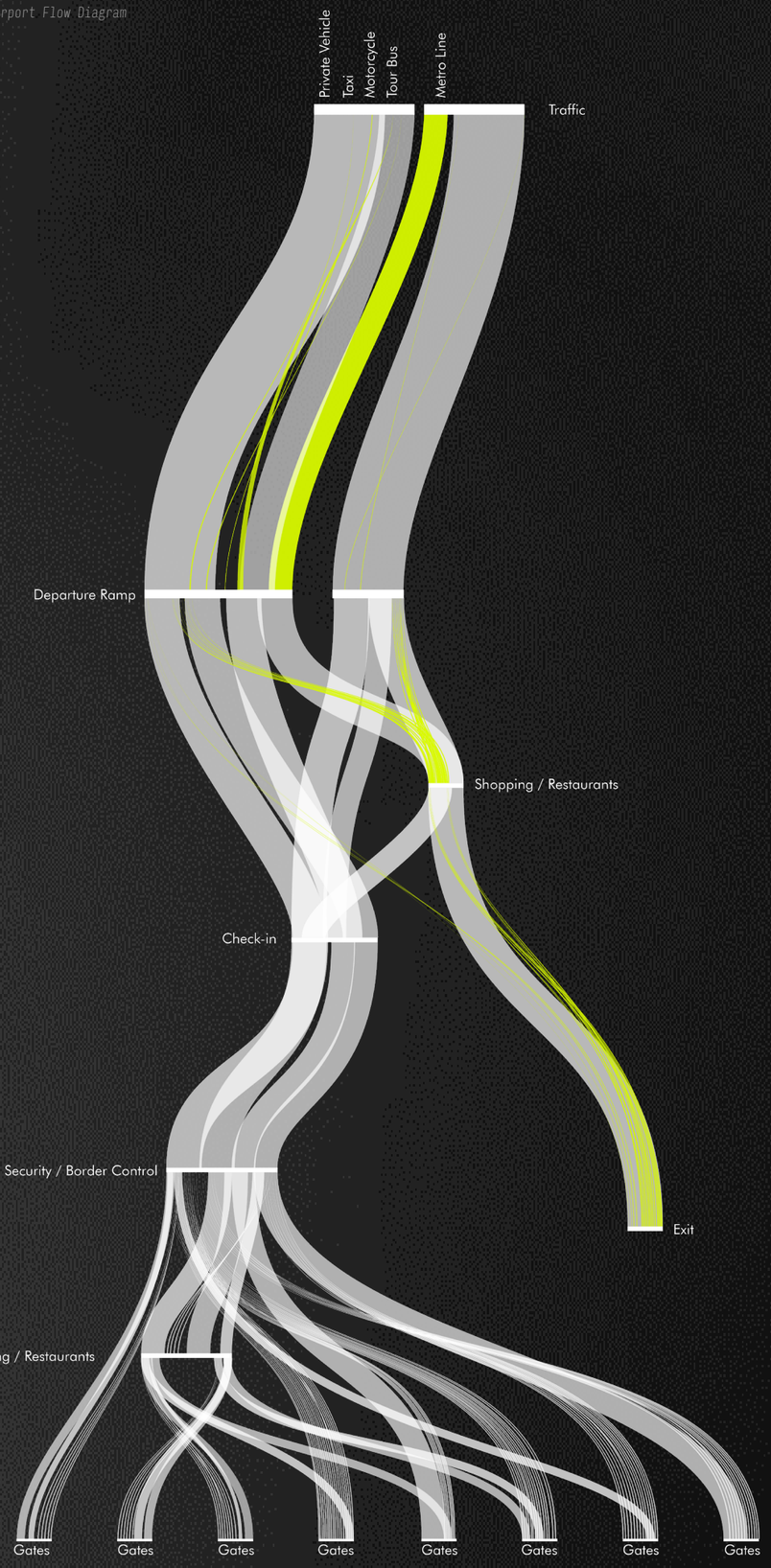
Figure 41 – Visitor at Tan Son Nhat Intl Airport

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”

Figure 42 – Visitor at Tan Son Nhat Intl Airport

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

Figure 44 – Expand & Connect

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

Figure 45 – Unison

Combine the two terminals to make one unison system.

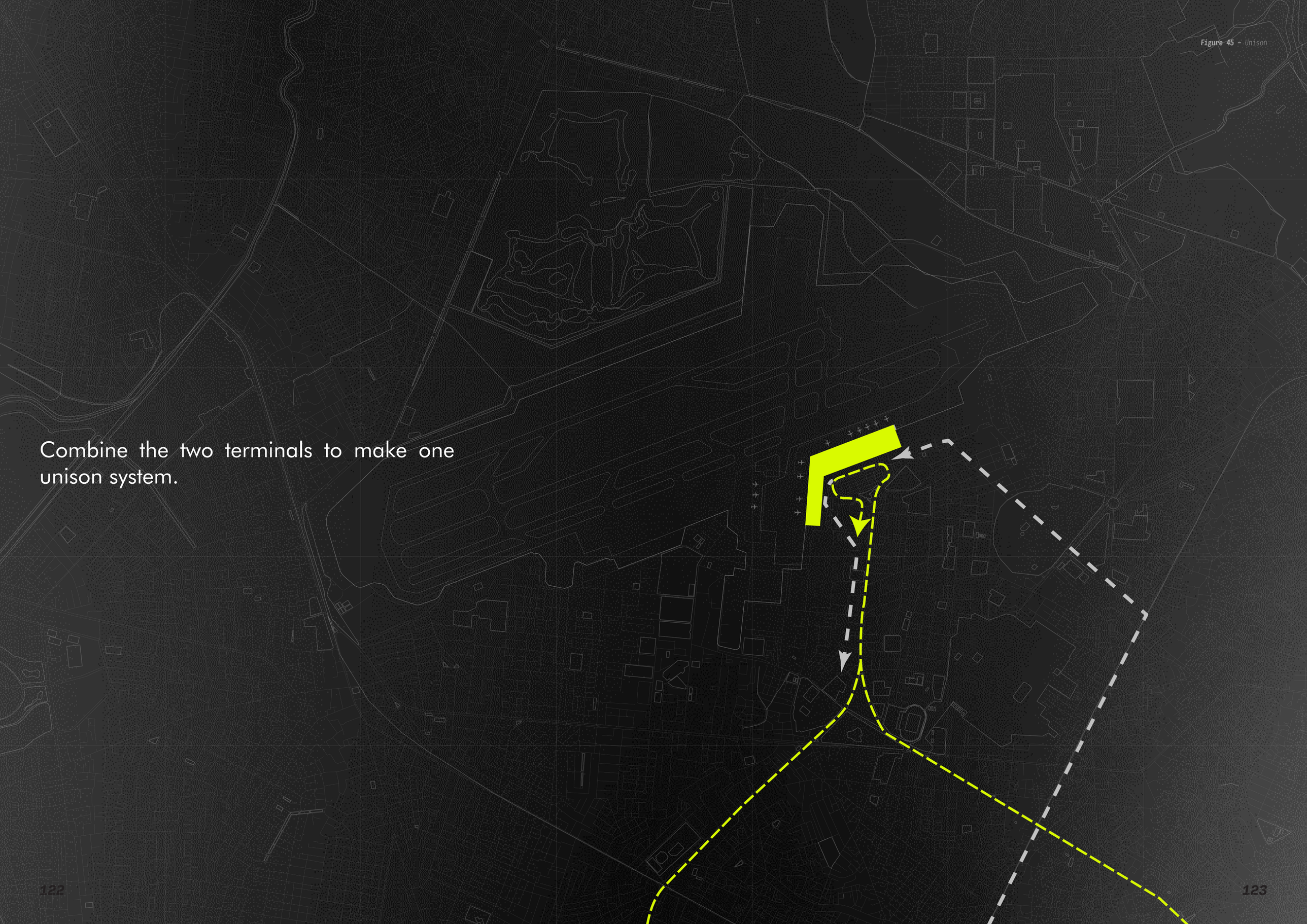
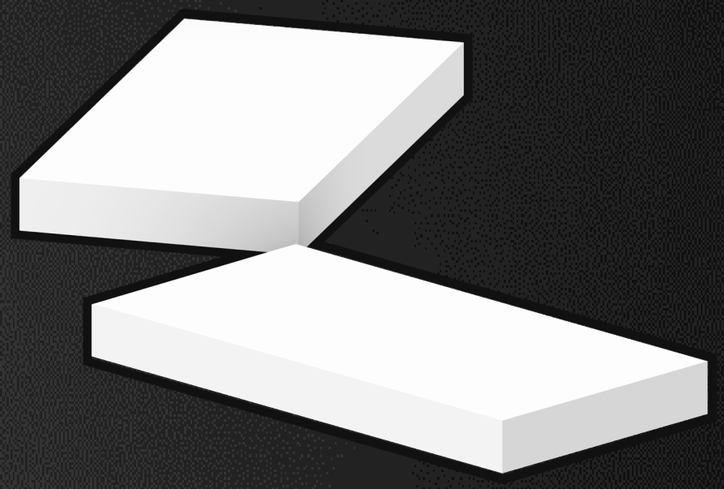
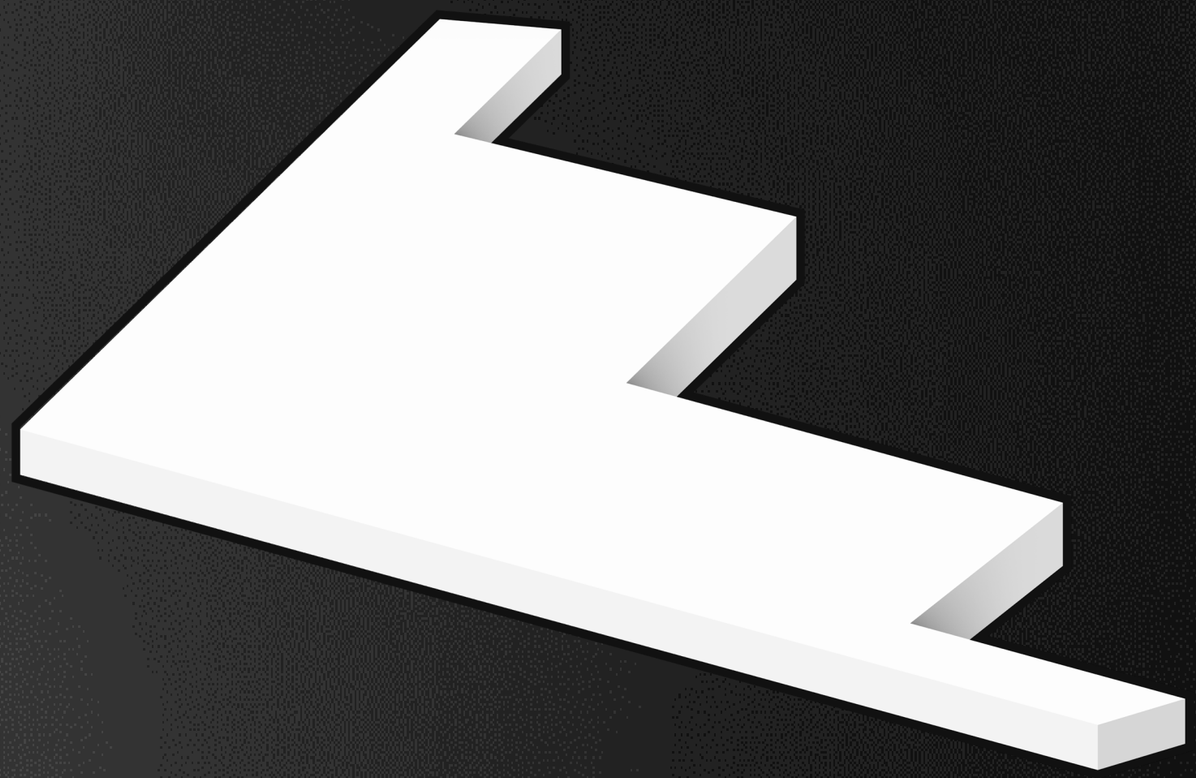


Figure 46 – Concept



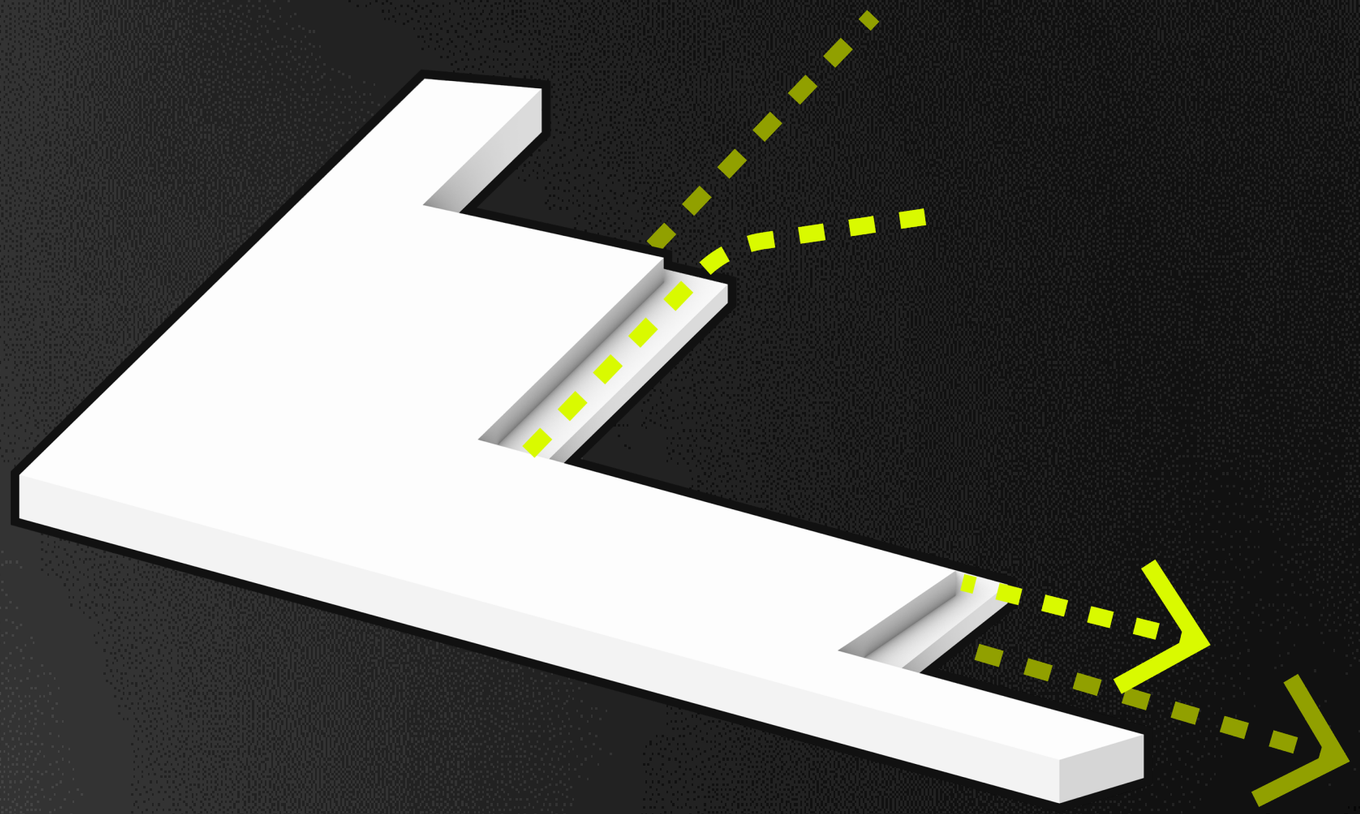
Define the masses of the both terminals.

Figure 47 – Concept



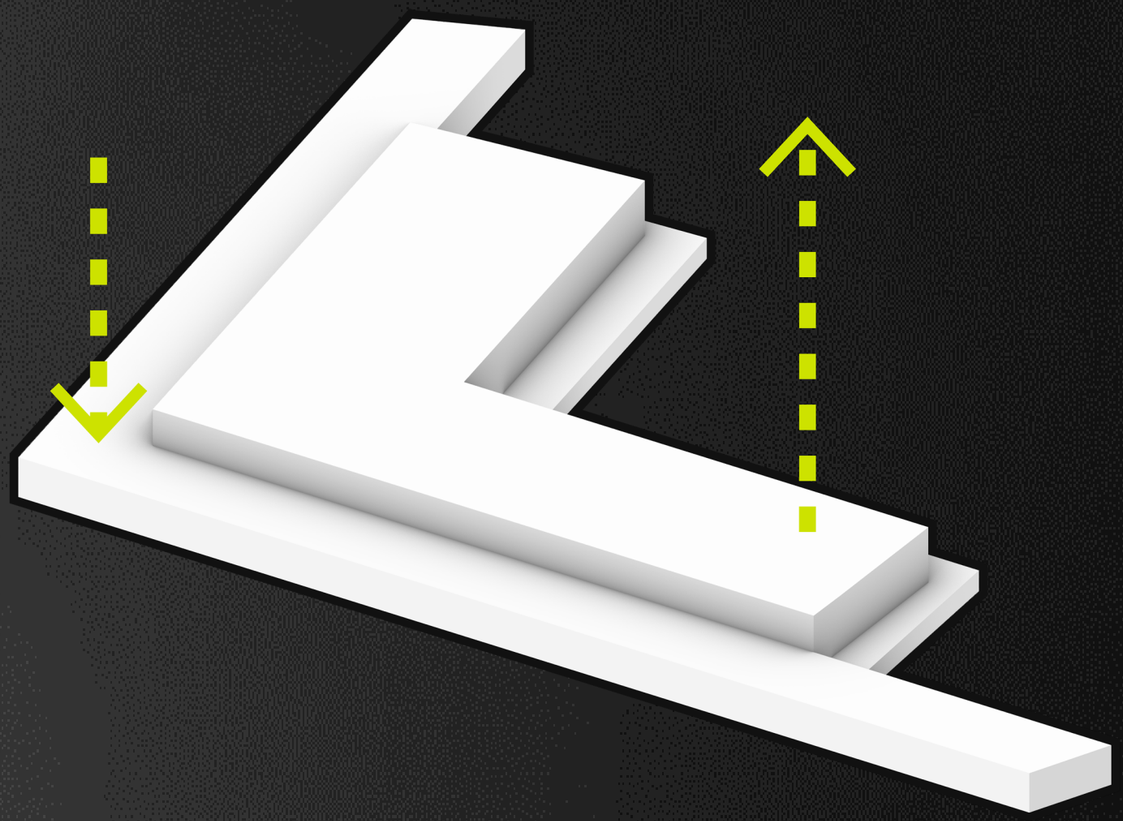
Combine and extend the mass of both terminal in a harmonious way, ensuring the efficiency of its functions.

Figure 48 – Concept



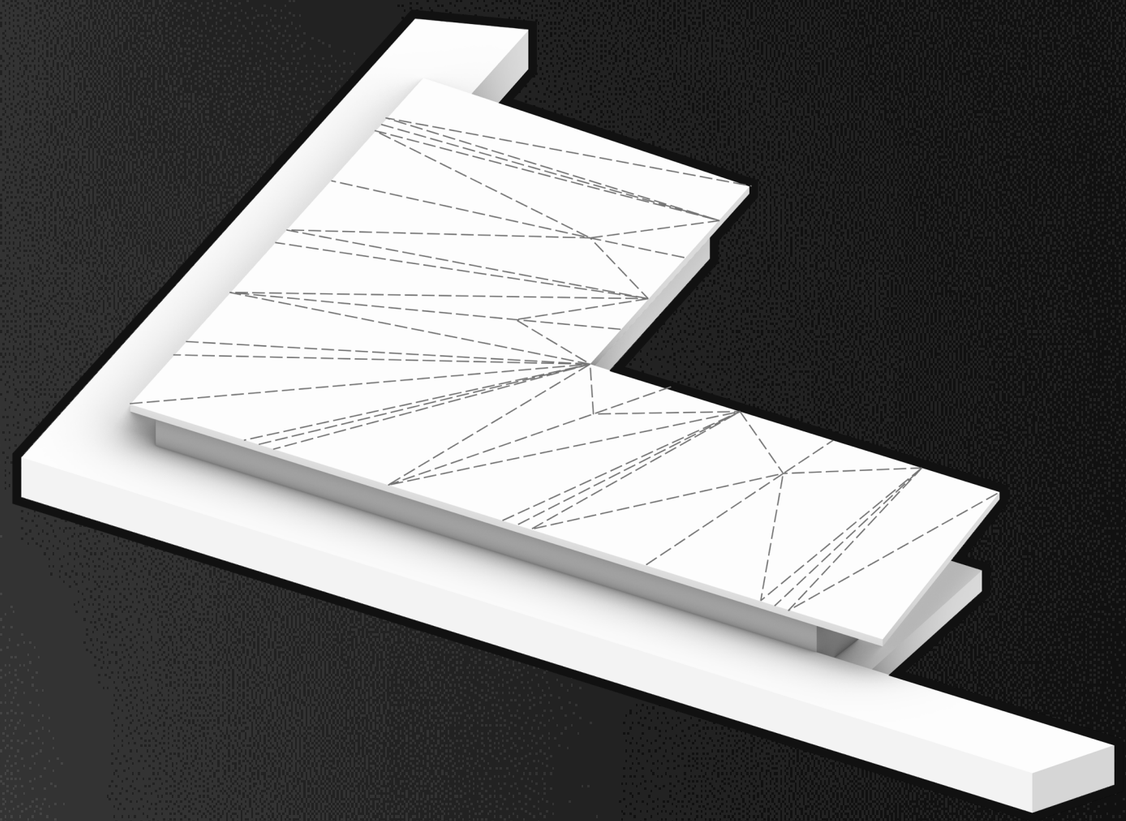
Cutaway to create space for the extension ramp for the metro line. Maintaining a sense of fluidity and connectivity.

Figure 49 – Concept



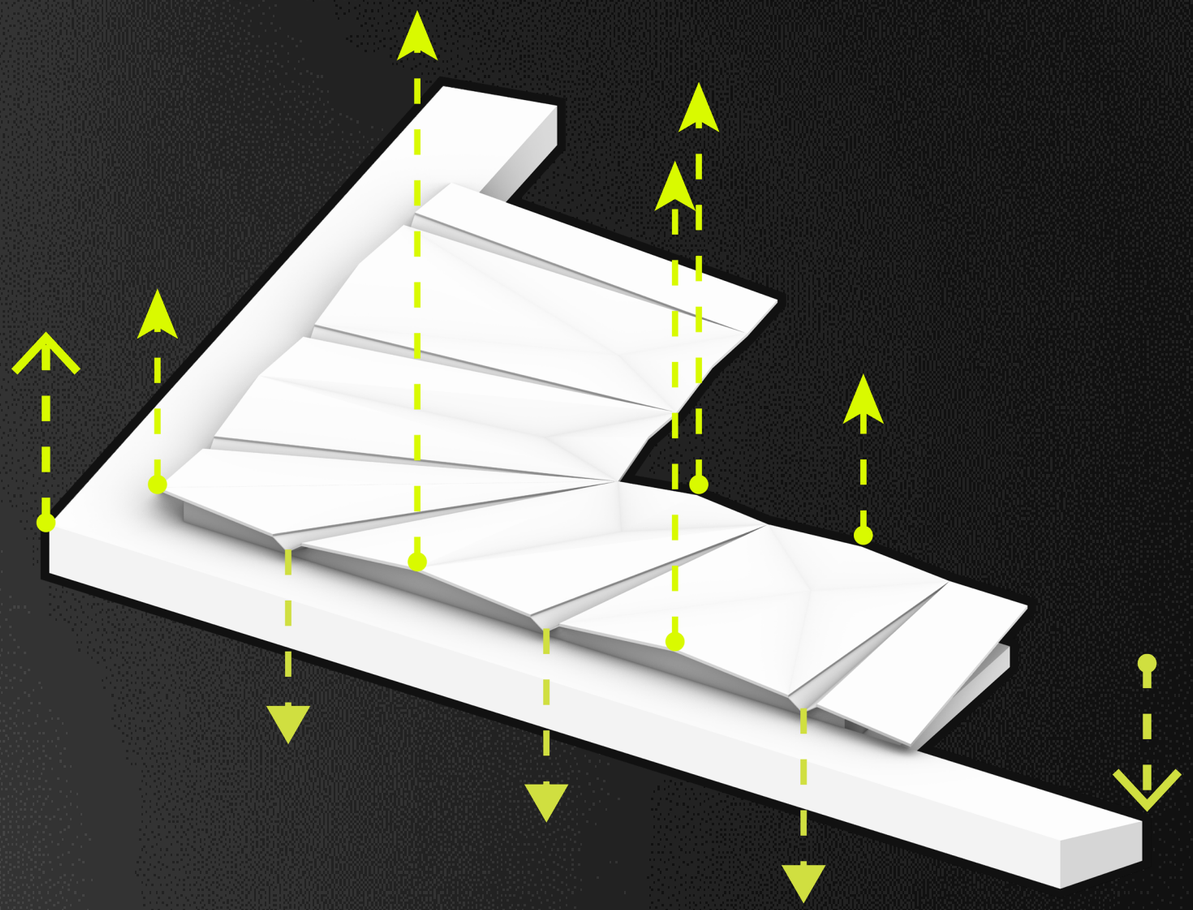
Curate distinct spaces within the terminals. Shaping them to accommodate their designated functions.

Figure 50 – Concept



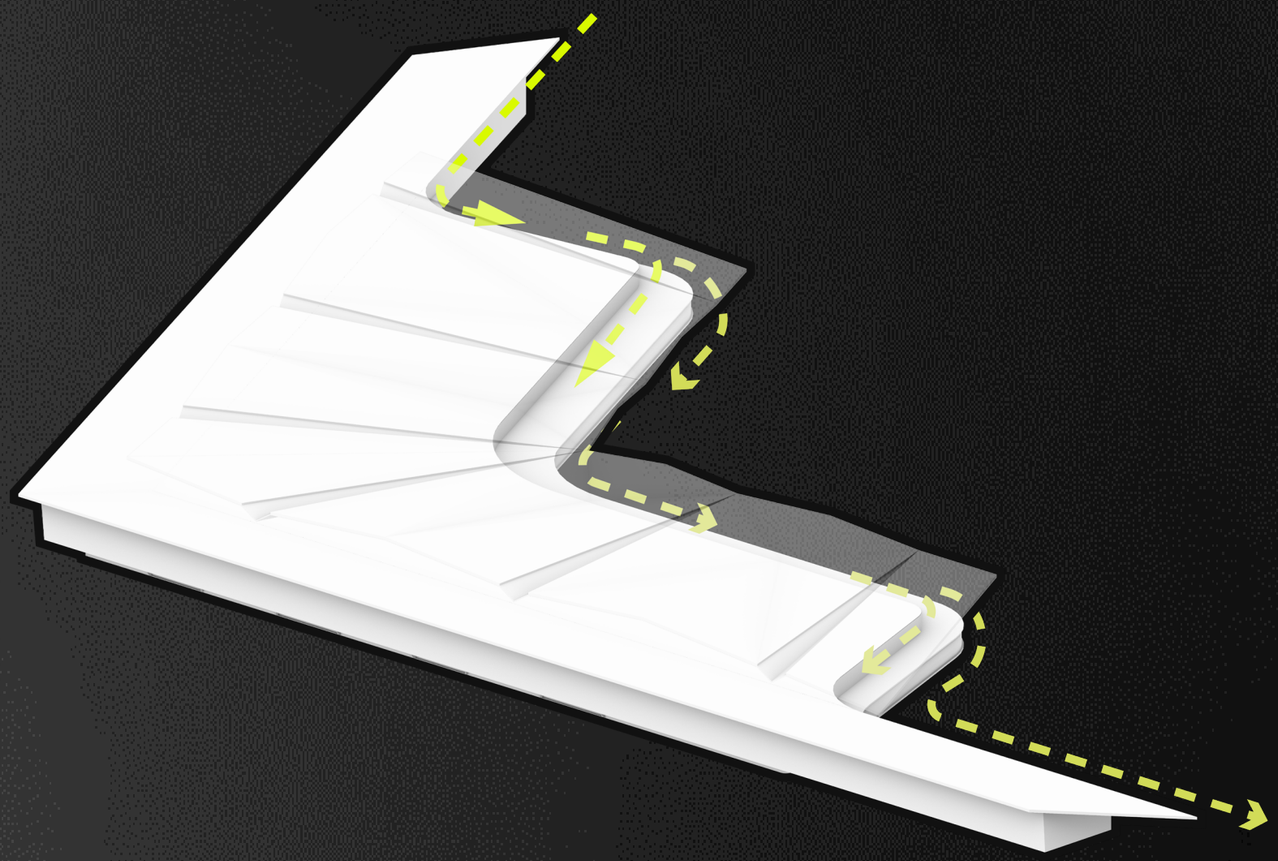
Divide the domain of the roof structures into unique different segments. Enhancing the overall visual appeal and spatial experience of the terminals.

Figure 51 – Concept



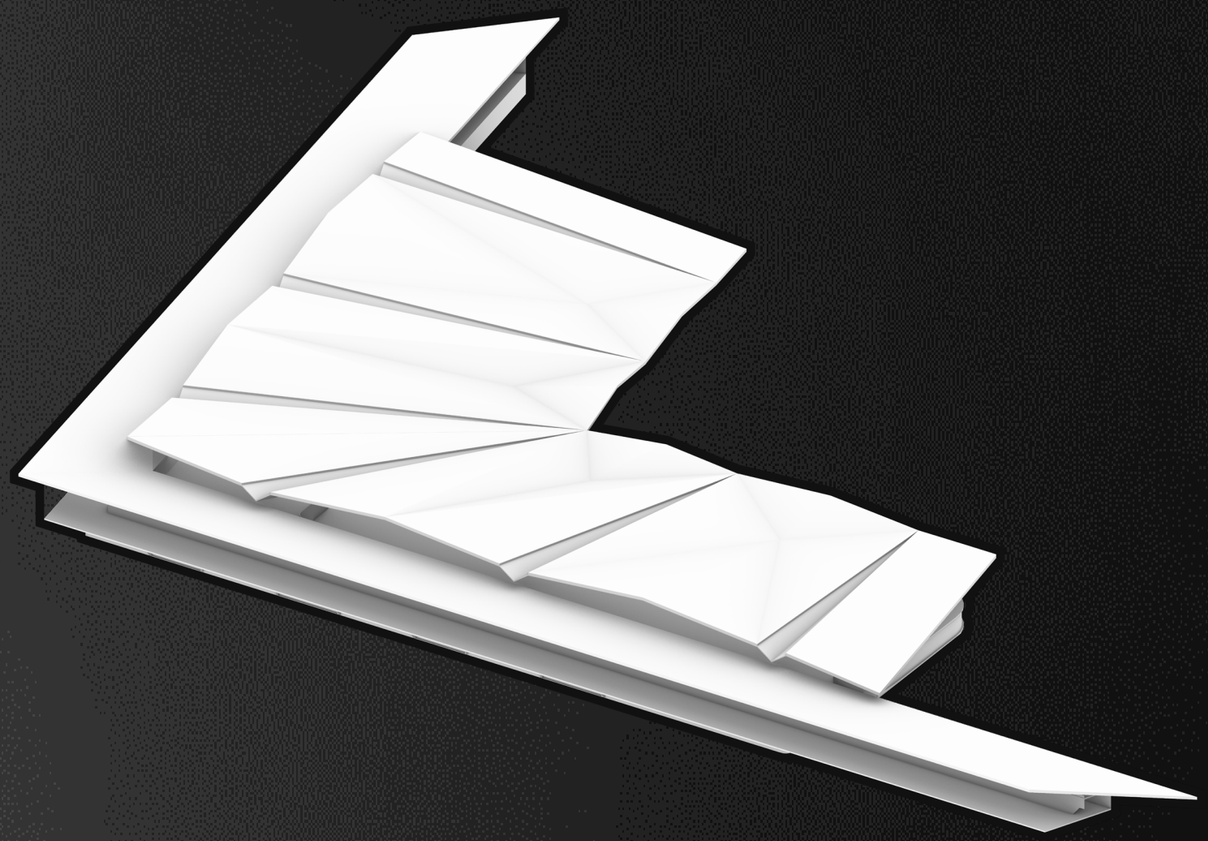
Manipulate points to create variations in height, allowing an abundance of natural light to permeate through the spaces.

Figure 52 – Concept



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

Figure 53 – Concept



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

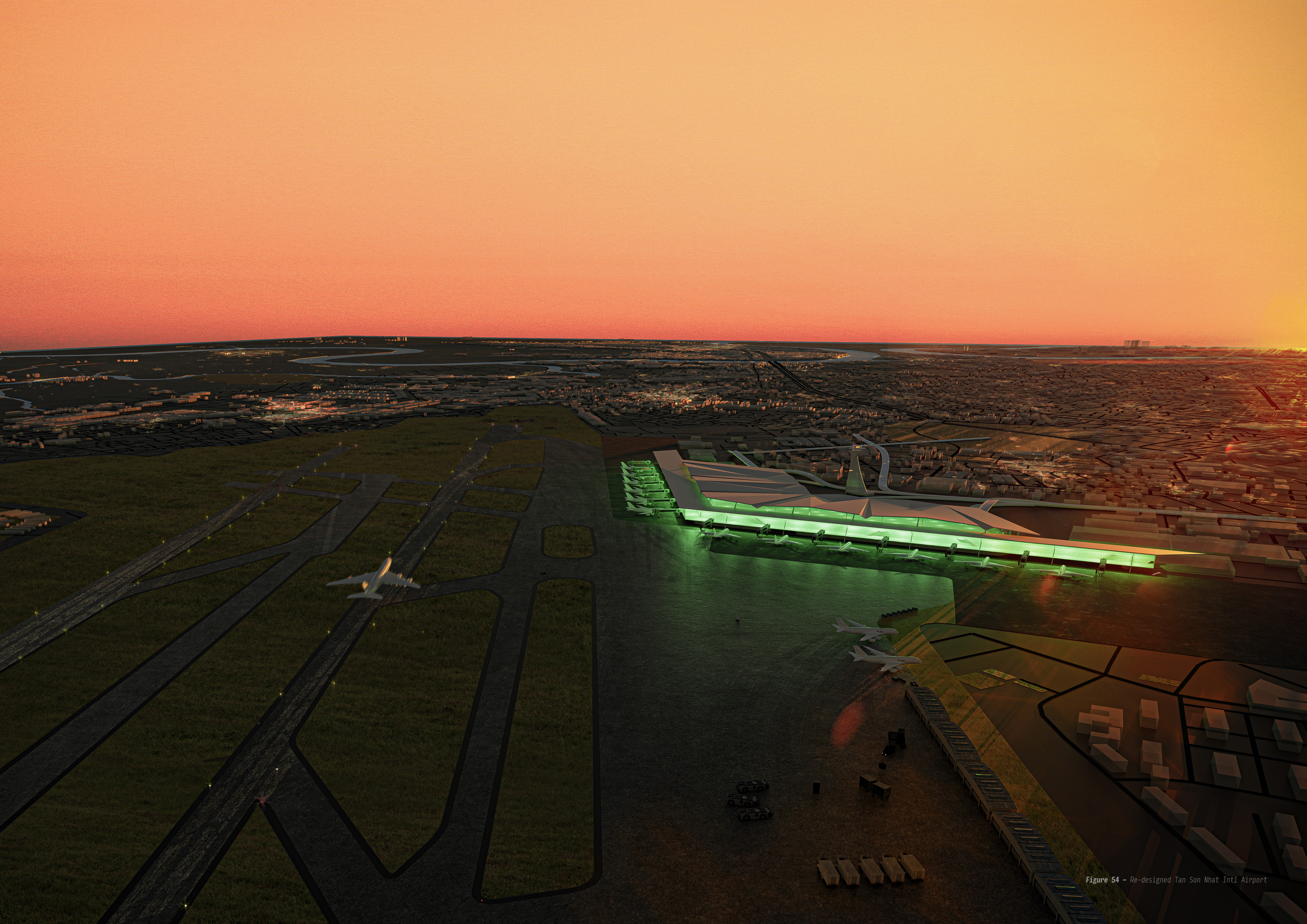


Figure 54 – *Re-designed Tan Son Nhat Intl Airport*

Figure 55 – *Axonometric Program Diagram*

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

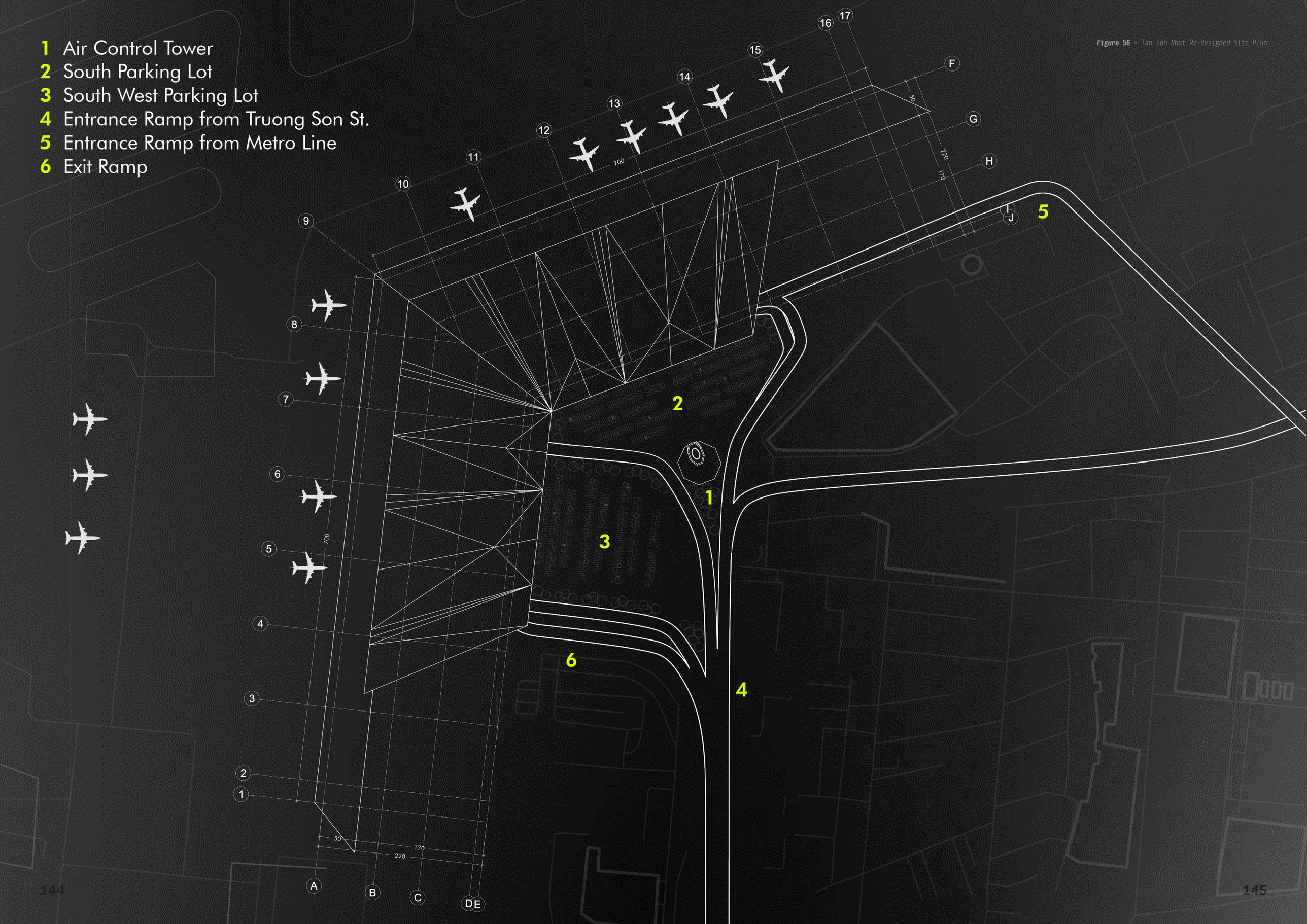


Figure 56 - Tan Son Nhat Re-designed Site Plan

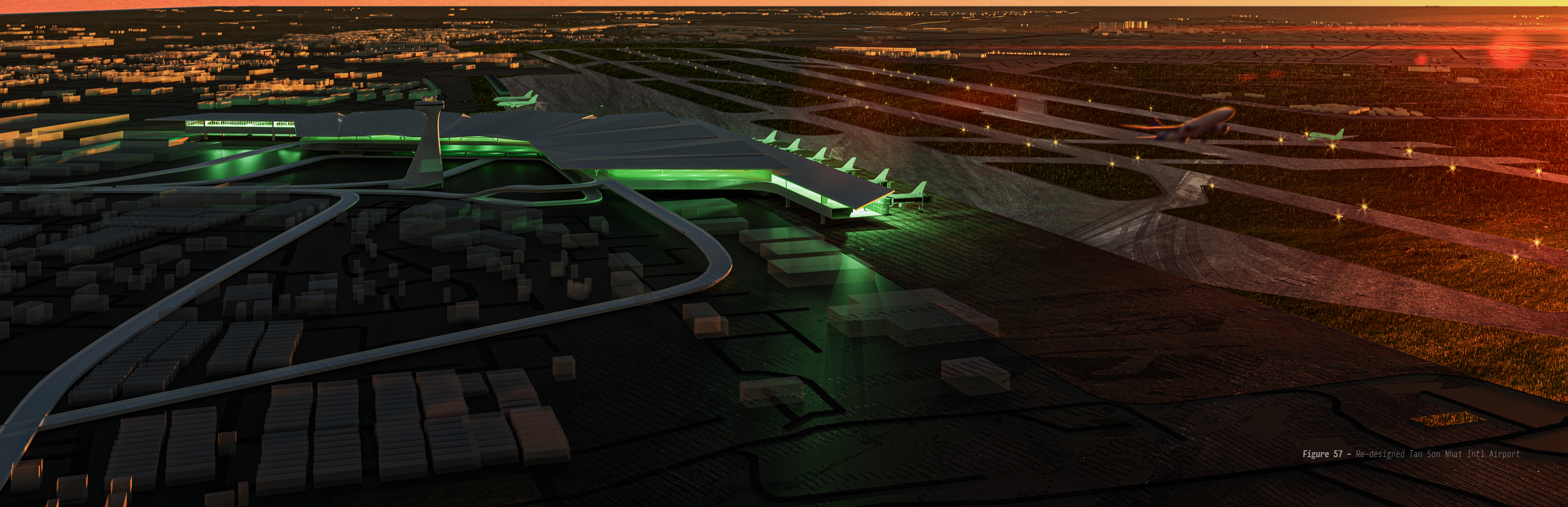


Figure 57 – *Re-designed Tan Son Nhat Intl Airport*

1	Vehicle Drop-off
2-3	Check-in Counter
4	To Visitor Area
5	Security
6	Departure Hall

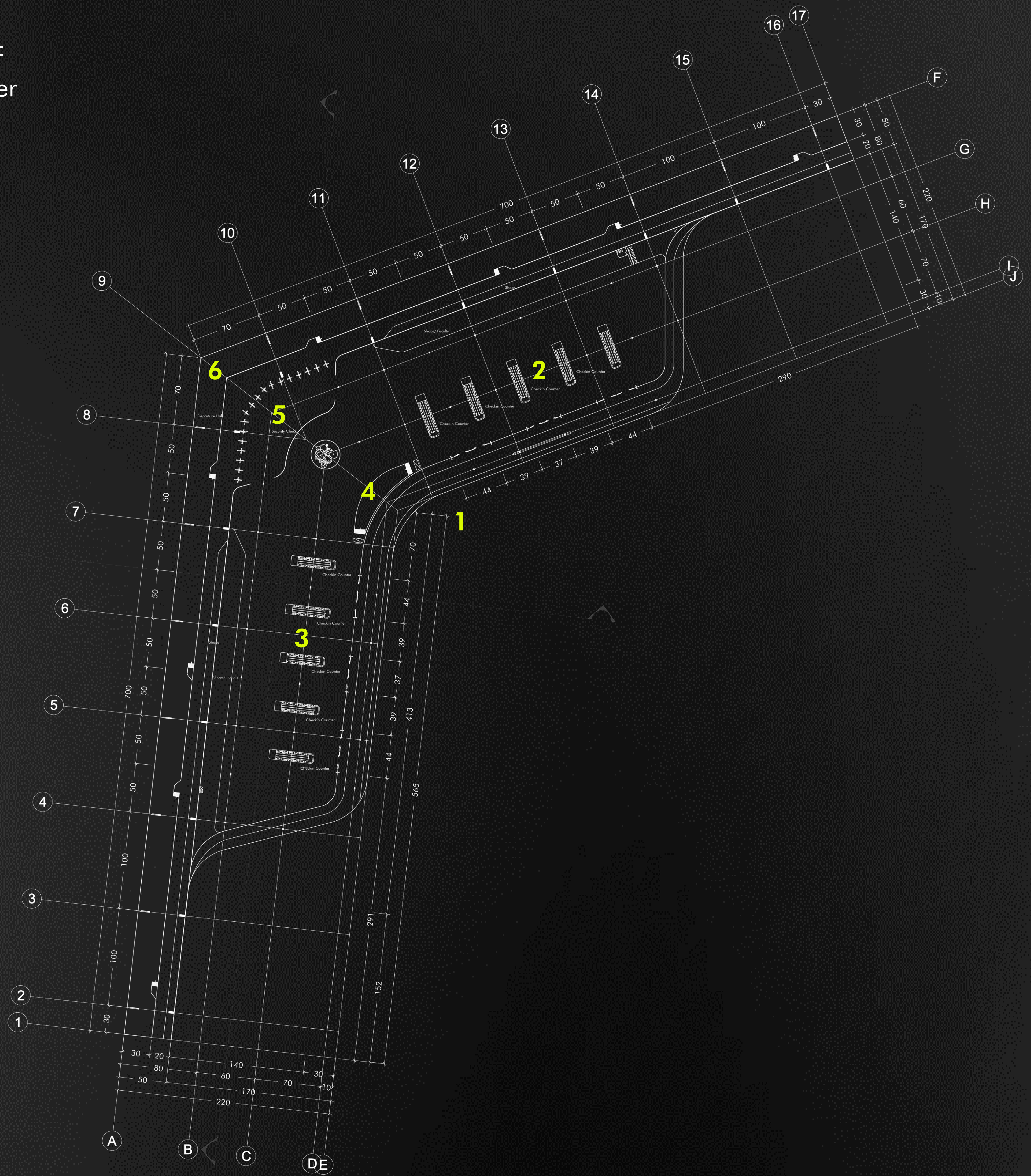


Figure 58 – Tan Son Nhat Re-designed 2nd Floor Plan

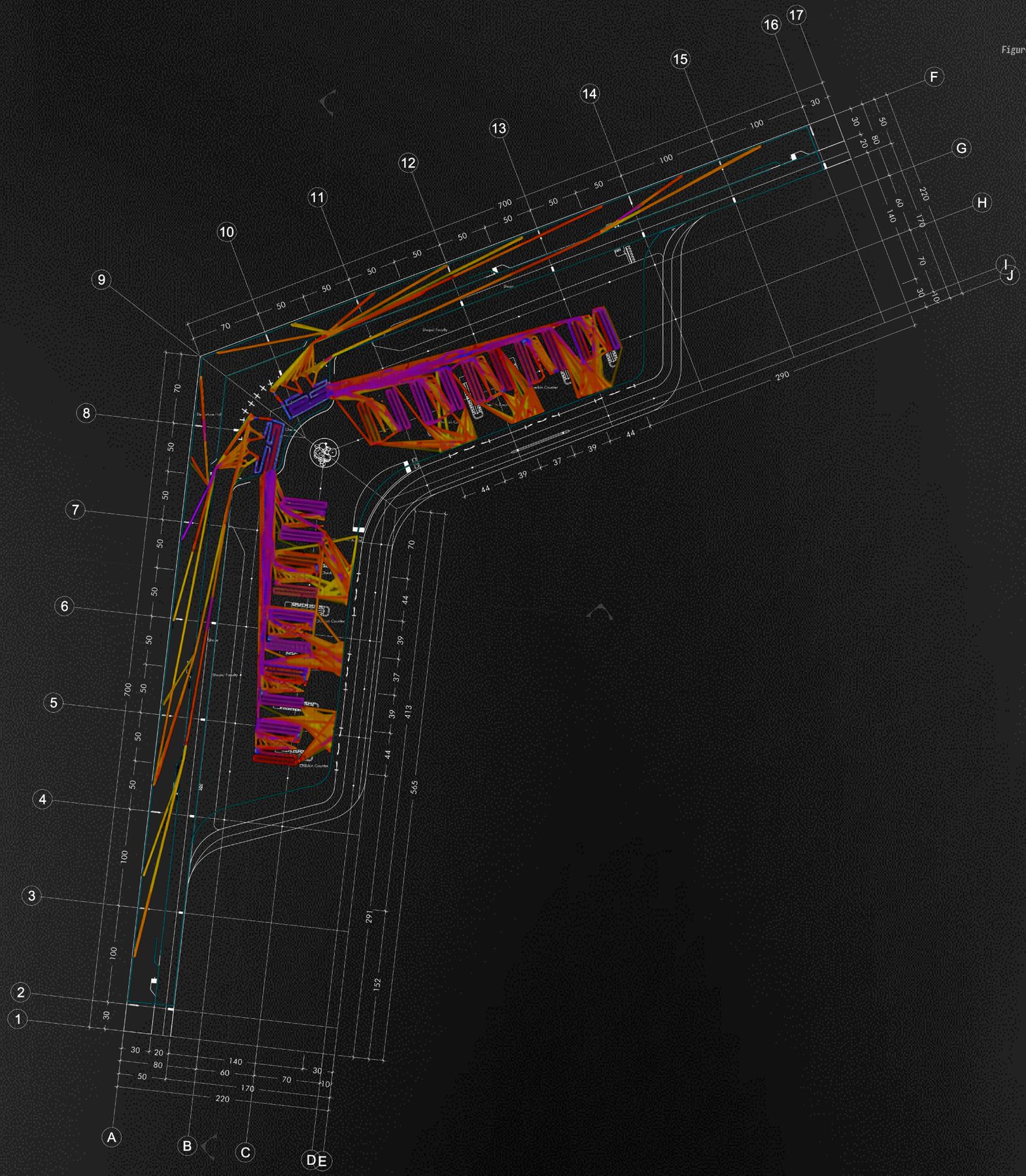


Figure 59 – Tan Son Nhat Re-designed 2nd Floor Plan Performance Analysi

Figure 60 – Re-designed Tan Son Nhat Intl Airport _ Check-in Hall

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

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

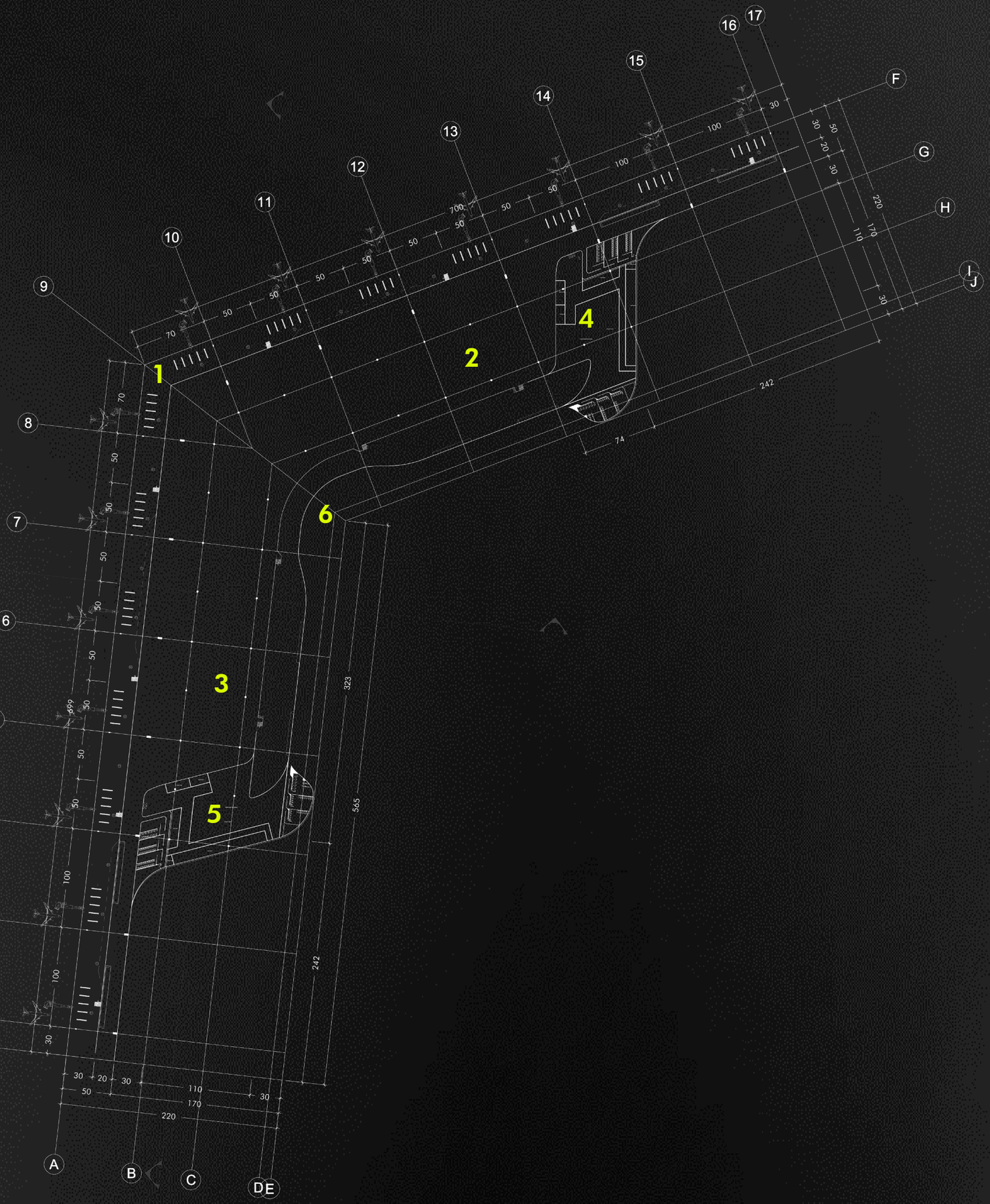


Figure 62 – Re-designed Tan Son Nhat Intl Airport 1st Floor Plan

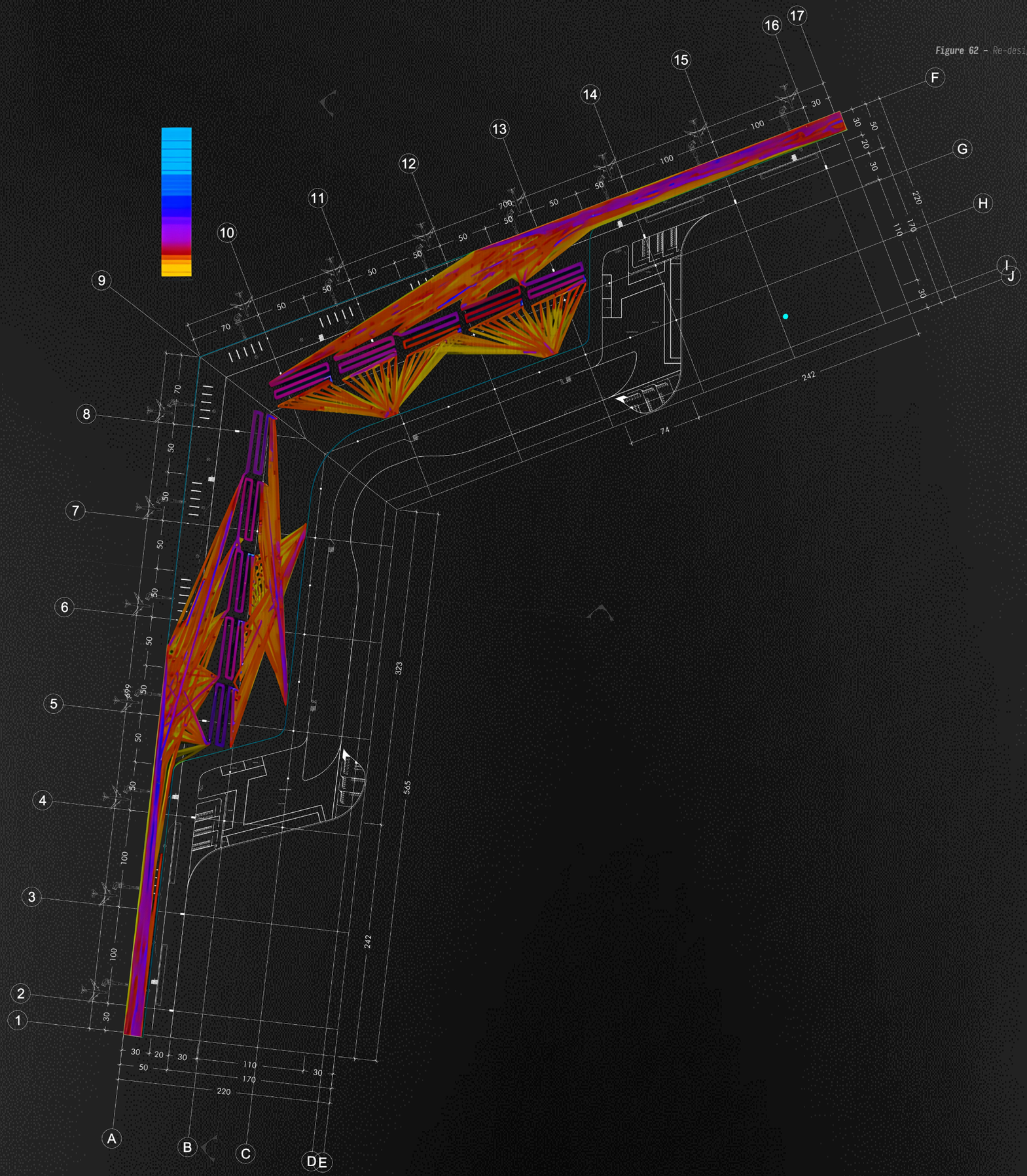


Figure 62 – Re-designed Tan Son Nhat Intl Airport 1st Floor Plan Performance Analysis

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

1-2 Baggage Claim
3 Vehicle Pick-up

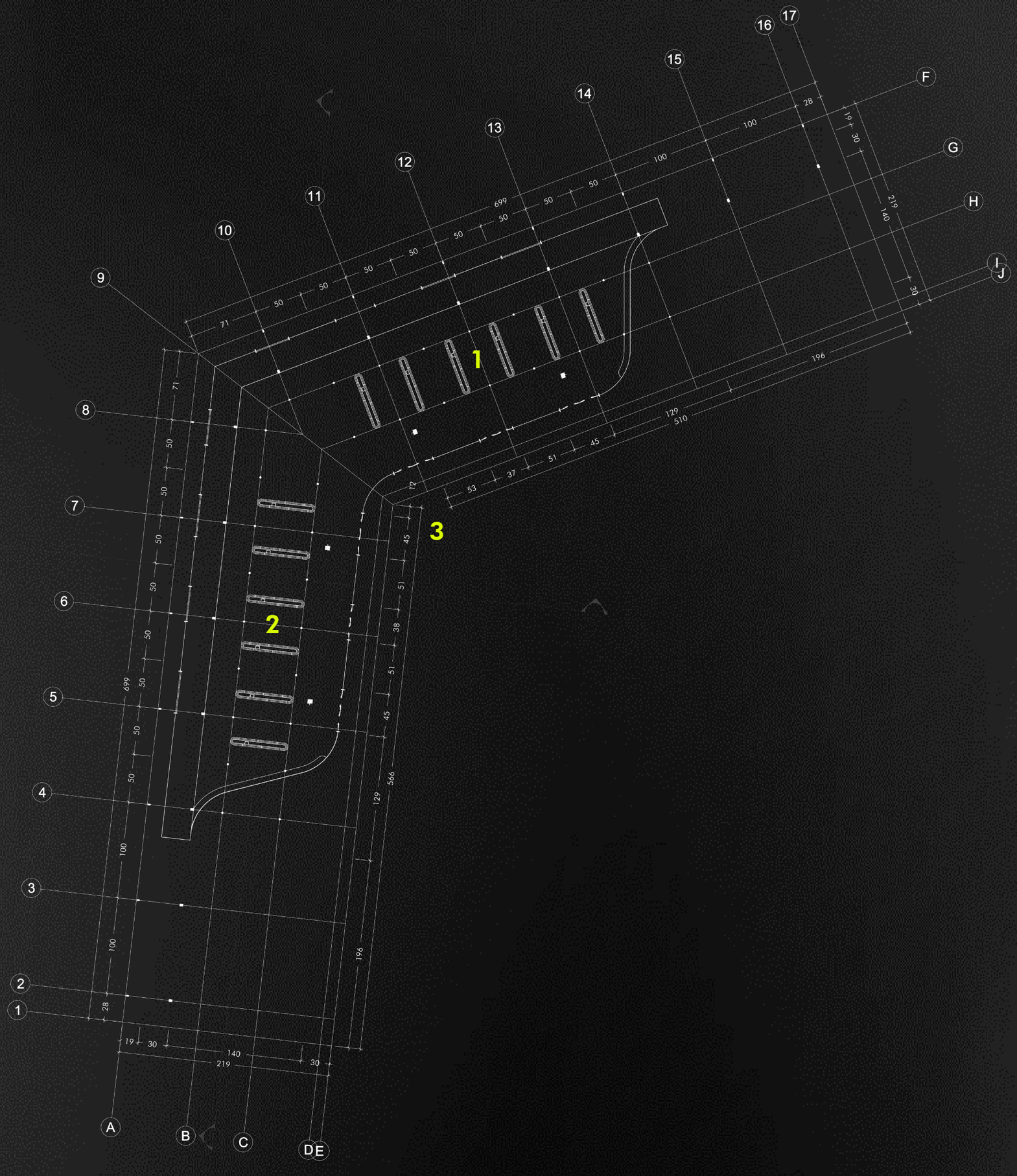
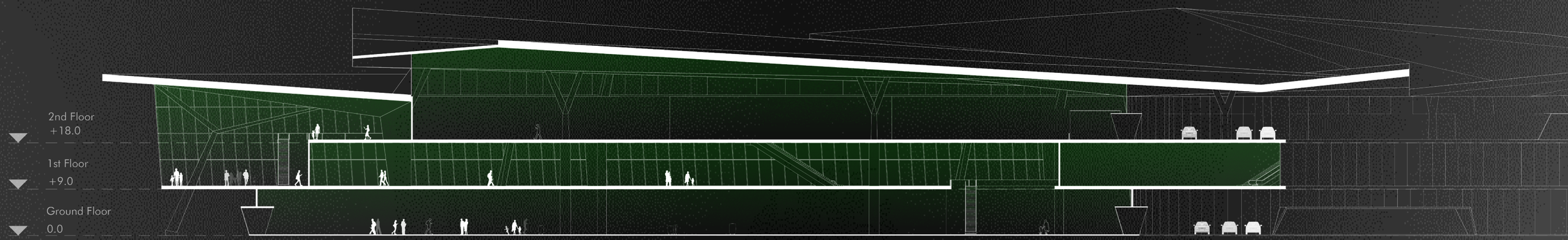


Figure 65 - Re-designed Tan Son Nhat Intl Airport Ground Floor

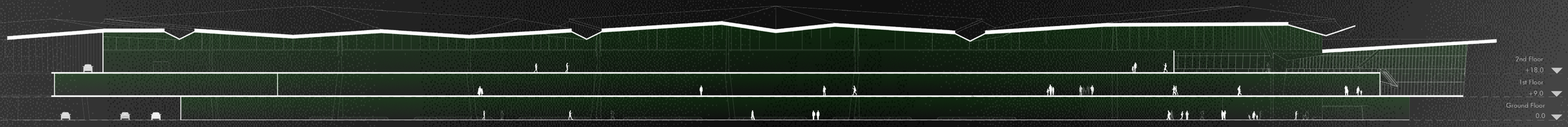
Figure 66 – Re-designed Tan Son Nhat Intl Airport _ Baggage Claim

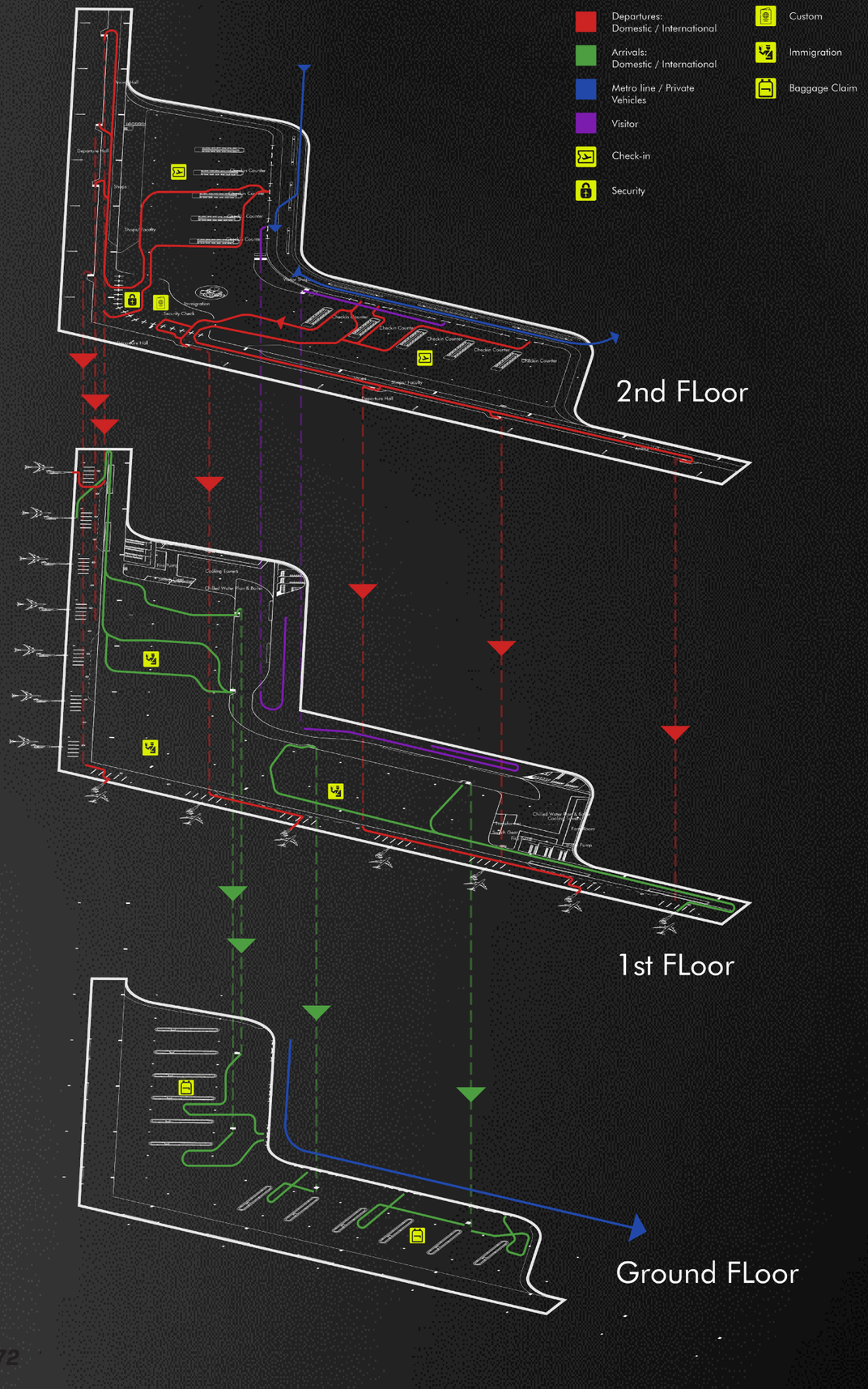
Figure 67 – Re-designed Tan Son Nhat Intl Airport _ Section 1A



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

Figure 68 - Re-designed Tan Son Nhat Intl Airport _ Section 2A





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*

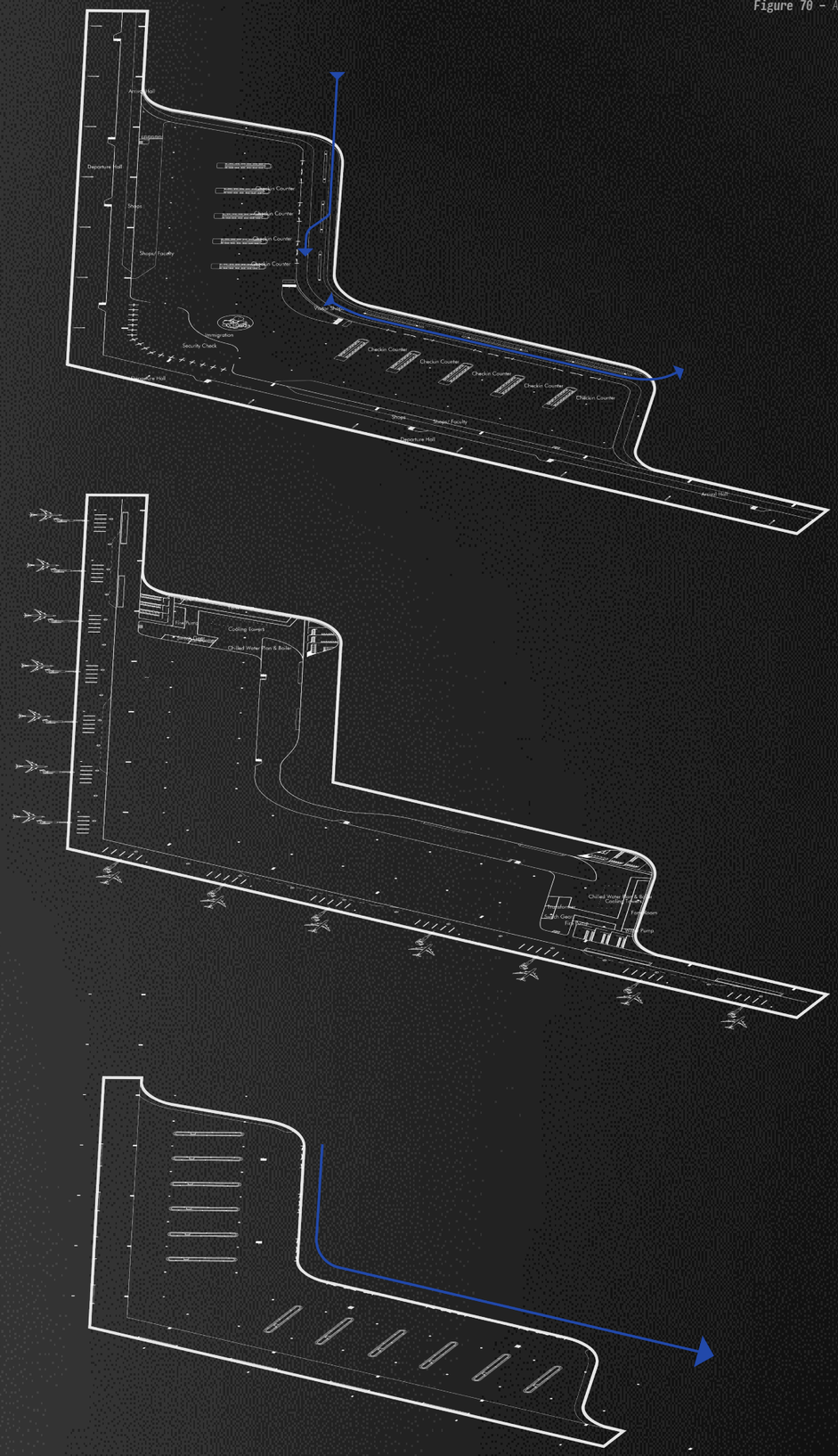


Figure 71 – *Axonometric Flow Diagram*

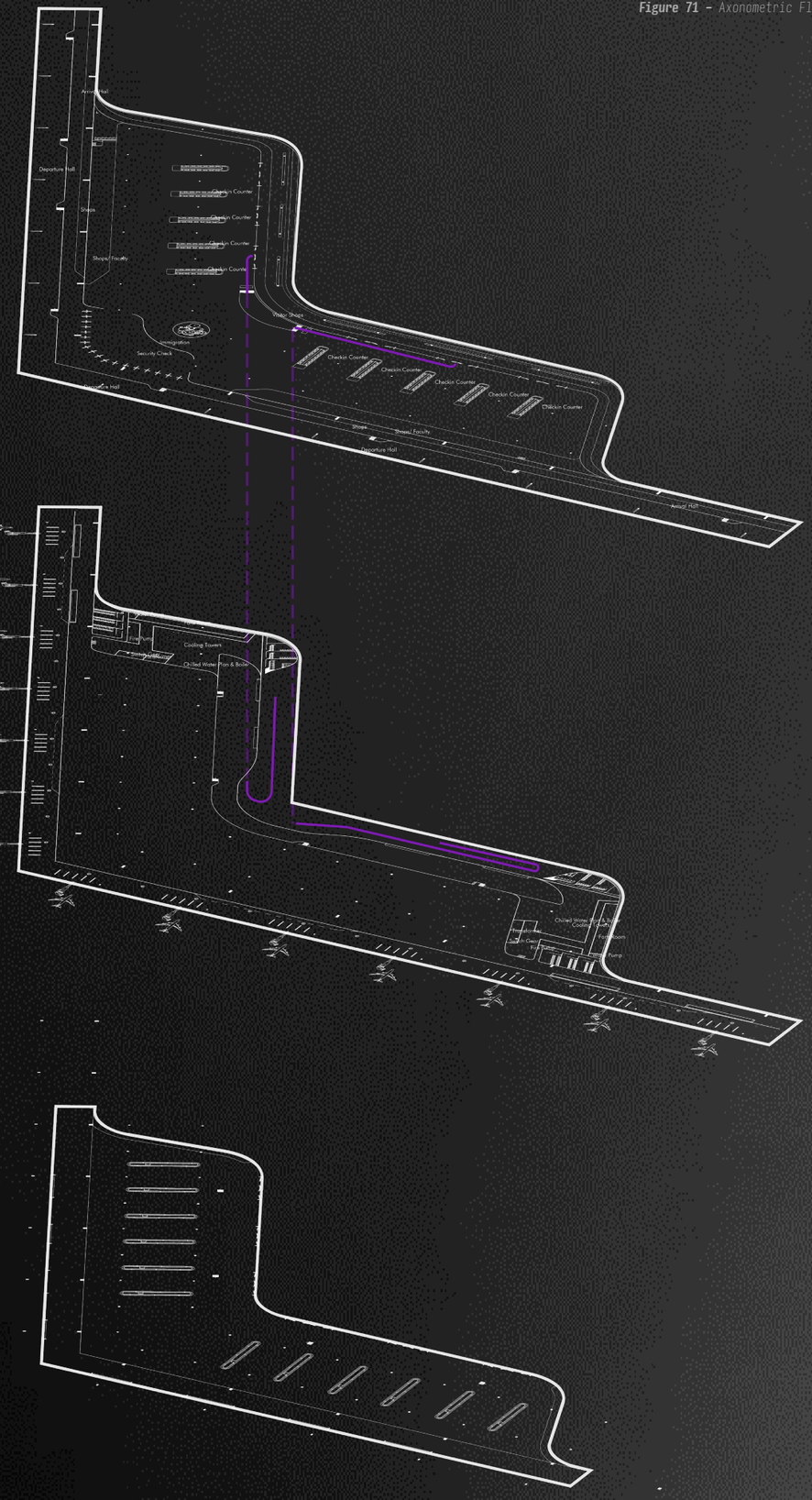


Figure 72 – *Axonometric Flow Diagram*

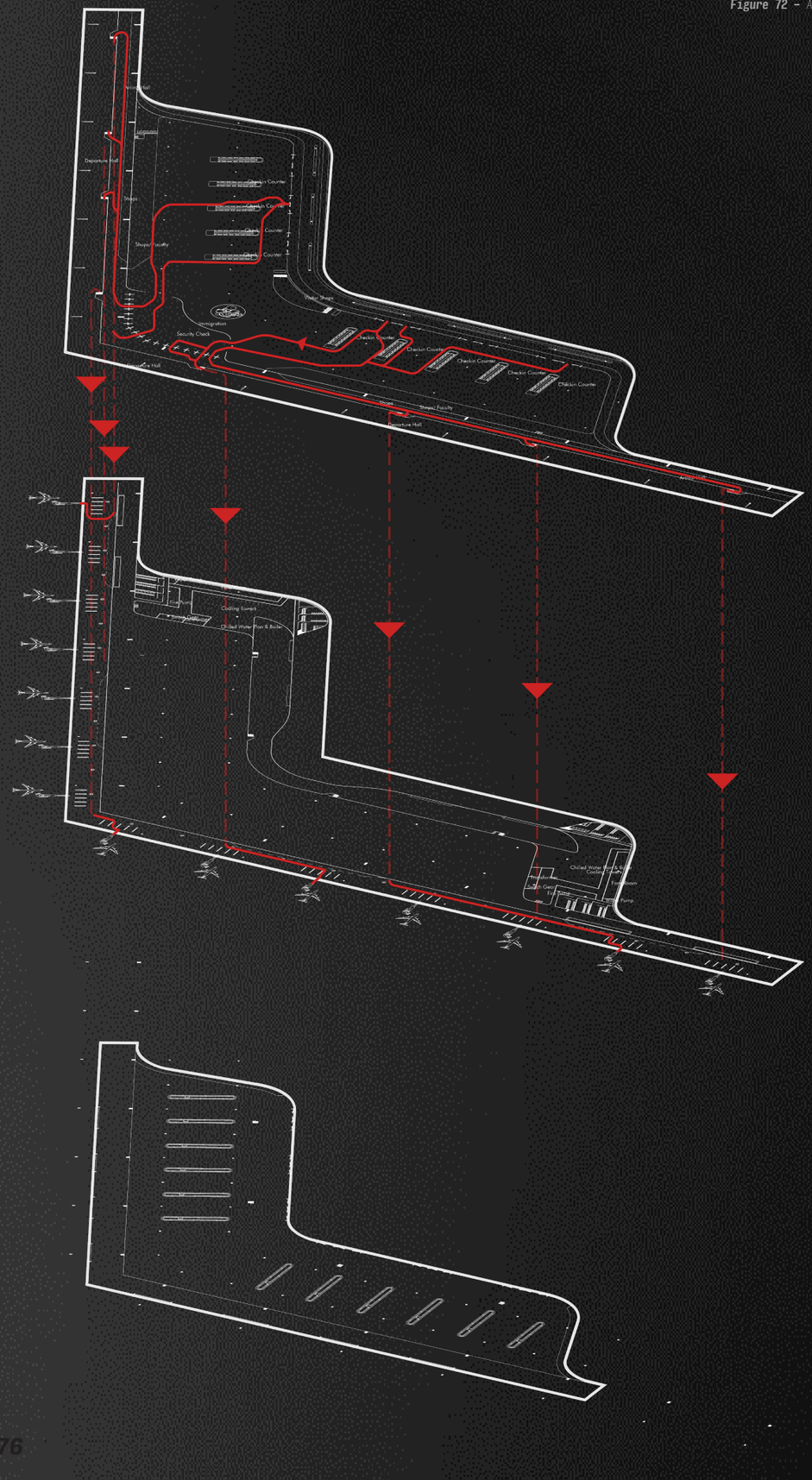


Figure 73 – *Axonometric Flow Diagram*

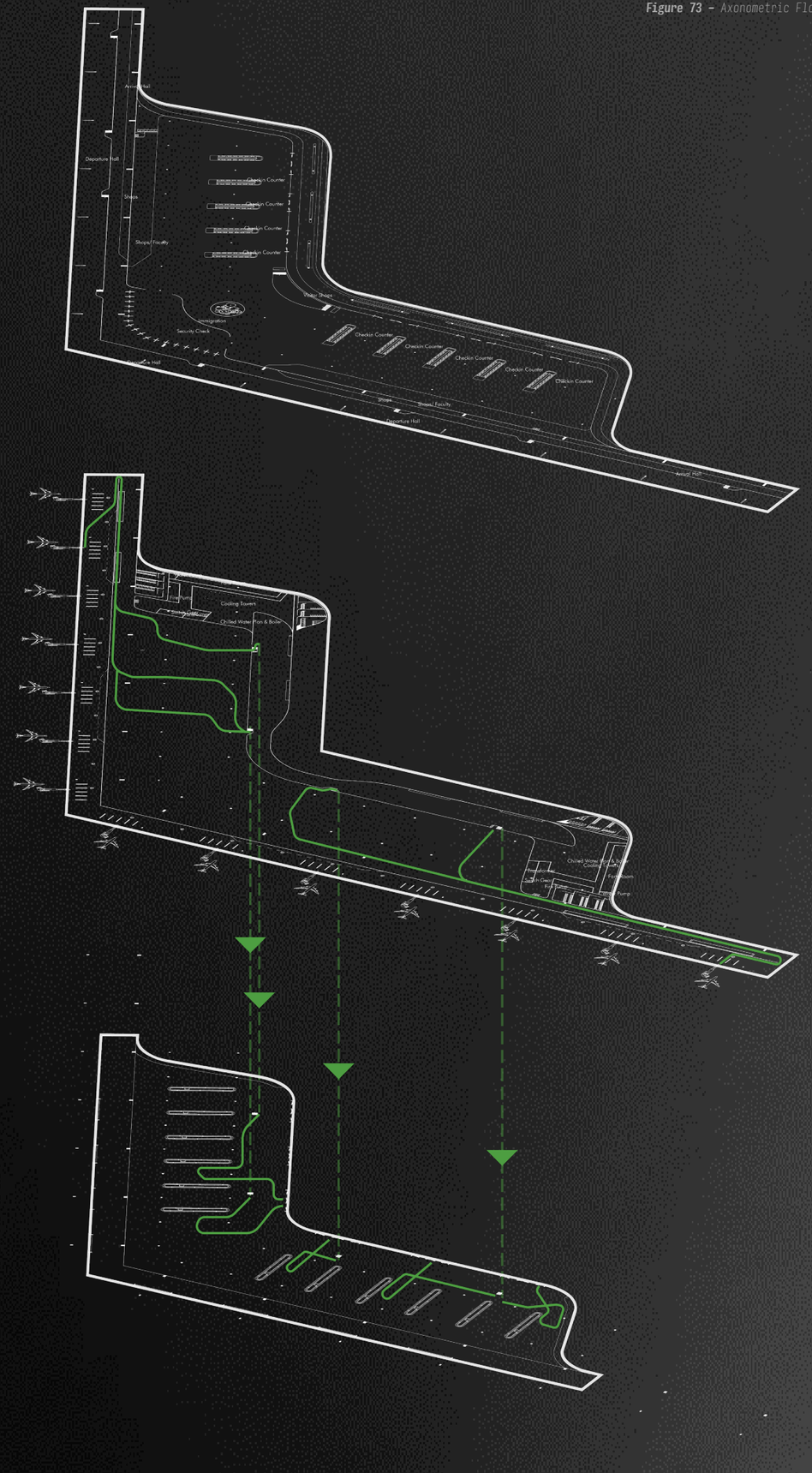


Figure 74 – Axonometric Structure Diagram

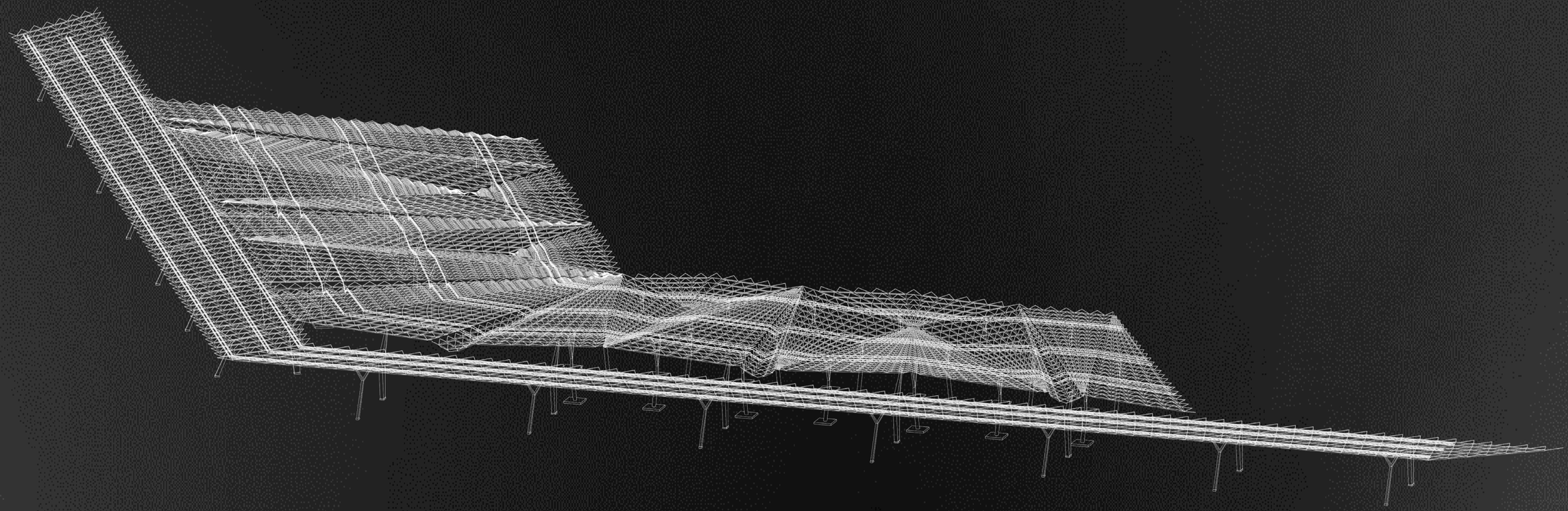
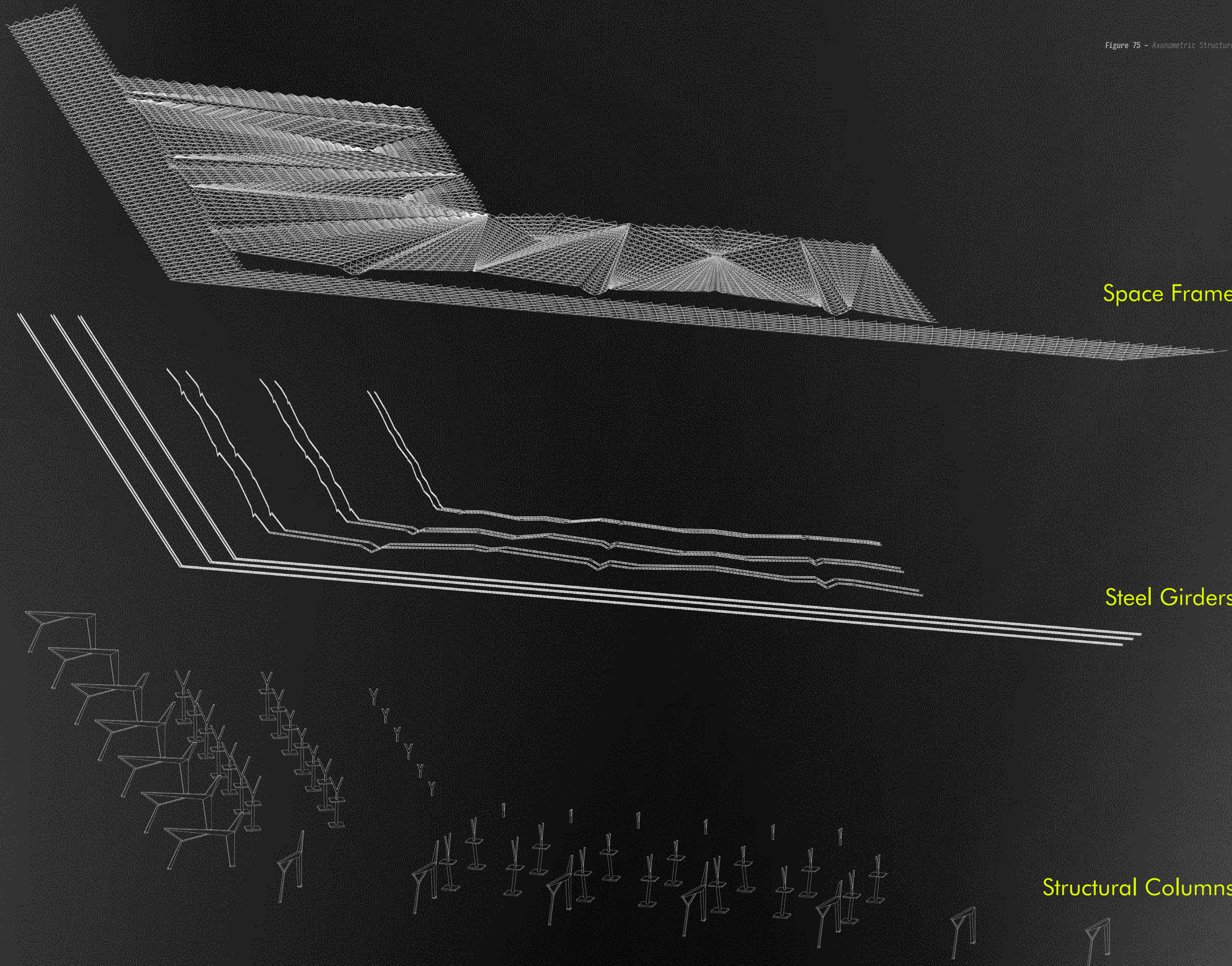
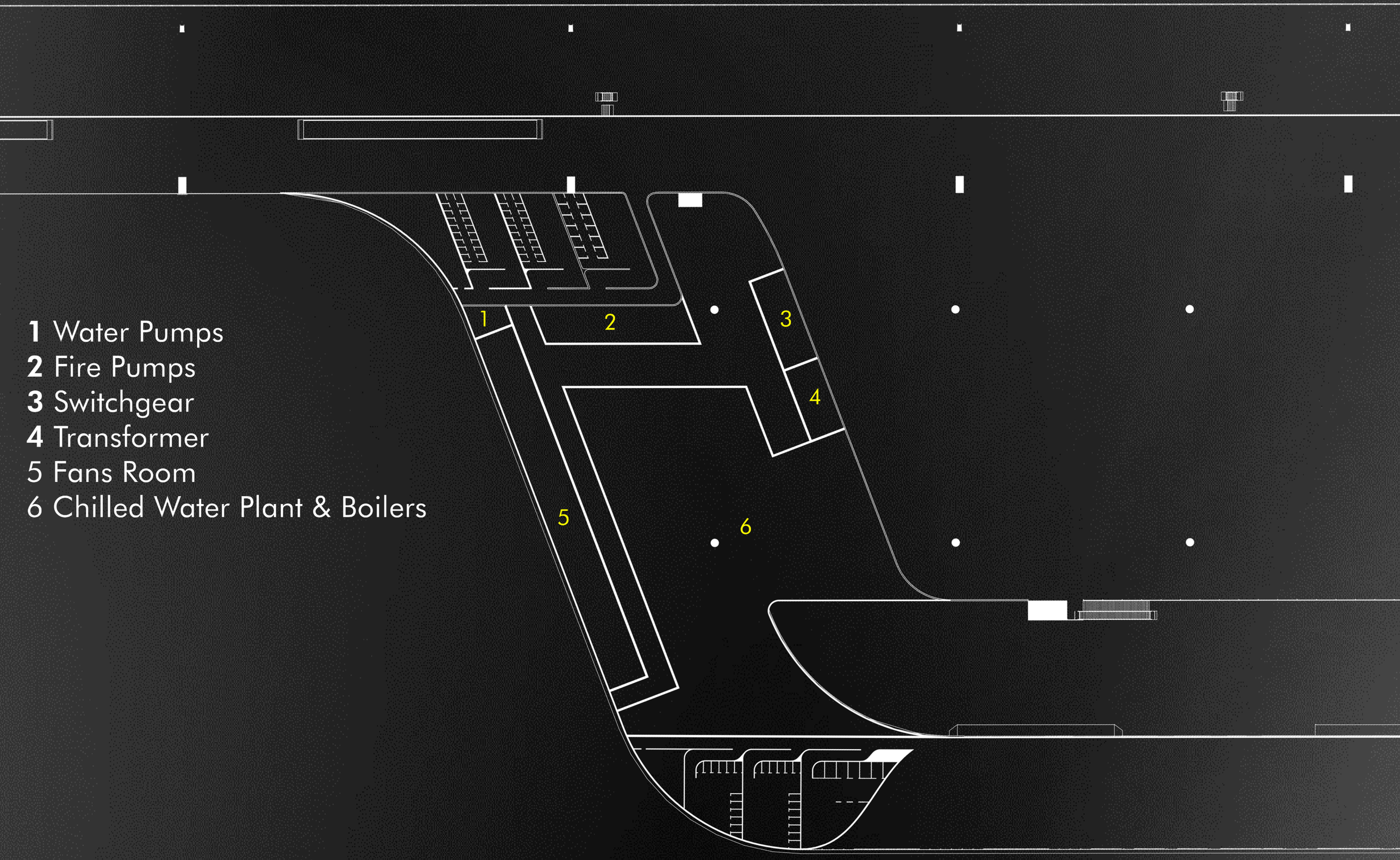
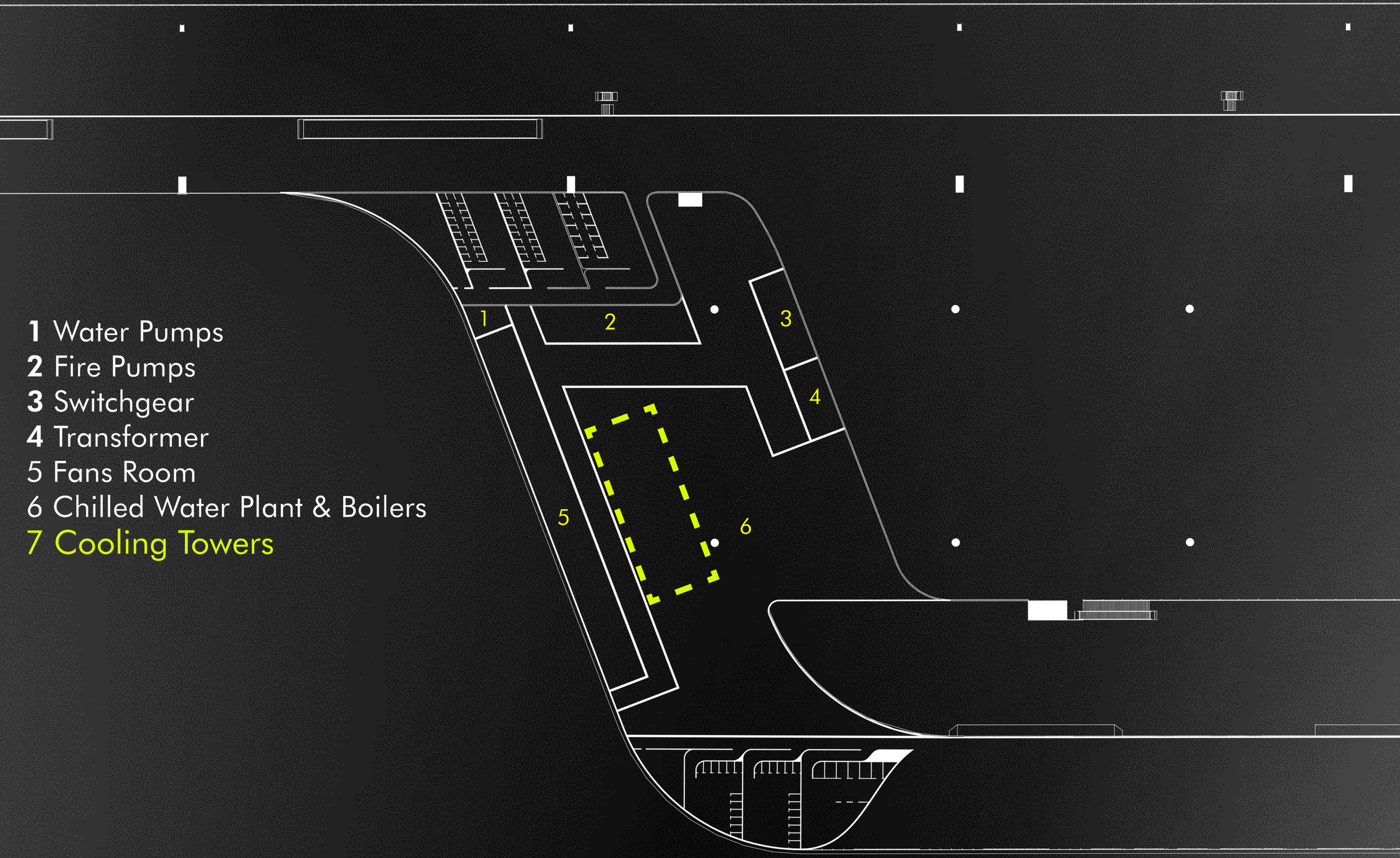


Figure 75 – Axonometric Structure Diagram





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

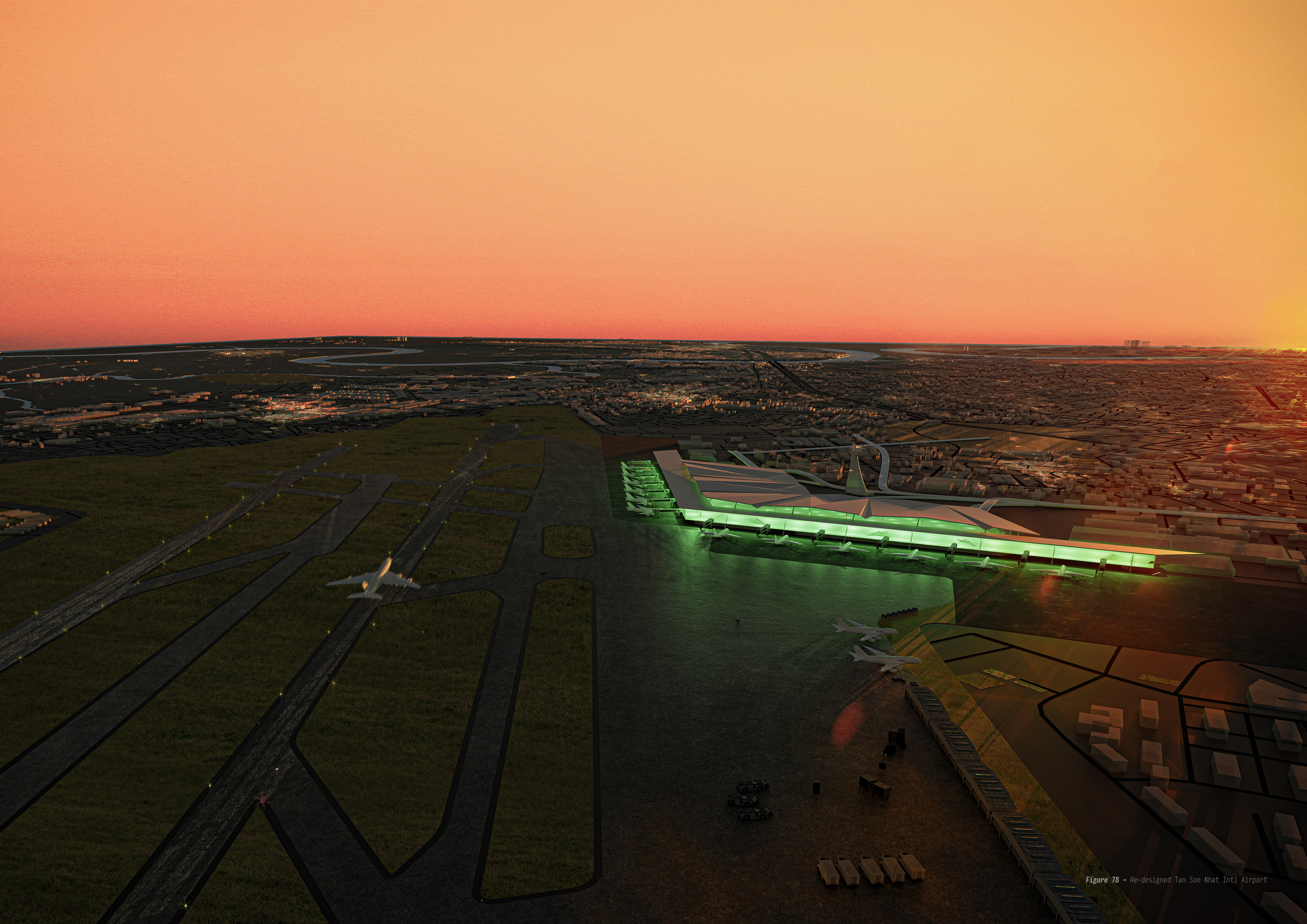


Figure 78 – *Re-designed Tan Son Nhat Intl Airport*

Figure 79 – *Re-designed Tan Son Nhat Intl Airport*

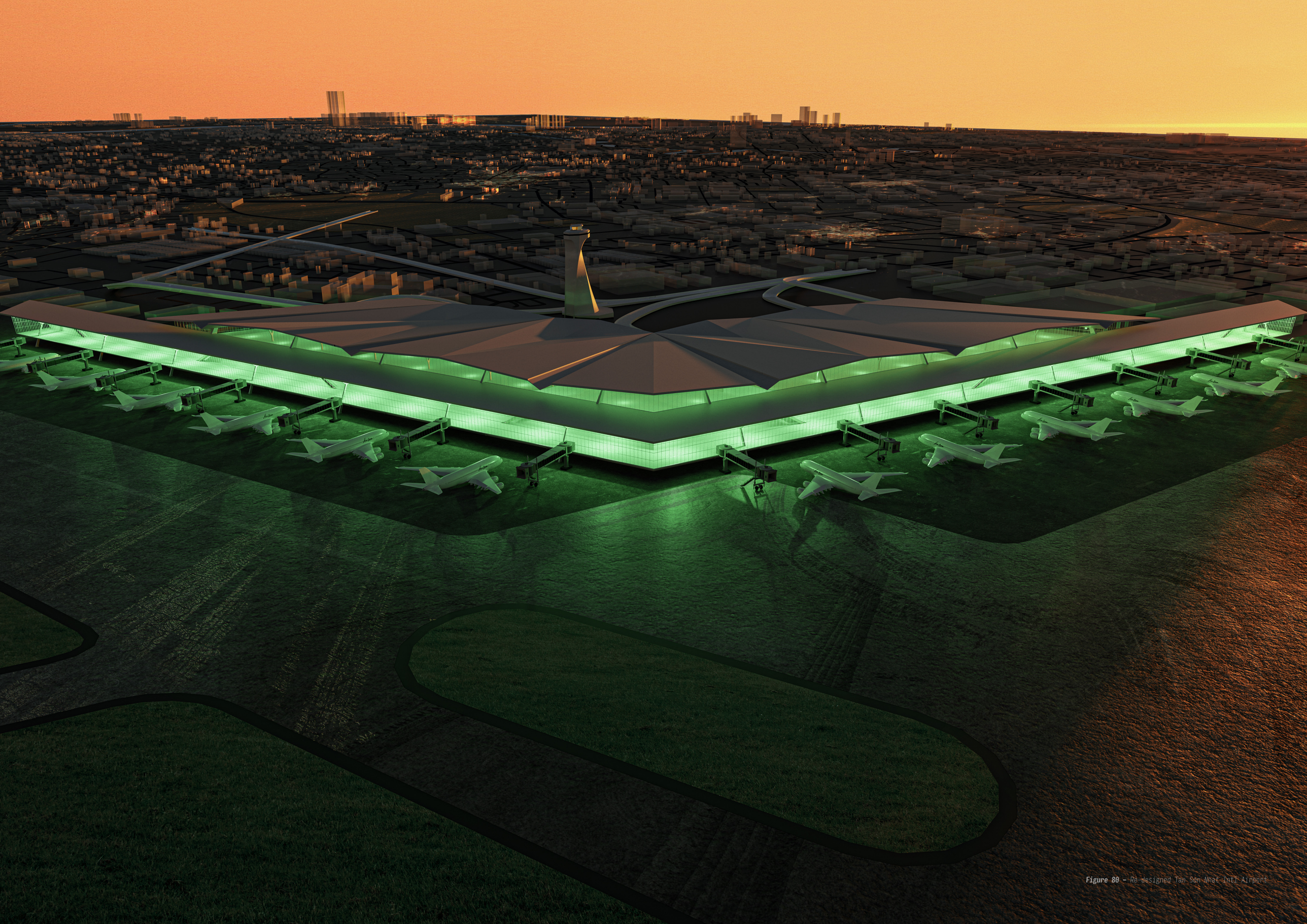


Figure 80 – Re-designed Tan Son Nhat Intl Airport

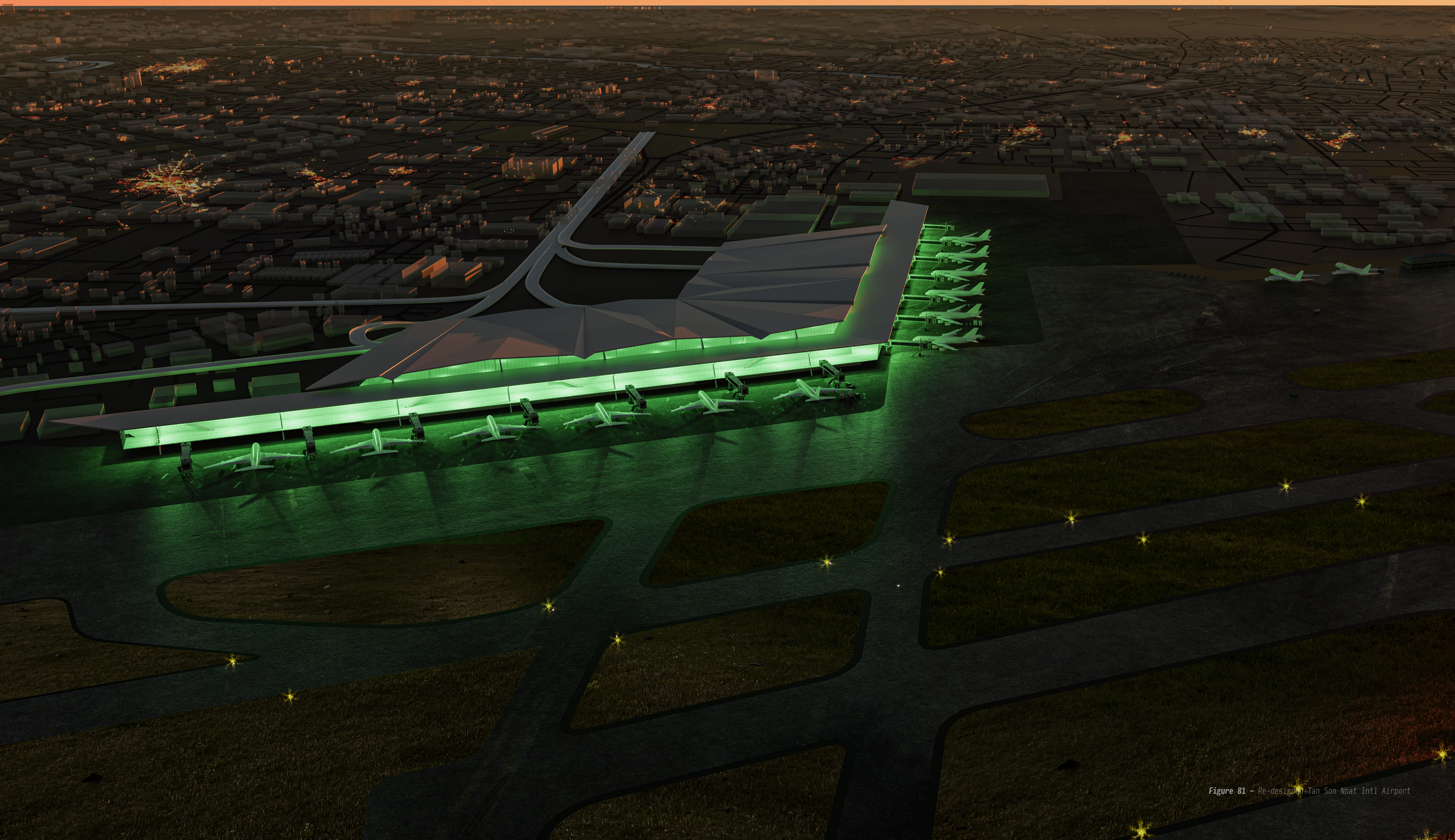


Figure 81 – Re-designed Tan Son Nhat Intl Airport

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