connecting US

A Design Thesis Submitted to the Department of Architecture
North Dakota State University

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Figure 1 | King's Cross Station

thesis abstract

Imagine experiencing multiple different cities and cultures within a single day. In Europe, this is easily accessible, partly because of the close proximity and small scale of countries, but also because of their means of travel. The ease and speed of their train system make traveling between countries almost effortless, so what has prevented the United States from doing so as well? The distance, as the crow flies, from London to Paris is about 212 miles, similar to Fargo to Minneapolis at 207 miles. However, the drive from Fargo approaches four hours, whereas a train ride from London barely breaks two (and also crosses an ocean, might I add.) In this document, I want to explore the reasoning as to why the United States has not developed an advanced rail system. Through my process, I want to analyze why the U.S. has not adapted this system, and what cost it would be at. A major aspect of the project I plan to examine is the environmental impact. The United States alone contributes to almost 25% of the worlds "passenger transport-related" carbon emissions. As for the physical design, I will take what I learned from my research to create a universal, modular train station that can be adapted to different situations. For example, based on a city's population, there are different sizes of the station that can be built; in a large city with the need of a large train hub, there could be the train platforms, ticket station, retail, dining, maybe even a hotel, whereas in a smaller city like Fargo, there may just be the platforms, ticket station, and dining. Overall, I hope to prove that train travel is a worthy investment for both people and planet, because it will allow people to take part of new experiences and lower carbon emissions.

thesis narrative

Europe is an area of so many amazing cultures, languages, and lifestyles. Their system of trains is unparalleled, making inter-country travel easy. The United States, though only a single country, also has diverse cultures from region to region. To start, I want analyze data showing the cost of train travel versus plane travel. I also want to look at the numbers of people traveling using different types of vehicles of their choice. The main question I want to address is **how traveling can be as efficient as possible while allowing people to experience new cultures, and how that can, in turn, change society and the ecosystem for the better.** I want to analyze the ease of travel. I will research what makes a great train station great and what does not.

I have always been a soul ready for any adventure. In high school, I jumped at the chance to travel with my French class around France. Later, I based my decision to go to NDSU because of their amazing study abroad semester that was offered. Though that experience was cut short because of the pandemic, I not only saw so many different cultures, but got to experience it first-hand. These trips were very drastic; jumping over an entire ocean, having to pack a huge suitcase, spending an arm and a leg to get there. Travel in Europe once we got there was mostly done by train with very little cost and very high efficiency. I have experienced personally how easy it is to decide to go on a weekend trip to Paris, or even to another city just for lunch. Having a train to ride allows time for the passengers to converse, relax, eat, even nap if desired. Just imagine a web of trains in the United States. Being from Fargo, going on a weekend trip to Medora becomes a completely fun experience rather than a dull, flat drive where you fight to keep your eyes open, you and your companions can talk and laugh the whole way there. A long drive to the cities for a girls' weekend becomes even longer when there's more time having fun on the way down being with each other than complaining about having to figure out who has to drive.

My thesis statement is to see if ease of travel can positively impact society, both at a societal/community level and a physical/environmental level. My theoretical premise is that I believe society will be positively impacted in many ways. One being the environment. More electric train travel will mean much less air travel, which is a large pollutant, especially from the United States. Another is socially. People who travel more experience cultures other than their own and see different ways of life, which hopefully in turn will make people more accepting of others different than them.

Now more than ever, we need to be thinking about the planet and each other. The answer should not be to travel less, but to find a solution to travel **better.**

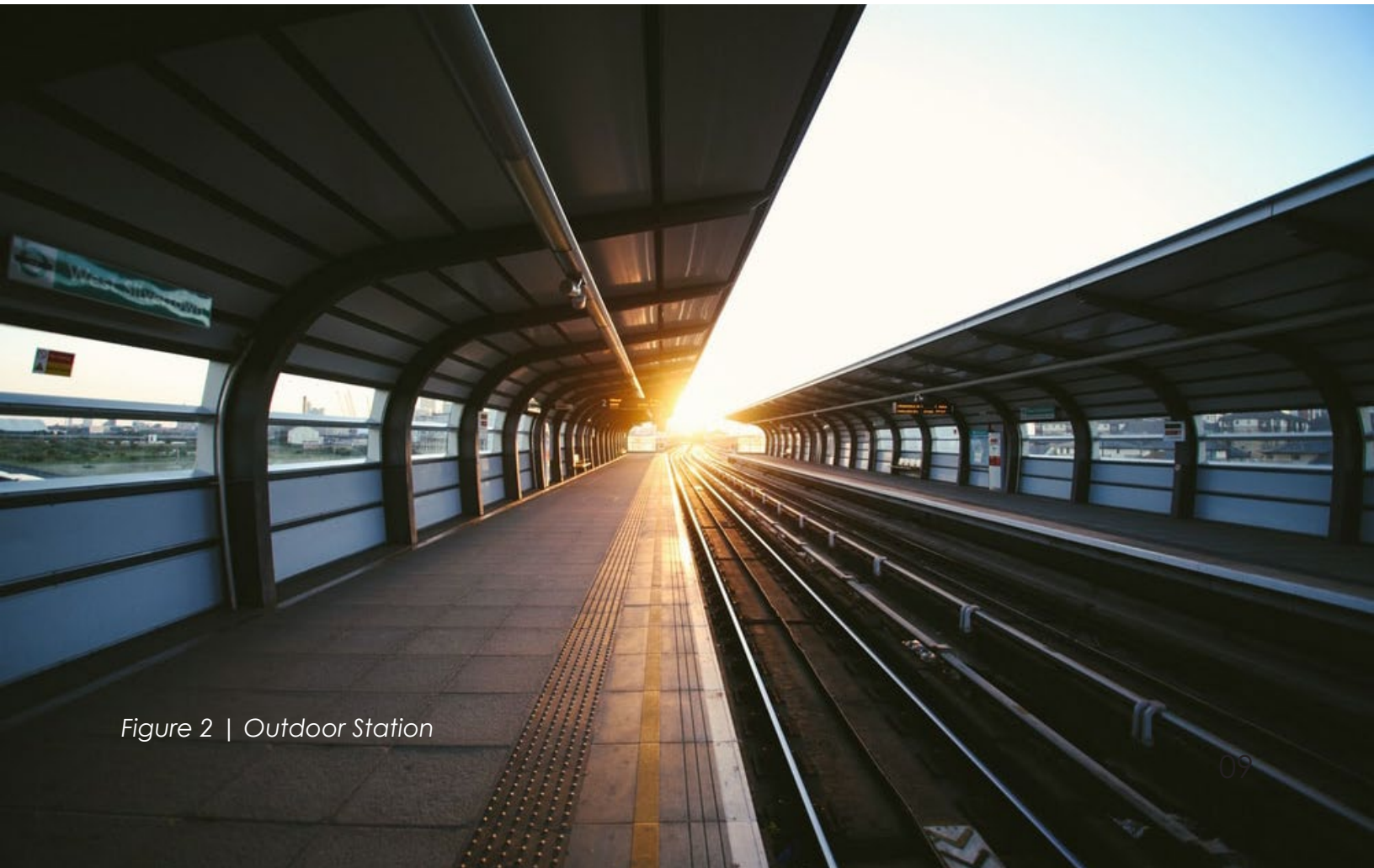


Figure 2 | Outdoor Station

project typology

The proposed typology will be modular train station that can adapt its size based on need of the city. In large cities, the station will be home to the necessities, including platforms, seating areas, and ticket booths while also incorporating dining options, entertainment areas, and even a hotel, while in smaller towns, the design will be scaled down. This typology was chosen for these reasons:

1. Improve ease of travel throughout the United States while promoting the reduction of carbon emissions.
2. Attract retail and consumers into areas of high traffic.
3. Encourage exploration of places, people, and Cultures.

Modular Design: Able to be adapted to many different needs but acts as a blueprint to make the build and financing of the stations efficient. Local architects can design the exterior to suit their city's personality.

Public Space: More than just a node where people come and go. The station will act as an entry way and exit point, but also has a spot where the public can shop, stay, and enjoy their time.

Station Use: Though the project will incorporate the city's needs into the design, the largest purpose of the building is to serve as a spot of connection.

typological research

Considerations

Project Typology: Size of project, modularity of the design, and use of building

Location: Diverse locations, in urban settings

Sustainable Design: Types of implementations, the effectiveness of the designs, passive strategies

Chosen Case Studies

Transbay Transit Center, San Francisco
St. Pancras Station, London
Kyoto Station, Kyoto, Japan

Figure 3 | Graz Main Station, Austria

transbay transit center

Figure 4 | Transbay Transit Center Entrance

Location: Downtown San Francisco, California
Size: Over 1 Million Square Feet - 1,430 ft x 165 ft x 5 Stories
Year Built: 2018
Architect: Pelli Clarke, Pelli Architects
Cost: $6 Billion
Certifications: LEED Gold

The Transbay Transit Center is an all-encompassing development in downtown San Francisco, including a transportation center, a public park, an outdoor amphitheater, kiosks, shopping, dining, among many other things. The center was developed using the Transit Oriented Development, which is a land-use strategy used to fight urban sprawl and the vehicle use that comes with it. The project itself had three parts, the center itself, the redevelopment of the area it is in, and the extension of the rail lines already present in the downtown. 11 transportation systems are brought together under one roof, creating 125,000 jobs. The project took place with the knowledge that there is a high-speed train in the works from San Francisco to Los Angeles, so it has all the necessary programming for the future. With the extension of the rail line, it is estimated to remove thousands of vehicles from the downtown area, meaning $360 million in travel time savings.

Figure 5 | Ground Level

Figure 6 | Lower Level

Figure 7 | Section View

City Park (Top): The 5.4-acre public park has many amenities. From the outdoor amphitheater to the gardens or open grass areas to the restaurant-café, a lot is squeezed into this rooftop oasis. Not only is the function to provide space for the public, it also serves as a green roof, an insulation layer between the sun and the building. The living roof also helps filter the exhaust from the transit center and improves air quality for the entire neighborhood.

Bus Deck: A bus loop designed around a central passenger waiting area.

Second Level: Administrative offices and retail space.

Ground Level: The main circulation area, consisting of the "grand hall" with escalators, retail, and ticketing machines. There is a large light column which brings natural daylighting through the space. The west end is reserved for maintenance and the loading docks. On the east there is a bus plaza.

Lower Level: The passenger connection between the "grand hall" and the train station. There is space for retail, ticketing, and bike storage.

Train Station Platforms: Three passenger platforms that accommodate six trains.

For the economics, the center will produce about $87 billion in Gross Regional Product and $52 billion for personal income through 2030. The entire project and related areas are aiming to produce $3.9 billion in value tor the commercial and residential properties in about three quarters of a mile around the center. Another astounding thing about this massive project is the fact that it is LEED certified. It accomplished this many ways, including the huge green roof and the comprehensive water runoff reduction and water conservation methods. It also uses advanced daylighting systems to offset the need of electric lighting and uses natural ventilation in the Grand Hall and bus deck level. The program also includes a three-stream waste separation system in an aim to become net zero waste in the future.

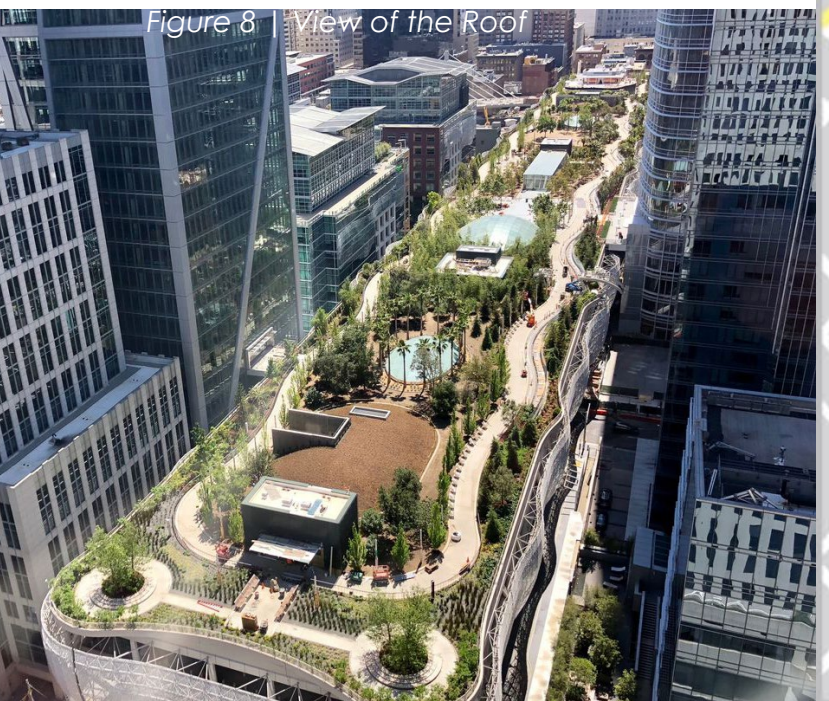


Figure 8 | View of the Roof

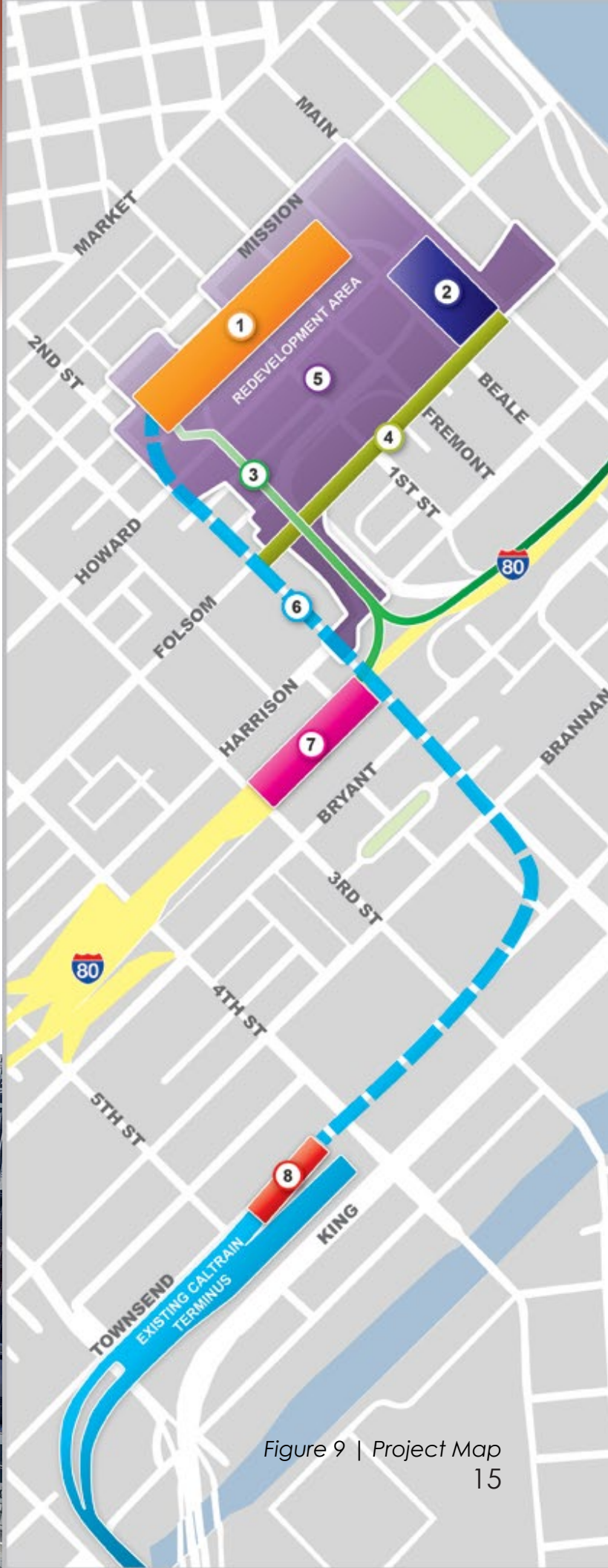


Figure 9 | Project Map

st. pancras international

Figure 10 | Exterior of St. Pancras

Location: London, UK
Size: 15 Platforms
Year Built: 1876, renovated in 2007
Architect: William Henry Barlow, renovated by Chapman Taylor
Cost: $64,445,000 renovation

St. Pancras is a vital station in the UK. From playing role in both world wars, to now seeing almost 36 million people a year, with that number on the rise. At the time that the station was built, it was using top technology. It was the longest single span roof at that time in the world with a 245-foot span at 689 feet long. The station's hotel was finally completed in 1876 but closed in 1935 because of poor profits. Since the renovation, it has become its own destination with shops, dining, and tons of history.

St. Pancras is not only on the map for its architectural integrity and splendor, it has many cool aspects on the inside as well. Inside is the nine meter high statue called *The Meeting Place* and a bronze statue of John Betjeman. They have a cool interactive piece for the station users as well. There are upright pianos in the main area for anyone to play at any time. Amenities this station has: charging ports, photo booths, a pharmacy, luggage storage, 36 retail stores, 22 food and drink options, among more. Because of it's historic bones, the station couldn't change a lot for sustainability reasons, but there are aspects they added. Sun shading with the new addition was a large addition.

Figure 11 | New Exterior of St. Pancras

Figure 12 | Map

Figure 13 | Upper Level

Lower Level: the main shopping area as well as the ticket area. There are many restaurant and shopping areas down here. The Eurostar also departs from this level and has a waiting area section devoted to it.

Figure 14 | Ground Level

Upper Level: The main 15 platforms are located here. Most of the area is circulation space, but there are options of dining on this level as well.

Figure 15 | Restored Hotel

Hotel: The old hotel, which was converted into rail offices in 1935, was refurbished back into an updated hotel called the Renaissance Hotel in 2011.

kyoto train station

Figure 16 | Kyoto Station

Location: Kyoto, Japan
Size: 18 Platforms, 15 Stories, 2,561,811 Square Feet
Year Built: 1997
Architect: Hiroshi Hara

The Kyoto train station has technically been in use since 1877, however this third station wasn't built for another 100 years, after a second station that was built burnt to the ground. An interesting fact about this station is that it was built for the city of Kyoto's 1,200 year anniversary. The futuristic, modern station is juxtaposed to the city's very traditional heritage, which sparked a lot of backlash when they unveiled the plans. However, this station was a huge turning point for Japan, as they tried to leave post-war design in the past. Earlier stations looked like nothing more than a plain department store. This station redesigned their thought process for buildings in the county in general. For the city itself, the construction of this station sparked a large development wave in the area, bringing commerce and tourists to the city.

This station is very high-traffic, seeing an average of 200,426 passengers daily in 2016, and it has only increased since then. It only follows the station in Osaka for ridership numbers. With a massive size of over two and a half million square feet and almost 12 different occupancy types and over 77 million visitors a year, this station could act as its own city.

Figure 17 | Station Commercial Space

Figure 18 | Grand Staircase

This station is all encompassing, with a large number of uses. Not only does the station attract a large number of passengers, but a huge number of non-riders to the area as well. The amenities the station has are listed below:

Figure 19 | Hotel

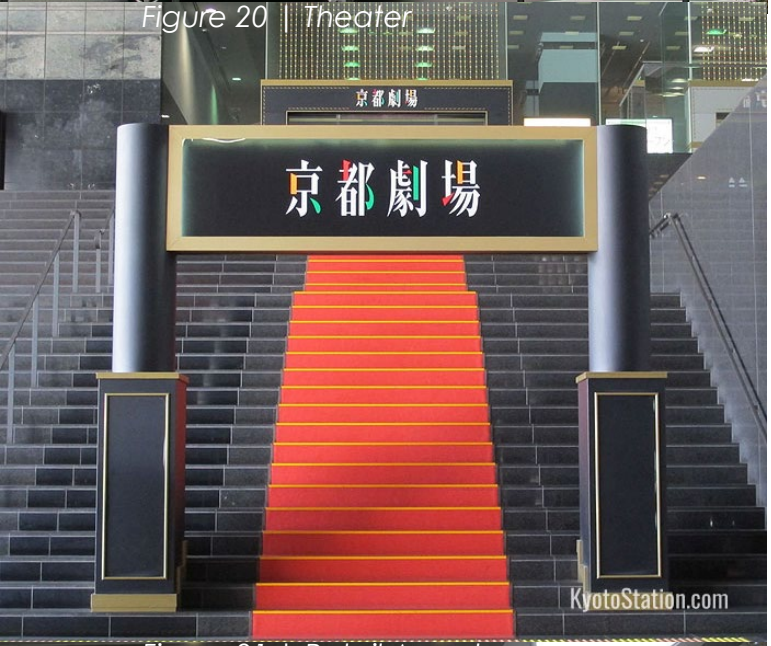


Figure 20 | Theater

Figure 21 | Retail Arcade

Hotel: located in the station, the location cant be beat. Along with the normal hotel rooms, there is a pool, event spaces and banquet halls.

International Center: an information station with multi-lingual staff to help out of town people with anything they need.

Theater: located in the north east corner, it hosts a range of theater and musical productions and concerts.

Museum: art gallery on the 7th floor, with changing exhibits.

Grand Staircase: people often sit here to rest and enjoy the space, and occasionally holds musical events.

Sky Garden & Happy Terrace: on the 15th floor, a nice spot to rest and take in city views.

Department Store
Restaurants
Shopping Arcade
Post Office
Government Offices
Station Lockers
Police

case study takeaways

These train station case studies have opened my eyes to what it takes to make a train station a true hub in a city. Though each are from different backgrounds, the Transbay being the newest and St. Pancras being the most historical, there is valuable information in each. My biggest takeaways follow:

1. Location, location, location. The area that the station is situated can make or break the success of the redevelopment. It must be central, easily accessible to all users, and somewhere that is easily connected to other means of travel.

2. There must be a wide array of uses to bring people to the area. The uses must be attractive and diverse, to avoid getting only a few user-types.

3. The design of the platforms is more important than you think. Even though they can be designed out of site, placement, orientation, and circulation can greatly affect the ease of travel and in turn the success of the station.

Though this project will not be an easy one, it will be a pivotal one. The United States must eventually get caught up, and eventually hopefully ahead, using high-speed rail travel.

major project elements

Depending on the location, different elements of the train station will be utilized. The table below divides different aspects of the stations into "essential" or "amenity" categories. Below is a diagram showing the different levels of station sizes depending on the need of the city.

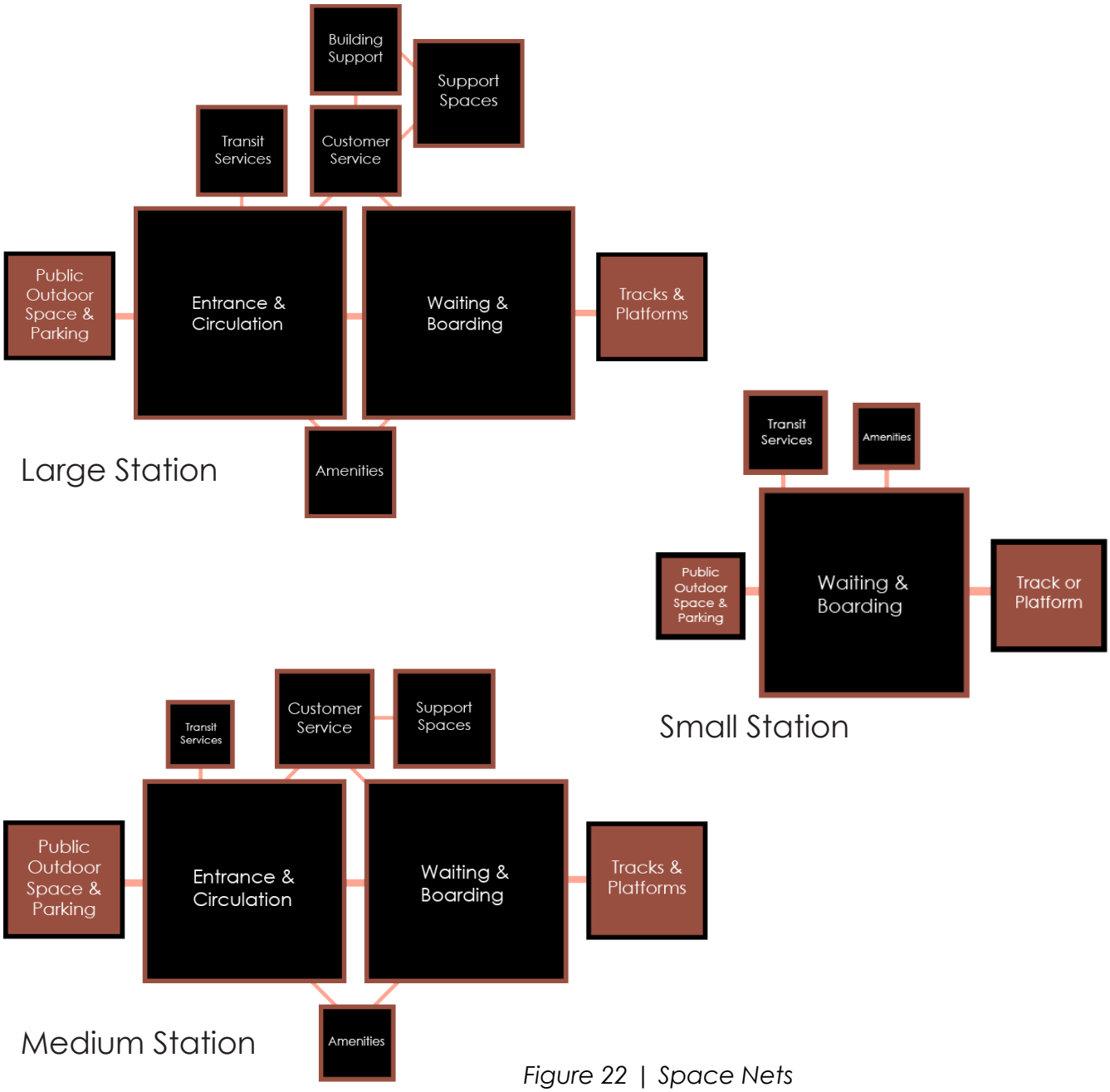


Figure 22 | Space Nets

essential	amenity	
Ticket sales	Security	Bus Station
Restrooms	Dining Options	Vending
Train Platforms	Fast	Hotel
Train Offices	Sit-down	Baggage Storage
Seating Area	Retail	Public Park
Customer Service	Commercial Offices	
Crew Base/Lounge	Entertainment Areas	
Parking	First Class Lounges	
Information Station	Info Desk	

Figure 23 | Budapest Station

users

The users of my thesis project will vary. Many different types of clients will utilize the larger city stations, whereas in smaller towns, more specified users will only be there. The station I design will be categorized as the largest station size, and therefor will have many users. These include people using the train station for travel (the family travelers, the business travelers, the solo travelers, etc.) Among others like restaurant goers, retail shoppers, and their respective workers needed. It will be important to make the spaces easily accommodating and navigated. The main purpose of the station is to act as a pit stop between locations, but I want to design the most efficient stop possible.

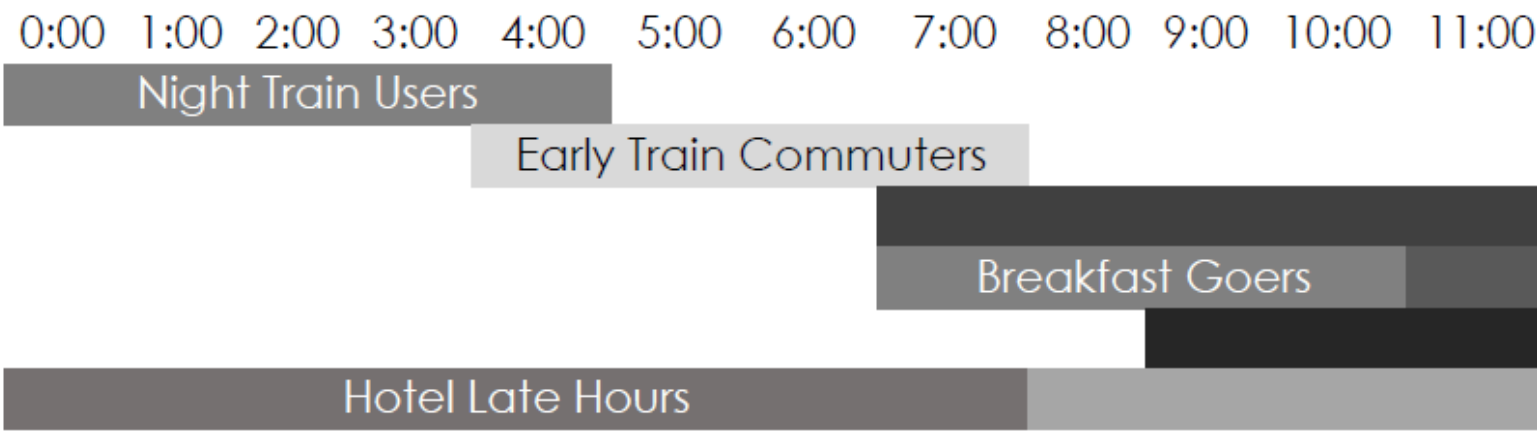


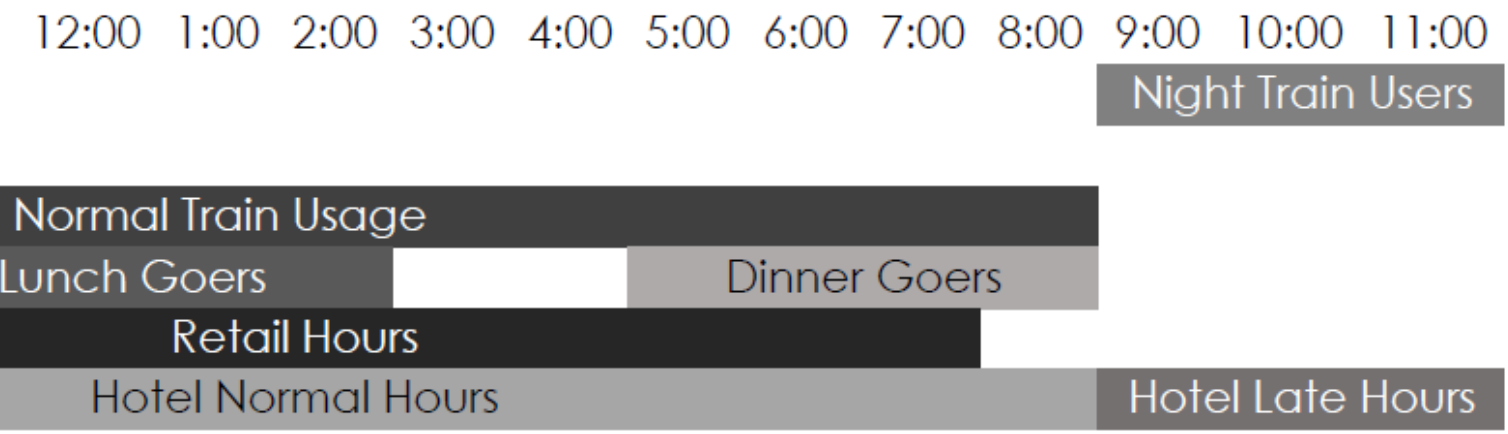
Figure 24 | Timetable of Station Use

Travelers: the main users of the station, especially in smaller modules. Must provide an efficient way to work through the station for their primary use of the trains.

Station Staff: the other main group of users. From the travel-related staff, like ticketing office staff, janitorial staff, security, and the like, to the amenity-related staff, like servers, retail staffing, hotel reception and cleaning staff, and the extra janitorial staff.

Train Staff: the ever-changing train staff include conductors, ticketing staff, dining car staff, and the janitorial team. This group will most likely travel the region, much like flight attendants do.

The Public: the most diverse group. Ranging from shoppers to diners to people just killing time in the area.



the site

Figure 25 | Proposed Florida Station

orlando, florida

The main site of the designed project will be an urban neighborhood and the station will serve as a hub in the heart of the city. Urban areas provide a lot of opportunity for many different uses and can majorly impact an area's economic activity. The smaller modules of the station can be placed around the country as cities see fit, and the design will portray those modules as well. Orlando was a natural city to pick, as it is centrally located in the state and is currently in the beginning stages of getting a high-speed rail project.

Region: Southwest U.S.
City Population: 285,705 People
Area Population: 2,134,411 People

Orlando, Florida is the city I chose to house the first of these stations. With a decent sized population of 285,705 people, Orlando is an up and coming city with almost a 2% growth rate from year to year and with a central location between many large cities.

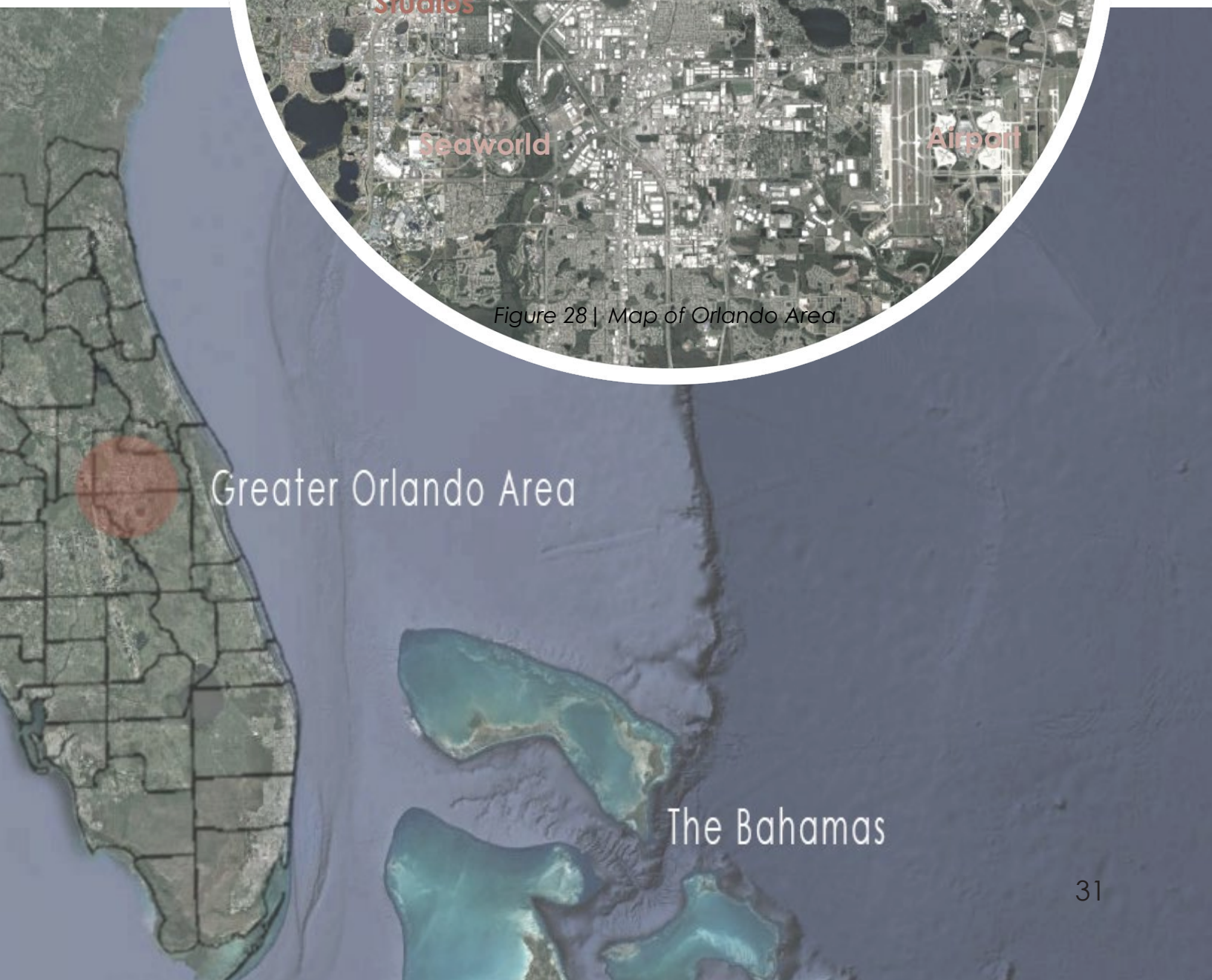
Figure 26 | Orlando, FL

the site

I chose this site because just south of the heart of Orlando's downtown. It is vital to have the location in the center of the action, close to a lot of people, and with close proximity to other attractions. The entire site is a neighborhood that needs some improvement, and being that the area is directly south of downtown, it has a lot of potential for growth. The images illustrate the surrounding context.

Figure 27 | Map of Florida Area

Figure 28 | Map of Orlando Area



the site

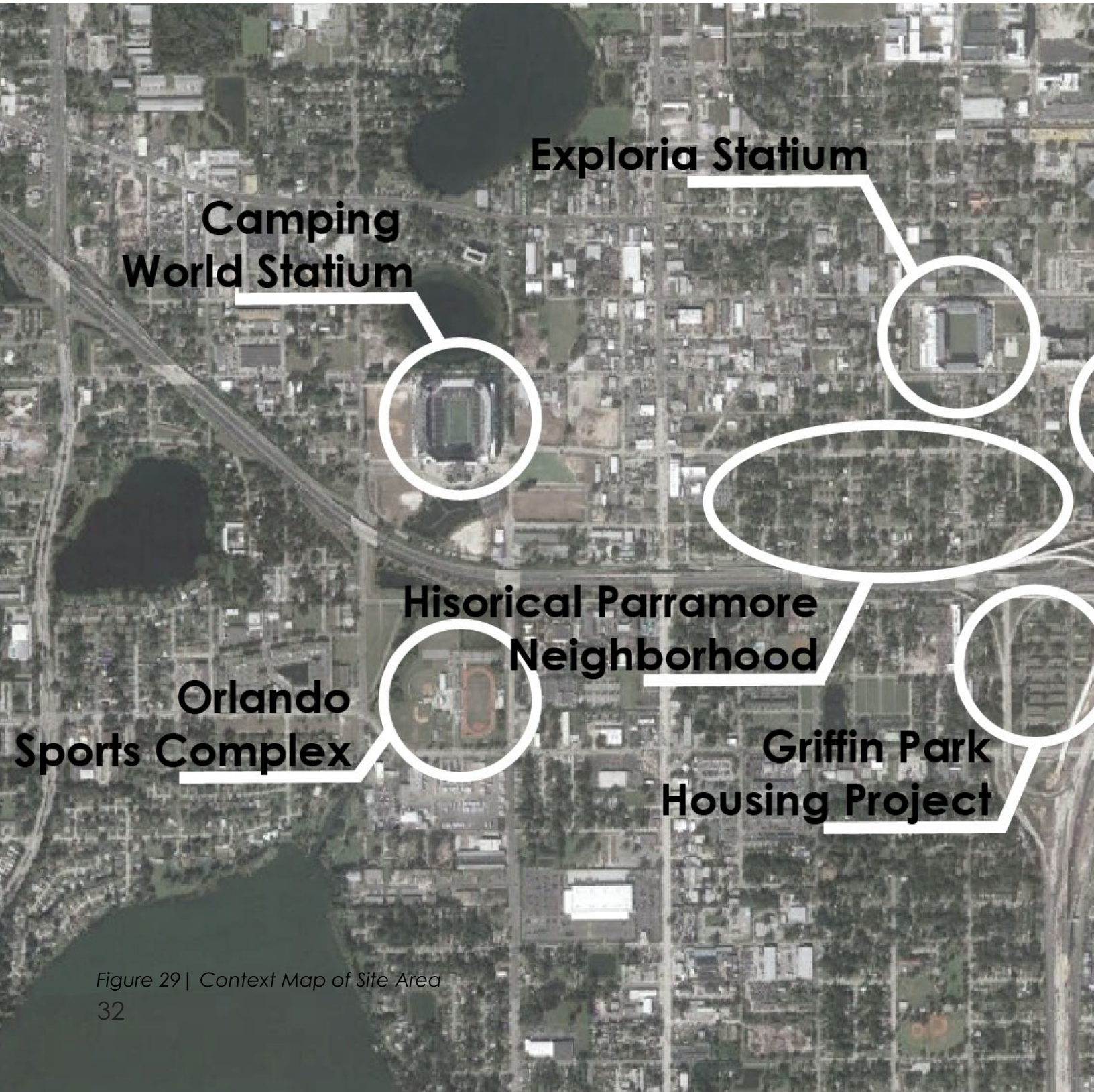
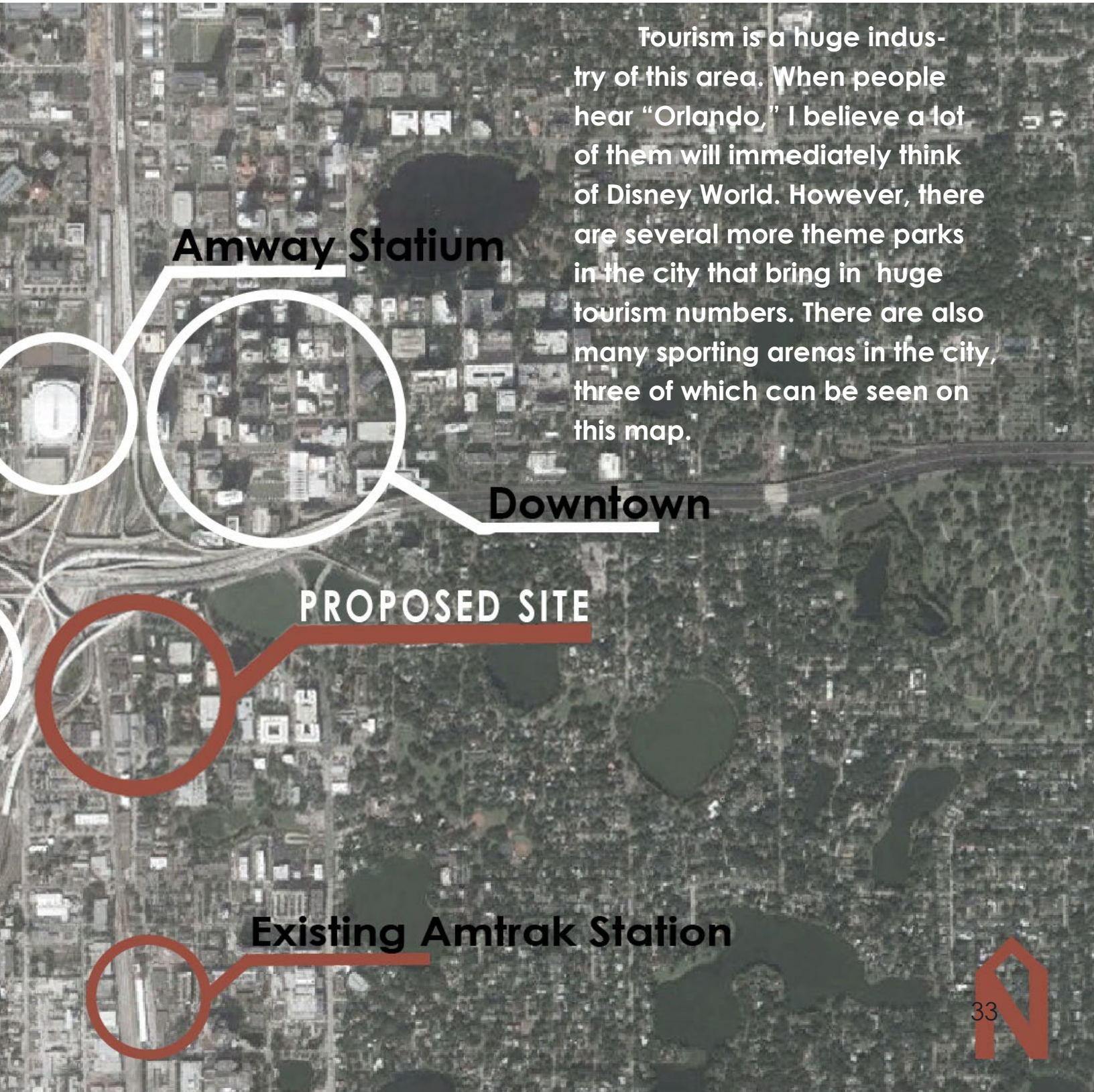


Figure 29 | Context Map of Site Area

orlando, florida



Tourism is a huge industry of this area. When people hear "Orlando," I believe a lot of them will immediately think of Disney World. However, there are several more theme parks in the city that bring in huge tourism numbers. There are also many sporting arenas in the city, three of which can be seen on this map.

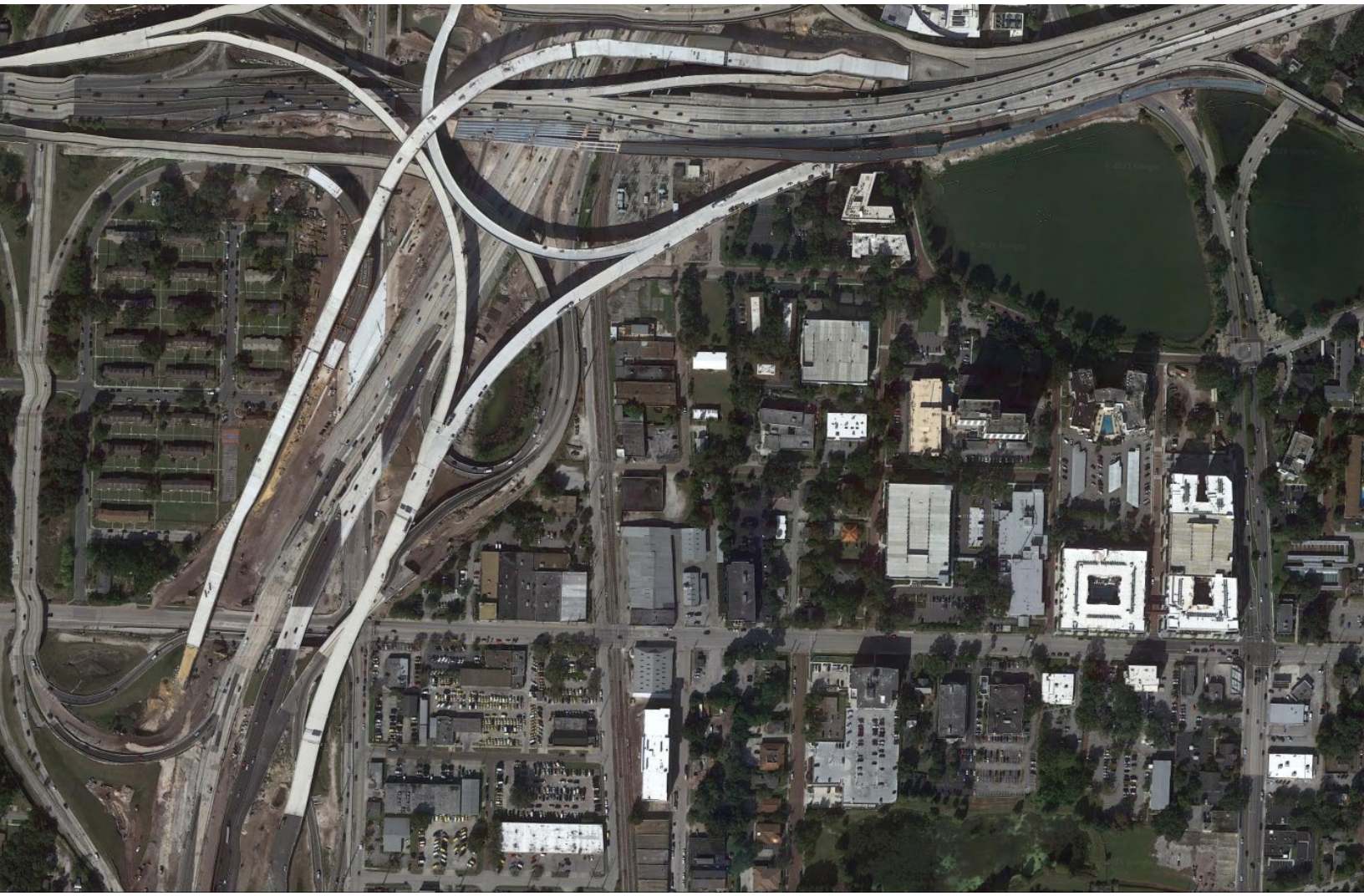
the site


Orlando
Existing Historical Residential District
Existing Downtown District
408
408
Proposed New Housing Development
Existing Residential District
PROPOSED SITE
Existing Mixed-Use Development
Existing Residential District
Existing Commercial District
Proposed Redevelopment Area
Existing Medical District
Existing Industrial District

orlando, florida

Figure 30 | Map of Site Area

Site Details:
Address: Franklin Lane, Orlando, FL 32801
Square Footage of Entire Site: 2,284,900 SF
Square Footage of Station Site: 168,700 SF



project emphasis

Modular Design & Programming:

The design of the station will be easily modulated from city to city. In larger cities, more amenity uses will be included whereas in smaller towns, only the essential uses. The design will easily be able to be separated on an 'as needed' basis, which the essential needs being met for the smallest station, and sections being able to be added on as it is needed in larger sites.

Train Station Responding to City:

The city commissions in charge of the development of such stations will determine what sections of the modules are desired. If the area is a highly-dense population more amenities will be added as needed.

Community Connection:

Community connection will be emphasized on both a national and local level. On the national level, cultural and social understanding will be much easier to reach because of the ease and efficiency of train travel. Locally, the station in larger cities will provide a great node for the public to gather at.

Promote Sustainability:

The stations, no matter the size, will aim to accomplish LEED Gold standards, and with a future aim of becoming net zero waste stations across the country. Train travel already is a great way to travel for the environment, and I aim to show that the stations can follow suit.

project goals

Social:

-Prove that the relationship between traveling and understanding different cultures and social economic areas is positive.

-Design a station that allows the users to travel as efficiently as possible while also being a source of education.

Physical:

-Prove that train travel is more sustainable than air travel and vehicle trips.

-Design the most efficient modular station.

-Design with high sustainable and energy efficient practices.

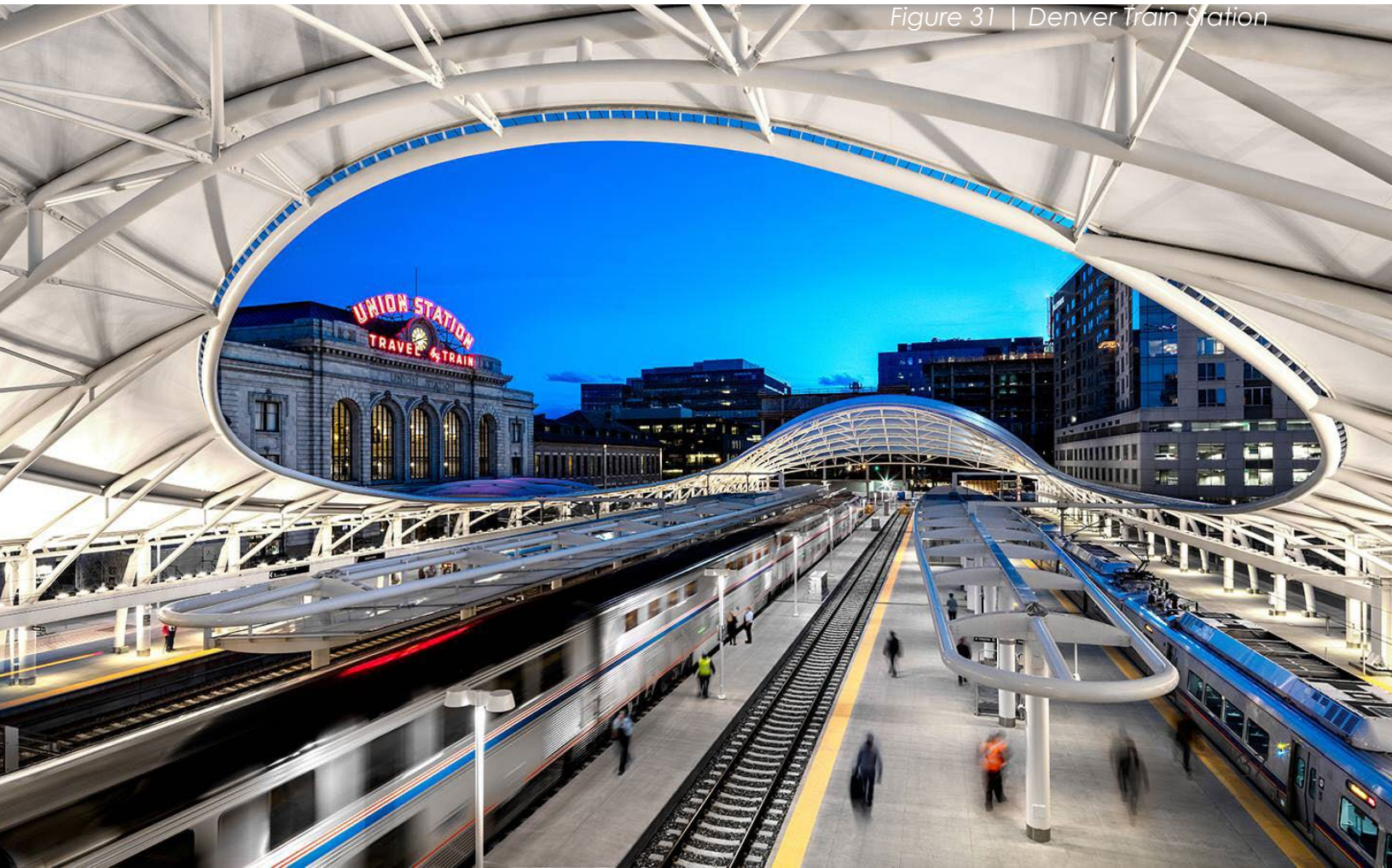


Figure 31 | Denver Train Station

schedule

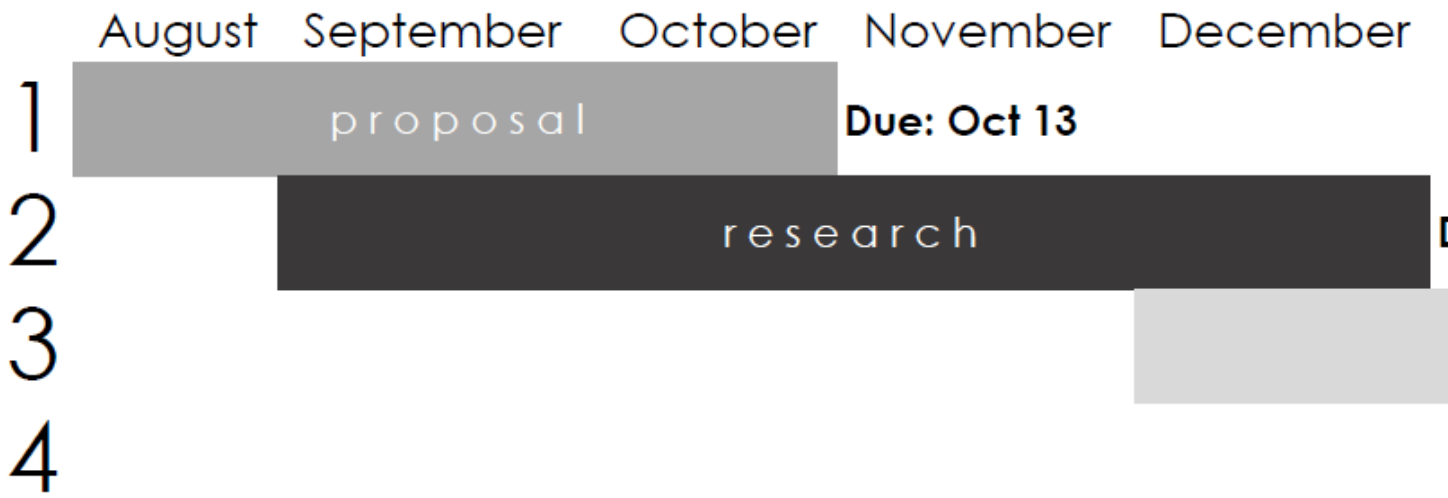
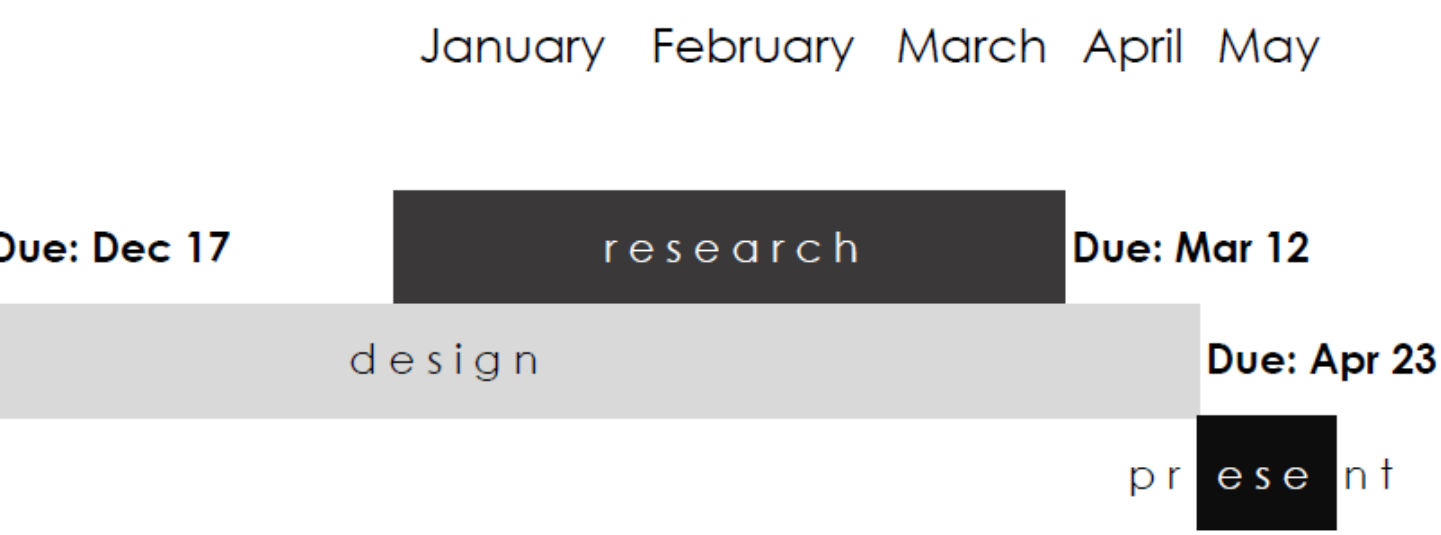


Figure 32 | Table of Project Schedule

1 **Proposal:**
Due October 13th. Detail out my intention for the thesis project. Define the thesis question.

2 **Research:**
Due December 17th. Support the thesis question fully by providing quantitative and qualitative research. Show the development of the design solution.



3 **Design:**
Due April 23rd. Design an answer to the thesis question. Must respond well to site selection, research, and project goals set forth by myself.

4 **Present:**
Due May 3rd-6th. Design a well thought-out exhibit and successfully present my project to the jury.

plan for proceeding

Research Direction:

For this thesis, many things will be used as a background for the design in the spring. It will implement both qualitative and quantitative research conducted by case studies, the building codes, peer-reviewed journals, studies, and the Amtrak station guide. The research will be utilized to fulfill the programming and design requirements for a meaningful solution.

Design Methodology:

I will use two design methods, the first being the Structured Design methodology, which identifies inputs and desired outputs to figure out the design. Using the research from this book, I will decide on which of the desired aspects of the design thesis is most important to use as a basis for the train station. The second is the Object Oriented Design methodology, which will base the final design on a system of interacting objects.

Documentation of Design:

All information and research will be documented digitally into the thesis research document due at the end of the first semester. The use of info-graphics, tables, graphs, and images will all be used in conjunction with my writing. Design processes will be documented, and the final design will portray the solution that the research helped conclude. An oral presentation will be given at the end to accompany the physical design display on the fifth floor of Renaissance hall. The thesis book will be printed and will be shown at the display as well, however the digital files for each piece will be kept in the NDSU Library database.

presentation intentions

The Book:

The final thesis book will be made up of the proposal document and the extensive research collected. One book will be ordered with plenty of time allowed for it to reach Fargo. A second book will be ordered with as much of the final design added to it as possible to receive the book at the last possible moment.

The Boards:

The final presentation boards will portray all necessary information to fully explain my design choices. Using up all space available, I will design my boards to show my design as efficiently and simply as I can.

The Video:

The video will animate what the station will look like and how the programming works. The model will be completed for the boards.

Final Presentation:

The oral presentation will combine the research and design solutions to explain my decisions to the best of my availability. I will use the culmination of my research to back up my design processes and use my presentation materials to get my design across.

the research

Figure 33 | Sau Bento Portugal Station

preliminary findings

While the topic of high-speed travel has been on the table for quite some time now, the United States still hasn't fully adapted the idea of having a country-encompassing full train system. In this research section of the book, I plan to dive into some different methods to prove that developing an effective train system would be beneficial. This includes:

1. Literature. I have found a handful of articles from the NDSU Library to analyze that will help to aid me in the design development and reasoning of my thesis.

2. Survey. I have created a brief survey to get the public's view of traveling in general and also on different modes of transport, mainly looking train and plane travel.

3. Amtrak Guide. Amtrak has a published guide as to what needs to be included into their stations. They have small parts about planning for high-speed rail, so I will analyze there tips and use it for my design.

Through my research, I plan to fully explain and support why a high-speed train system would offer many benefits to society as well as the environment.

I also plan to develop an efficient system of high-speed implementation. I will use GIS to develop a map of track-building phases and show what is existing as well and what I believe the best route is for proceeding.

research results

I have learned an incredible amount about high-speed trains and all the effort it takes to make a nation-wide system successful. I have also learned that the success is not just solely based on the trains and its respective infrastructure. The stations and traveler experience have everything to do with the success.

My most important takeaways follow:

- The entirety of a project like this is extremely costly, and to gain public support must be efficiently designed and effectively implemented. Nothing can be left unplanned.

- Stations are much more than just places people depart from and arrive at. It is a place for adventure, learning, relaxation, public gathering, shopping, dining, working, and so much more. The station has a chance to be a city within the city, bring in more tourists, and create a large economic opportunity for the city.

- The location of the station is just as important. If there are no other options of transportation to or from the area, no one will en joy the process of trying to come or leave. There must be ample parking available nearby, bike and pedestrian routes, rental cars or rideshare areas, bus routes, and ideally in large cities a subway or light-rail stop to connect the station to further parts of the city.

-Traveling should not be a burden. It should be something to look forward to, and the system must be on time, fast, and convenient enough for people to choose rail travel. Whether it be for work trips or for fun, the station and trains need to cater to the needs of the users.

Overall, I have my work cut out for me in designing an effective and modular station. This research will help me in deciding space requirements and what amenities should be prioritized, and how to make the station environmentally friendly.

high-speed rail implementation

Implementing an entire high-speed rail system in a country the size of Texas in no easy task, let alone the entire United States. The funding needed is beyond comprehension, and so therefor a lot of consideration is needed to plan such a task. There are many informational resources out there, but I have proposed a very general idea on different phases to start the infrastructure. Below is an image of existing major railways that exist already. It is a majority of freight railways, with a little commuter railways, and the colors represent the companies that own them. Ideally, for most longer segments of phase one and two, existing railways will be upgraded to be able to function a faster train than currently, however not as fast as a completely new and separate high-speed track. For the upgrades, new metal rails, rail ties, road overpasses, tunnels, and adding side rails to pass slower moving trains would be a few of the upgrades needed. For direct links between large cities that are relatively closer, I think that building new, dedicated high-speed lines will be the most beneficial to attract people to a very fast route. On the following page, I have shown the phases I believe to be a good route, starting with Phase 1 routes to gain popularity and then as more people are exposed to high-speed rail, expand the lines further and further with phases 2 and 3.

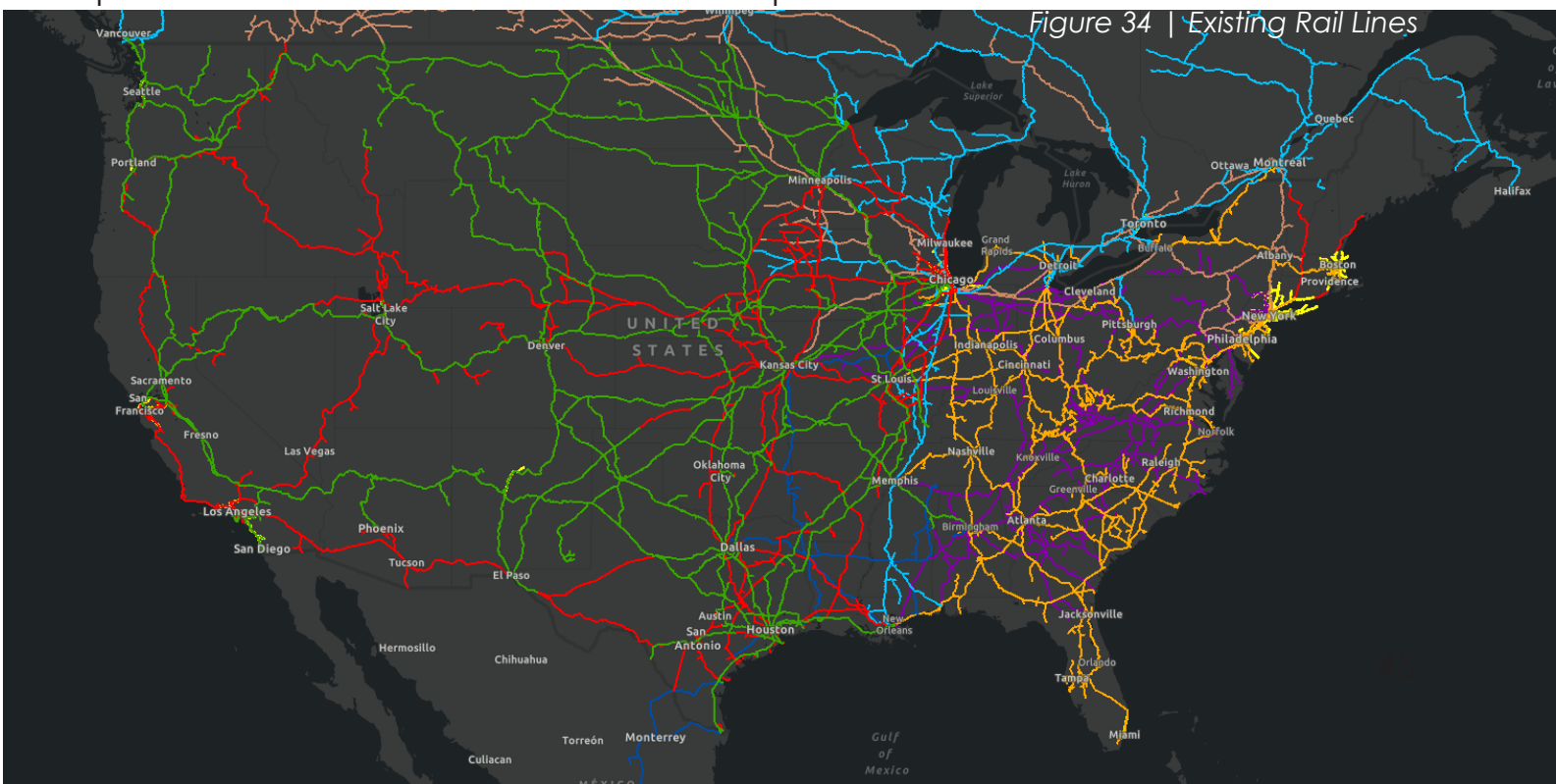
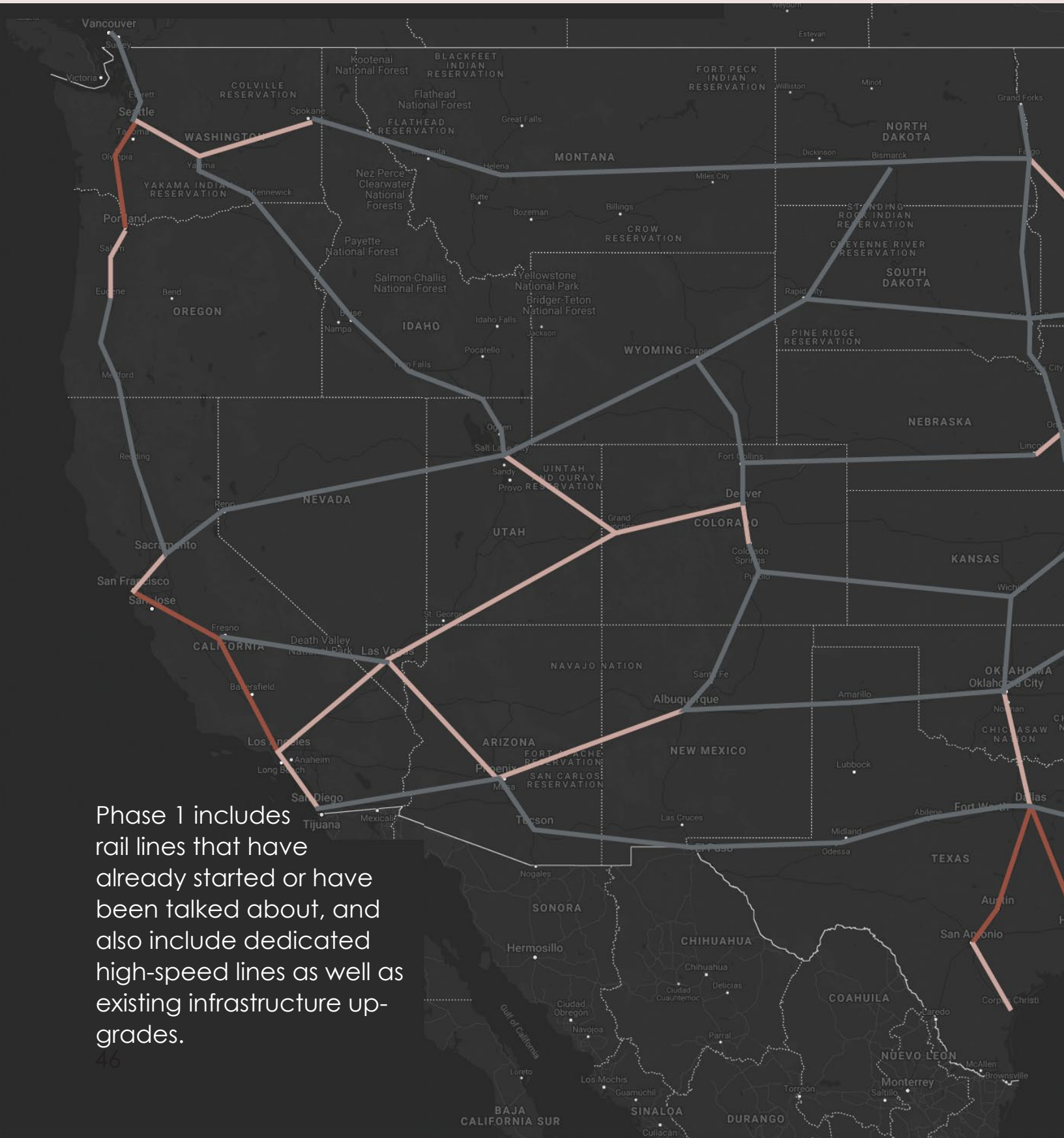


Figure 34 | Existing Rail Lines

high-speed rail implementation



Phase 1 includes rail lines that have already started or have been talked about, and also include dedicated high-speed lines as well as existing infrastructure up-grades.

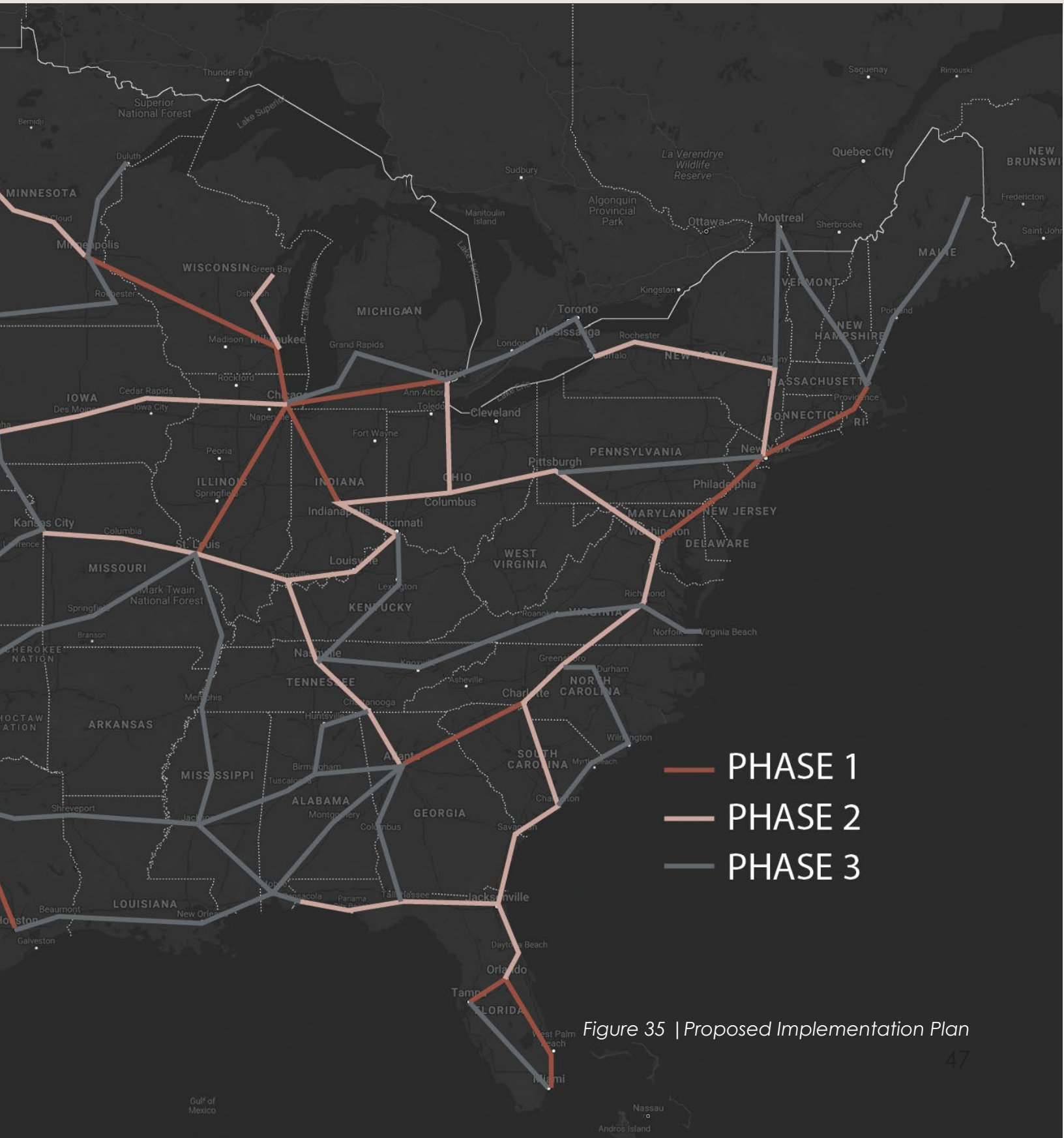


Figure 35 | Proposed Implementation Plan

Figure 36 | Liege-Guilleminns Belgium Station

historical, social & cultural context

The World

When most people think of high-speed train travel, their minds go straight to Europe, however, the first "bullet train" system was developed in Japan in 1964. Japan's system connects 22 cities with nine rail lines serving them and on a typical weekday carries over 420,000 passengers. As for Europe, France initiated the start of the system in 1981 with Germany following ten years later. Soon after, many European countries began to develop tracks. In 2007, the European Union formed a team to develop and promote trans-Europe high-speed rail networks. The new front-runner in development of high-speed travel is China. The government's generous funding has developed a system starting in 2008. By 2025, China is expected to have almost 25,000 miles of track and almost 30,000 miles even longer term, which is more than the rest of the world combined. The cost of China's train and track development has cost a hefty $300 billion. Overall, the world is far more advanced in their high-speed train development and I believe that the United States should catch up.

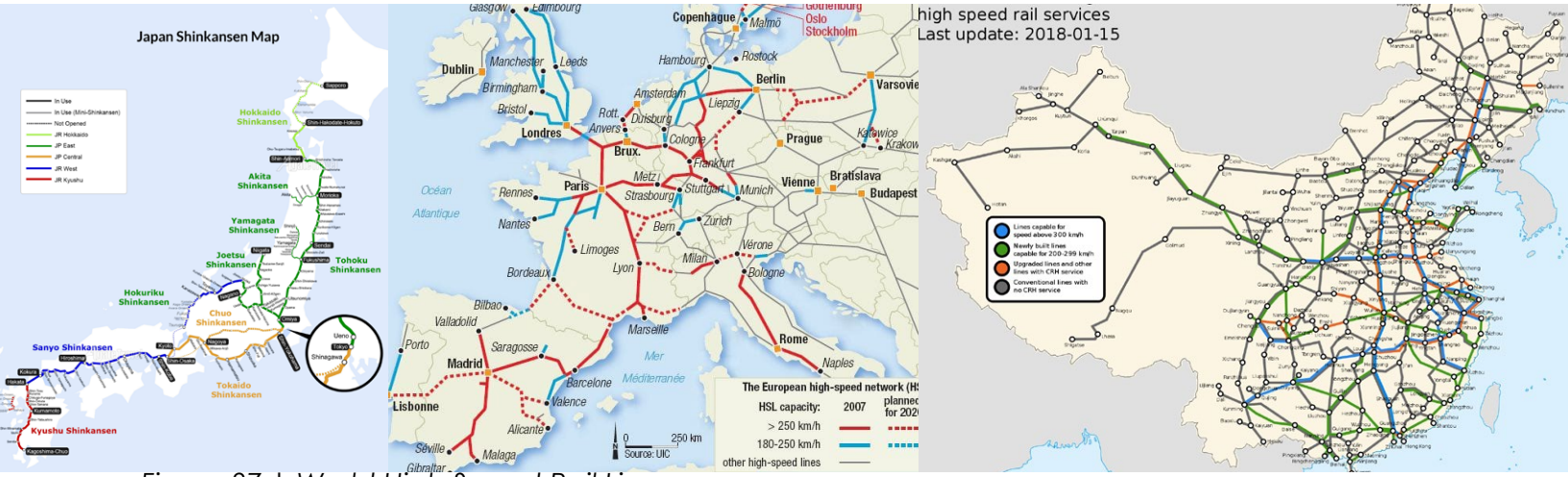


Figure 37 | World High Speed Rail Lines

historical, social & cultural context

The United States

Railroads in the United States are almost as old as the country itself. The first transcontinental railroad was completed in 1869 and was the beginning of sort of "golden age" for railroads. A train system is a rich part of our history, with westward expansion, two world wars, and low costs, train use was booming. Unfortunately, when the automobile began to be produced with the assembly line in 1908, the downfall of passenger trains began. Amtrak is the United States' largest passenger rail agency. They began operation in 1971 and are a large part of the push for high-speed rail development. Amtrak has fought through several challenges, including inadequate government funding and operating on private, freight-owned tracks instead of their own or shared tracks.

After many of the freight rail carriers failed in the late 60s after the government heavily switched to highway investments, Congress passed the Railroad Revitalization Act in 1976, which let Amtrak buy the Northeast Corridor area of track which includes service to New York, Washington D.C., and Philadelphia.

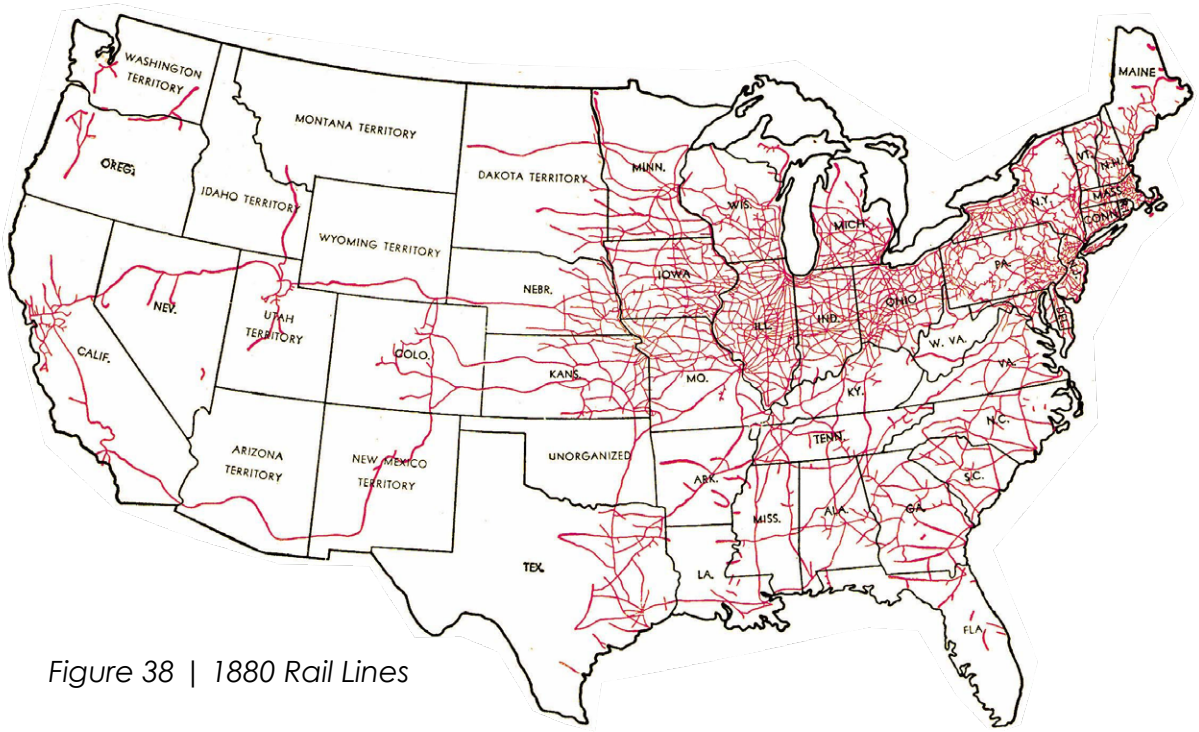


Figure 38 | 1880 Rail Lines

Social Context:

Traveling is a vital and natural want of humans. Since the beginning, hunters and gatherers traveled to follow the food source. They traveled out of need. As time went on and society advanced, traveling became more for fun, and then even for work. Now, especially in American society, people count down for over a year until their next vacation. A national network would make traveling much more budget friendly, as well as time friendly. Imagine if it would only take an hour train ride to travel from Fargo to Minneapolis. Some people's auto commutes from a suburb to a city take longer than that. The ability to travel more often can have a widespread positive effect on a society. These include improvement in social skills, enhances to responses to uncertainty, boosts in confidence, broadens horizons, and can encourage people to be more understanding, among many others. These effects have the power to change a society, and let's be honest here, we need that change.

Cultural Context:

In American culture, there's a lack of accessibility of travel, yet American's flaunt it as though they go somewhere new every weekend. I believe travel can be more than just an instagram picture. Europe is made up of over 40 countries. Though each of them have distinct cultures, languages, and traditions, they are all very tolerant of each other and people easily travel from country to country, with a sense of trust and pride in each other. I believe that when people can travel cross country, even if the U.S. is just one country, they will eventually develop the same attitudes that Europeans have.

sustainable design

Figure 39 | Solar Power

Figure 40 | Green Roof

Figure 41 | BioSwale

LEED Certification:

Aiming for Gold - 60 to 79 points

Categories to Focus On: Diverse Uses (3pts), Inter-modal and Placemaking (4 pts), Rainwater Management (2pts), Water Use Reductions (7 pts), Optimize Energy Performance (19 pts), Renewable Energy Production (2 pts), Daylighting (2 pts), Heat Island Reductions (2 pts)

Solar Power:

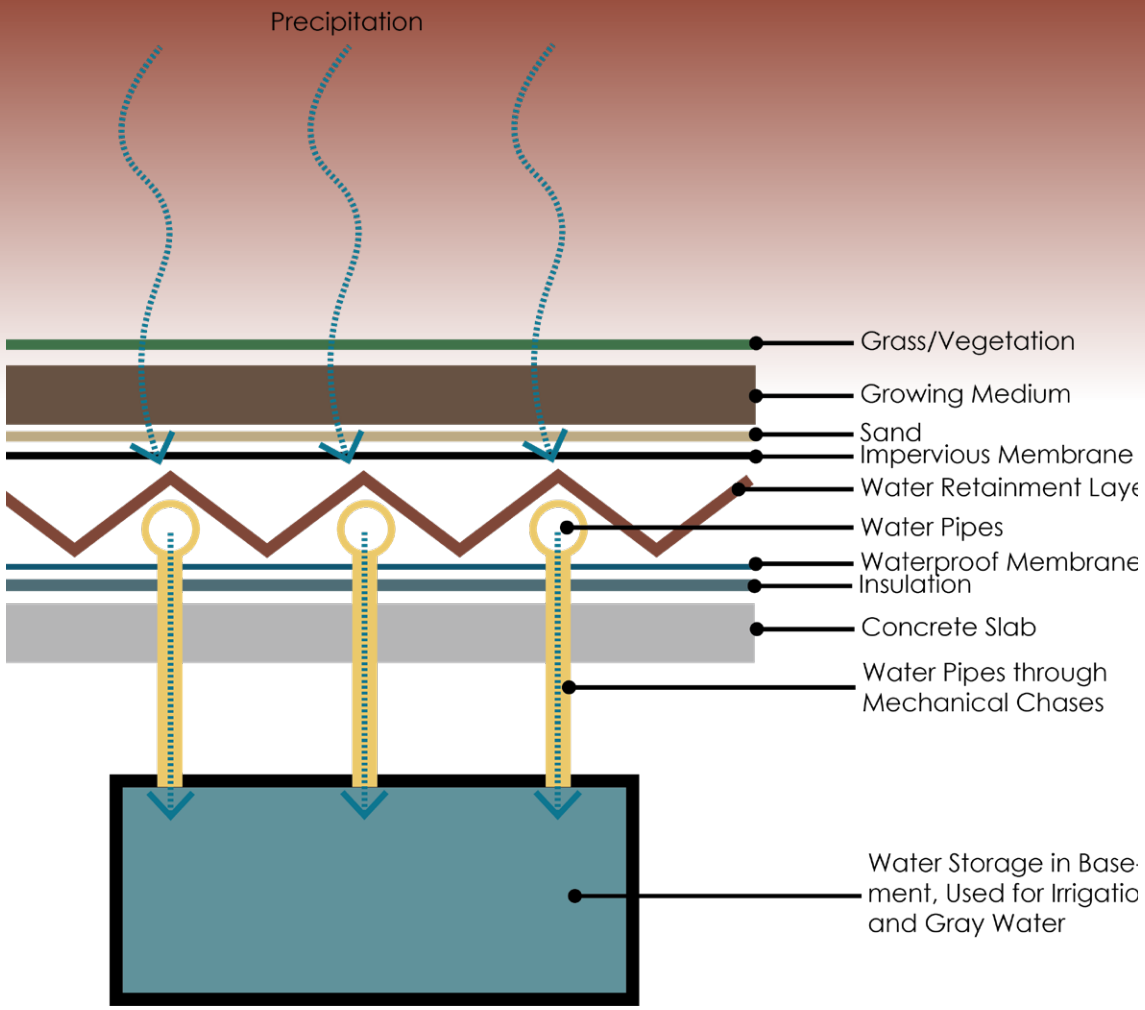
Placing as many panels where it fits. Walls of the parking structure, roof of the train station servicing shed, even the structure over the platforms depending where they end up being located.

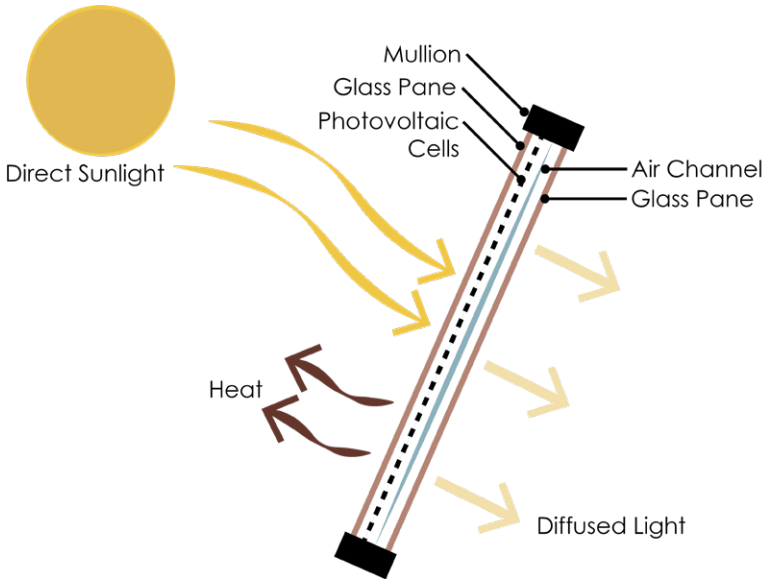
Green Roof:

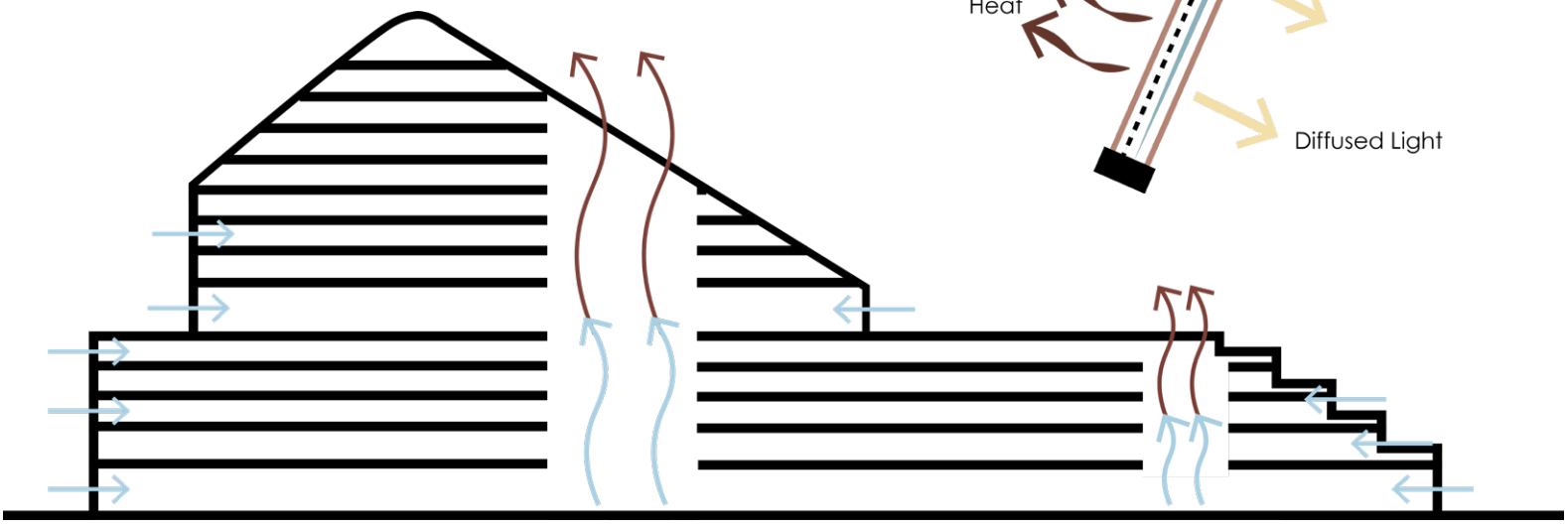
Like the Transbay Center, I want to incorporate a public green roof space. This will help with the water absorption on the site as well as giving the users a unique space to use.

Open Air Ventilation:

With Orlando having such a great climate, it will be very imporant to take advantage of it. With having an open-air station, it will minimize the need for extensive mechanical equipment.


Precipitation
Grass/Vegetation
Growing Medium
Sand
Impervious Membrane
Water Retainment Laye
Water Pipes
Waterproof Membrane
Insulation
Concrete Slab
Water Pipes through
Mechanical Chases
Water Storage in Base-
ment, Used for Irrigatio
and Gray Water


Mullion
Glass Pane
Photovoltaic
Cells
Air Channel
Glass Pane
Direct Sunlight
Heat
Diffused Light



modular design

Modular Design is an approach to design that subdivides a system into smaller "modules" that can be individually used for different needs and potentially in different systems. Two benefits of this design approach is cost and design flexibility. Modular design combines both standardization and customization, however, a designer must be careful to make sure that the design does not end up becoming low quality.

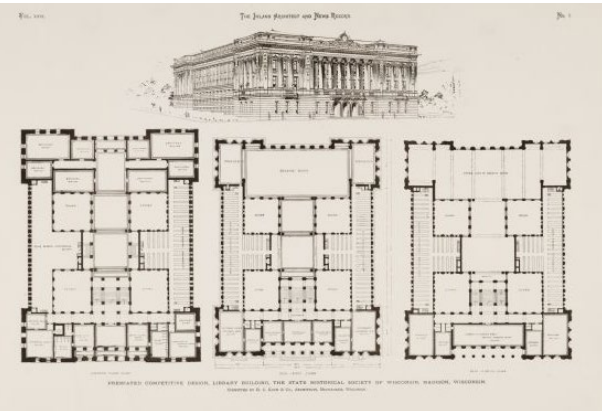


Figure 42 | 1896 Floorplan

The history of modular design goes way back. In houses, columns would mark room placement, and room areas would be the same size, with some rooms being separated more. Even back then, this was done for construction and cost efficiency.

The challenge of modular design is that the process may mean that there is inefficient building performance as well as a loss of design identity and uniqueness. However, with the right team, these can easily be avoided. Following are important characteristics of Modular Design:

- Easily upgradeable
- Good flexibility
- Design "modules" can be rearranged as needed

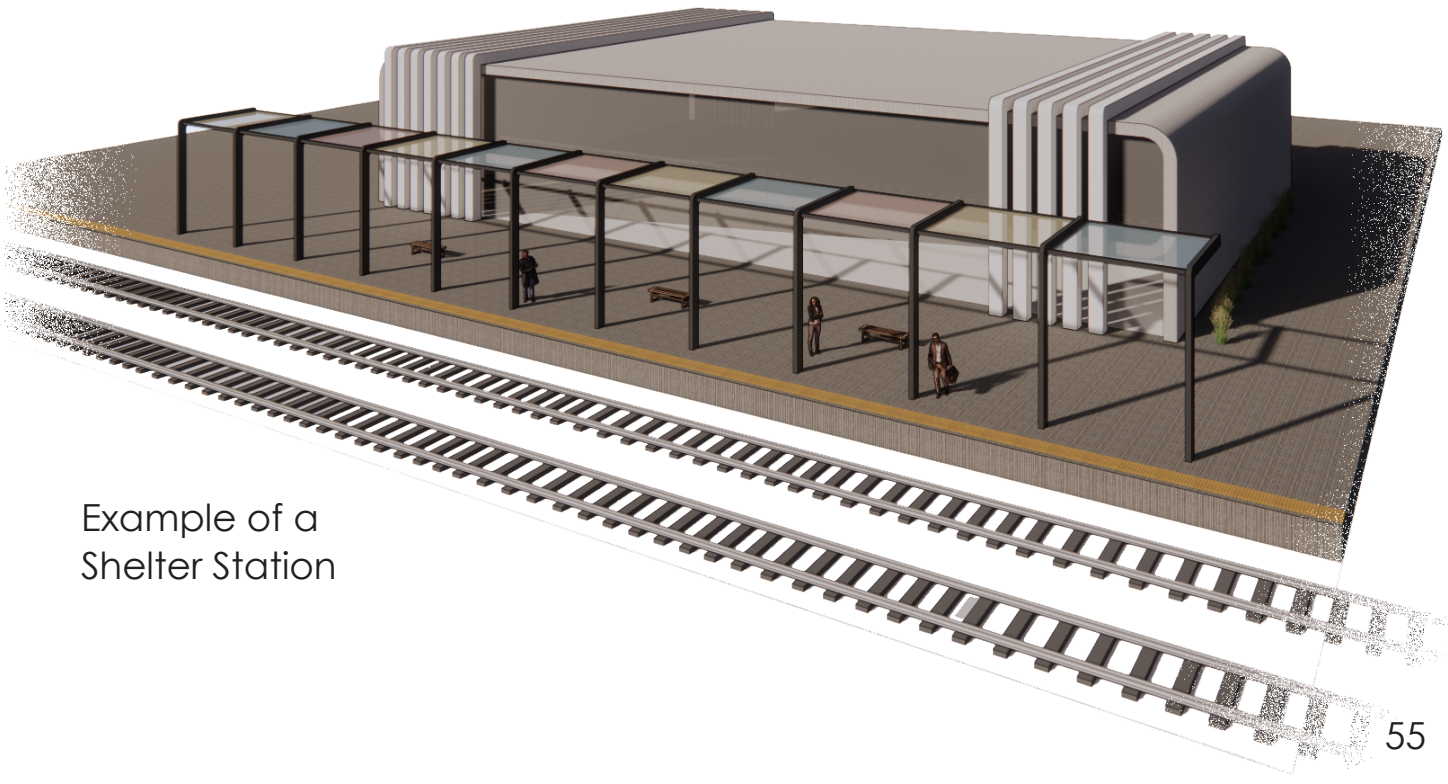
-Efficient replacement/ upgrade of individual modules

-Cost effective

Figure 43 | Modular Buildings

	Large	Medium	Caretaker	Shelter
Projected Annual Ridership	Greater than 400,000	100,000 to 400,000	20,000 to 100,000	Less than 20,000
Route Service Type				
High Speed Rail	■	■		
Corridor Service	■	■		
Long Distance Service	■	■	■	
Station Location Environment				
High Density	■			
Medium Density		■		
Low Density				
Multi-Modal Services				
Full Range (Metro/Light Rail)	■			
Basic (Bus)		■		
Minimal (Taxi/car)			■	■
Customer Service Staffing Level				
Fully Staffed, Management Present	■			
Basic Staff for Ticketing, Baggage, Operations		■		
Caretaker, No Passenger Assistance			■	
Unstaffed				■
Baggage Services				
Checked Baggage/Red Cap/ Package Express	■			
Checked Baggafe/Agent Assistance		■		
None			■	■
Station Configuration				
Side Platforms	■	■	■	■
Vertical Circulation Platforms	■	■		
Terminal Services	■			

Typical Characteristics	■
Service Possible	



Example of a Shelter Station

literature review overview

For the literature analysis portion of my research, I searched through NDSU's library to find suitable articles. When searching, I was looking for writing that would give me information on station design, focusing on the entire site and how to make it successful in a city. I also was looking for information about high-speed rail projects and how the infrastructure works, as I had very little background knowledge on the subject other than my personal experience. I eventually narrowed down my findings into these articles:

"The Development of High Speed Rail in the United States: Issues and Recent Events" from the Congressional Research Service

"Assessing spatial planning strategy in high-speed rail station areas in Spain (1992–2018): towards a sustainable model" from European Planning Studies

These articles were a heavier read, so I also found a foundational book for some basic information on high-speed trains to help people (including myself) learn the background knowledge needed to understand the research:

"High-Speed Trains from Concept to Consumer" by Steven Otfinoski

The following reviews explain both what the authors wrote about in their articles and what I found useful from them. There were many broad aspects written about, but each had information that is proving invaluable for the design of the station.

literature review

"High-Speed Trains from Concept to Consumer" by Steven Otfinoski

This book gave helpful background and basic knowledge on high-speed rail, both throughout the world and the United States. It covered the history, the present, and the future of high-speed rail. This book was vital for my understanding of how high-speed rail works and how to best accommodate it in the station design.

This book also had some great information regarding all the workers needed to make the train and stations run efficiently together. I thought this was interesting, and probably overlooked a lot of times as no other resources I found talked about the relationships the workers have with the stations and trains. It's up to the workers to make sure the users feel comfortable both at the station and aboard the train. From the conductors making sure everyone is on time, to the security officers carefully watching, to the ticket booth attendant making sure everyone gets the correct tickets for the correct times, a lot goes into making a safe environment. The book opened my eyes to the huge role that employees play in the success of the project.

One of the coolest things that the author talked about was 'maglev' technology. This type of train isn't fully in use many places, but the potential of this technology is amazing. Though the theory of this was found out in 1922, it was never really explored until more recent times. Basically, this technology allows a train to be levitated off the tracks and pushed by magnets. This allows for virtually no resistance between the train and the track, and no need for an engine or electricity, resulting in very light trains and very little maintenance needed. Test trains using this technology have reached speeds of 361mph. The only downfall to maglev trains is that in order for the magnets to work, the track must virtually be straight with slow change in elevations. This is important to think about when designing stations and the infrastructure, as technology advancement must be thought of.

literature review

"The Development of High Speed Rail in the United States: Issues and Recent Events" from the Congressional Research Service

From basic information on what is considered "high-speed" rail in the United States, to the types of programs and funding that has been granted, to specific projects that are in the works, many topics are covered. Towards the end, pros and cons are given for high-speed rail, as well as an analysis of what other countries have done about the high-speed rail in their specific countries. The information in this article has helped immensely in my background knowledge of high-speed rail systems and how to potentially implement it in the United States.

It is important to note that there is no set definition of what exactly high-speed rail is. "The European Union defines it as:

-Separate lines built for speeds of 250 kilometers per hour (155mph), or

-Existing lines upgraded to speeds of 200 kilometers per hour (124mph), or

-Upgraded lines whose speeds are constrained by circumstances such as topography or urban development." (p. 7)

However, the U.S. government has a few different definitions for high-speed rail as well. The Federal Railroad Administration (FRA) defines it as a service "that is time-competitive with air and/or auto for travel markets in the approximate range of 100 to 500 miles" (Development, p. 9). They emphasize that it is a market-driven definition in which the clients are more interested in the entire trip time rather than the speed. The FRA has continued to develop three different categories to define high-speed rail:

-Emerging High Speed Rail: Top speeds of 90-110 mph

-Regional High Speed Rail: Top speeds of 110-150 mph on grade-separated track

-Express High Speed: Top speeds of at least 150 mph on grade-separated track dedicated to passenger service.

These categories will help me in planning the high-speed rail network and

how to best implement the infrastructure best.

High speed rail has been on the government's mind since the early 1960s when Japan created the first high-speed corridor, but 2009 was the first year that major funding was available for projects in the United States. In 2009 $8 billion was appropriated by the Obama Administration for high-speed rail projects, but since then, no other amount has been explicitly direct funding. A majority of the projects funded by the grants were to update existing rail infrastructure to allow for faster speeds and to include bypass lanes to allow for more trains in a corridor. The largest and only track that is considered "high-speed" in the U.S. is the North Eastern Corridor, which is operated by Amtrak, a government-owned entity. It was important for my research to look at the existing high speed corridors in the United States to analyze how they work and at what speeds they operate at. Below is a table showing information about each of them:

Corridor	Miles	Power	Top Speed (MPH)	Average Speed (MPH)	Average Time
Los Angeles to San Diego	130 (520 in future)	Diesel-Electric	90 (220 in future)	47	(2h40m in future)
Chicago to Detroit	304	Diesel-Electric	110	57	5hr
Chicago to St. Louis	284	Diesel-Electric	110	53	4h30m
New York City to Albany	158	Diesel-Electric	110	56	2hr40m
Philadelphia to Harrisburg	104	Electric	110	64	1hr45m
Northeast Corridor	457	Electric			
-Boston to New York City	230		150	62	5hr
-New York City to Washington D.C.	227		135	79	3hr30m

As you can see, the average speed is barely half of the top speed, and the top speed is attained only for a very short amount of the total trip. Much of the government funding goes to upgrading existing infrastructure rather than laying completely new higher-tech tracks. The cost is the most advantageous aspect of upgrading already existing infrastructure as it

is (in 2007 $) $7 million per mile whereas entirely new rail track costs an upward of $35 million per mile, though it allows in much higher speeds being achieved. So, for my proposed transcontinental rail system, I will need to heavily weigh the feasibility in cost, and determine what lines can just be revamped rather than having new lines be invented.

The research piece continues to talk about different train and rail types. With one exception, all rail in the U.S. is conventional steel wheels on steel rail technology, with most trains being diesel-electric. The most effective technology though are purely electric trains, as they are lighter-weight and can travel faster. Based on what is presented in this document, electric trains would be an ideal technology to move towards as existing tracks can be upgraded to be electrified. Of course, cost is a large negative when talking about high-speed train travel.

Infrastructure costs and operating costs are the two general categories of high-speed train travel. An astounding fact is that about only two rail lines in the world have enough revenue to cover both categories of cost. Infrastructure needs a lot of up-front funding without getting any return on the investment for a long time. For the higher speed trains, a system much like the highway interstate system is needed to ensure that trains do not have to intersect with auto traffic when at higher speeds. This emphasizes the point where (when possible) it is far more effective to improve existing lines. Operation costs are basically everything from the train itself, fuel, labor, etc. The train corridors must make a decent amount of revenue by having full trains to make the investment worth it.

In the potential benefits section, it names the pros of having a developed rail system and also in turn shows the weakness of those pros, which is very beneficial as I am forming the argument that the U.S. should develop a better high-peed rail system. Helping alleviate highway and airport congestion is the first benefit they list. In the U.S. air travel is the most efficient way to go long distance, and the industry as a whole is very expensive, so train travel can become an efficient competitor. The con they say is that studies show auto congestion is usually alleviated by only 2%

because traffic is usually when people are just traveling locally. I believe that can be fought with better in-city metro systems long term. The next benefit is reducing energy consumption. While I believe this to be an important factor in train travel, for it to be effective the trains must have high passenger loads and purely use clean ways of producing electricity. People against high-speed train travel say that putting money into making air and auto transportation is a better investment. Other benefits given were improved transportation safety, giving travelers a choice of modes, and high-speed rail promotes economic development.

An eye opening last few pages outlined what many other countries have done with train travel. Though the United States has a huge land area, meaning the densely populated areas are more spread out in comparison to European countries for example, a train system can work. In Japan, they have a rail network of about 1,665 miles used by private rail companies, and use a mixture of private-public and government funding to pay for new projects. In France, they have about 1,185 miles connecting their biggest cities. Where the travel time is less than 2 hours, trains have taken about 80% of air travelers, and where the time is 3 hours, about 60%. Germany's constitution states that the government is responsible for rail transportation. Germany's rail system connects many large cities and incorporates smaller cities in between, making for longer travel times. Their goal now is to improve their existing lines rather than creating new ones.

Overall, the efficiency of high-speed rail system investment depends on geography, economics, and governmental policies. Countries all over the world have successfully implemented country-wide policies to encourage rail travel. Though the expenditure is a costly one, with a very long timeline, I believe that in the end the investment is worth it. The benefits outlined in this research document outweigh the cons, and if implemented correctly in different phases slowly working across the country, high-speed rail can change the way Americans look at traveling.

literature review

Assessing Spatial Planning Strategy in High-speed Rail Station Areas in Spain (1992–2018): Towards a Sustainable Model

In this peer-reviewed journal, the authors analyze what makes high-speed rail stations successful, as they combine 12 different analyses of stations in Spain. They purely cover the spatial analysis of the station in the city, and not the station plans themselves as that will vary greatly by city. Right off the bat, this article opened my eyes and after analyzing it, influenced me to change the site of my project to a more urban, city-centered site; from a site by the Denver, CO airport (basically 25 miles from the Downtown area) to the heart of Orlando, FL. The points covered in the article will help me to best understand where to put my site and what makes a station site successful.

Station Planning

The article emphasized the role that these urban station plans have on the neighborhood development around it, which is key for creating a space that is usable and loved. Location is everything. It even points out how in the U.S., the station is viewed as a "regeneration opportunity" (p.3). However, the U.S. cities are not as compact when it comes to space between them, which is a detriment to the train system, though a small one. There are enough large cities in areas to be able to efficiently connect them using high speed rail. My thesis idea touches on making the station more than just a node, more than just a point on a map where you must go to get from point A to point B. This article backs that idea up saying that by using high-speed rail, the system can be used to create changes both regionally and locally by 'generating' new attractions and development and 'distributing' existing local resources to the area. Maximizing the amount of activities you can do in the area will maximize the use. The authors recommend finding a balance between passengers and non-passengers. Integration of the station into the city is vital when creating the plan, I now know that I need to minimize the barrier effect and allow for

the station to be used basically all the way around the site. Of all the case studies, the average area of actual track surface area never surpasses 10% of the total area. It was pointed out that since there is the lack of immediate profit with these new rail lines, the development of the station and the area around it is vital to the success. The location also matters as in these studies, when looking at the year that the stations were built, as time goes on the cities move further and further into the city center. This makes sense when I think back to when I was traveling in Europe. When you go to a city, you want to stay in a hotel closest to the city center, closest to all the action. It would be an added bonus if the train station itself was in the vicinity for ease of travel. When looking at very large cities, it is important to plan for the other modes of transportation that will be utilized by the population.

Defining Factors of Quality in Case Studies Analyzed

	Case Study 1	Case Study 2	Case Study 3	Case Study 4	Case Study 5	Case Study 6	Case Study 7
City Integration	Central Location Minimal Barrier Effect Dense Surroundings		Urban Structure		Spatial Planning		Land Availability Connectivity Protected Land
Spatial Planning	Diverse Amenities Public Places & Plazas for congregation External Station Building Distinctive Architecture Scatter parking structures Available bike parking	Commercial Use of Real Estate Provide public space Contribute to identity of area	Functional Diversity Public Space Architecture	Diverse Use, Lower income Uses Minimize motor vehicle occupation	Interactivity	Balance in activity distribution Quality of life	
Functional Integration	Good Intermodal Connections Good Service Good Pedestrian Access	Link Catchment Area & Transport Network Support Transfer Between Modes		Walk, Cycle, Connect, Transit	Intermodality Accessibility	Internal & External Accessibility	National, Regional & Local Accessibility Urban Projects Linked to High-speed Rail
Policy, Governance, Economics	Public Involvement Political Leadership Public Private Partnerships Multi phased Planning Land Assembly & Banking					Balance in the social distribution of effects Influence in regional economy	Tourism Economic Development Station Area Development

Figure 44 | Defining Factors of Case Studies

This table, a condensed version of the table the authors constructed on page seven, basically lays out guidelines for what I should focus on as I begin to plan out my station design. The planning principles are broken down into the four categories which are shown on the left. Several of the case studies are examined here and whatever the strengths of the projects are written in their respective categories. So from this chart, I can easily see that the station area needs to be well connected to the city and other transportation modes. It is also important that there are diverse activities happening in the area.

Sustainable Design

Sustainability was the next topic talked about, and I feel as though Europe is far more focused, and in turn more advanced, on sustainable design. These are the topics they recommend focusing on for overall sustainable development:

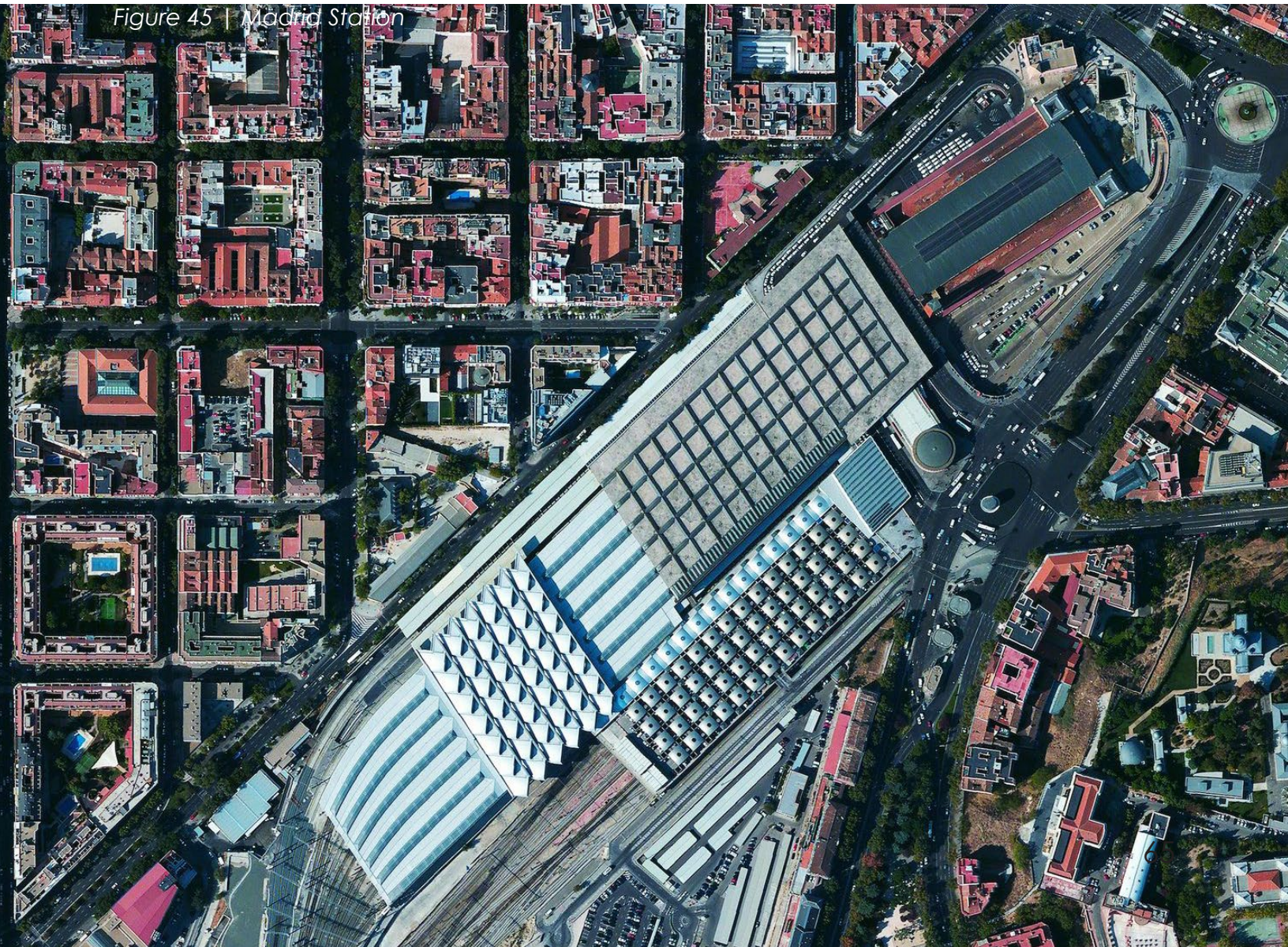
-Compactness/density
-Public Space
-Diversity & Mixed Use
-Sustainable Mobility
-Green Infrastructure
-Environmental Sustainability
-Social Sustainability
-Local Policies
-Identity

Having a compact design plan for around the station will help boost property value and make the most out of the development. To counter the denser areas however, it must be compensated for by incorporating the much desired outdoor public spaces. In the case studies analyzed, residential presence in the neighborhood is high, usually having floor area ratios of anywhere between 0.2 to 0.9 (p. 16). Considered by the authors to be one of the most important spaces in the site, the average percentage of public space of a site being around 31%. Each user should have

about 105 square feet of space. Their guidelines express that a floor area ratio of one and a dwelling unit ratio of 30 units per acre are ideal uses of the site. Using these will help me to organize my site proposal and develop sustainable ideas from the beginning of my project!

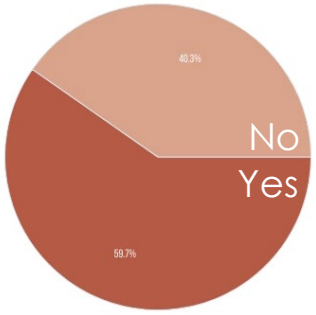
In the end, train station design is not only related to the station itself. In fact, in all cases studies showed that 20-40% of the site is for commerce, and only 2-13% was actually for the railway. The railroad is a means of travel, but the station can be a way of life. It can come to act as an artery of the city. This article helped me to understand what all needs to be going on in the entire surrounding area, not solely the physical station.

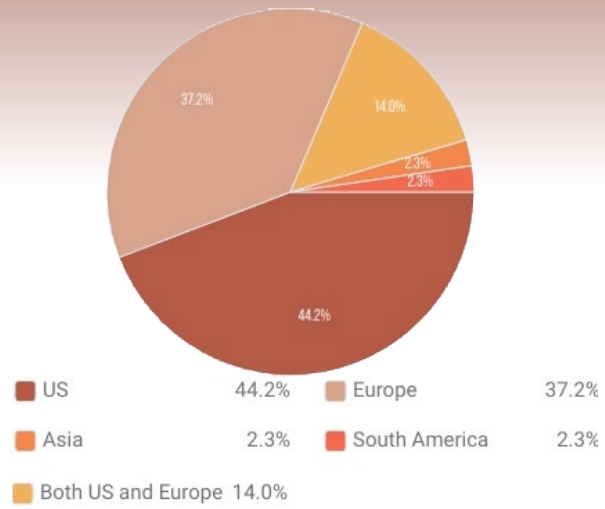
Figure 45 | Madrid Station



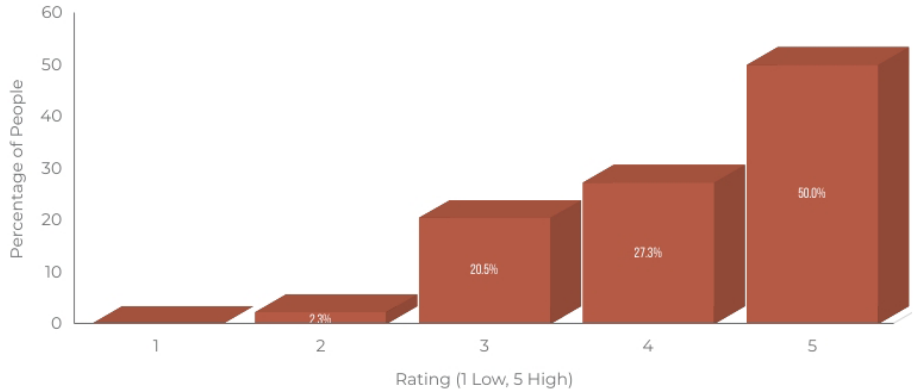
survey results

1. Have you ever traveled by train?
If yes, where?

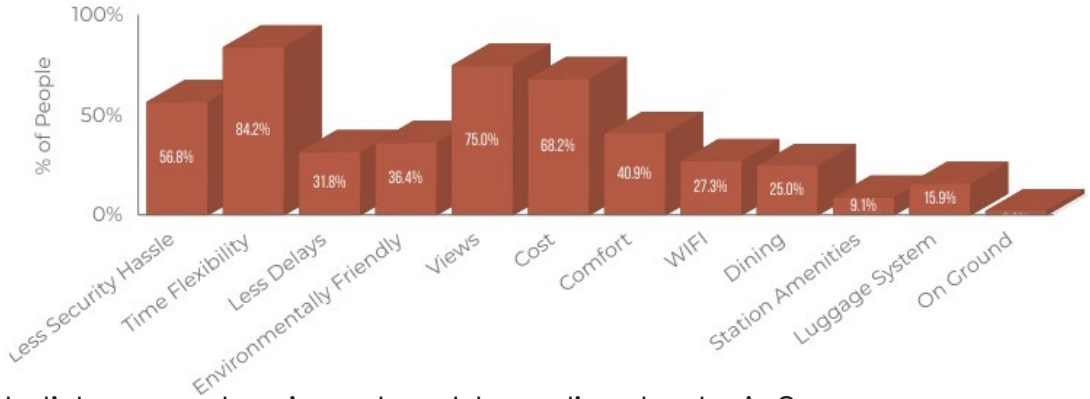




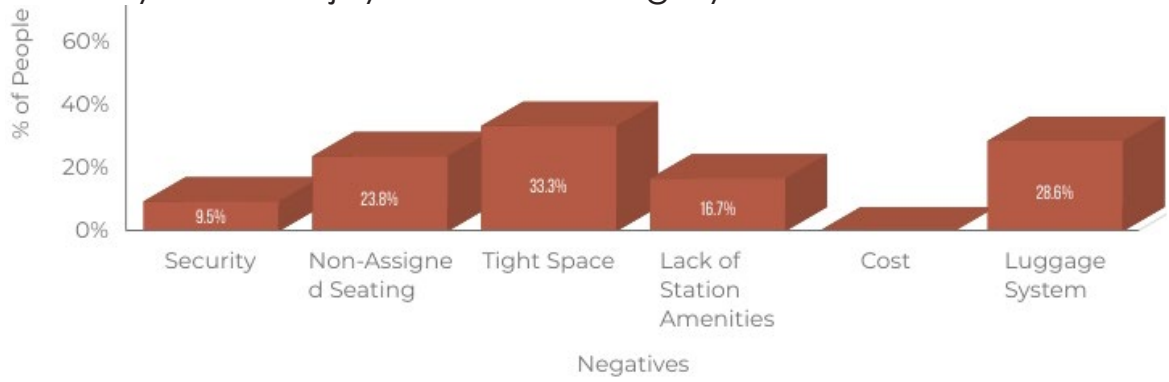
2. Based on your experience, how likely would you choose to travel by train again?



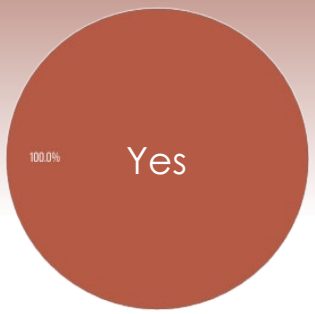
3. What did you enjoy about traveling by train?

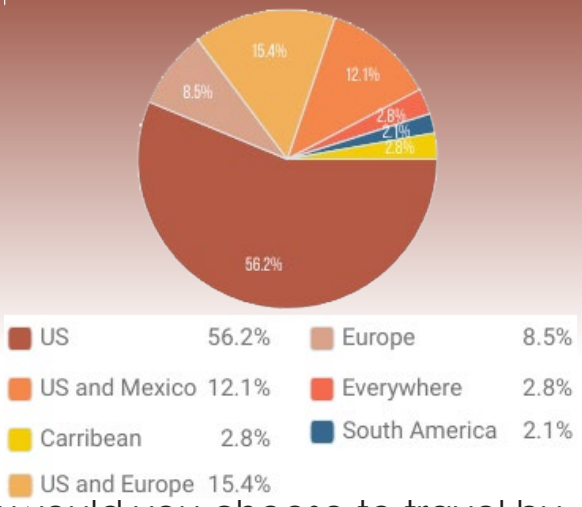


4. What did you not enjoy about traveling by train?

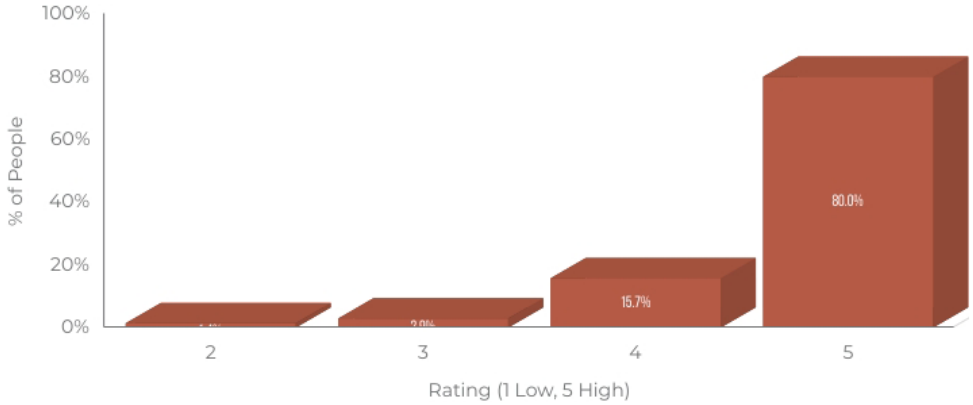


5. Have you ever traveled by plane?
If yes, where?

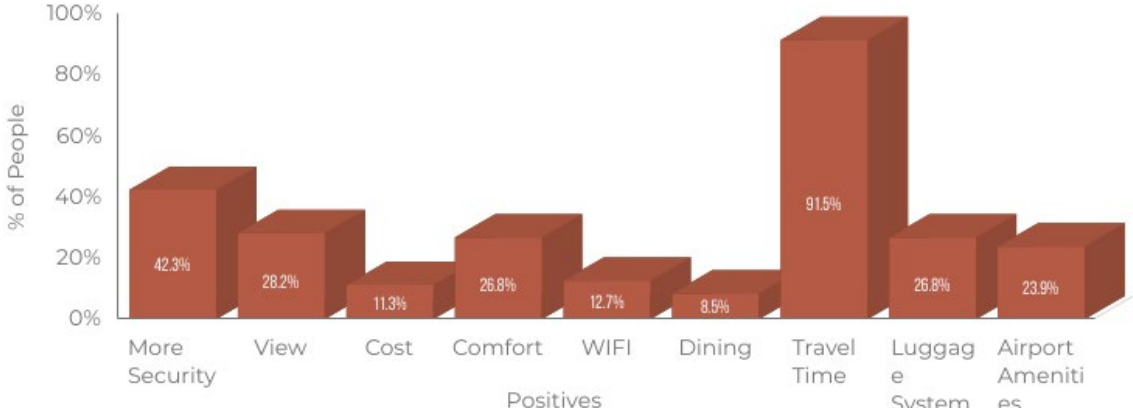




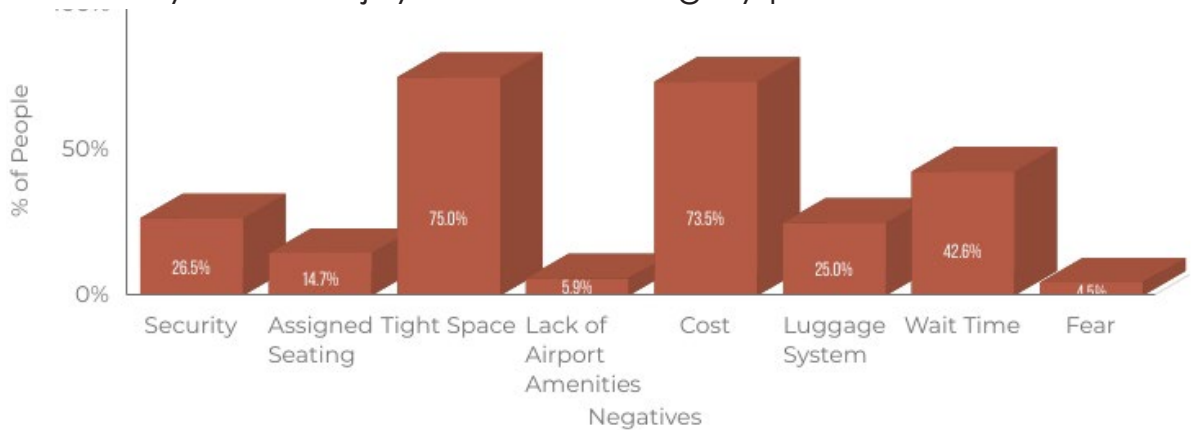
6. Based on your experience, how likely would you choose to travel by plane again?



9. What did you enjoy about traveling by plane?

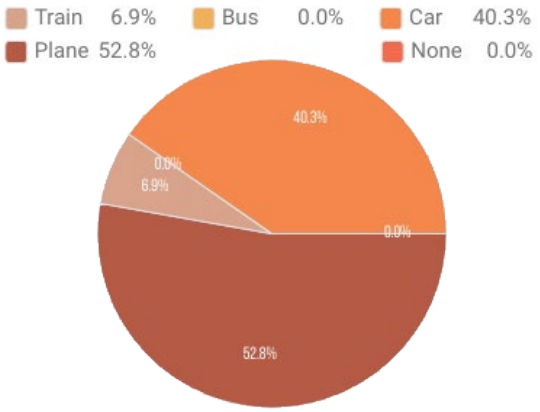


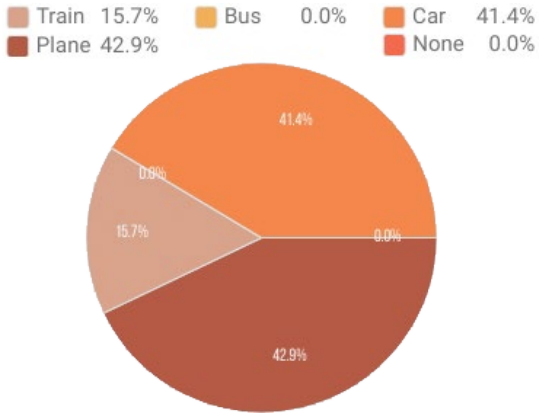
10. What did you not enjoy about traveling by plane?



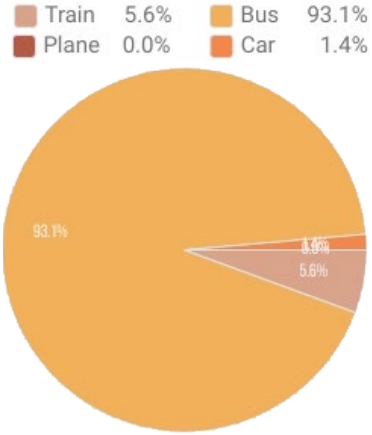
survey results

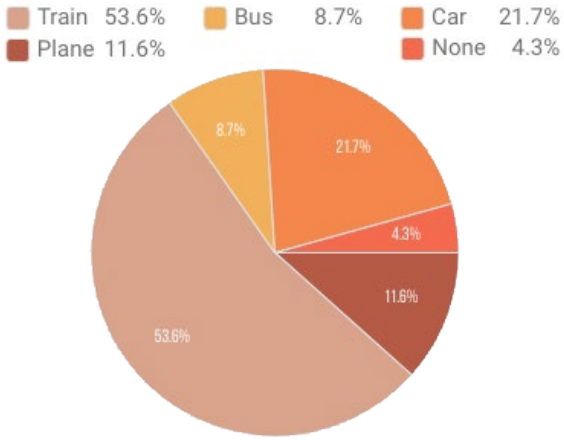
11. What's your most preferred travel option? Your second most preferred?



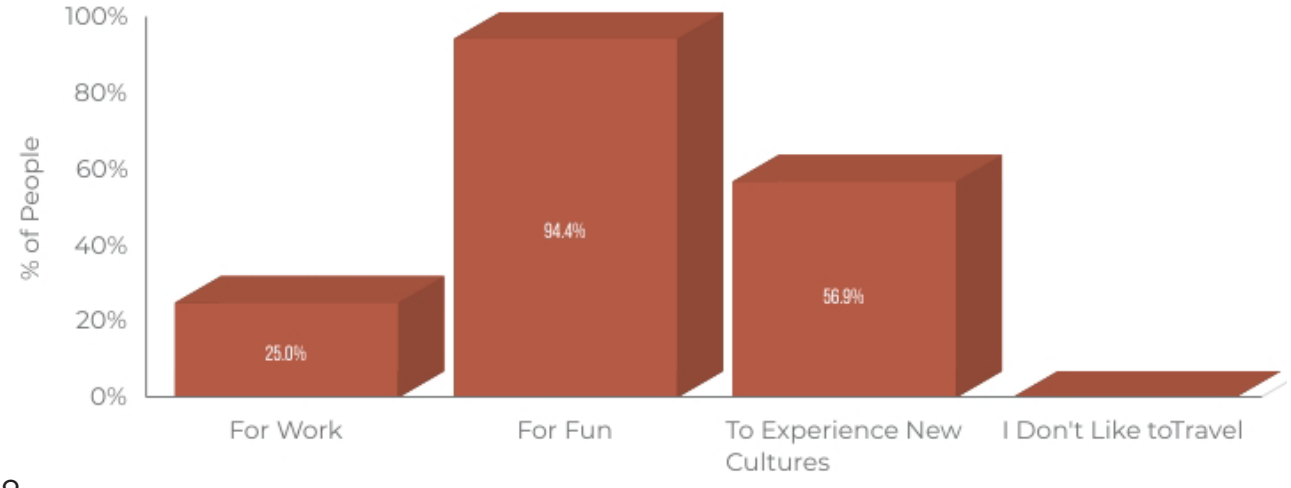


13. What's your least preferred travel option? Your second least preferred?

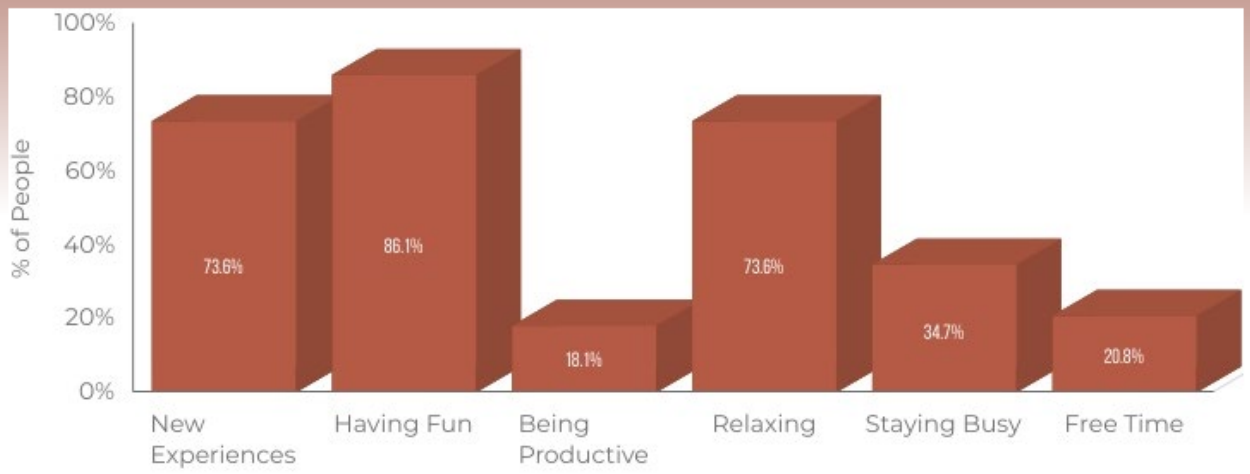




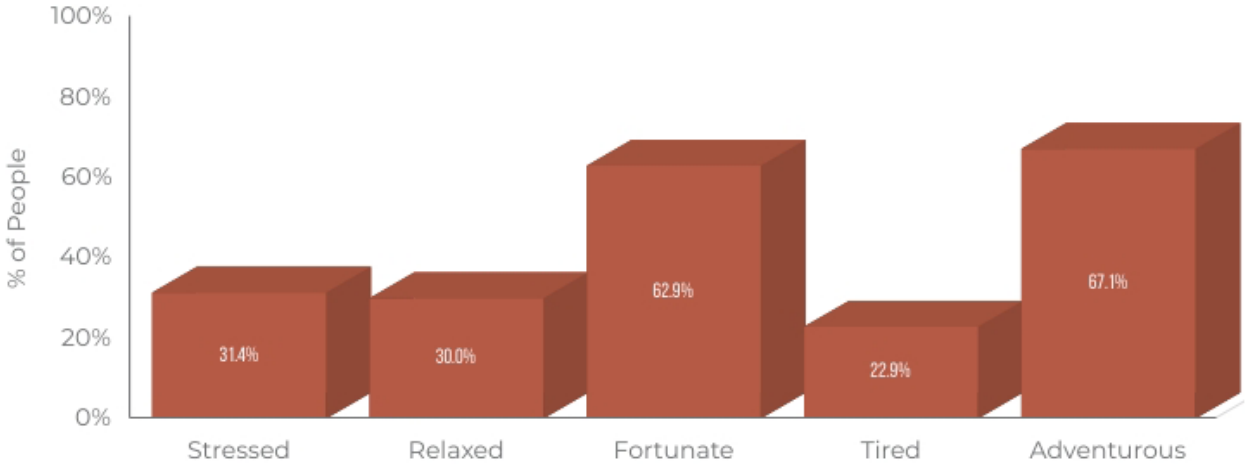
15. Why do you travel?



16. What makes a travel experience successful to you?



17. How does traveling make you feel?



Survey Results:

The survey was important in being able to determine some key factors that real-world travelers find important. The Pros to air travel can easily be transmitted to train travel to make rail more appealing, as well as using the airplane travel Cons to further drive a wedge between the two where it makes sense (i.e. shorter trips). The Pros for train travel will be vital to emphasize in my project to make it not only appealing, but feasible. The Cons will be aspects to address and try to find solutions too, like ensuring train design to be competitive seating-option wise. The reasons of why people travel can aid me in tailoring the station amenities to accent the reasons for traveling. For example, providing coffee shops for people to work at when on business trips.

amtrak

Amtrak Fast Facts

21,000 Route Miles

Service in 46 States, Washington D.C., and 3 Canadian Provinces

Invested $78 million into ADA-related design

Met all annual energy, fuel, recycling, and gas emission targets

Operated as a "for-profit" company

2019 saw a record number of trips at 32.5 million

Amtrak Objectives (from their Station Program & Planning Guide)

1. Good Service
    - From ticketing to waiting, to boarding, to riding, the passenger experiences courteous and efficient service.
    - Station operations, back office support and baggage handling are performed with efficiency and sustainability in mind.
2. Convenient Access to the station
    - Station is a major hub in a multi-modal network connecting downtown and other important places in the region.
3. Enjoyable physical environment in and around the station
    - The passenger or visitor experiences the station as a community asset or important public place.
    - Through its urban design and architectural design, the station positively contributes to the public realm.
    - The station architecture exhibits "fi rmutas, utilitas, venustas"* —that is, it is solid, useful and beautiful.

− Station sustainability in construction
− Universal design—accessibility for all
− Safety and security—through a CEPTED-like approach (Crime Prevention through Environmental Design)

Amtrak Station Categories (from their Station Program & Planning Guide)

Categories are important for programming and determining the amenities of a station to meet the need of the local area and may be blended categories.

Category 1 Stations: serve the centers and edges of large urban areas, and are highly integrated with supporting public transportation systems. They are typically the heart of urban and regional multi-modal transportation networks, are staffed to provide ticketing and support services, and often include significant retail space or transit oriented development surrounding the station.

Category 2 Stations: are staffed and serve a wide variety of communities, and also have significant variability in rail service type and program function. Category 2 Stations are primarily oriented to State Corridor service, or major destinations along Amtrak's Long Distance services, and have ticket offices and minimal staff.

Category 3 Stations: are not staffed by Amtrak agents, but include an interior waiting facility, with restrooms, that is opened, closed, and maintained by an Amtrak caretaker or staffed by another entity.

Category 4 Stations are not staffed and include only a shelter and/or platform canopy.

amtrak

Below is the formula Amtrak provides for configuring the waiting area capacity programming using the expected daily ridership. At the bottom is a table that portrays the amenities expected for large stations, which will aid me in my programming. On the next page, there are comparison of offerings and amenities between all sizes of stations.

Waiting Area Capacity Formula

1. Determine daily ridership at the station
   = Annual ridership / 270 days
2. Determine peak hour ridership (6+ trains/day)
   = 0.15 x daily ridership [for 2 way]
   = 0.65 x (peak hour ridership 1 way) [for 1 way]
3. Determine waiting area space requirements
   = 0.5 x (1 way peak hour) x 20 sf/person (seated)
   = 0.5 x (peak hour) x 10 sf/person (standing)

Annual Passengers	**400,000 - 1,000,000**	**1,000,000+**
Train Frequency (weekly)	**70-650**	**200-850**
High Speed Rail	67%	100%
State Corridor Service	100%	100%
Long Distance Service	45%	100%
Multi-Modal	60%	100%
Mixed Use	Retail, restaraunts, office and entertainment uses - often in isolation; adjacent hotel, residential and office	Retail, restaraunts, and adjacent office, residential, hotel and entertainment uses
Amtrak Program	Staffed ticket offices with baggage service, customer service offices, first class lounges, seating in waiting areas. Often include a crew base and commissary. All include Amtrak Police.	Staffed ticket offices with baggage service, customer service offices, first class lounges, seating in waiting areas. Often include a crew base and commissary. All include Amtrak Police.
Checked Baggage	60%	100%

Figure 46 | Amtrak Large Station Characteristics

	Large	Medium	Caretaker	Shelter
Projected Annual Ridership	Greater than 400,000	100,000 to 400,000	20,000 to 100,000	Less than 20,000
Route Service Type				
High Speed Rail				
Corridor Service				
Long Distance Service				
Station Location Environment				
High Density				
Medium Density				
Low Density				
Multi-Modal Services				
Full Range (Metro/Light Rail)				
Basic (Bus)				
Minimal (Taxi/car)				
Customer Service Staffing Level				
Fully Staffed, Management Present				
Basic Staff for Ticketing, Baggage, Operations				
Caretaker, No Passenger Assistance				
Unstaffed				
Baggage Services				
Checked Baggage/Red Cap/ Package Express				
Checked Baggafe/Agent Assistance				
None				
Station Configuration				
Side Platforms				
Vertical Circulation Platforms				
Terminal Services				

Figure 47 | Amtrak Station Amenities

Typical Characteristics	
Service Possible	

Amtrak Review:

Amtrak's Guidebook has proved invaluable when it comes to station research and programming. From different sizes, to platform configurations, to the different amenities Amtrak can offer, it lays out the whole process. The past few pages have outlined some of the most important information for the beginning process of designing a station. This guide will continue to aid me in my understanding of stations and the best way to configure them, and will be utilized constantly in the coming months.

project justification

I have always loved traveling, especially in Europe. Their train system makes traveling efficient, both time and money wise. At airports, I always feel stressed and rushed to make it to the gate as there is a lot of pressure to be early and the emphasis on security is often very imposing on the timeline. Train travel felt much more relaxed and honestly just a lot more fun. This project tests my limits because it is more than just a building. It's an entire infrastructure project that could drastically change the American Society. My project is about more than just designing a building in a city. It's designing a building that can be adapted to ANY city. High speed train travel is something that everyone is thinking about. Europe and Japan have had a system in place for many years, and China is developing theirs at a very fast rate. The United States is quickly falling behind (even further than we already were) and though we have started developing systems, no widespread plan has been proposed. As for the building aspect, having a modular train station that can be adapted based on the city's needs could drastically change how buildings are designed.

I believe a high-speed rail system to be imperative. To stay competitive with the other countries in the world, we need an advanced system. As I have stated before, other countries wouldn't be funding a project of that caliber if it isn't worth it. The benefits of train travel outweigh the costs, and that is what I am trying to prove with my thesis project. Cost wise, having a modular design cuts down on the basic designing costs as the infrastructure is already done for you. In the long run as well, increasing train travel will help lower CO2 emissions and will positively impact the environment, while also making traveling more accessible to a greater number of people. The more expensive part however, is getting enough funding to implement the high speed train systems. The infrastructure is very expensive, and a single project in California is costing $80.3 billion dollars and over 10 years to complete. So it's a very expensive project with a slow timeline for profit. However, it is believed that the positives outweigh the

cost, so over the timeline of the project more money can be collected. A lot of funding is actually governmental and some is private. With high speed rail technology being such a good market, it is smart for the government to fund the development of the rail system.

Now more than ever the world needs to be connected. There are severe differences and a lot of uniqueness in society, however when people can easily (and cheaply) travel it can psychologically be a benefit. Studies have shown that traveling makes you happier. Culturally, over time a fully-implemented high-speed system could change the way of life for Americans. In Europe, taking the train is just about as common as taking a car, if not more, so imagine the change that would take place overall.

Figure 48 | Swedish Train Station

performance criteria

Space Allocation

An integral part of the design process will be making sure there is enough space allocated for the most important uses of the station. Top priority is the waiting areas for the trains. Since the station I am designing will be one of the largest for the modular design, making sure there is sufficient space for uses is important. Outside of the waiting area, making sure that there is enough office and 'behind the scene' space is important, as well as utility areas, such as bathrooms. To properly measure this, it'll be important to look at comparable case studies and how those places worked out with their spacing. Post-occupancy, observations of the area will easily show if there is enough waiting space and restrooms, etc. Amtrak's Station Guide also helps to walk through what each space will need in all different sized stations. Computer simulations would be extremely useful in this situation to look at circulation within the station. To best judge this, the post-occupancy evaluation will be the most important way to see if I successfully designed the train station or not. A post-occupancy survey as well as the observation would help determine the percentage of people who feel comfortable in the designed spaces.

Energy Consumption & Environmental Impact

A big goal in my design is to end with a net-zero carbon design. A huge pro for high-speed train travel is that it is extremely environmentally friendly. I want the station I design to reflect that as well. These design features include photo-voltaic panels, green walls, a radiant cooling system, among other things. To guide this goal, the Energy Design Modeling Guide from the AIA as well as the Zero Energy Guide from ASHRAE. These will give me guidelines to go by when designing the station. Calculations using the MEEB will be useful when designing passive techniques to lower energy use. Without being able to physically build the station to see what the energy consumption will truly be, the best way to judge the performance will be the final simulation numbers. If the building is within 90% of the targets I put forward, I will consider the project to be successful.

Behavioral Performance

For my design of the Orlando station, I want diverse ranges of people coming to the site to visit. This means not solely travelers. Of course the main use for the station will be people utilizing the high-speed train system, but for the project to be successful, I want people to come to the site for shopping, dining, entertainment or even to just hang out. I believe a good way to measure the behavioral performance of my design project is to take a post-occupancy survey of what brought the users specifically to the site. This would reveal the people that came to the station just for travel versus the people that come to the station for recreation. If 20% of the post-occupancy group visits the site for purely non-travel reasons I believe that my project would be successful. After a longer period of time as use of the station increases over all, I would hope that the percentage would increase to 30% of use being for non-travel reasons.

Code Compliance

The most important code to follow I believe to be is the ADA code, as everyone should be able to travel equally. The International Building code would be next, because it is anticipated that a lot of travel within the high-speed system would be used by tourists. There needs to be a certain level of conformity between stations outside of the United States as well as inside. The ADA and IBC code books will allow me to have a set of rules to follow easily and will provide structure throughout the modular designs. Amtrak's Station Guide will also prove to be very helpful in what train stations need to be efficiently well planned.

Cost

The cost of any one station would be tough to try and nail down a cost. A city-center station with many amenities, many rail lines, and other inter-city travel options (buses, subway, taxis) can cost anywhere from $68 billion to $149 billion. As this will be a project with government funding, the budget will be kept efficient on the basic plan design. Individual

performance criteria

cities will be able to use funding to design the exterior as it would fit the city. Case studies will prove to be very important when gauging the cost of building a multi-use train station. Also, the average construction cost in the US is about $193 to $224 per square foot. If the total cost comes out to be about $225 per square foot I believe that the project will be successful.

Summary

For my design, I plan to prioritize several points in the design of my station that will echo the positives of high-speed train travel. These include:

-Minimal Environmental Impact
-Efficient Design
-Use of Facility

Overall, the design of the train station will serve more than one purpose. It will be an epicenter of activity and commerce, whether it be tourism or entertainment. A single-use building makes no sense when talking about all the people who will be traveling to, and through, Orlando. The station will also act as an icon for green building standards, and because it is a module design, it can be implemented in any city, with the adjustments needed for climate and size. Aiming for net-zero design is a high standard, but one that ultimately can be reached. This is where the efficient design criteria comes into effect. As the stations will often be government funded, at least in part, they must not waste money. In larger cities where there may be city or public funding, that leaves more room for the entirety of the station to become a designed icon. To proceed, I will dig more into the net-zero design guidelines and how to design a building with that in mind. I will also outline Amtrak's station guidelines, which fully comply with ADA standards. The Amtrak guide has already been extremely helpful in what I need to start thinking about in my research. Lastly, I will begin to look into what analytical/design simulation programs that I can use to gauge energy consumption and efficiency of my building, as well as pedestrian circulation and interaction.

spacial relationships

Though the information below is very much a rough draft, it already shows so much about what all will need to be incorporated when more realistic programming begins in the spring. Below is a table showing estimated square footages for spaces that are both directly and indirectly related to the main station. The auxiliary spaces (like commercial and hotel spaces) are also included, however, the other more broad neighborhood improvement development is not included. The right side shows Amtrak's equations for ridership and the waiting areas, and Orlando's codes for parking spaces.

	Urban Plan	
	Square Feet	**Percentage**
Entrance Area	1,000	0.29%
Train Tracks & Platforms	(Underground)	
Long Distance	36,000	10.37%
Corridor	33,600	9.68%
Train Service Area	(Underground)	
	8,000	2.30%
Waiting Area	20,000	5.76%
Restrooms	7,000	2.02%
Ticketing Office	650	0.19%
Train Office Space	1,000	0.29%
Break Areas	650	0.19%
Customer Service	650	0.19%
Support Spaces	1,000	0.29%
Circulation Space	10,000	2.88%
Mechanical	20,000	5.76%
Transit Sercive Areas (Int.)	650	0.19%
(Ext.)	2,000	0.58%
Outdoor Public Space	20,000	5.76%
Parking	(Off Site + Public)	
	40,000	11.52%
Retail Space	30,000	8.64%
Commercial Space	60,000	17.28%
Hotel Space	55,000	15.84%
Total	347,200	100.00%
	Footprint of about 190,000 SF	

Ridership (People)

Current Annual Ridership: 1,600, 000
Current Daily Ridership: 5,926 = Annual / 270 days
Peak Hour Ridership (2 Way): 889 = 0.15 x Daily
(2) Long Distance= 1,200 ft x 15ft
(4) Corridor= 700 ft x 12ft
Peak Hour Ridership (1 Way): 578 = 0.65 x Peak 2 Way

Waiting Area (Square Feet)

Cooridor Service:
Seated Area: 5,780 = 0.5 x Peak 1 Way x 20sf
Standing Area: 2,890 = 0.5 x Peak 1 Way x 10sf
Long Distance Service:
Seated Area: 8,670 = 0.75 x Peak 1 Way x 20sf
Standing Area: 4,335 = 0.75 x Peak 1 Way x 10sf

Parking

144 x # of spaces
10% reduction when close to transit
5% reduction when including affordable housing
5% reduction when including enhanced bike and pedestrian facilities

Hotel:
.5 : # rooms
5 : 1000sf of other space
Office:
2.5 : 1000sf

Retail: 2.5 : 1000sf

spacial relationships

The table matrix below shows the adjacency of spaces that are included in the entirety of the station plan. Like the previous table, it is an early estimate and will be updated as the station is developed. To use this table, find the meeting point between two spaces and take note of the color, which is explained in the key beneath.

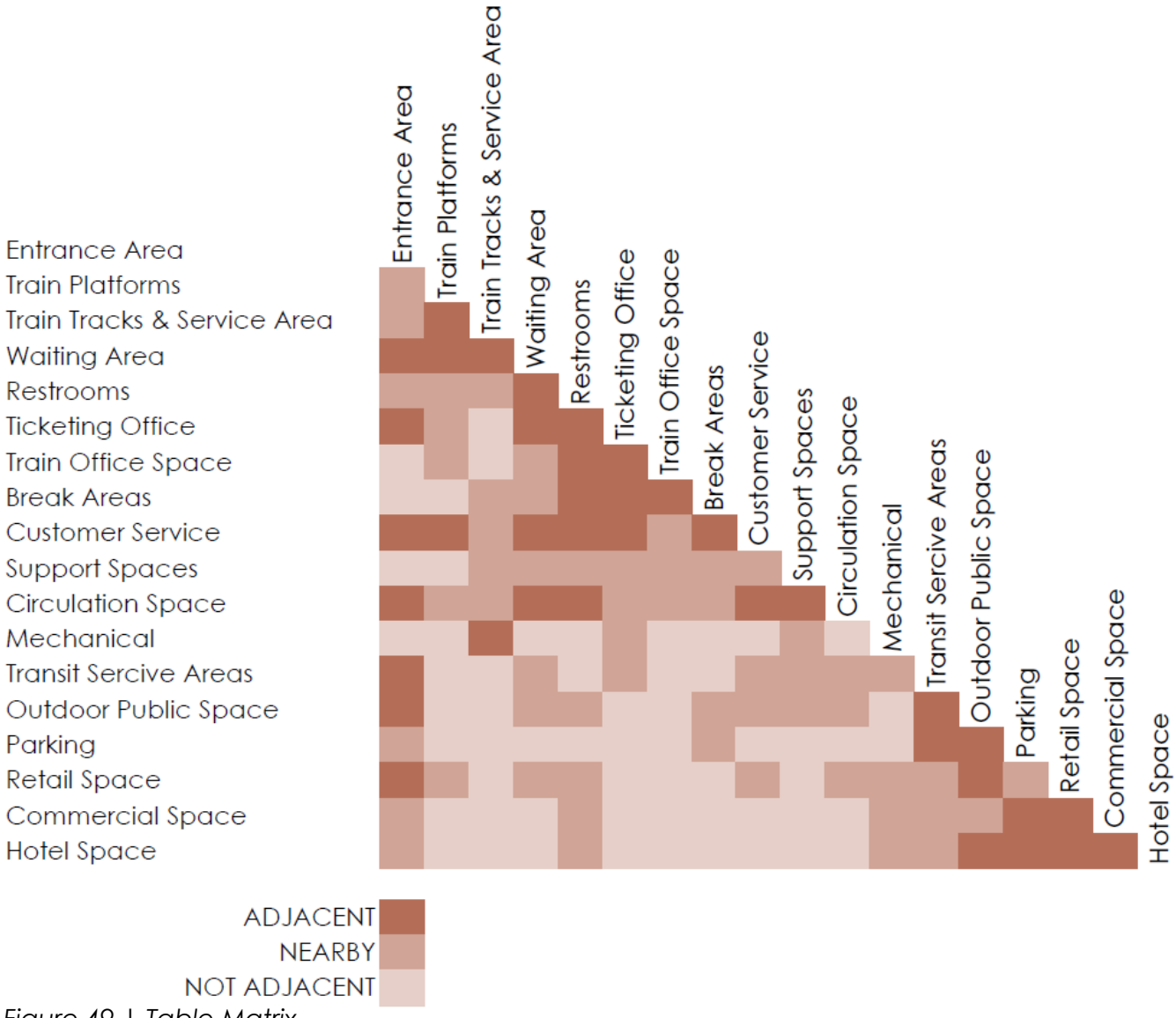


Figure 49 | Table Matrix

The space net below shows general sizing of programmed areas along with how each of those areas relate to the adjacent ones. This matrix relates directly to the last two images of the sizing needs of each area as well as how they relate to one another, but aids in understanding by being visually easier to read. The red color represents spaces correlated to being inside the station, while back represents the spaces that are only related to the station, but also incorporates the non-traveling user space.

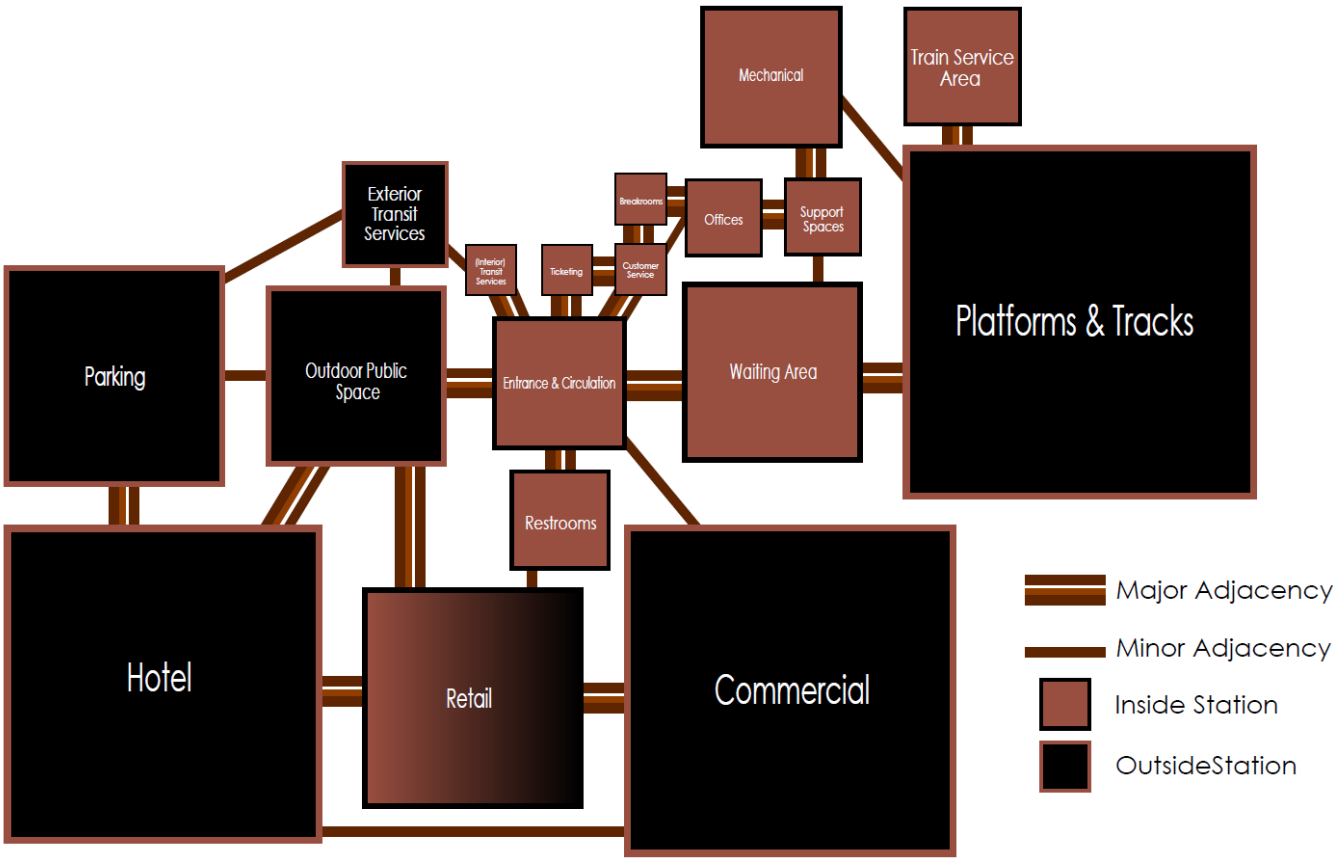


Figure 50 | Space Net

site analysis

Climate Data

Humid Subtropical Climate:

Hot & Rainy Season - May to Mid-September

Warm and Dry Season - October through April

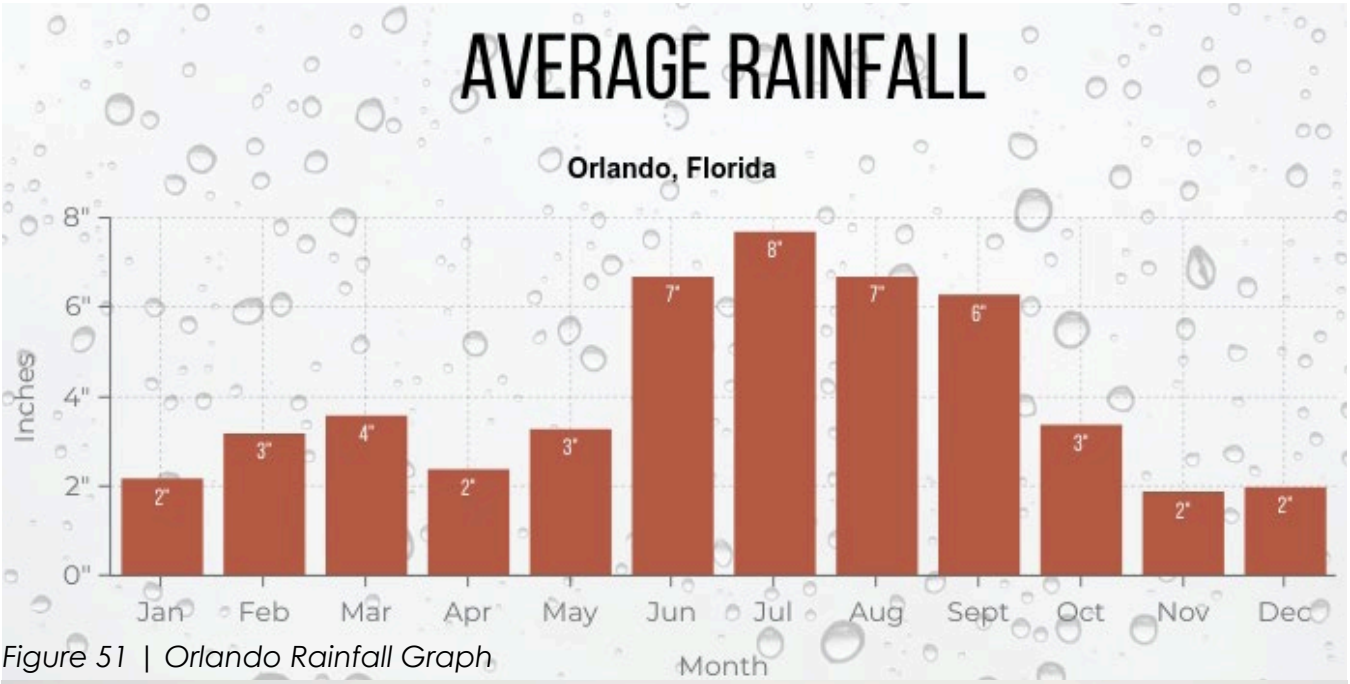
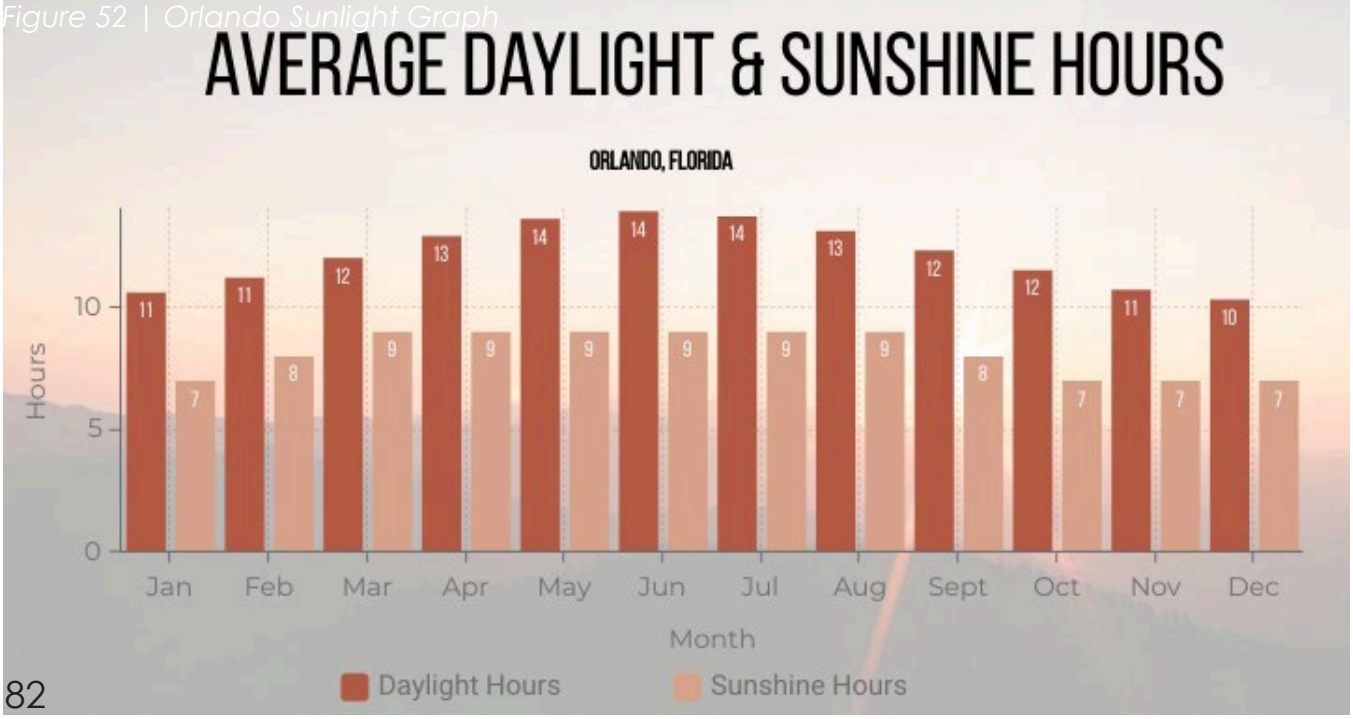


Figure 51 | Orlando Rainfall Graph

Figure 52 | Orlando Sunlight Graph



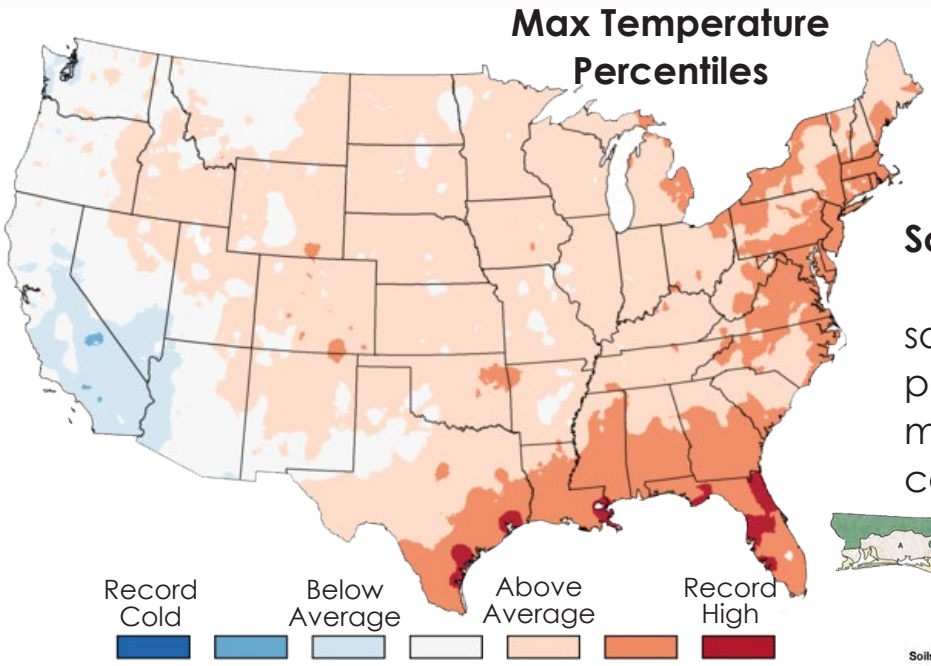


Figure 53 | Max Temperature Percentile

Soil Condition:

Central Florida soil tends to be clay, peat, and sand. Low moisture and nutrient capacity.

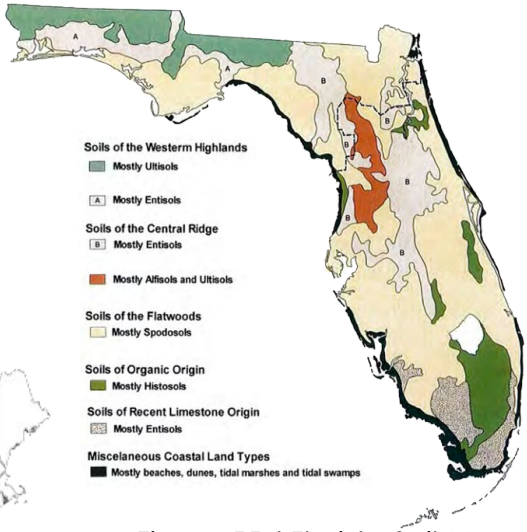


Figure 55 | Florida Soil Map

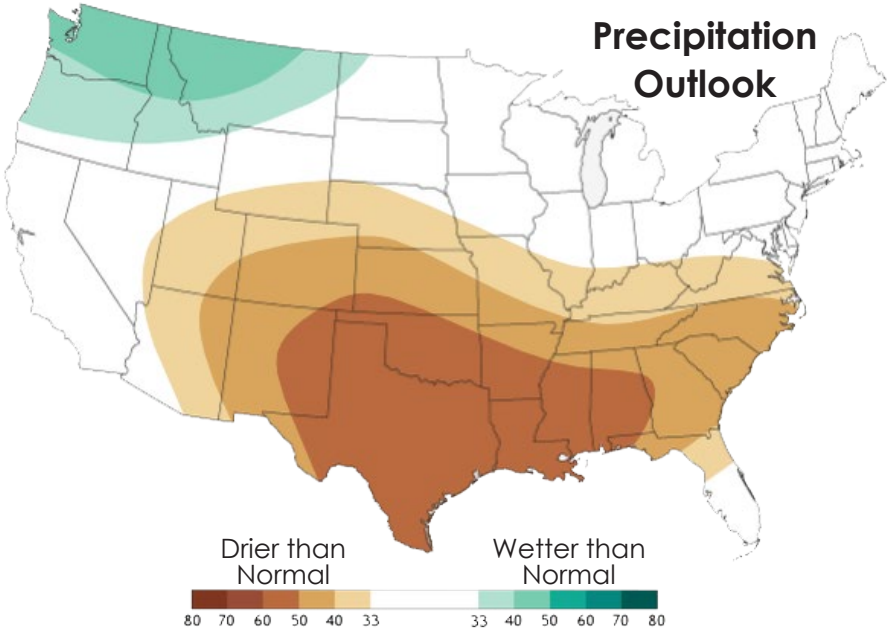
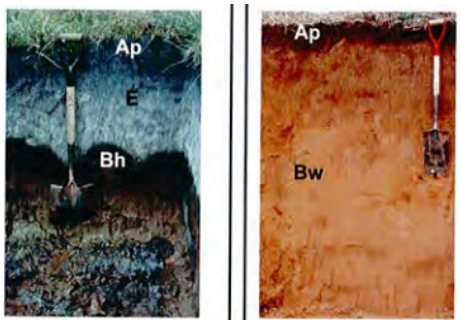


Figure 54 | Precipitation Outlook



Spodosols Entisols

Figure 56 | Soil Images

site analysis

Orlando is a growing city, with quite a diverse make up. It actually ranked 26th overall for mid-size city diversity in the country. Along with that, the city is also highly above the national poverty rate average.

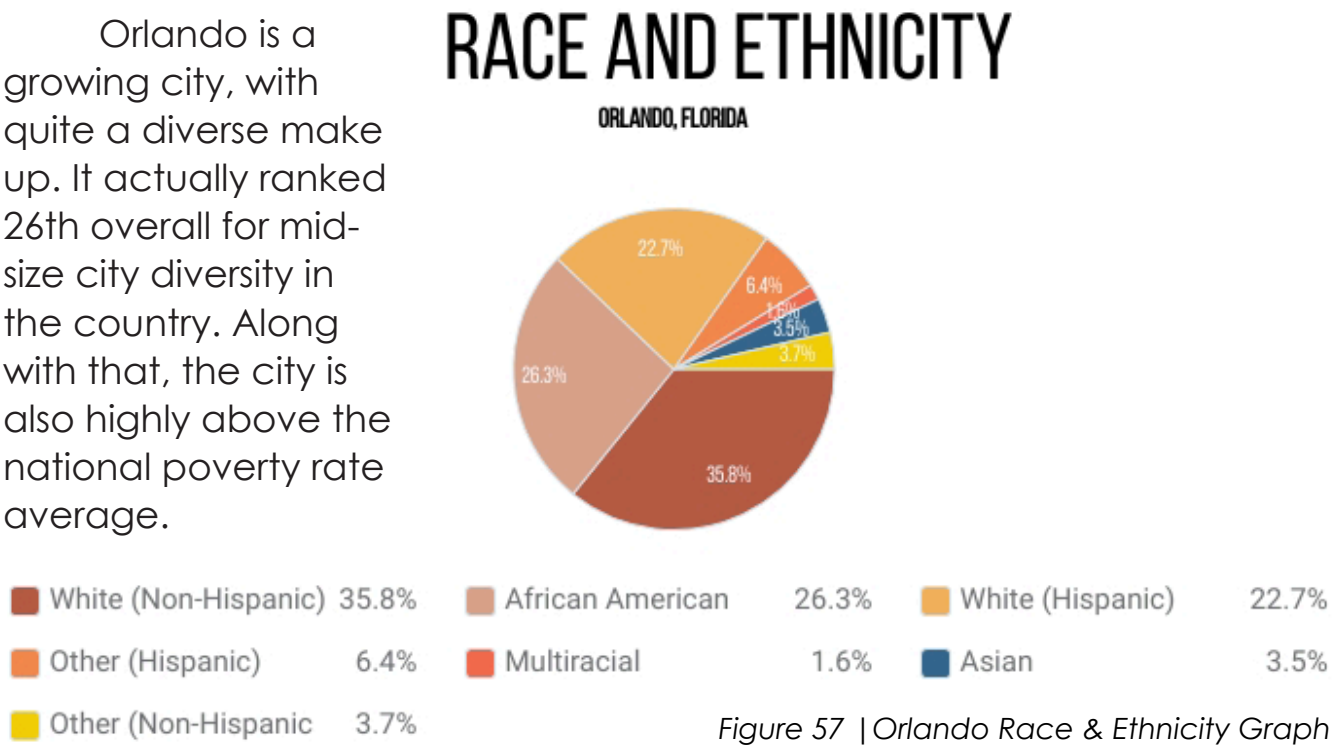


Figure 57 | Orlando Race & Ethnicity Graph

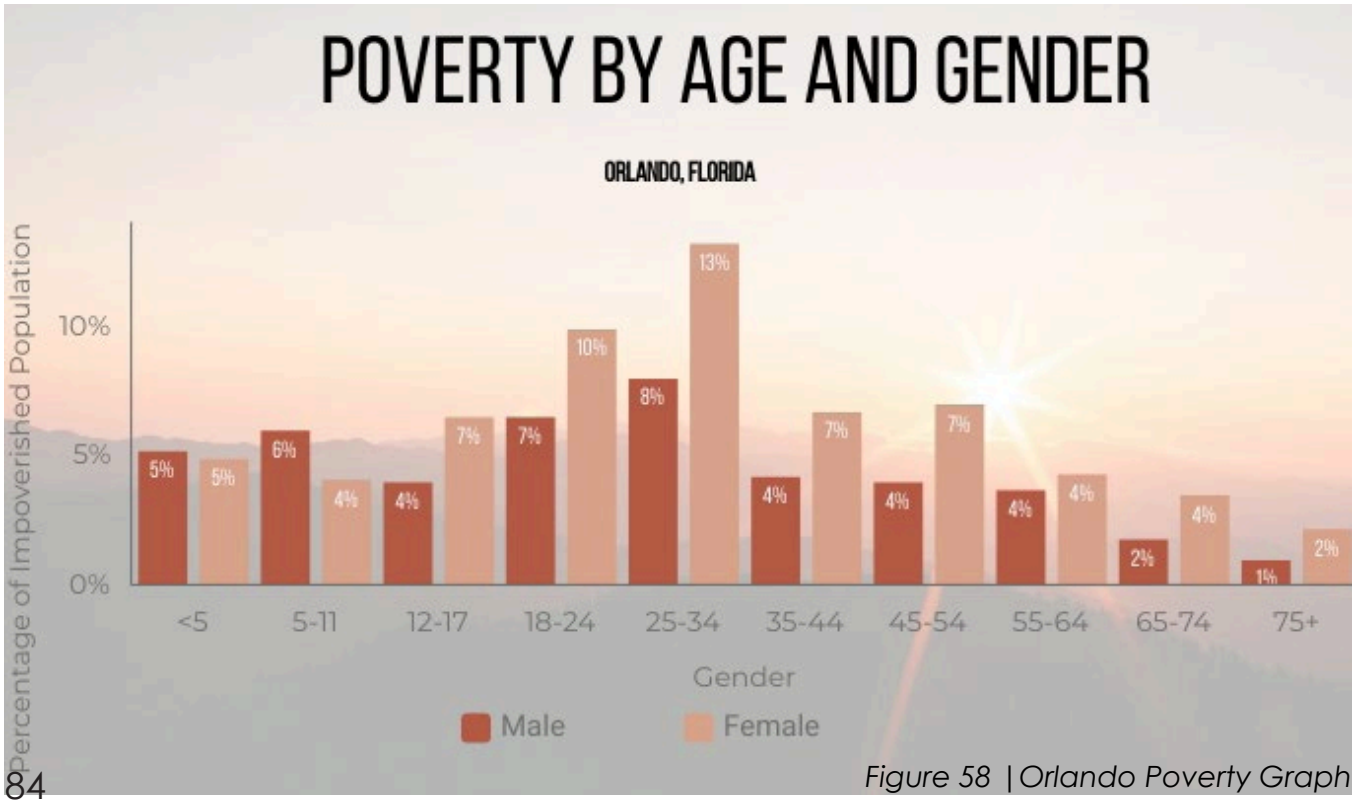


Figure 58 | Orlando Poverty Graph

orlando, florida

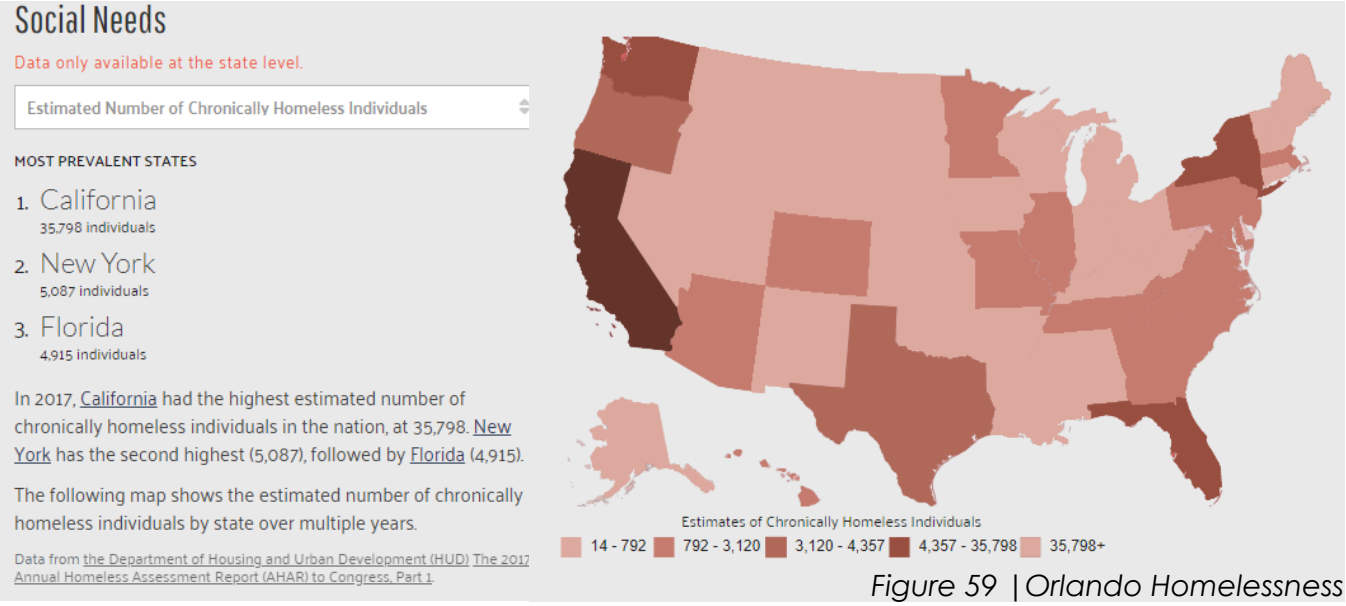


Figure 59 | Orlando Homelessness

Unfortunately, along with the high poverty rate comes a high number of homelessness. Florida is the 3rd ranked state in the United States. Below shows the household income, which relates to the poverty rate, and you can see it's far below the other lines. Lastly, I thought it was important to show the chosen transportation options so I may address that in my project.

Figure 60 | Orlando Income Graph

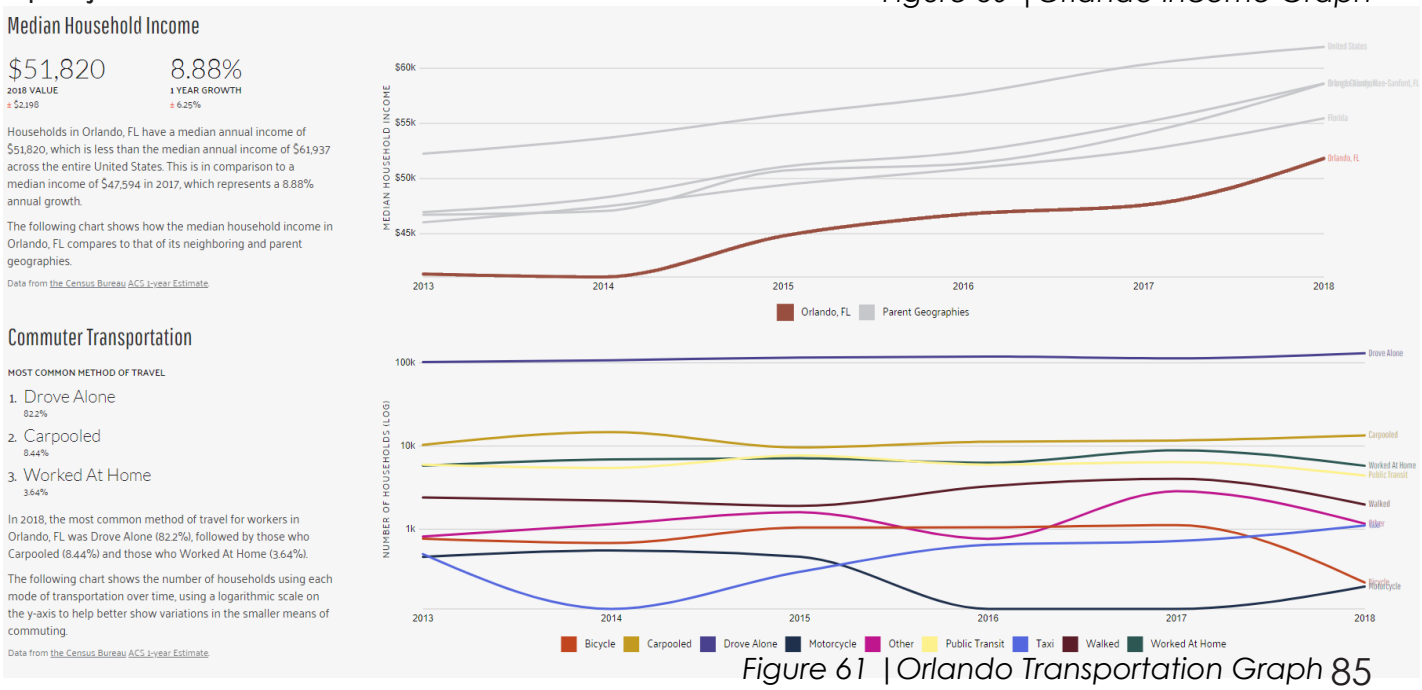


Figure 61 | Orlando Transportation Graph

site analysis

Site Circulation

The circulation around the site is heavily vehicle emphasized. Pedestrian circulation is extremely lacking, though there have been some improvements to streets on the east end of the site. As you can see, the train tracks go right through the site in north and south direction, but the massive interstate system in the city intersects to the northwest of the site.

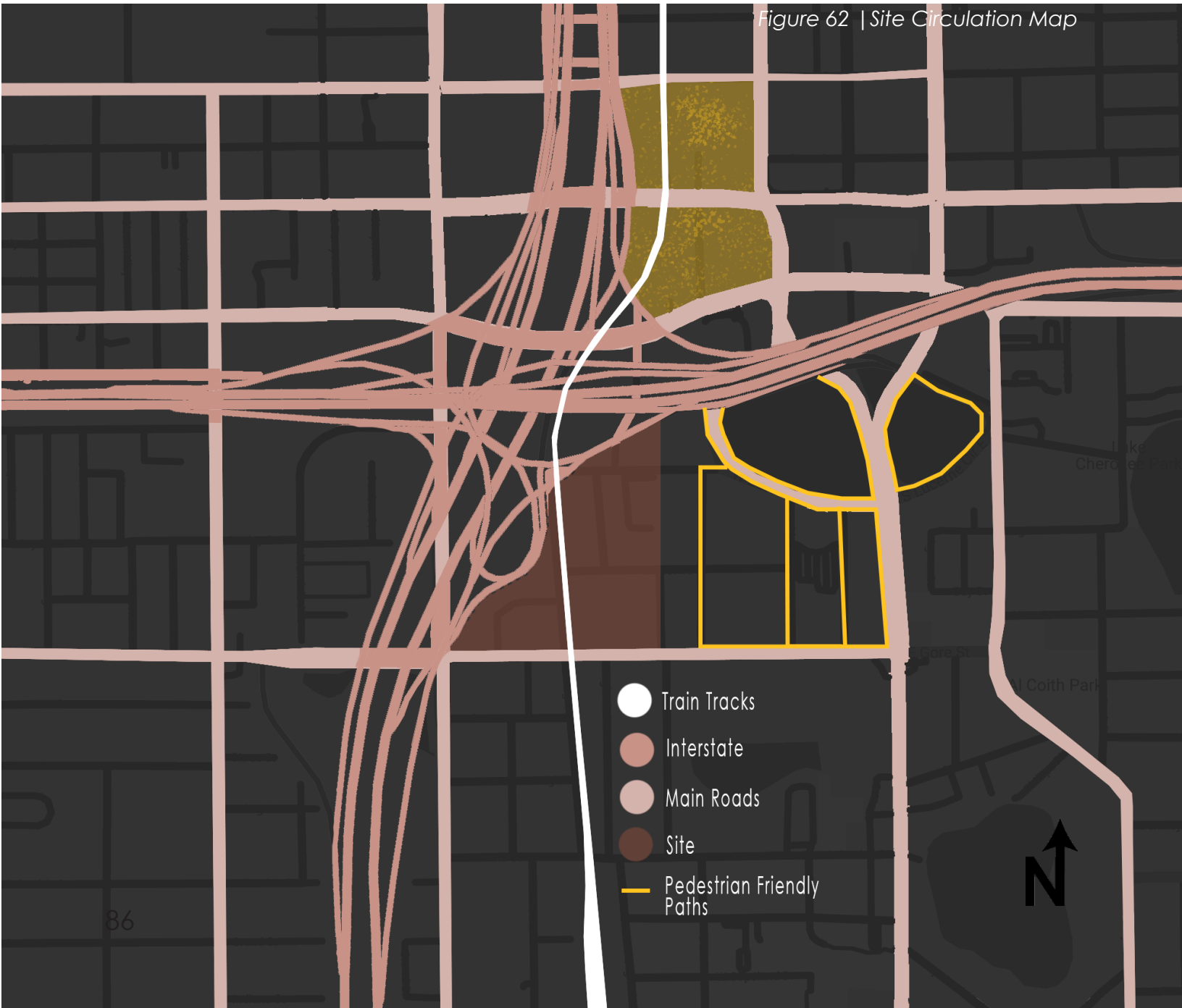
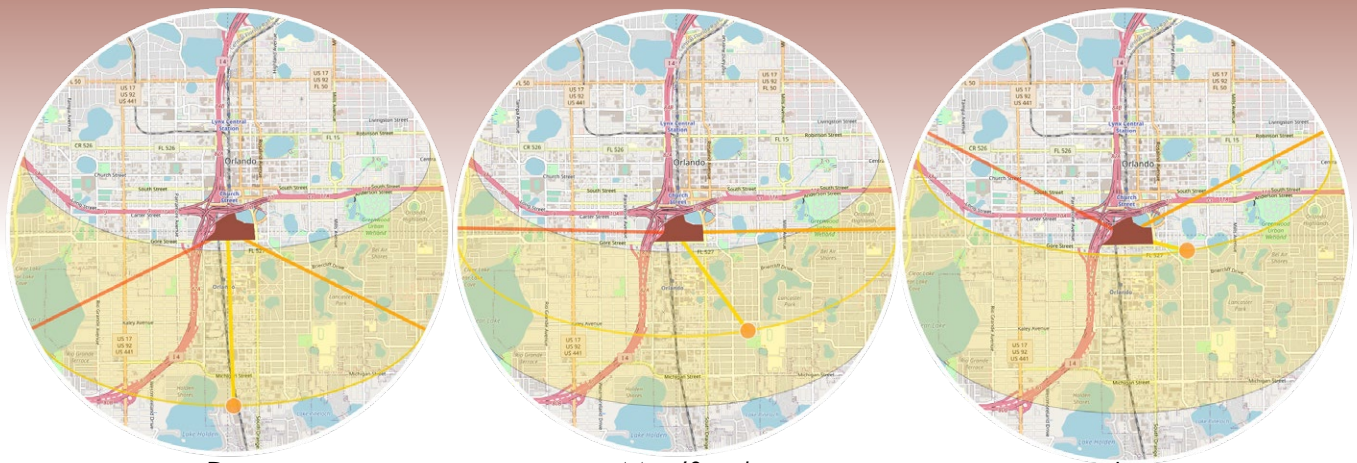


Figure 62 | Site Circulation Map

Orlando Sun Charts



Dec | Mar/Sept | Jun

Figure 63 | Orlando Sun Charts

Site Analysis

Figure 64 | Site Analysis Map

site history

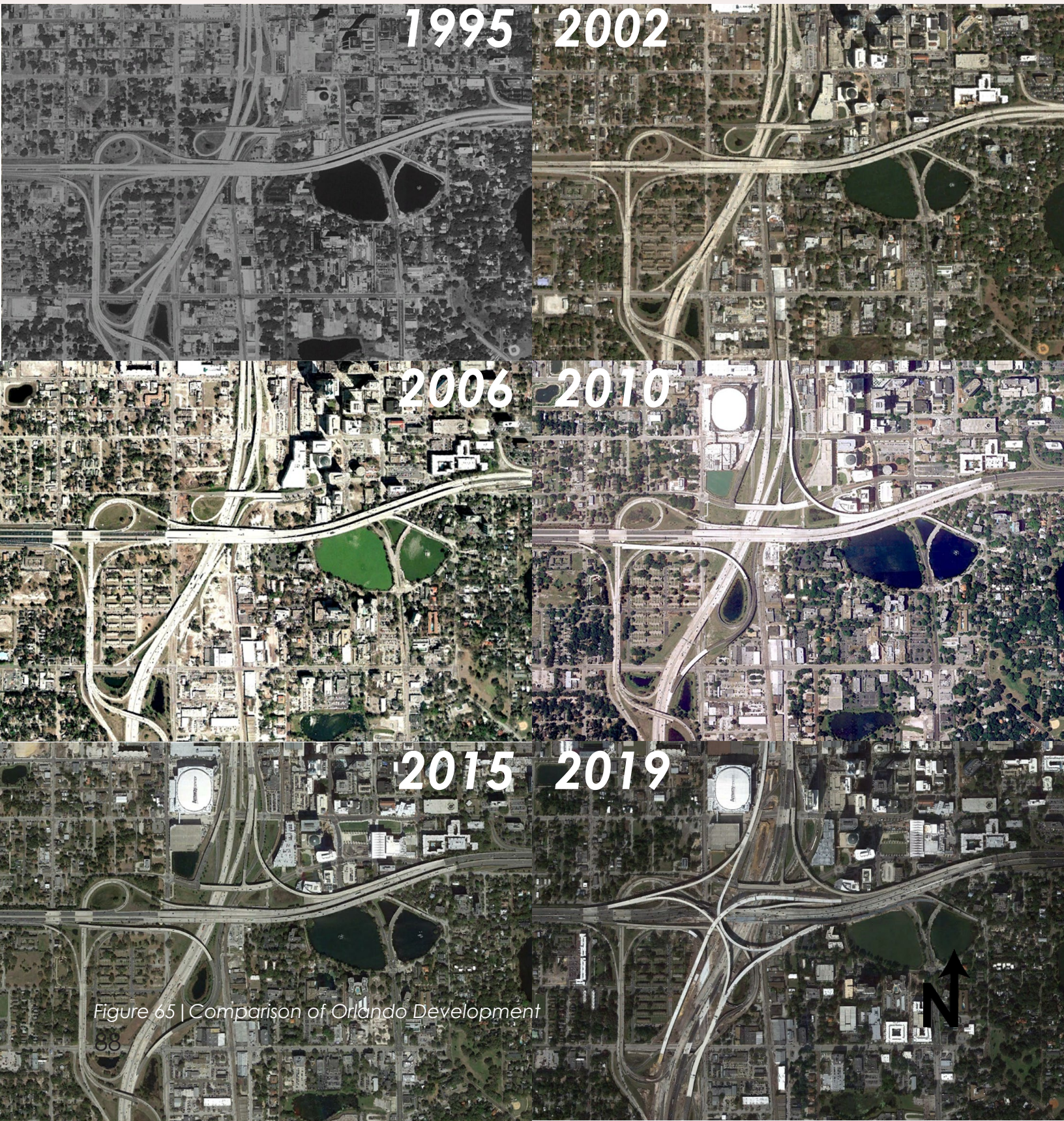


Figure 65 | Comparison of Orlando Development

orlando, florida

The last few pages have shown a lot of foundational information about the site. From the warm climate, I can best decide the sustainable practices and passive strategies for an environmentally efficient design. The amount of sun hours will help me figure out how effective photo-voltaic panels will be, and knowing the average rain amounts and when will help to plan and size bioswales on the site. In sunny Orlando, daylighting will be effective for saving energy. In the future, developing more in depth site plans will be aided by the analysis tools shown on the last two pages.

The site circulation map will help me in building placement, development, and orientation. I already believe that the south west corner of the site on the left of the train tracks will house the train yard and servicing area, since it is not very accessible. I also want to have the "back" of the station to the west to block the north-south interstate, however, I want to keep the views of downtown so the east/west interstate will probably end up not being blocked in their entirety.

To the left are satellite images showing the historical development in Orlando around my site over the years. It was cool to see how the downtown area on the top right of the images developed more and more, as well as the additions to the interstate interchanges. It is good to see these side by side to analyze the growth patterns of the city to plan for the future.

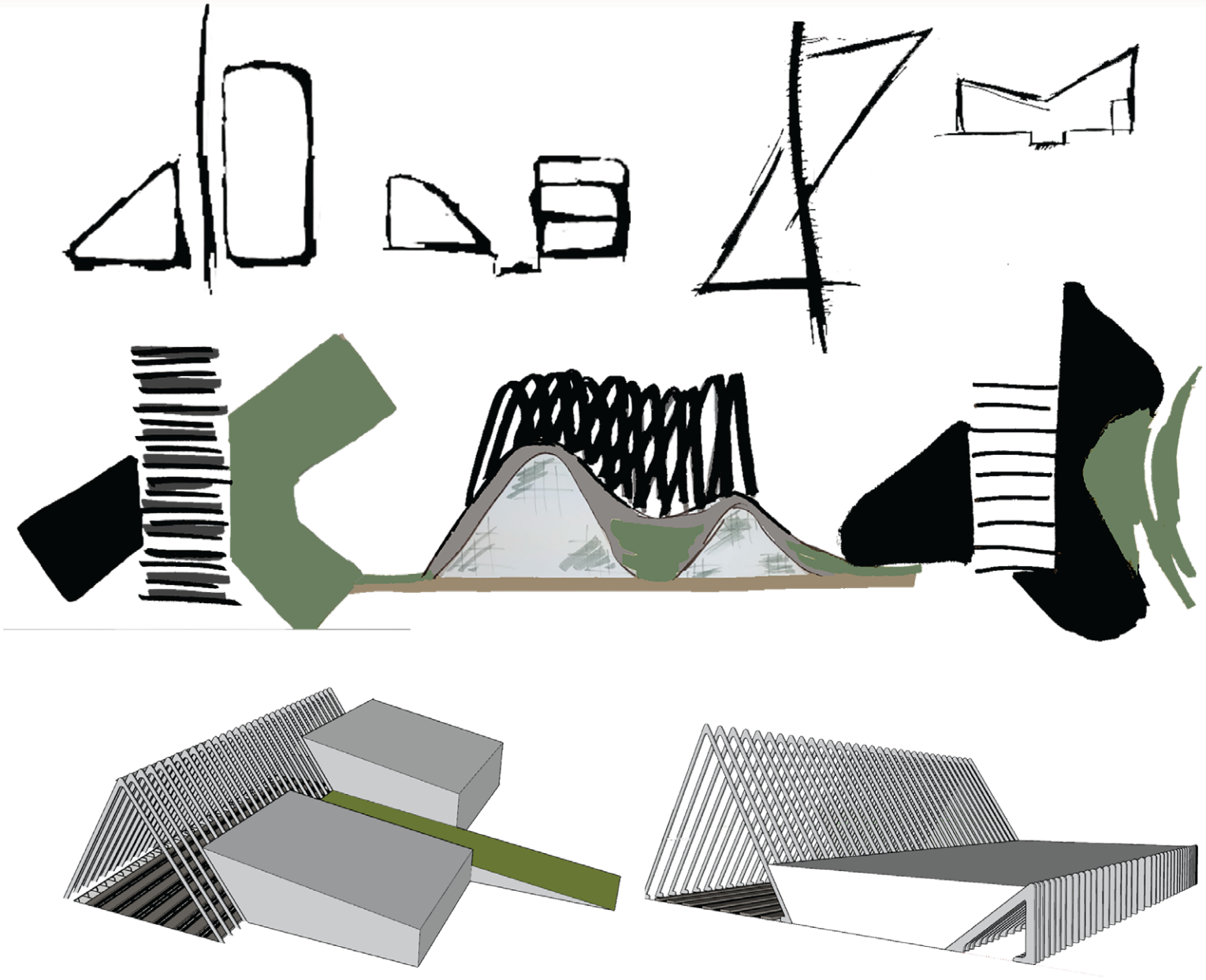
As touched on a little bit before, tourism is a huge economic sector for Orlando. In 2019, it was announced that Orlando had broken a record for the amount of visitors in the course of the year - 75 million. 6 and a half of those visitors are international and grew 5.4% from 2018. The airport is actually the busiest in the whole state, with 47.7 million passengers, something that a high-speed rail system could help with the future increase in numbers.

the design

the station

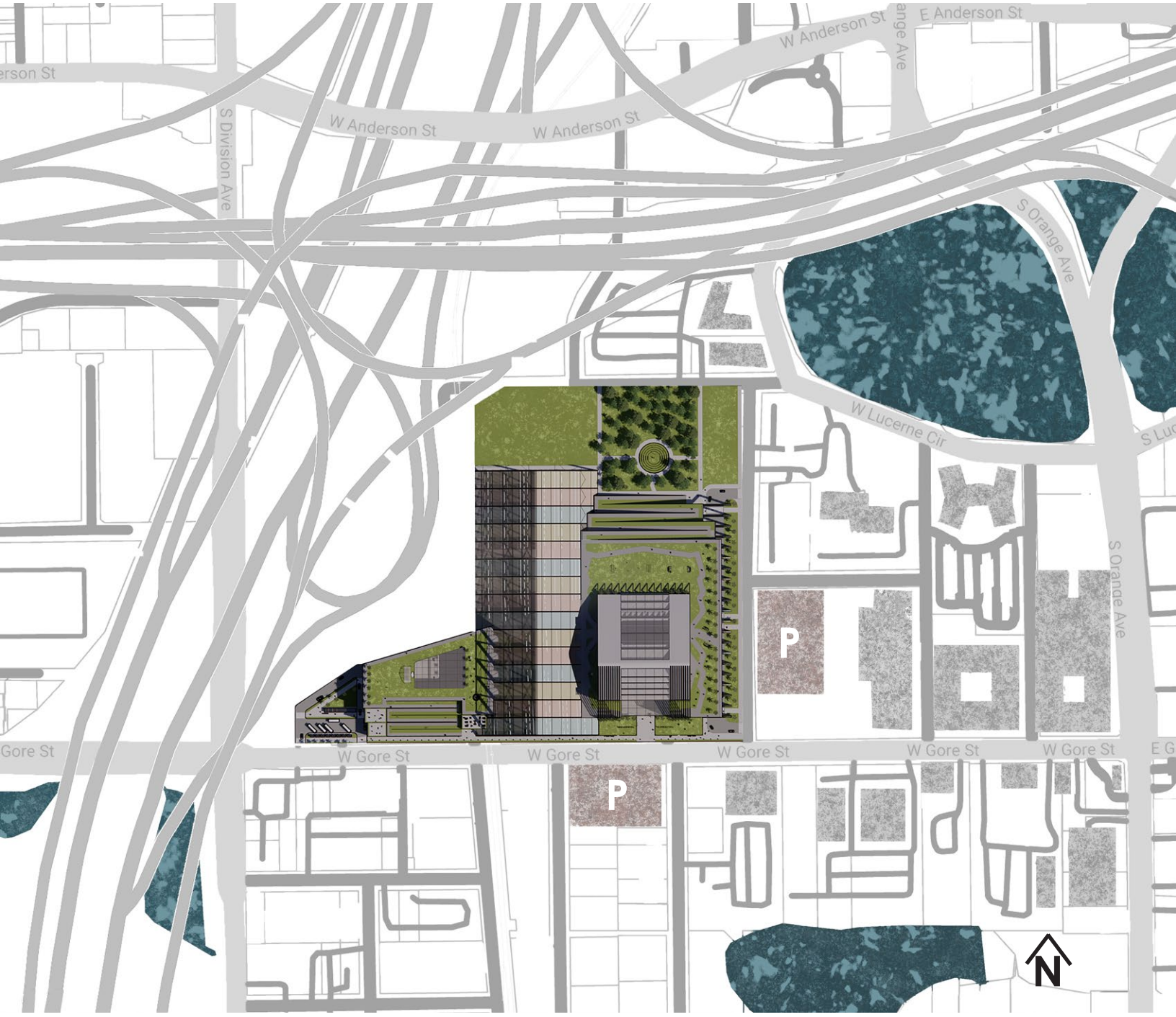
Stations are much more than just places people depart from and arrive at. It is a place for adventure, learning, relaxation, public gathering, shopping, dining, working, and so much more. The station has a chance to be a city within a city, to bring in more tourists, and to create a large economic opportunity for the city. The location of the station is just as important. If there are no other options of transportation to or from the area, no one will enjoy the process of trying to come or leave. There must be ample parking available nearby, bike and pedestrian routes, rental cars or ride-share areas, bus routes, and, ideally in large cities, a subway or light-rail stop to connect the station to further parts of the city. Traveling should not be a burden, it should be something to look forward to, and the system must be on time, fast, and convenient enough for people to choose rail travel. Whether it be for work trips or for fun, the station and trains need to cater to the needs of the users. Now more than ever, we need to be thinking about the planet and each other. The answer should not be to travel less, but to find a solution to travel better.

the development

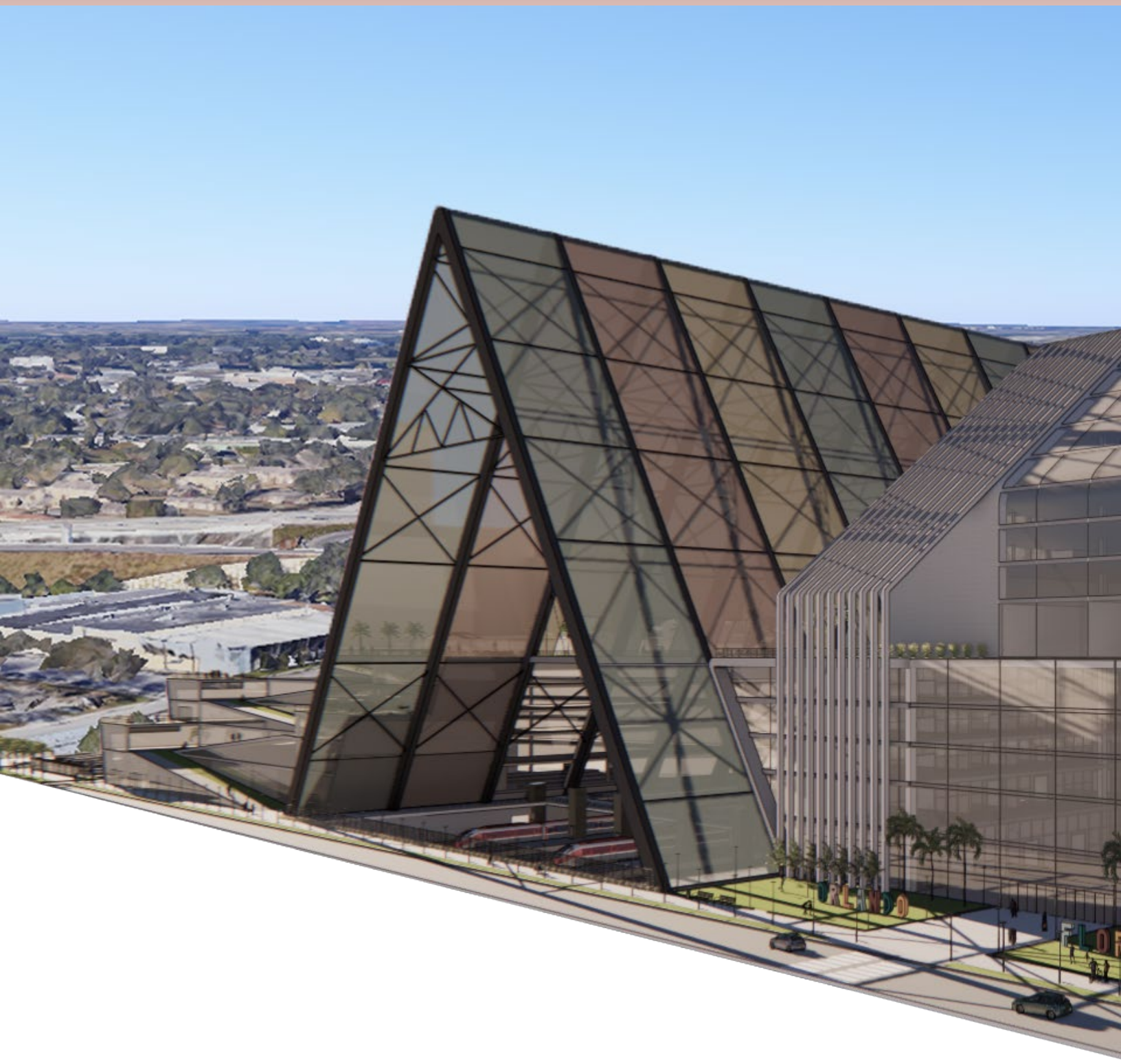


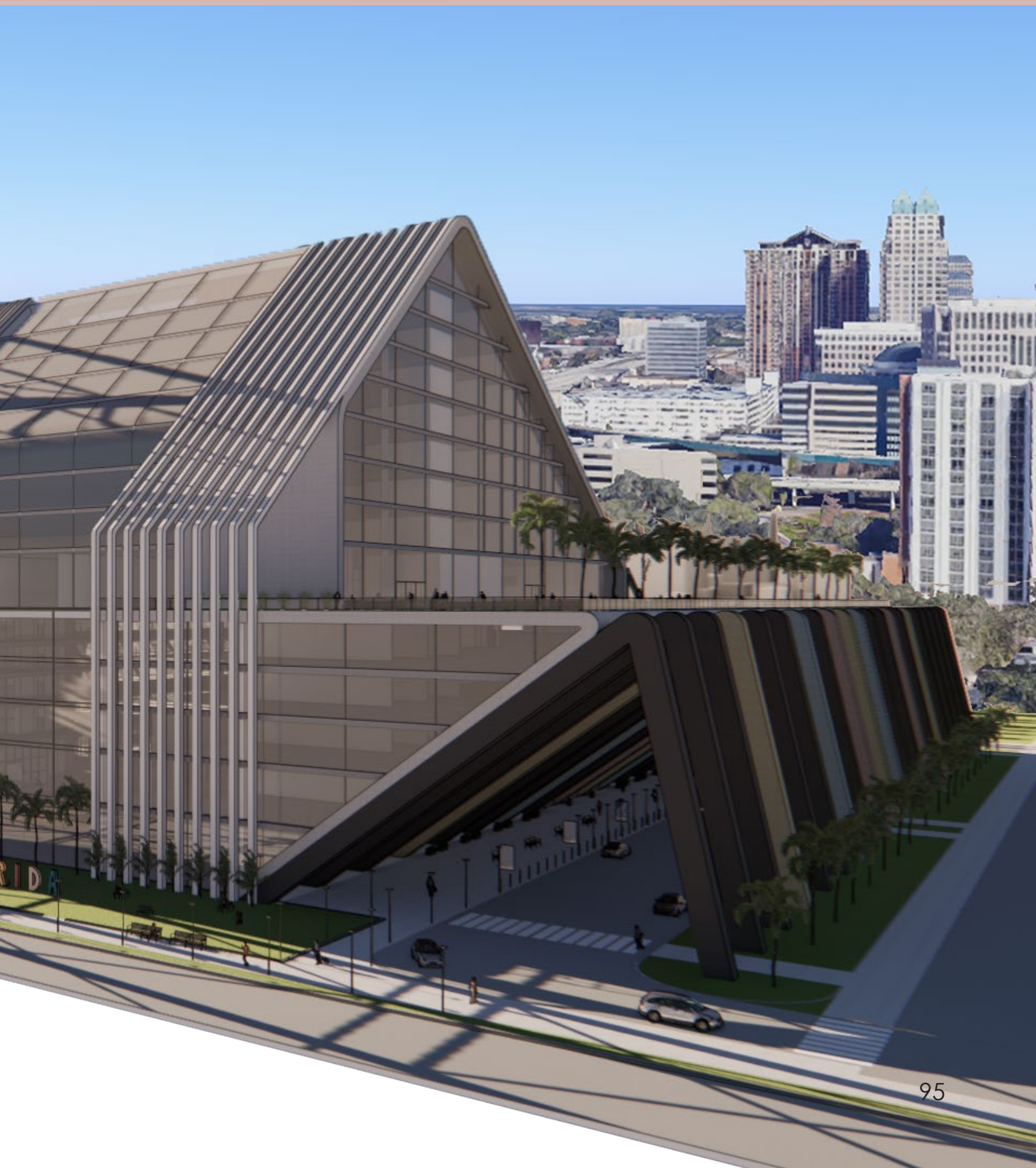
From the beginning, I knew the station would be developing around the train tracks rather than just attaching to the edge of it. Also early on, I decided on the A-frame structure to provide protection from the elements on the platforms, but also became the iconic skyline of the building.

the site

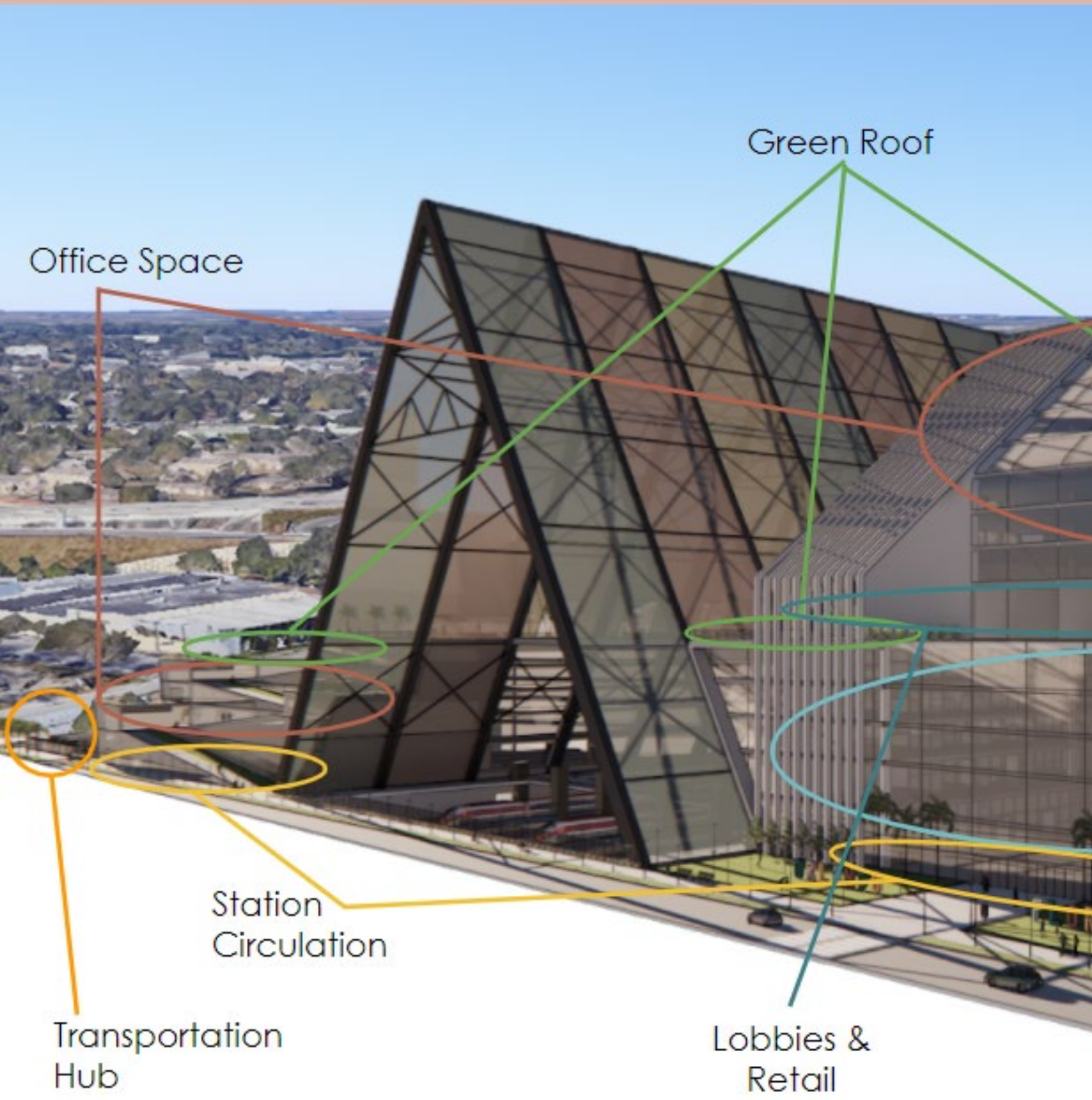

W Anderson St
E Anderson St
W Anderson St
W Anderson St
S Division Ave
S Orange Ave
W Lucerne Cir
S Orange Ave
W Gore St
W Gore St
W Gore St
W Gore St
W Gore St
P
P
N

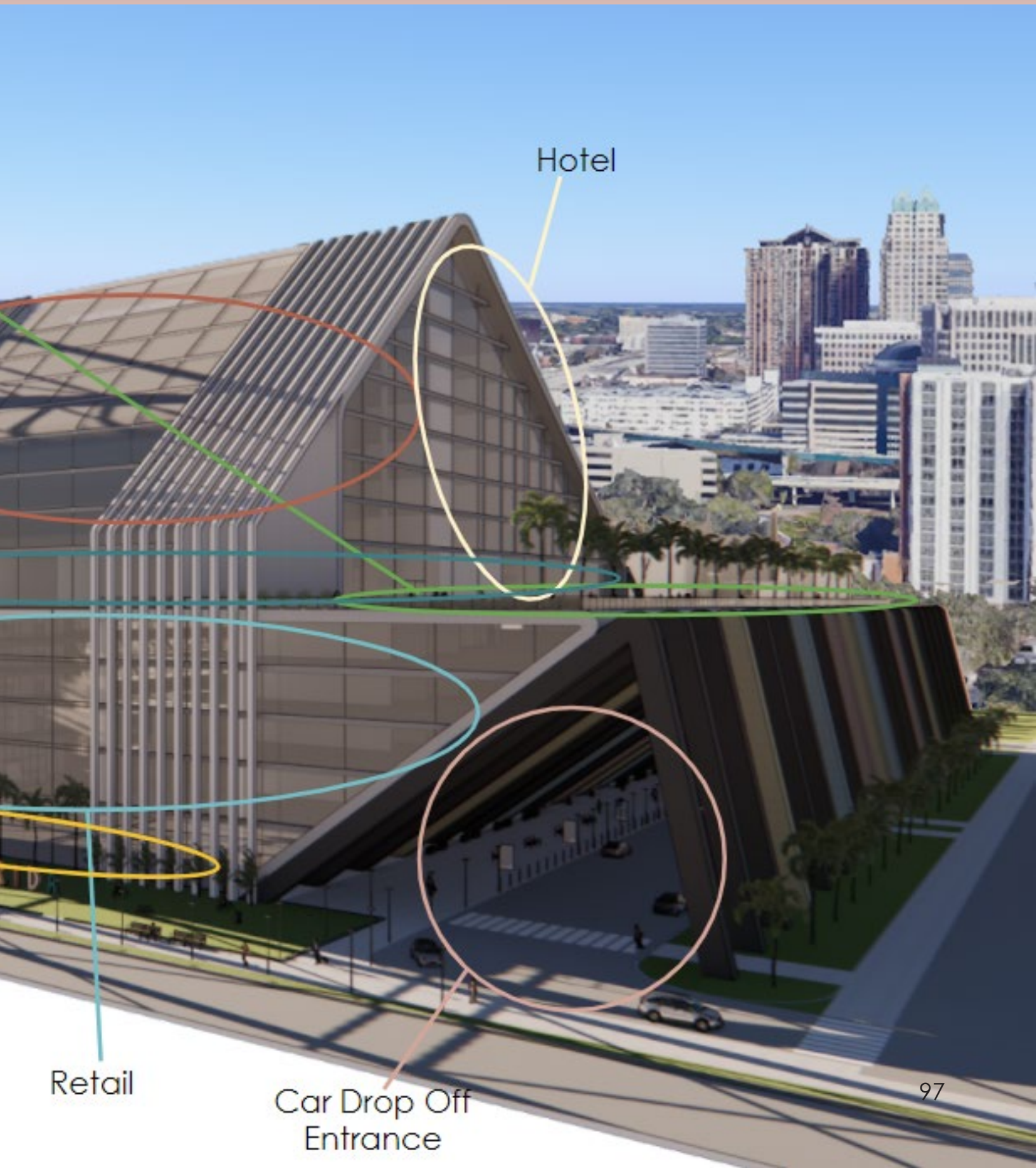
the station



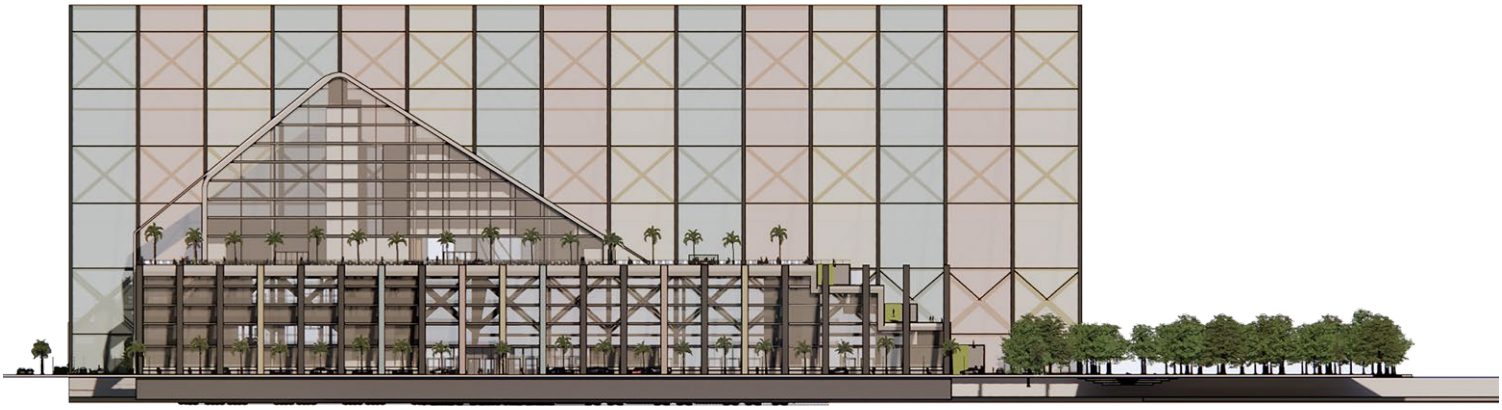


the program

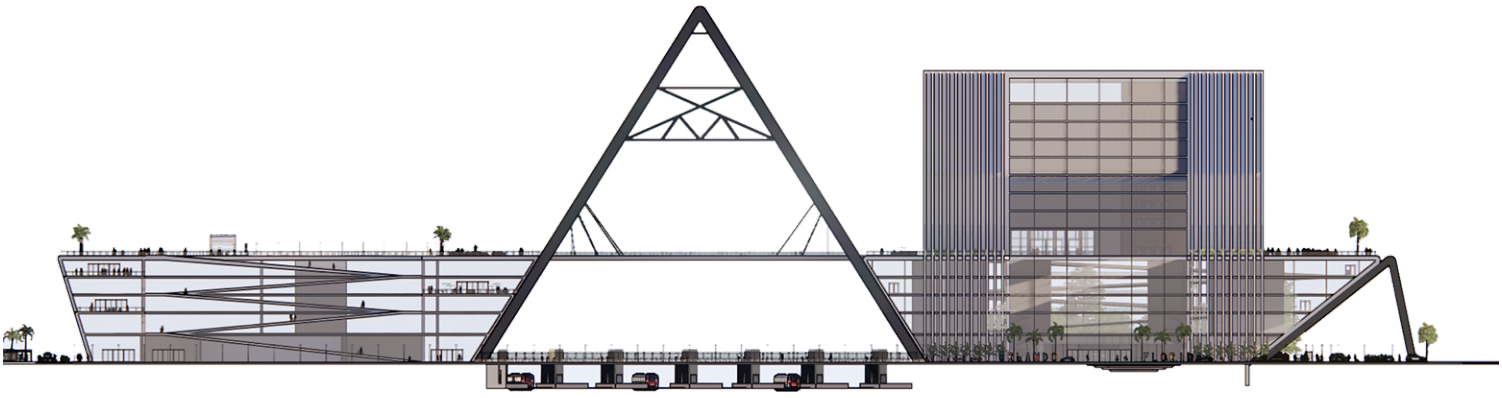

Green Roof
Office Space
Station
Circulation
Transportation
Hub
Lobbies &
Retail


Hotel
Retail
Car Drop Off
Entrance

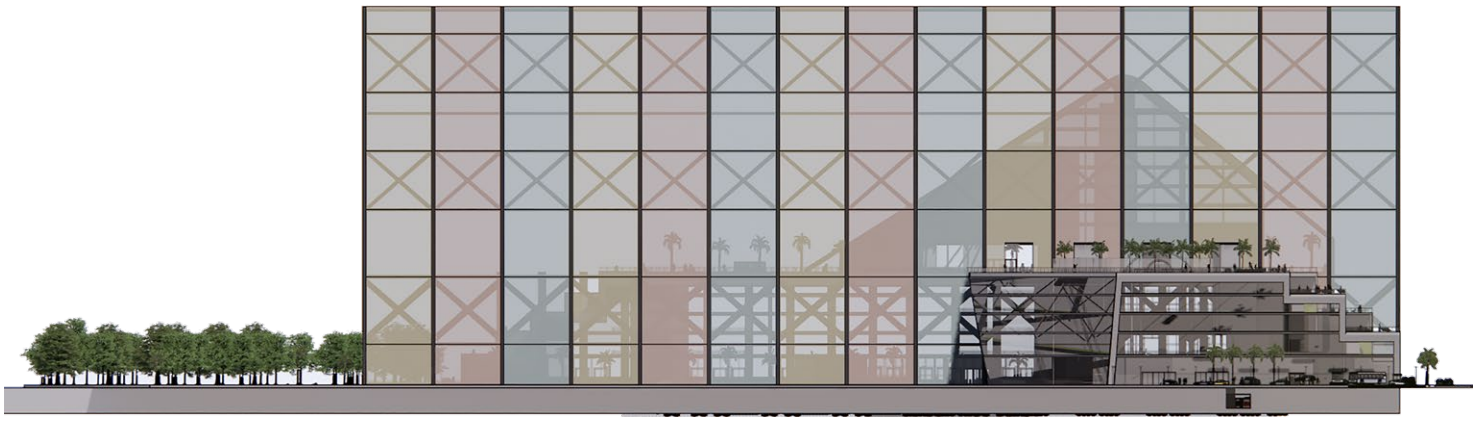
elevations



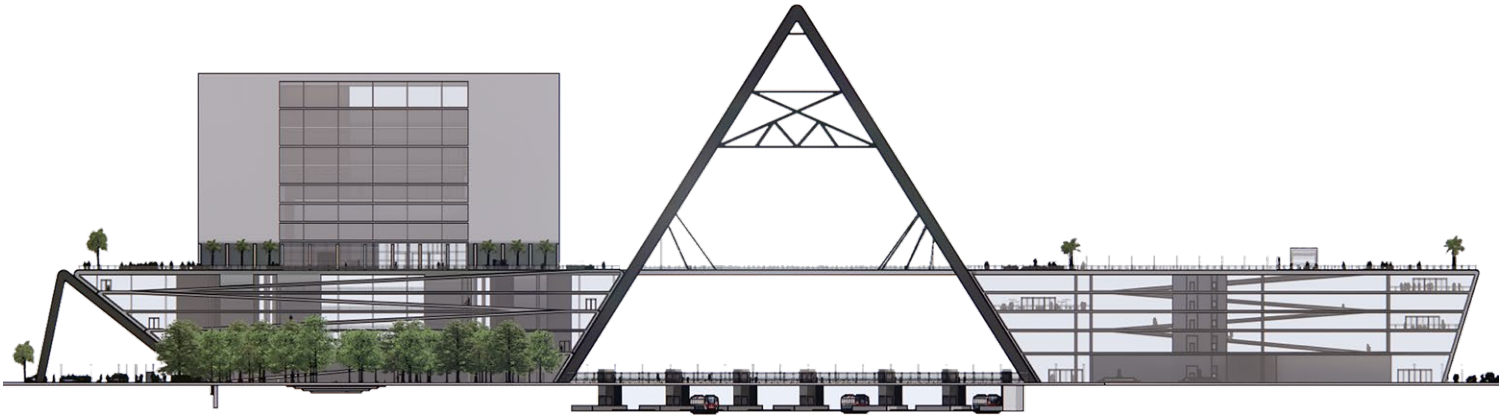
East Elevation



South Elevation

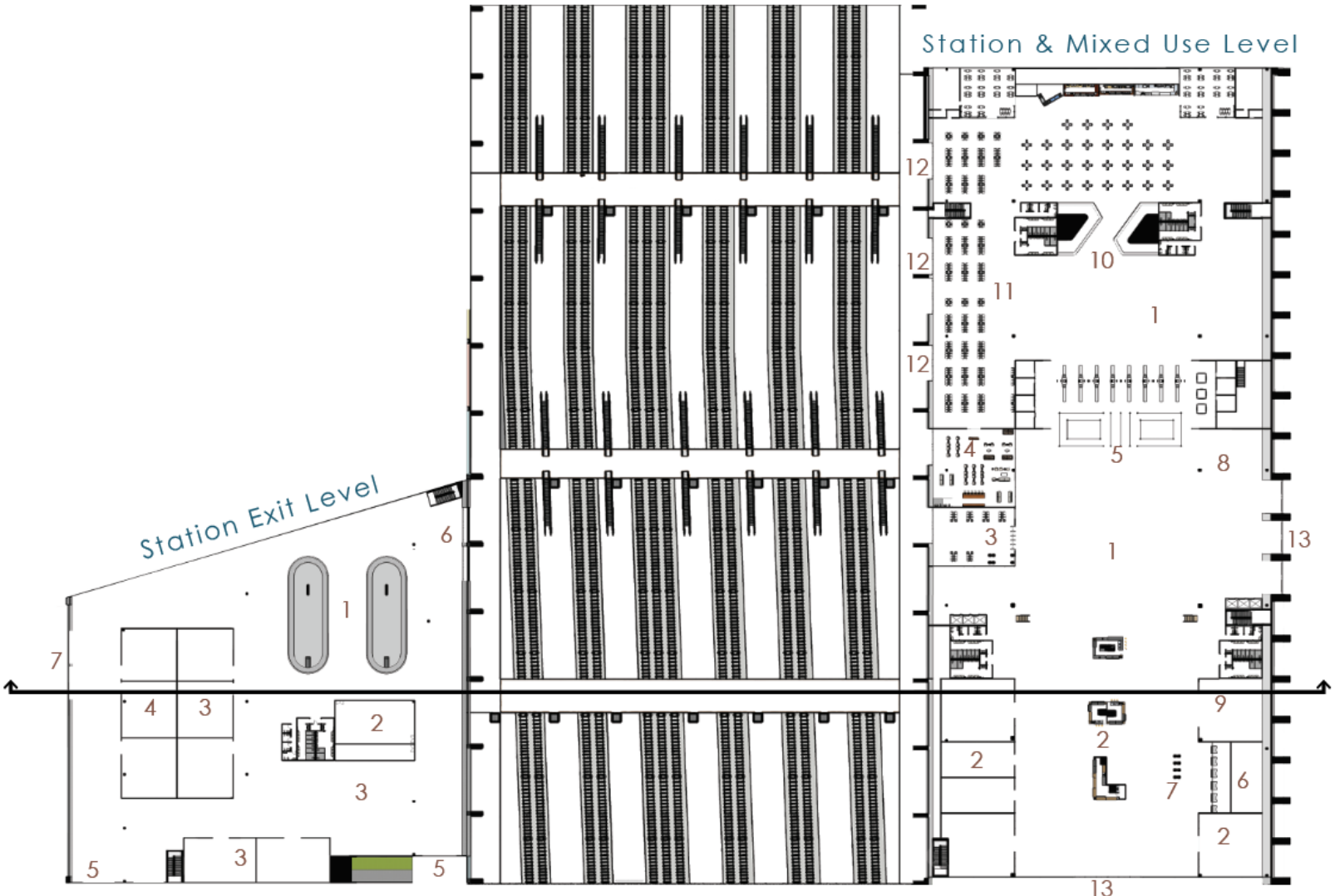


West Elevation



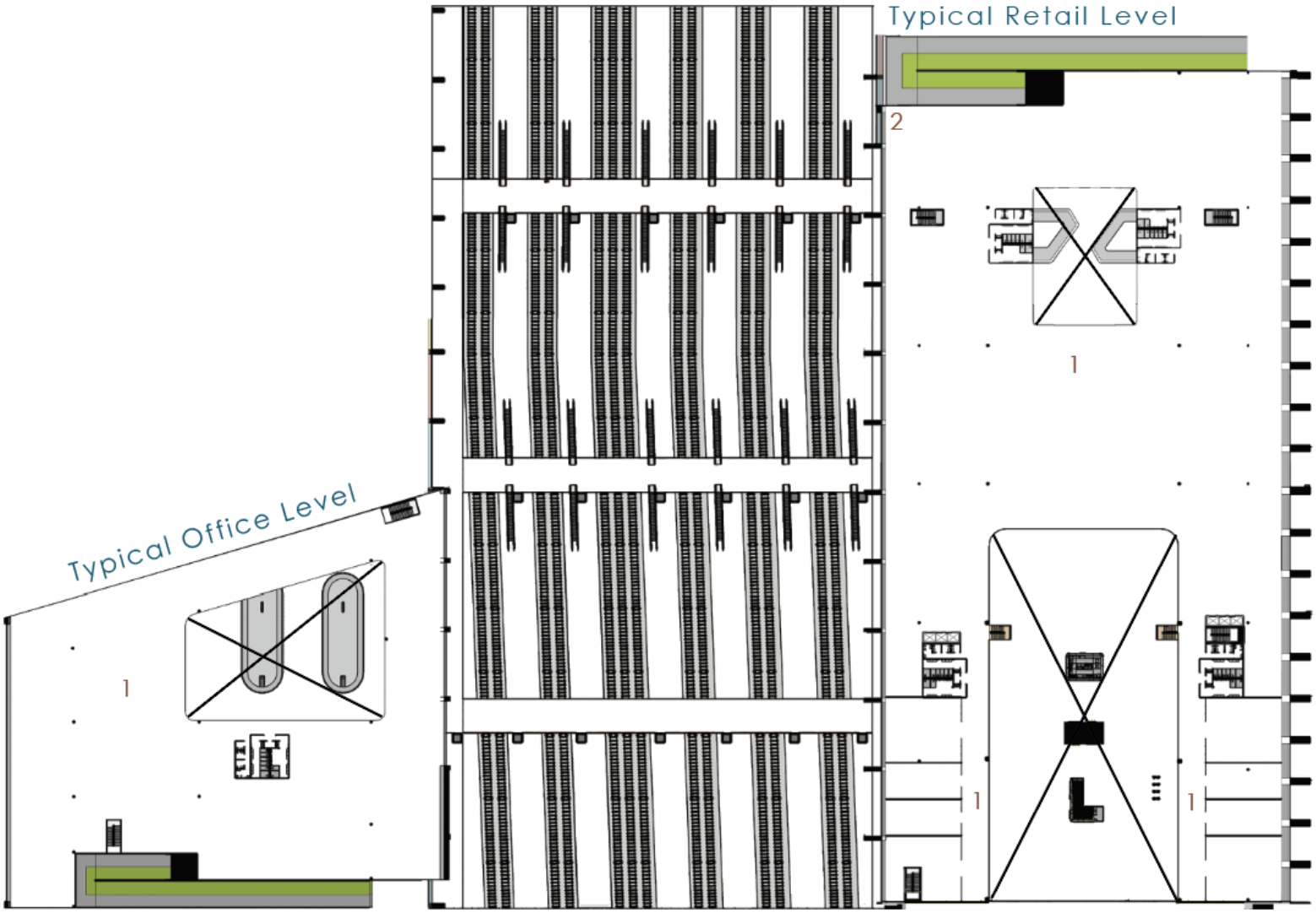
North Elevation

floor plans



1 Baggage Claim
2 Baggage Handling Area
3 Retail
4 Transportation Offices
5 Entrance
6 Entrance From Platforms
7 Exit to Ride Share & Transportation Services

1 Waiting Area
2 Retail
3 SunRail Waiting Area
4 First Class Waiting Area
5 Security
6 Ticket and Baggage Desks
7 E-Ticket Kiosks
8 Info Desk
9 Customer Service
10 Food Court
11 Waiting Area
12 Exit to Platforms
13 Entrance



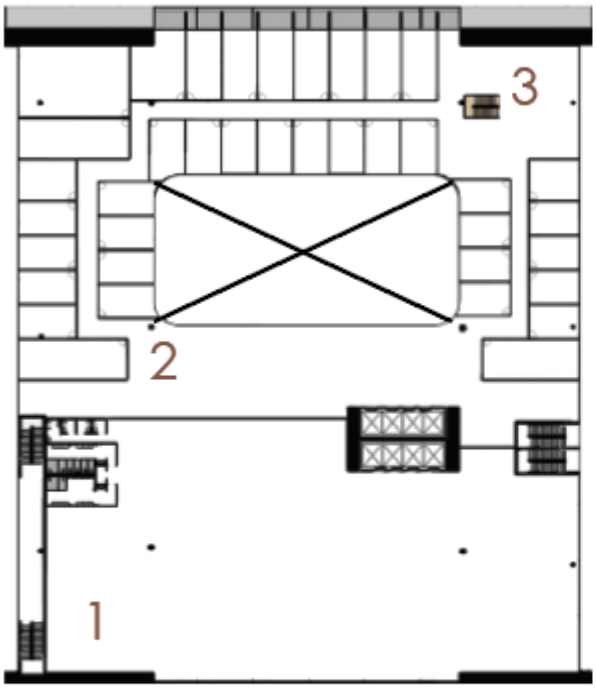
1 Office Space

Second Level

1 Retail Space
2 Green Roof Access

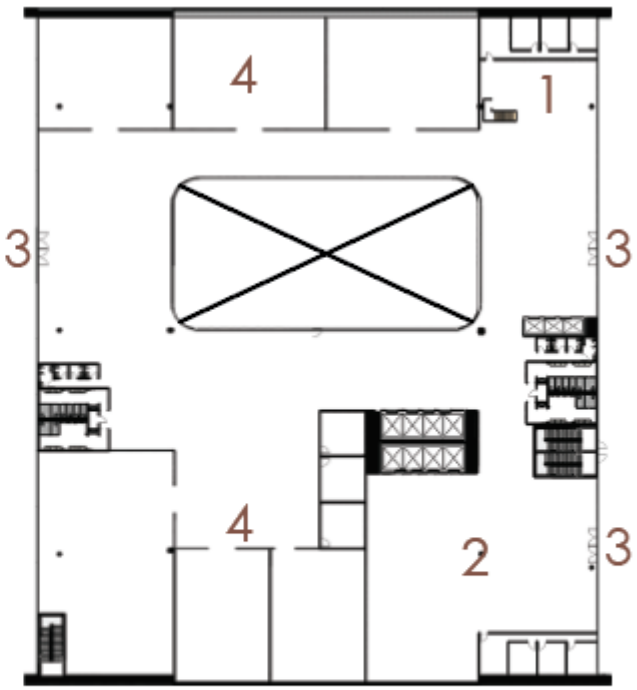
floor plans

Hotel & Office Level



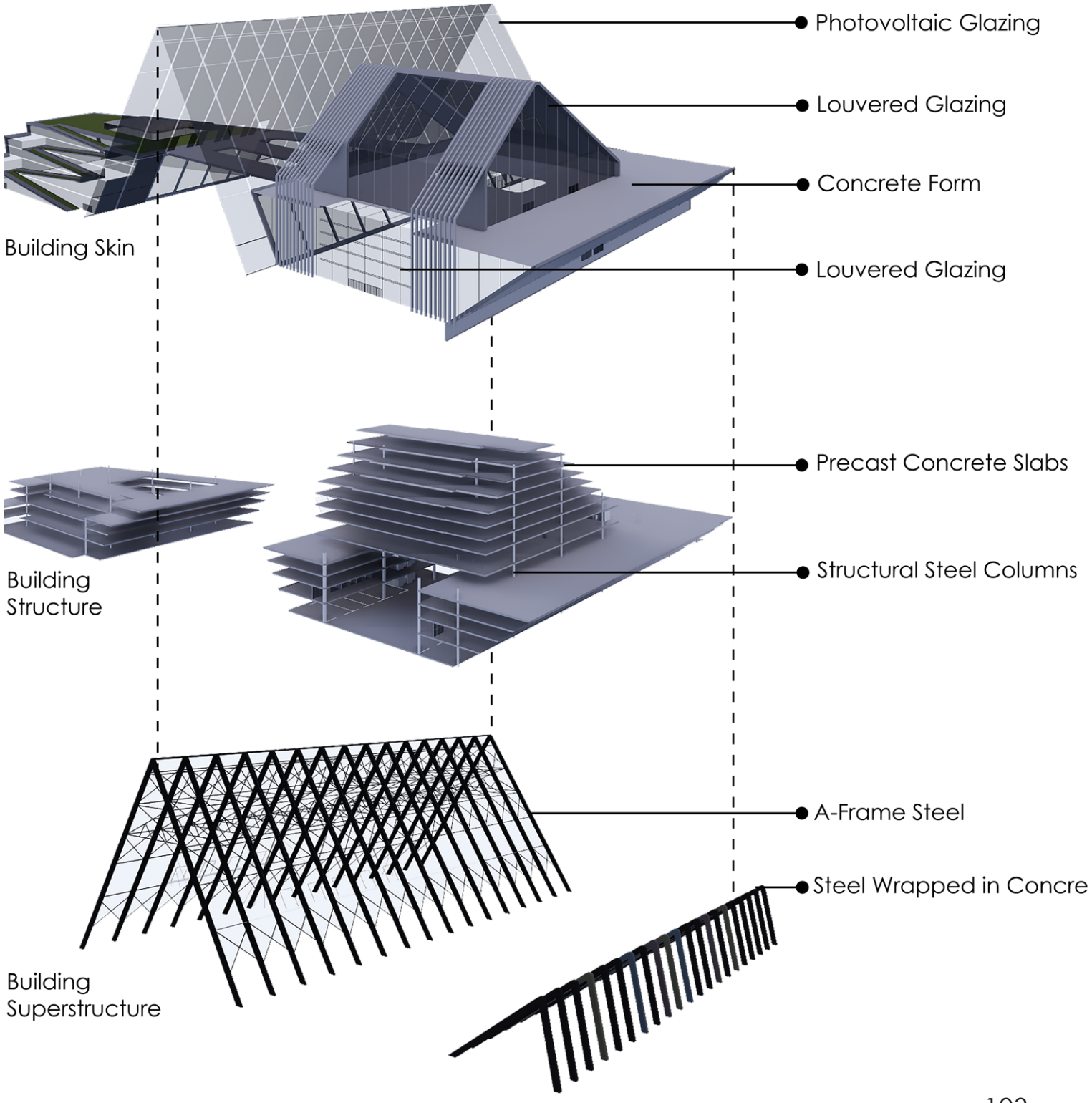
1 Office Space
2 Hotel
3 Cafe Space

Lobby & Retail Level

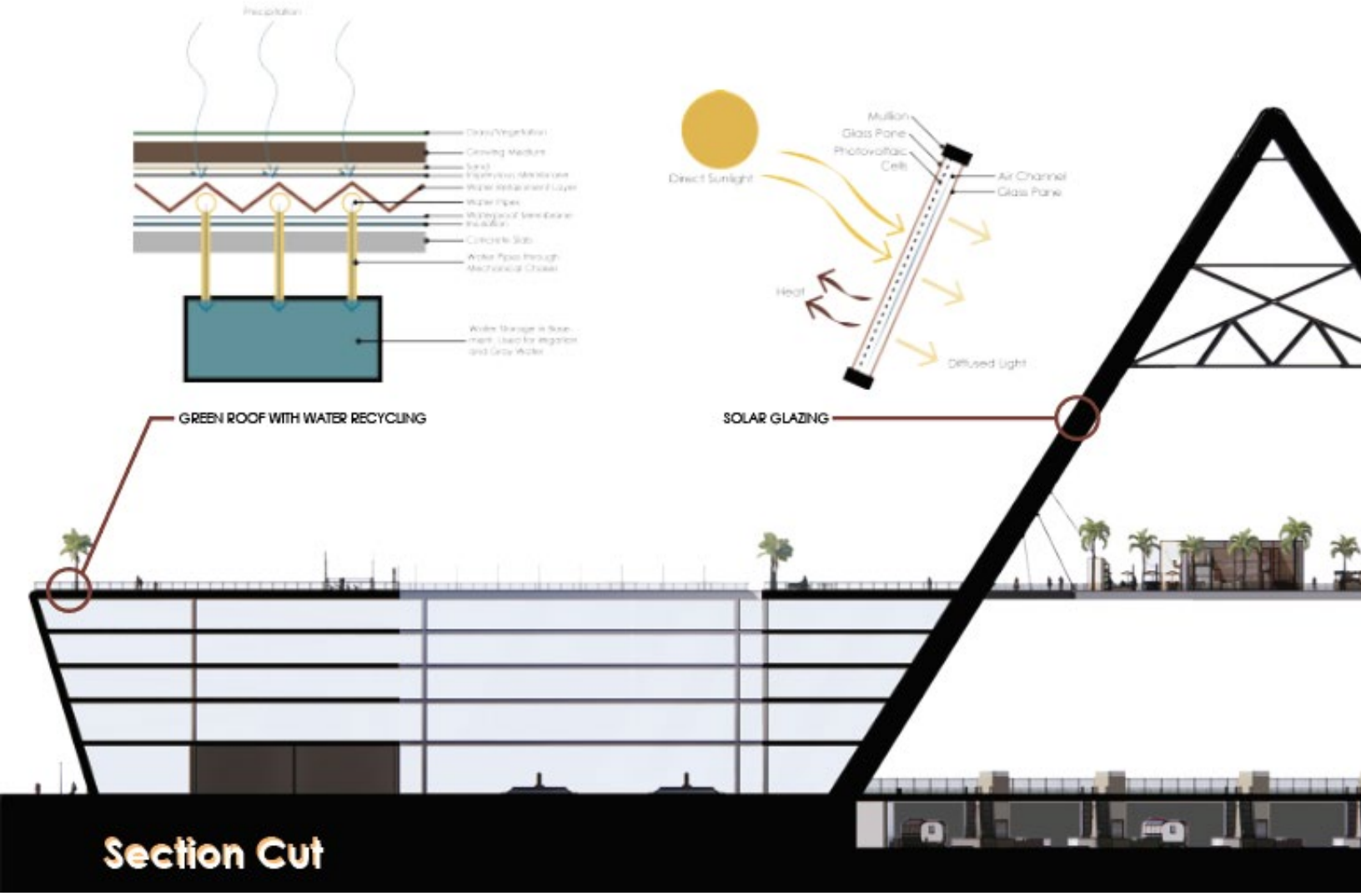


1 Hotel Lobby
2 Business Lobby
3 Entrance
4 Retail

the structure

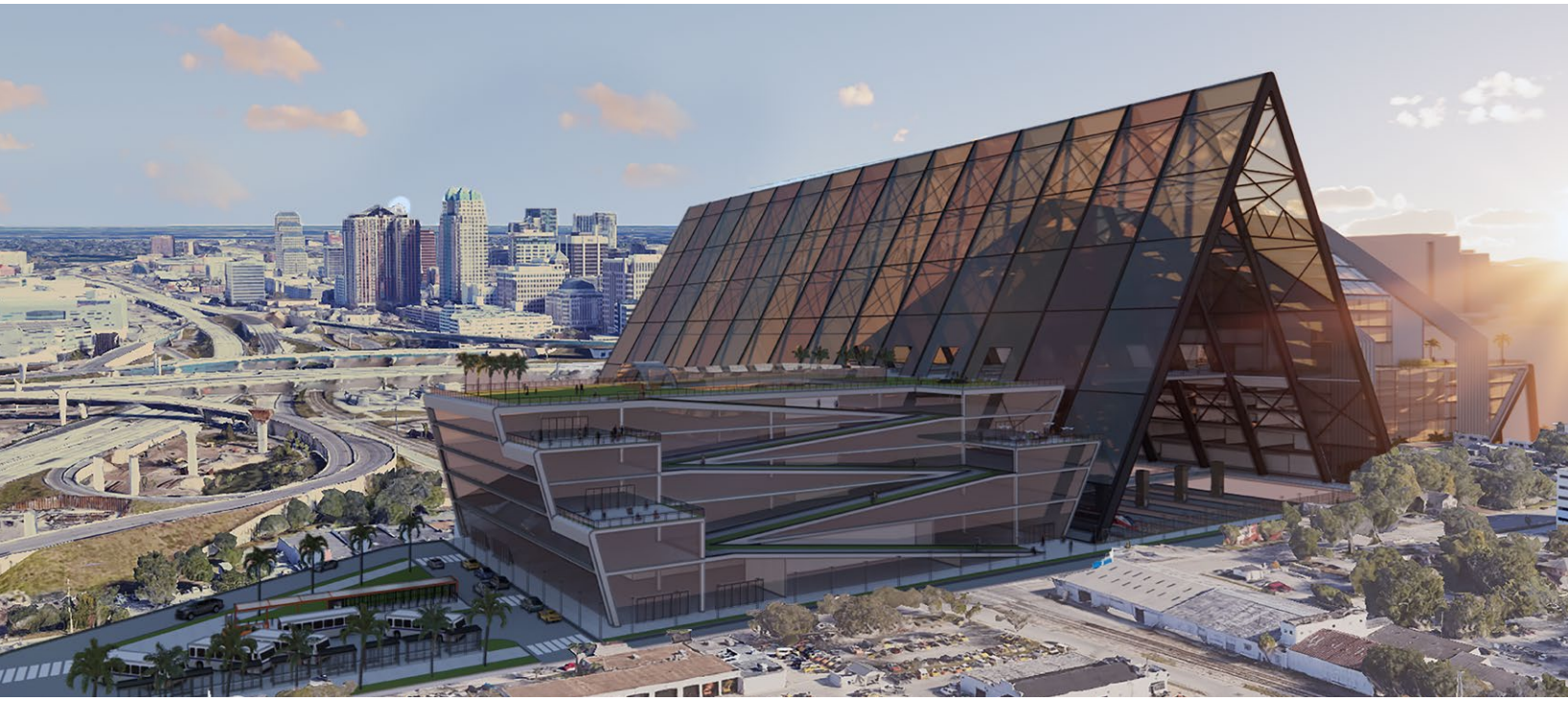


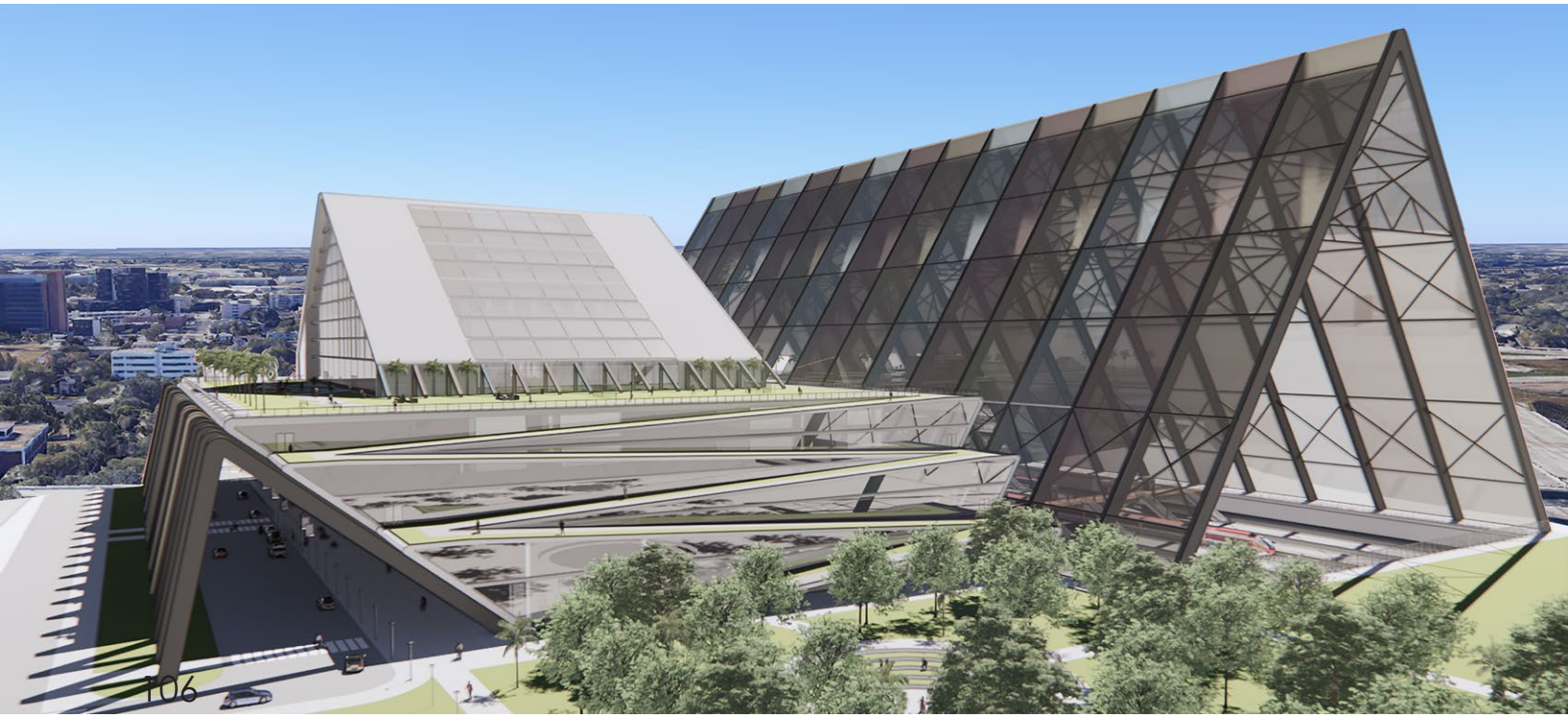
section cut

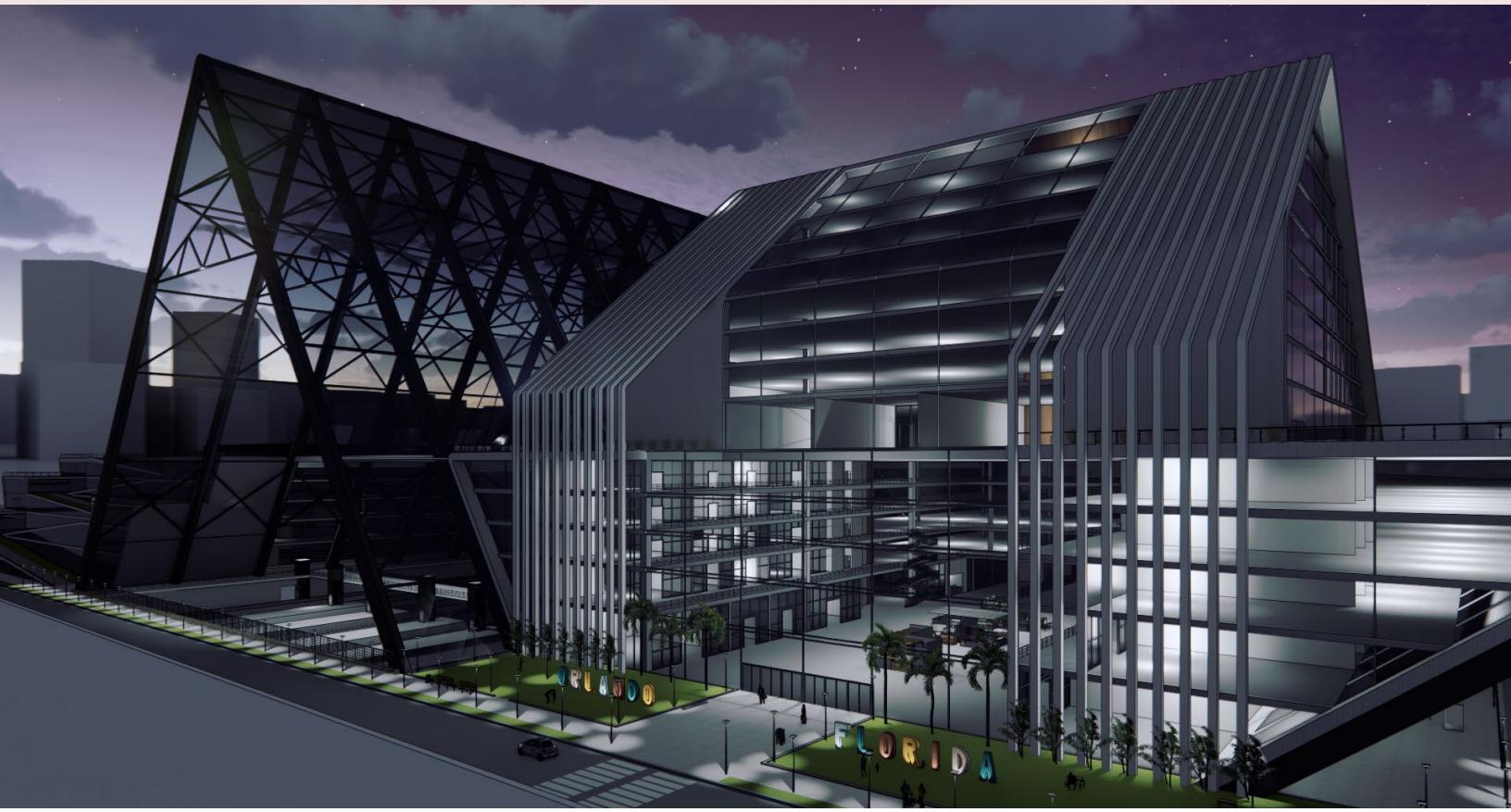

Precipitation
Direct Sunlight
Mullion
Glass Pane
Photovoltaic Cells
Air Channel
Glass Pane
Heat
Diffused Light
GREEN ROOF WITH WATER RECYCLING
SOLAR GLAZING
Section Cut


NATURAL VENTILATION THROUGH PUBLIC AREAS

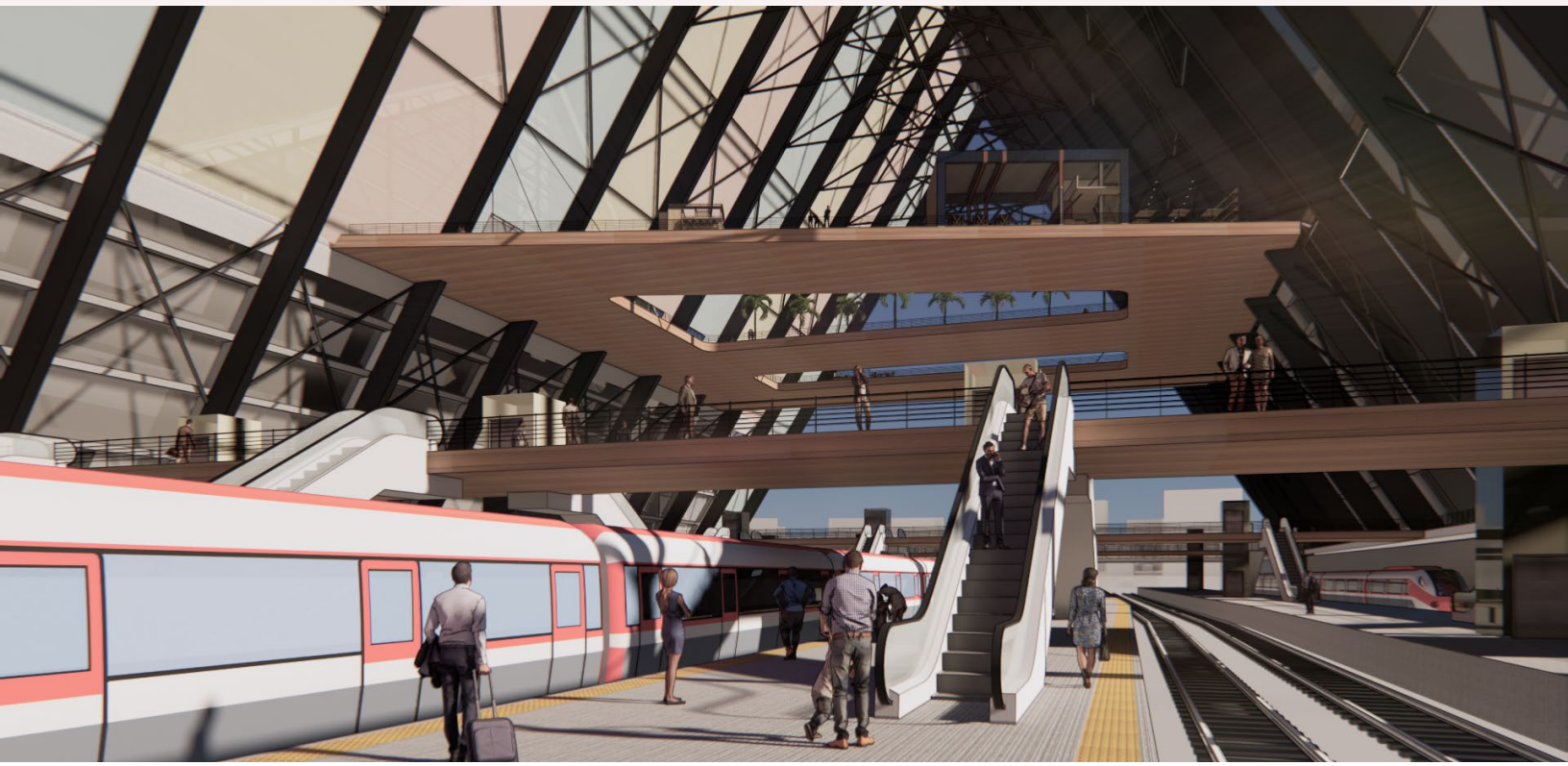
renders






ORLANDO
FLORIDA

renders



the appendix

Figure 66 | Sao Paulo Station, Brazil

sources

Programs Used

InDesign	Photoshop	GIS
Adobe Acrobat	NDSU Library Database	
Microsoft Excel	Google Earth	

Case Studies

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"America is ready for livable communities. America is ready for high-speed rail."

Greg Abbot

Figure 67 | Antwerpen-Centraal Station

about the author

Taylor Ford
taylor.ford@ndsu.edu
[redacted]

"To create, one must first question everything."

Eileen Gray

studio experience

Fall 2017
Cindy Urness
Tea House, Moorhead
Boat House, Minneapolis

Spring 2018
Milton Yergens
Mixed Use Building, Moorhead
Tiny House, Colorado

Fall 2018
Paul Gleye
Welcome Center, Fargo
Mixed Use Building, Fargo

Spring 2019
Seleria Alenjery
Endless Museum
Native American Museum, Moorhead

Fall 2019
Cindy Urness
Miami High Rise Capstone

Spring 2020
Paul Gleye
Brussels Study Abroad Trip

Fall 2020
Ron Ramsey
1940s Moderne Train Station

Spring 2020
Bakr Aly Ahmed
Orlando Train Station