



2022-2023
ARCHITECTURE PORTFOLIO

ZHIKANG LIU

M.S. AAD, GSAPP

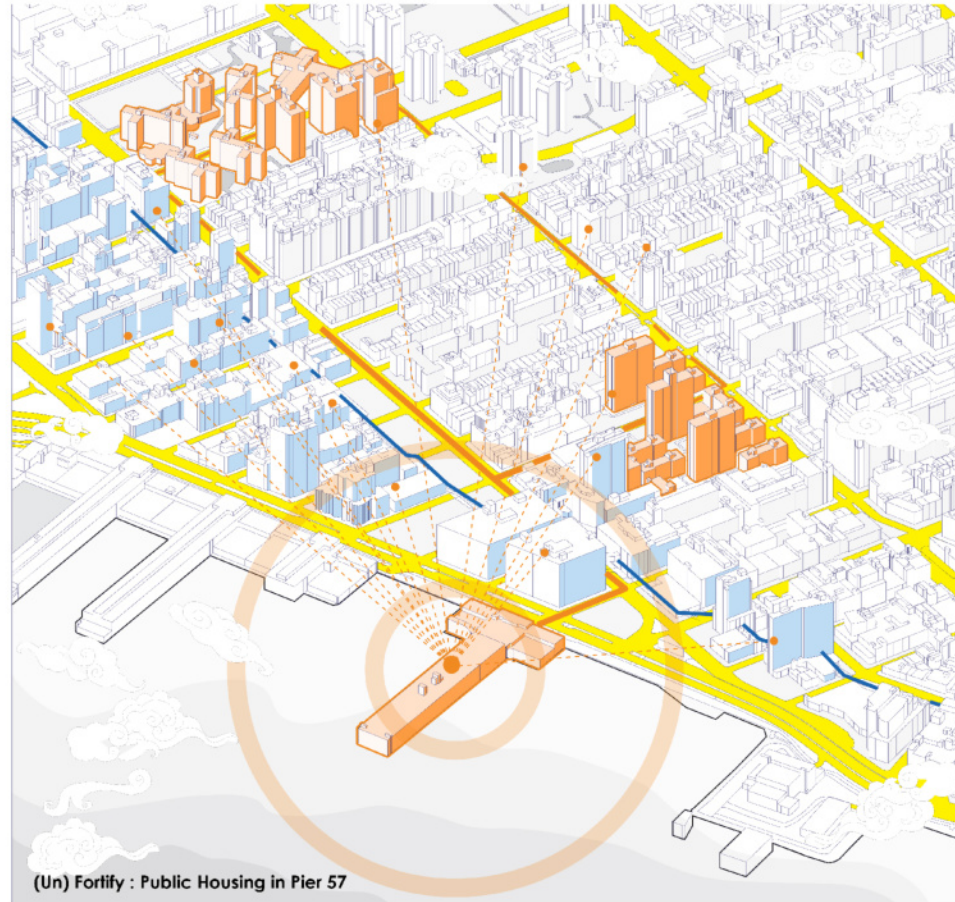
PROLOUGE

"Man is declared to be that creature who is constantly in search of himself--a creature who in every moment of his existence must examine and scrutinize the conditions of his existence." --Ernst Cassirer

Architecture is declared to be that thing which is constantly be questioned by the society--the thing that in every moment of its existence must examine and scrutinize the conditions of the poeple and environment.

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(Un) Fortify : Public Housing in Pier 57

01

Pier 57 (Un)Fortify

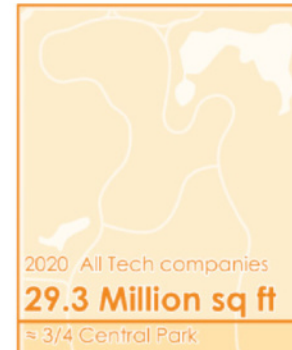
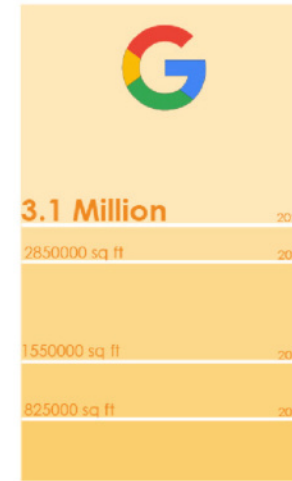
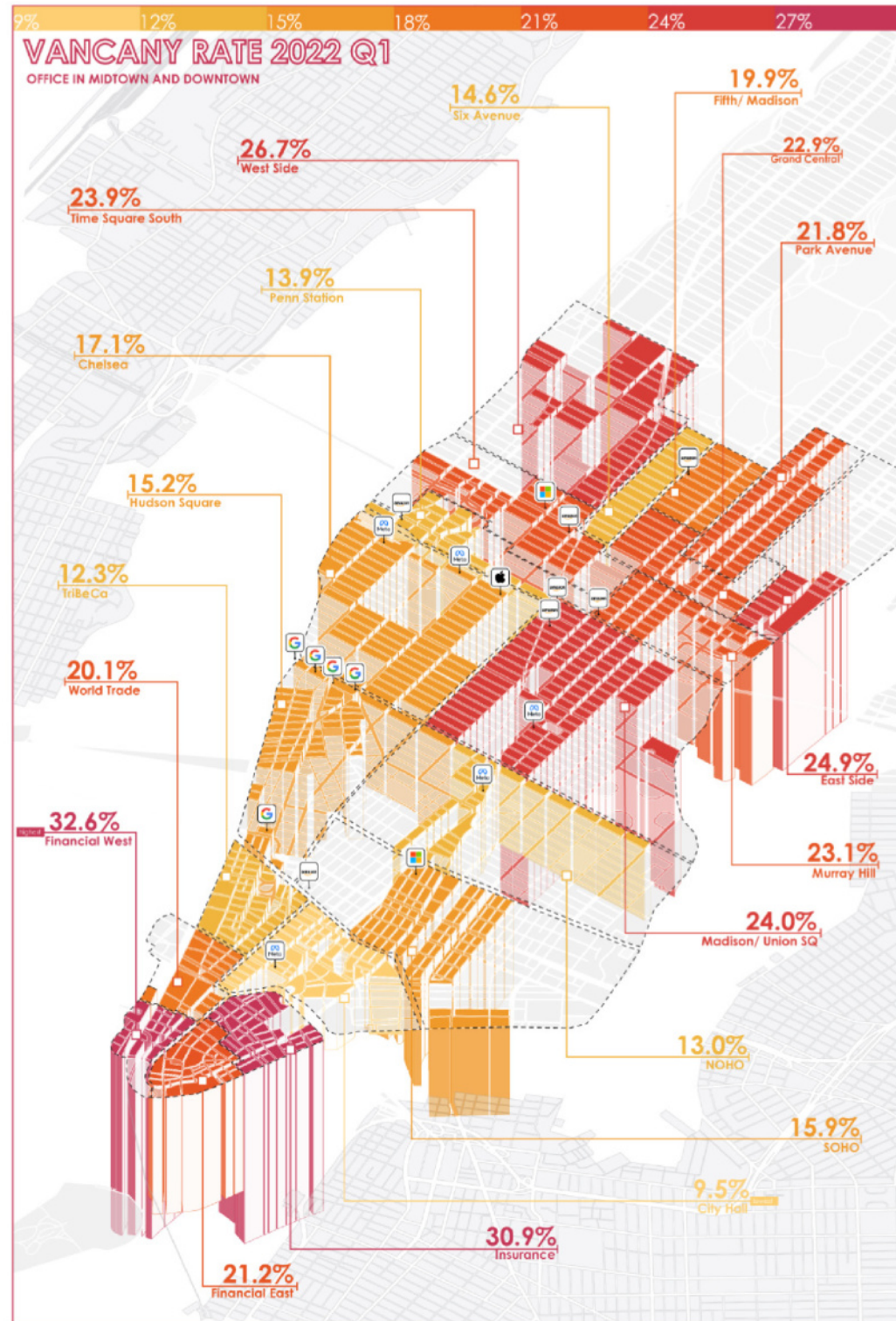
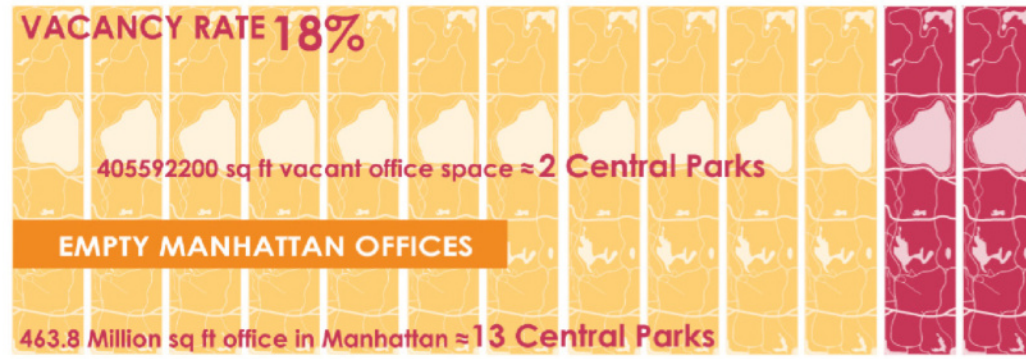
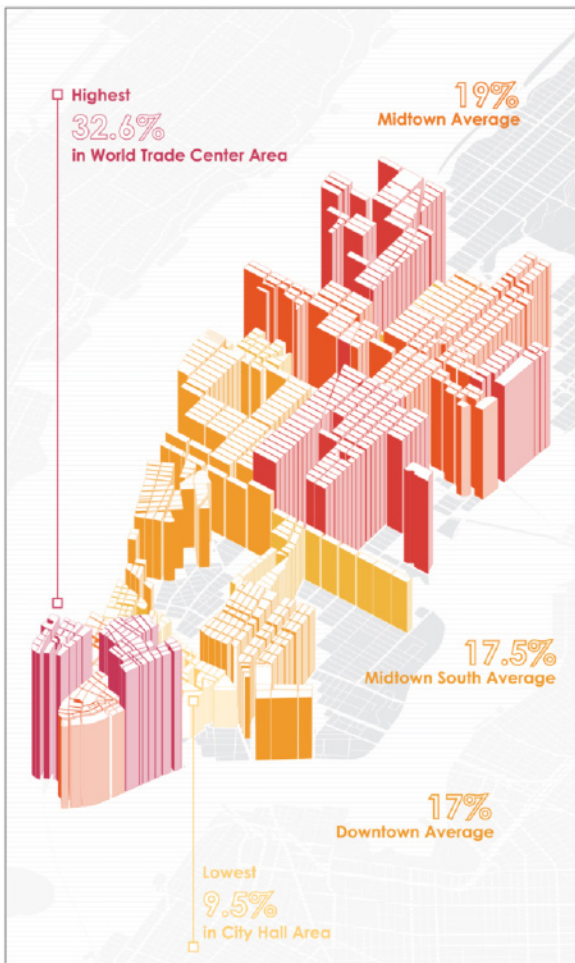
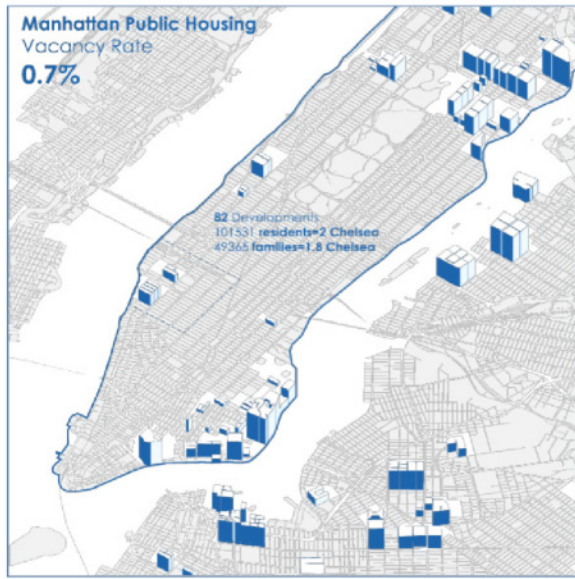
Social Housing, New York, U.S.

Team: Zhikang Liu, Victoria Shay, Haseeb Amjad

Instructor: Karla Rothstein

Summer 2022

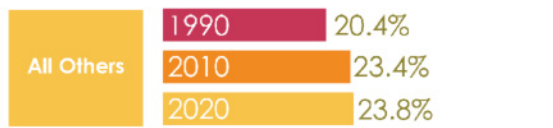
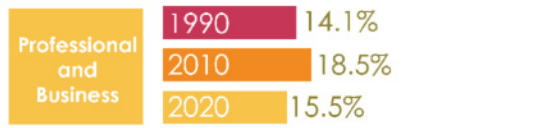
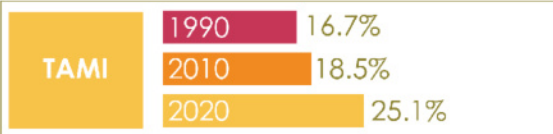
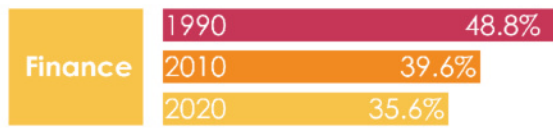
The abundance of vacant office space in Lower Manhattan stands in stark contrast to the scarcity of public housing space. By analyzing public housing needs and gentrification in the Chelsea area, this project explores the possibility of transforming the historic Pier 57 into a public housing project.



- BIG TECHS**
- Apple
 - Amazon
 - Meta-Facebook
 - Google
 - Microsoft



Who Own the Office



TAMI: Technology, Advertising, Media and Information

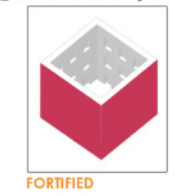
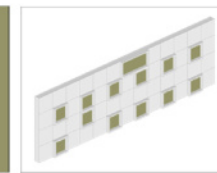
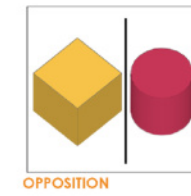
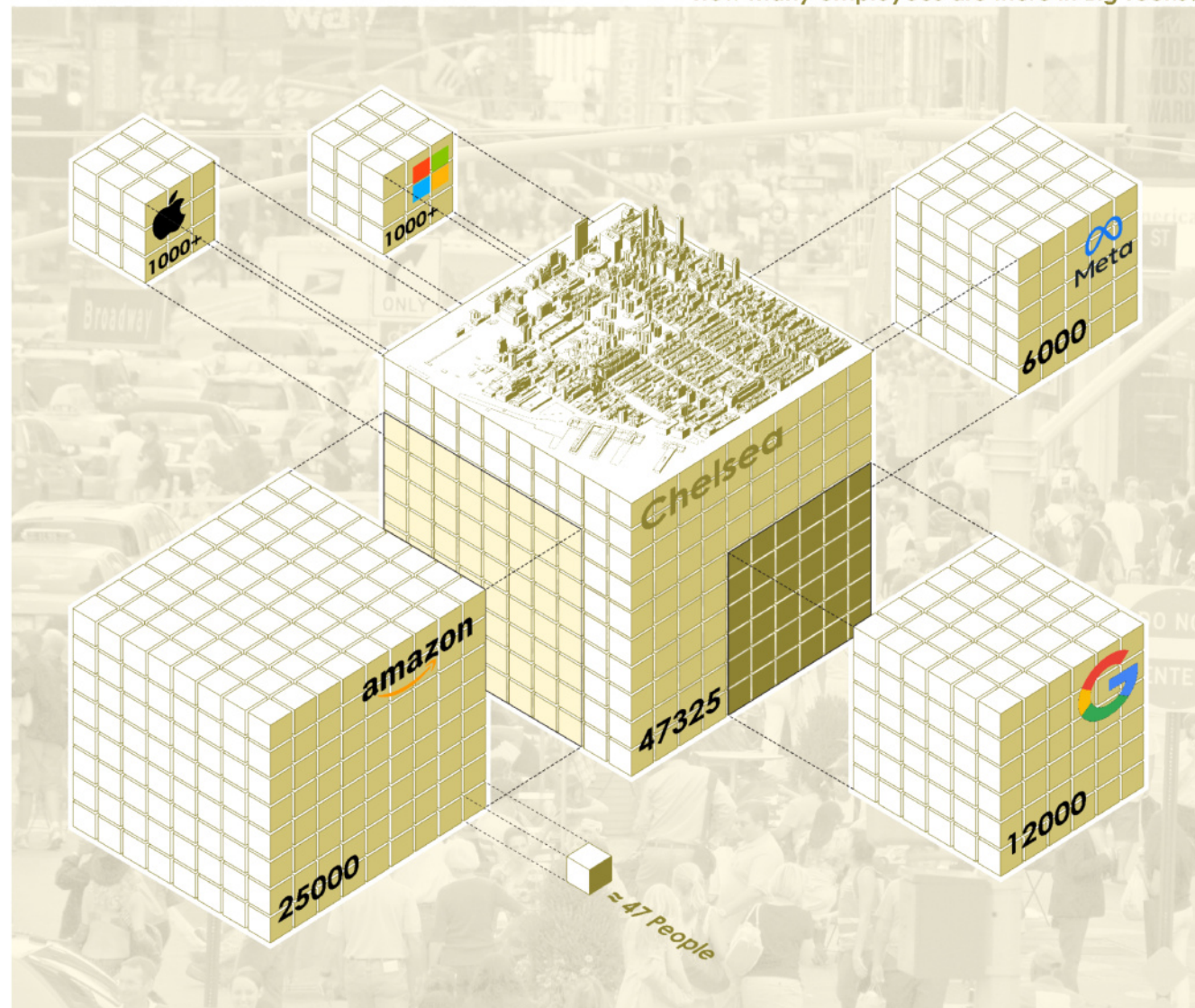
During Epidemic,
Big Techs Lease **1.25 Million sq ft**
≈ **1 Columbia University**
Morningside Campus

≈ **Queensbridge Public Houses** (Largest housing development in North America)

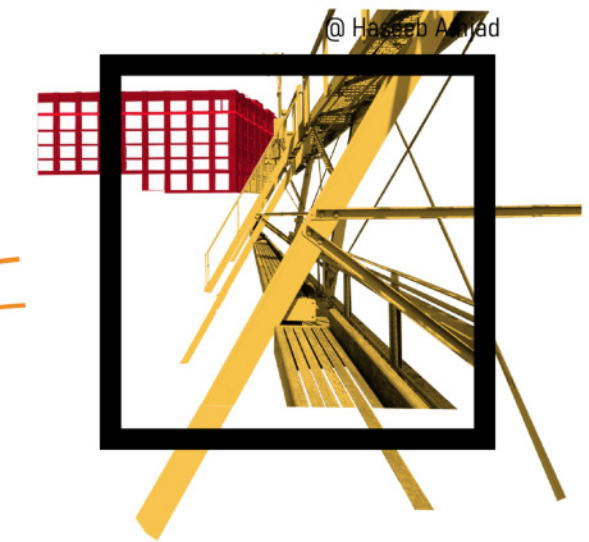
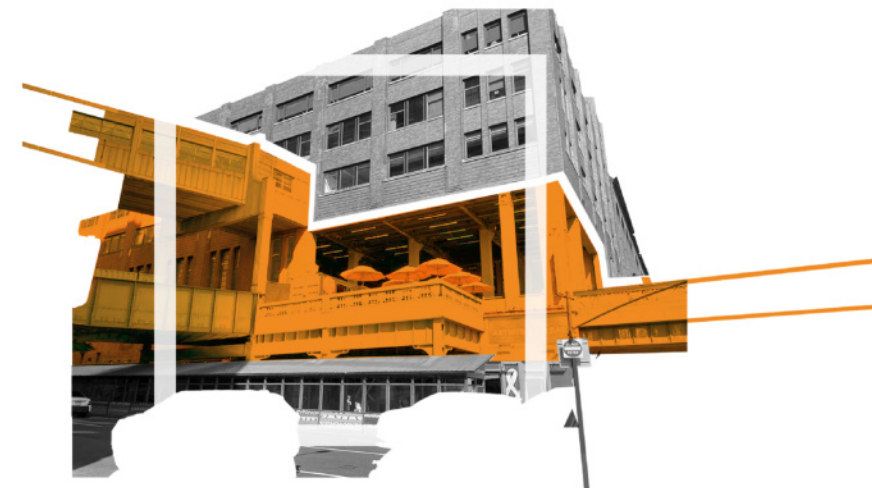
≈ **1604 Apartments**

≈ **3204 Residents**

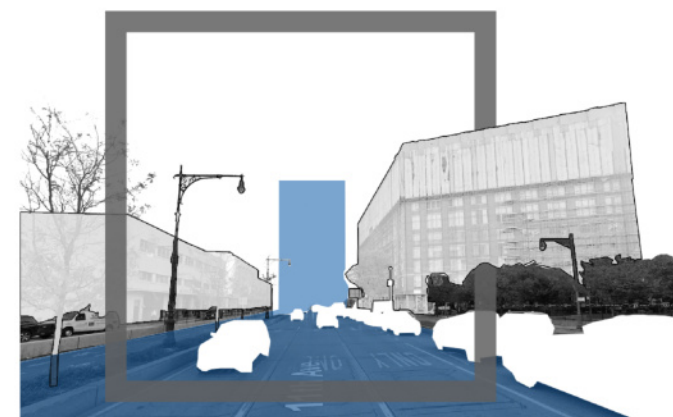
How many employees are there in Big Techs?

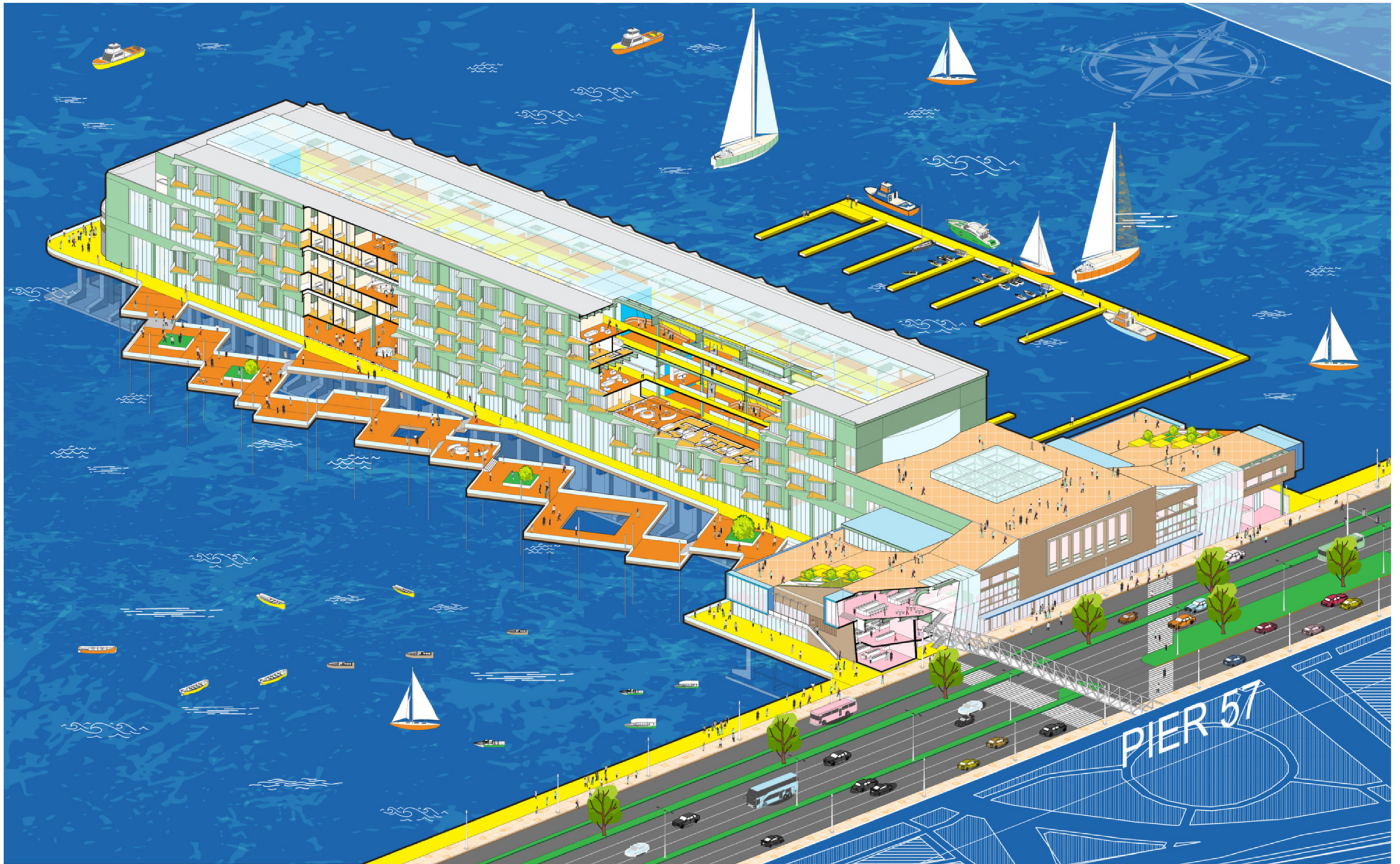


@ Haseeb Amjad

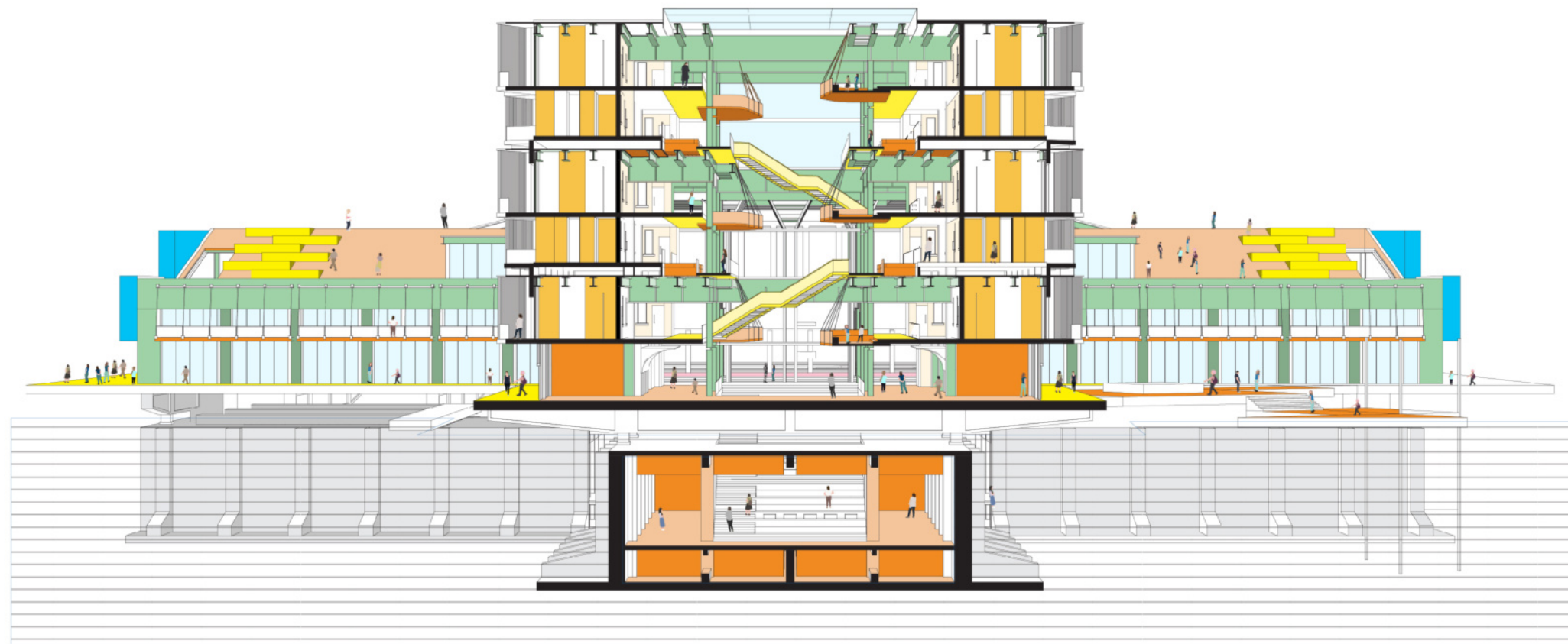
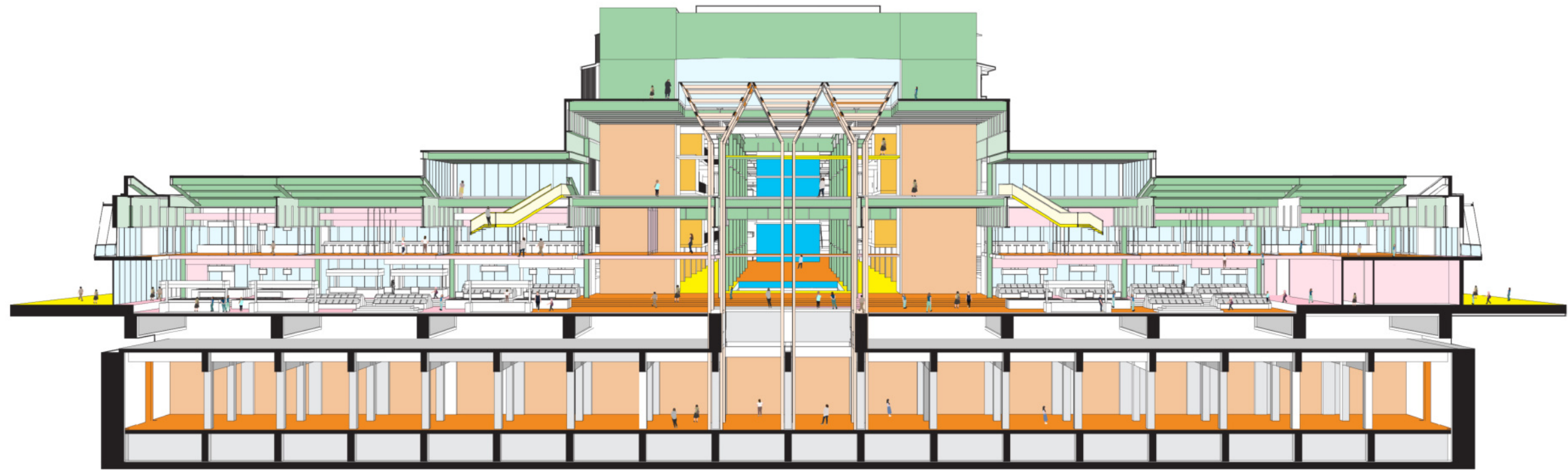


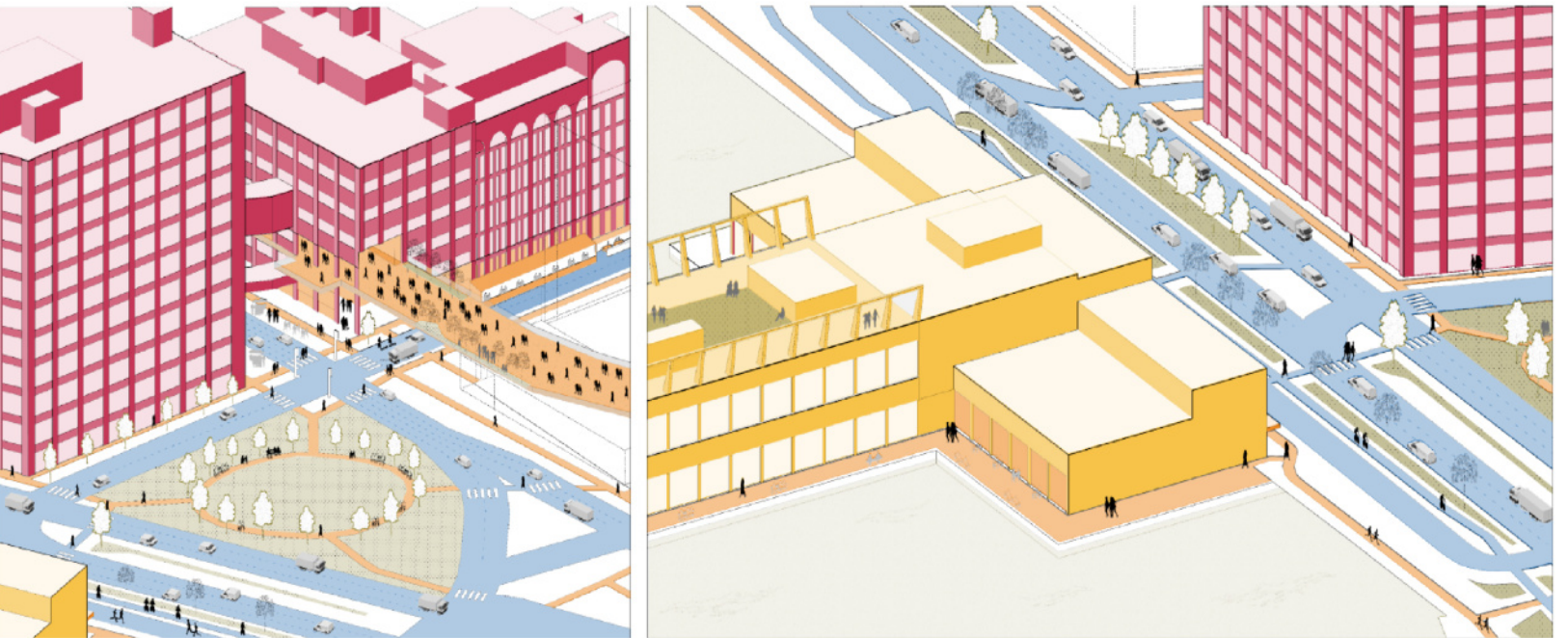
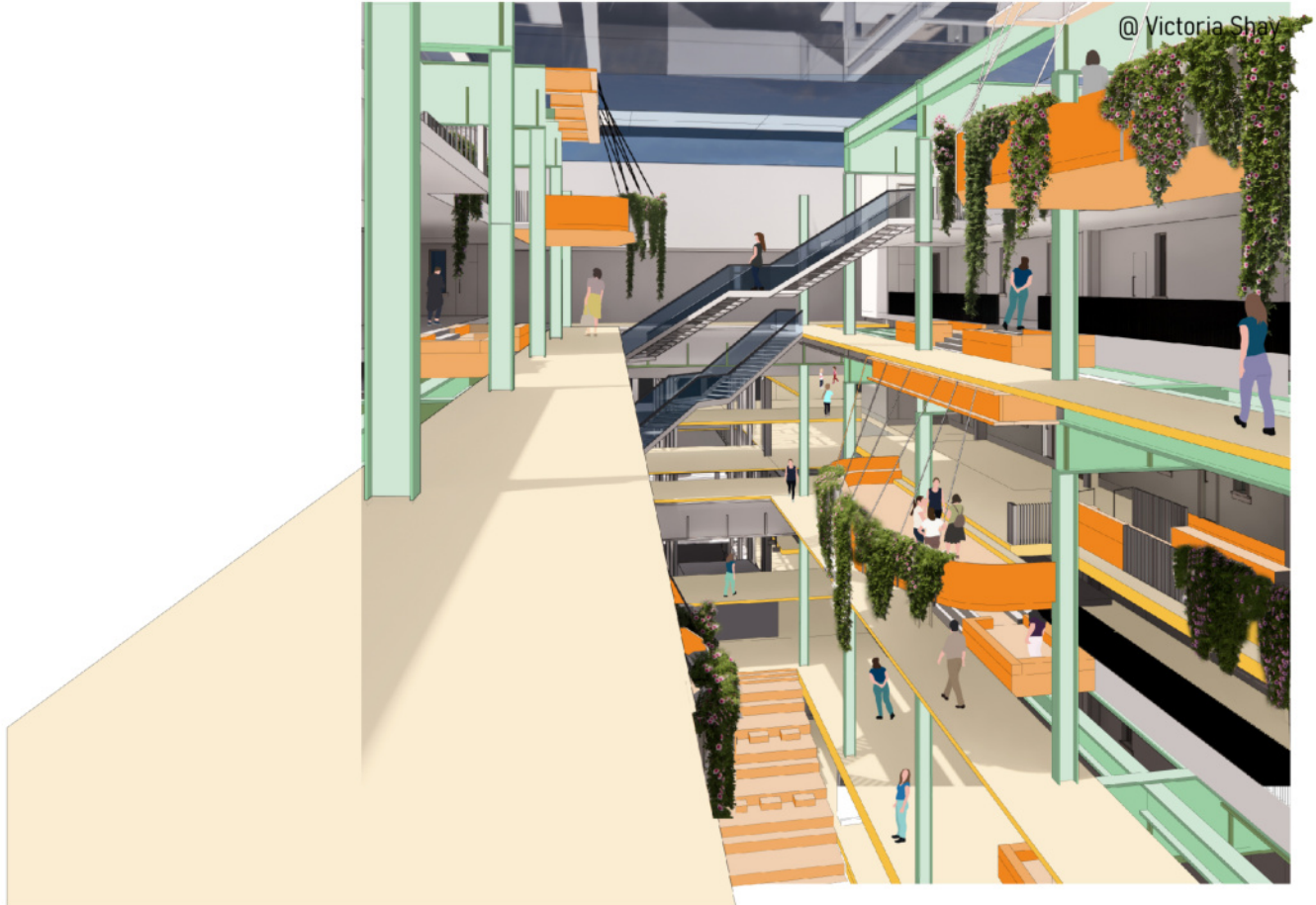
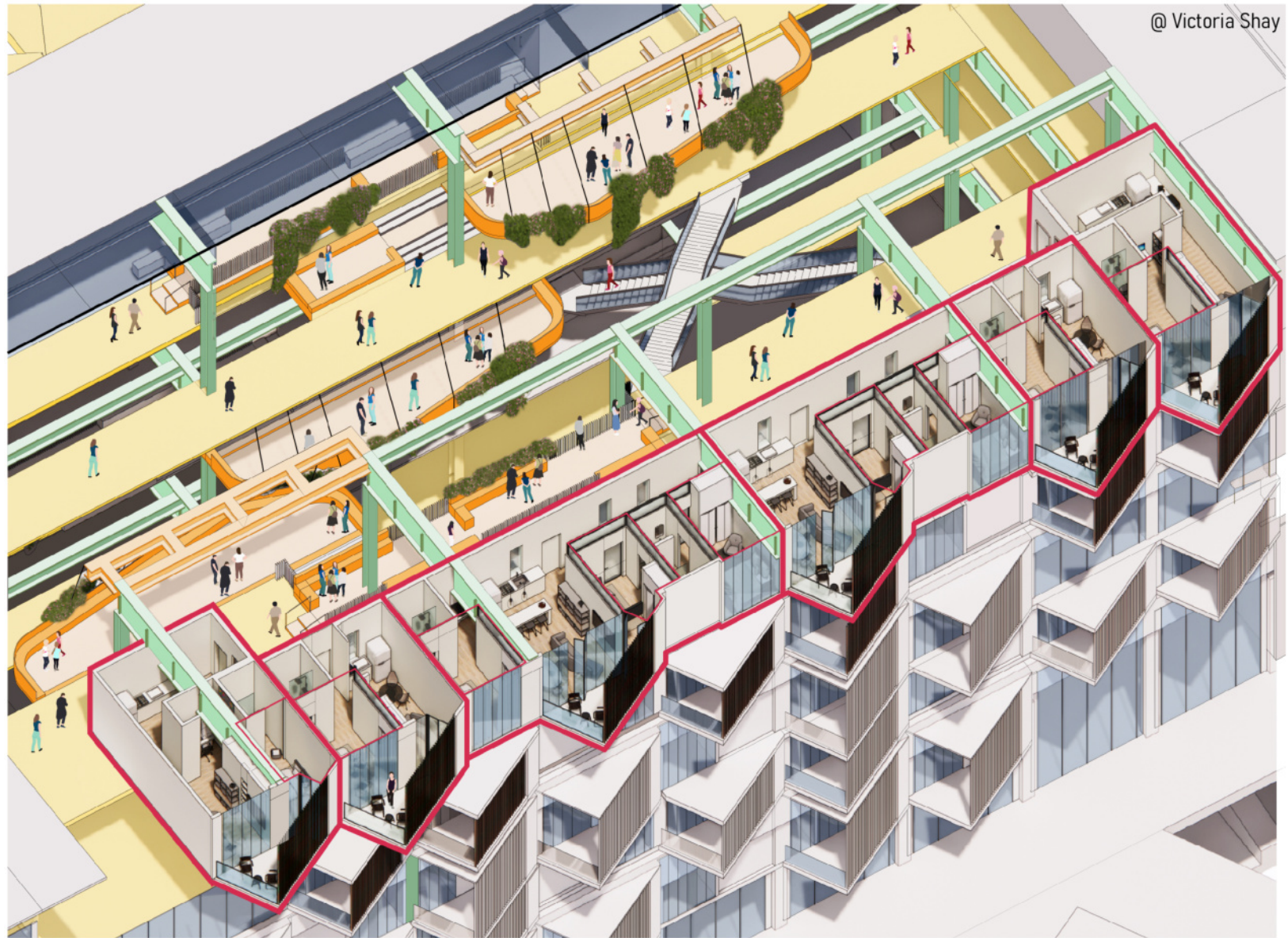
@ Haseeb Amjad

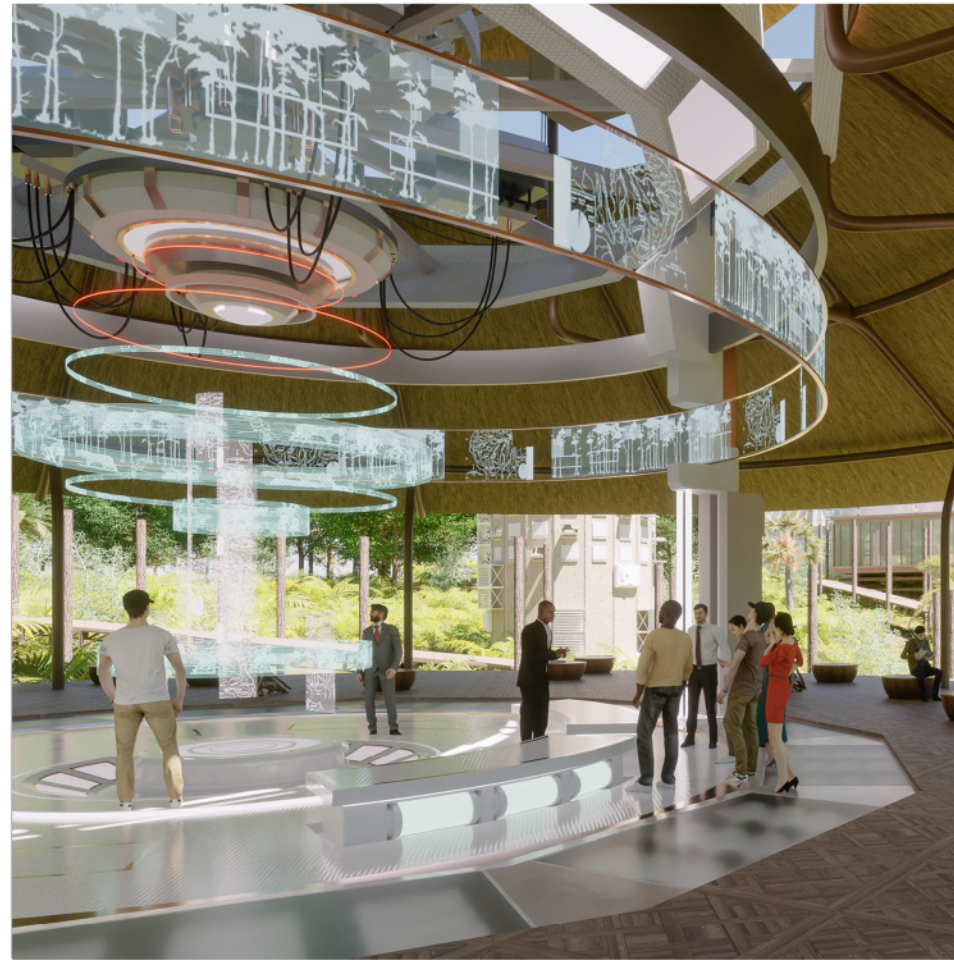




PIER 57







02

Eyes of Amazonia

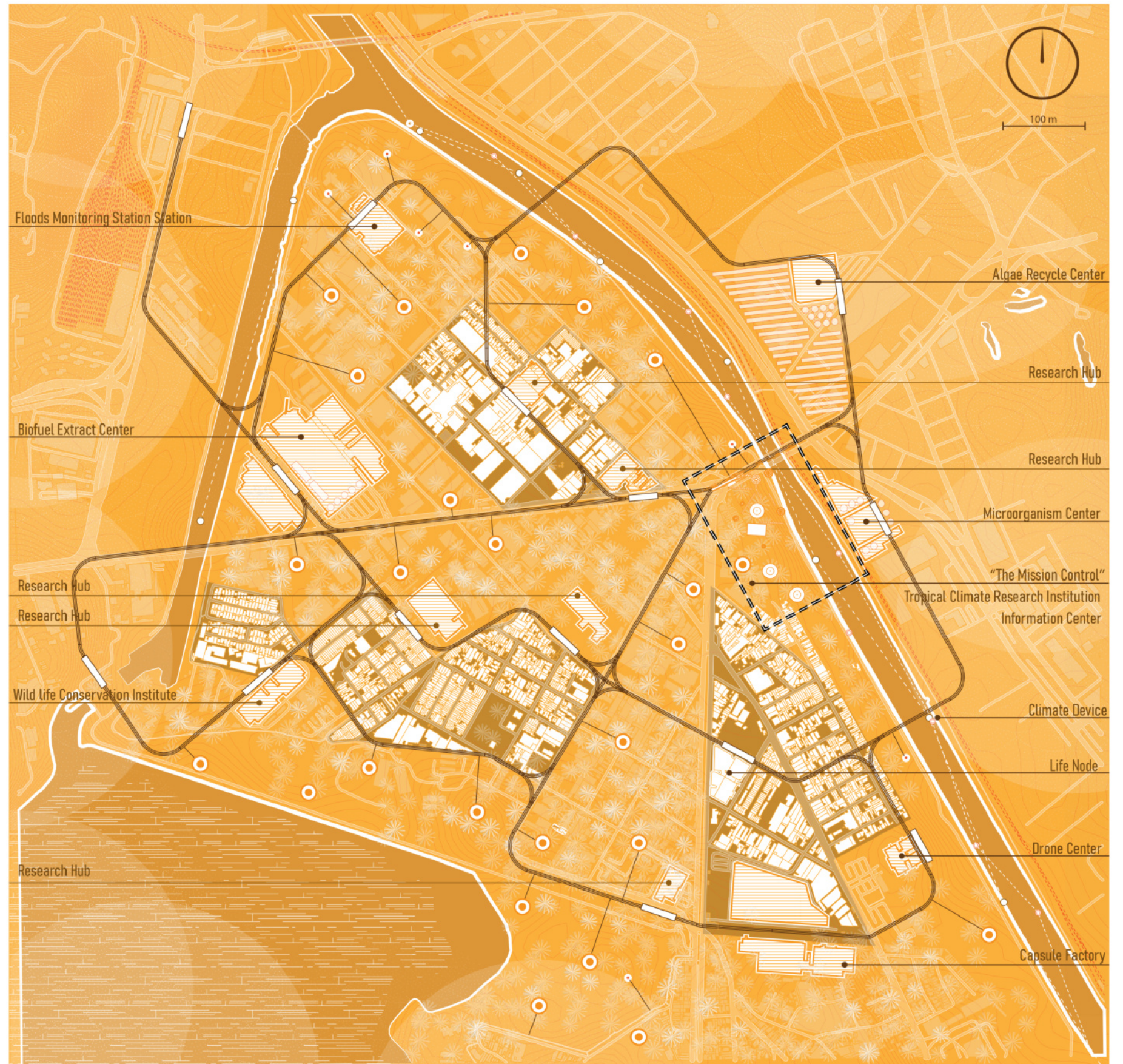
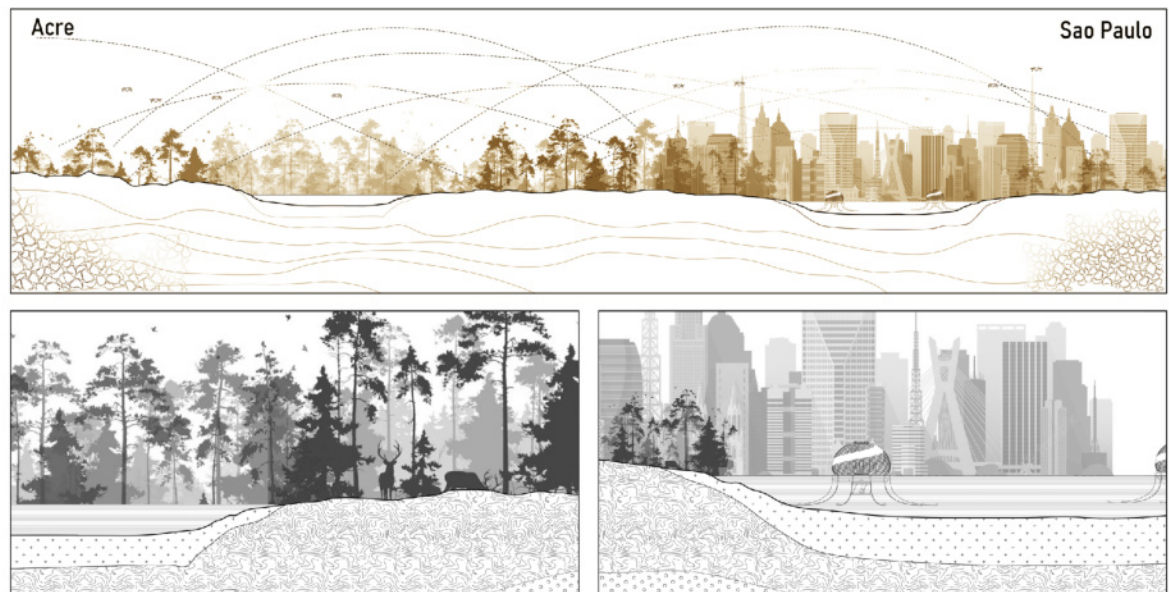
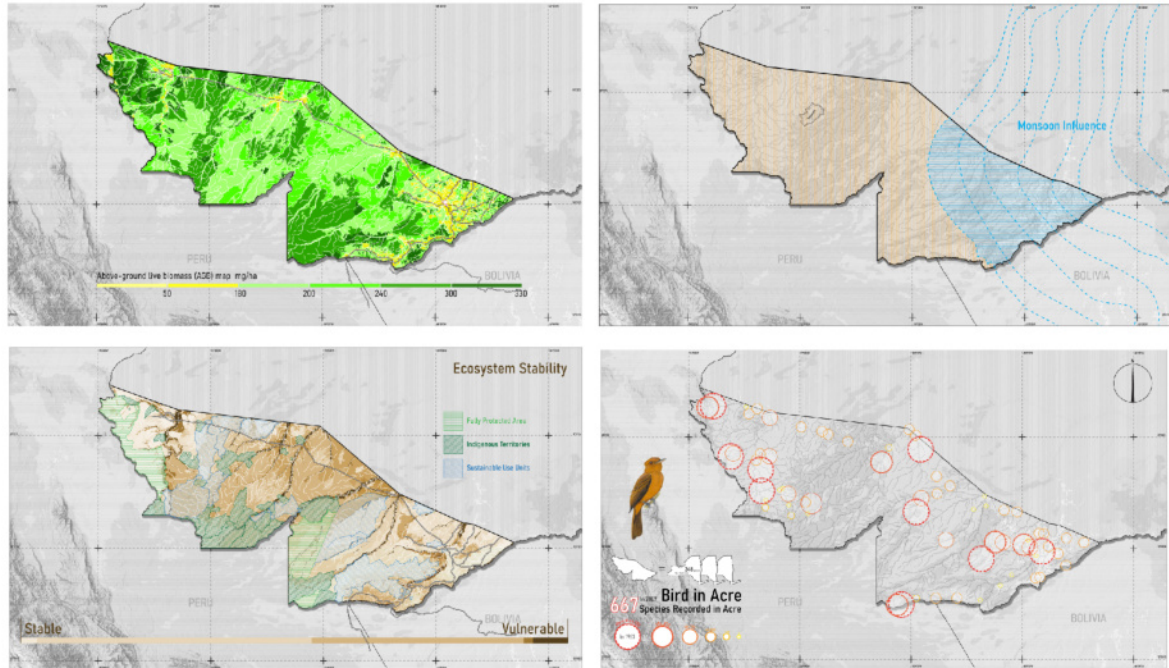
Education Center, Sao Paulo, Brazil

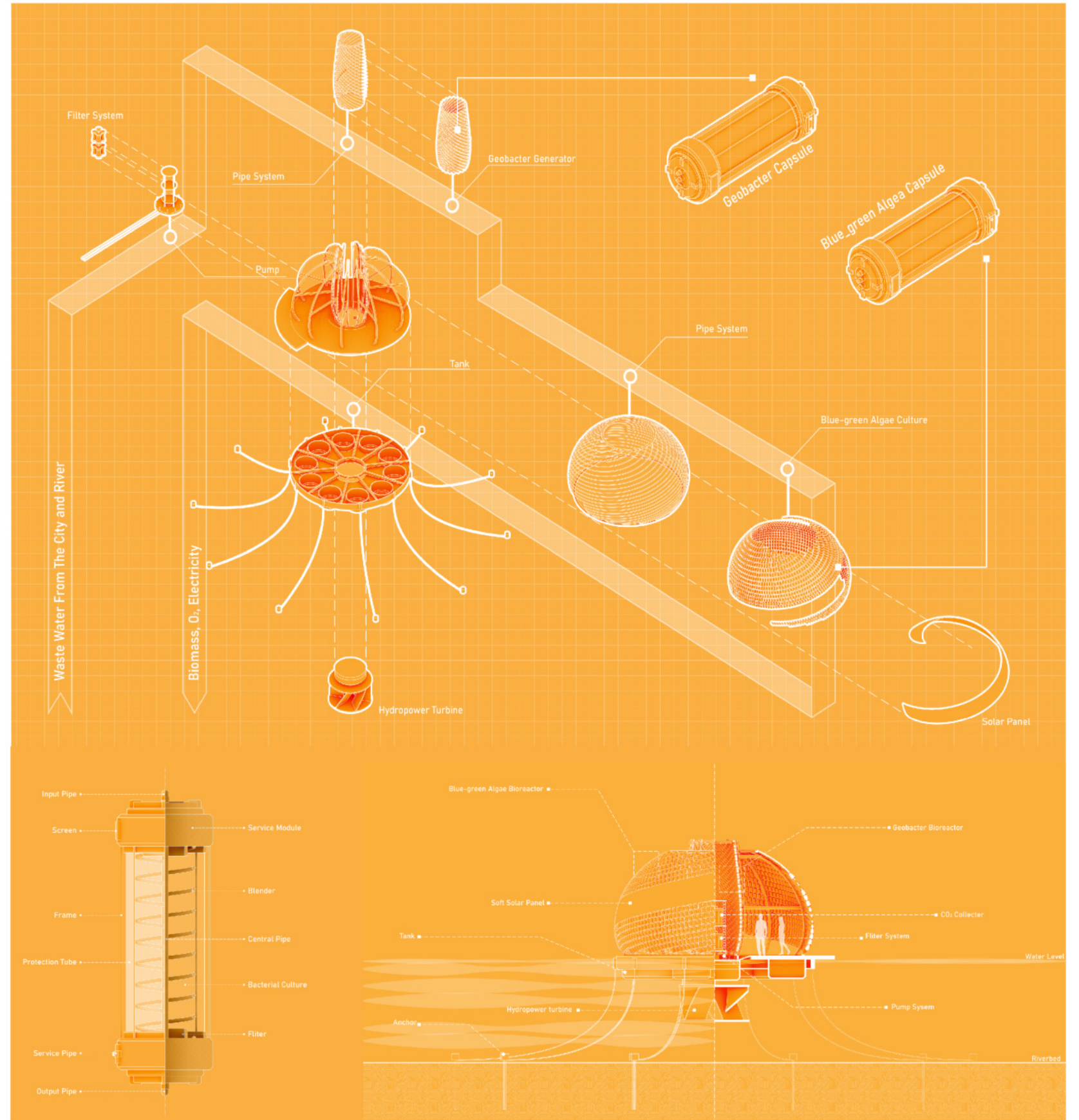
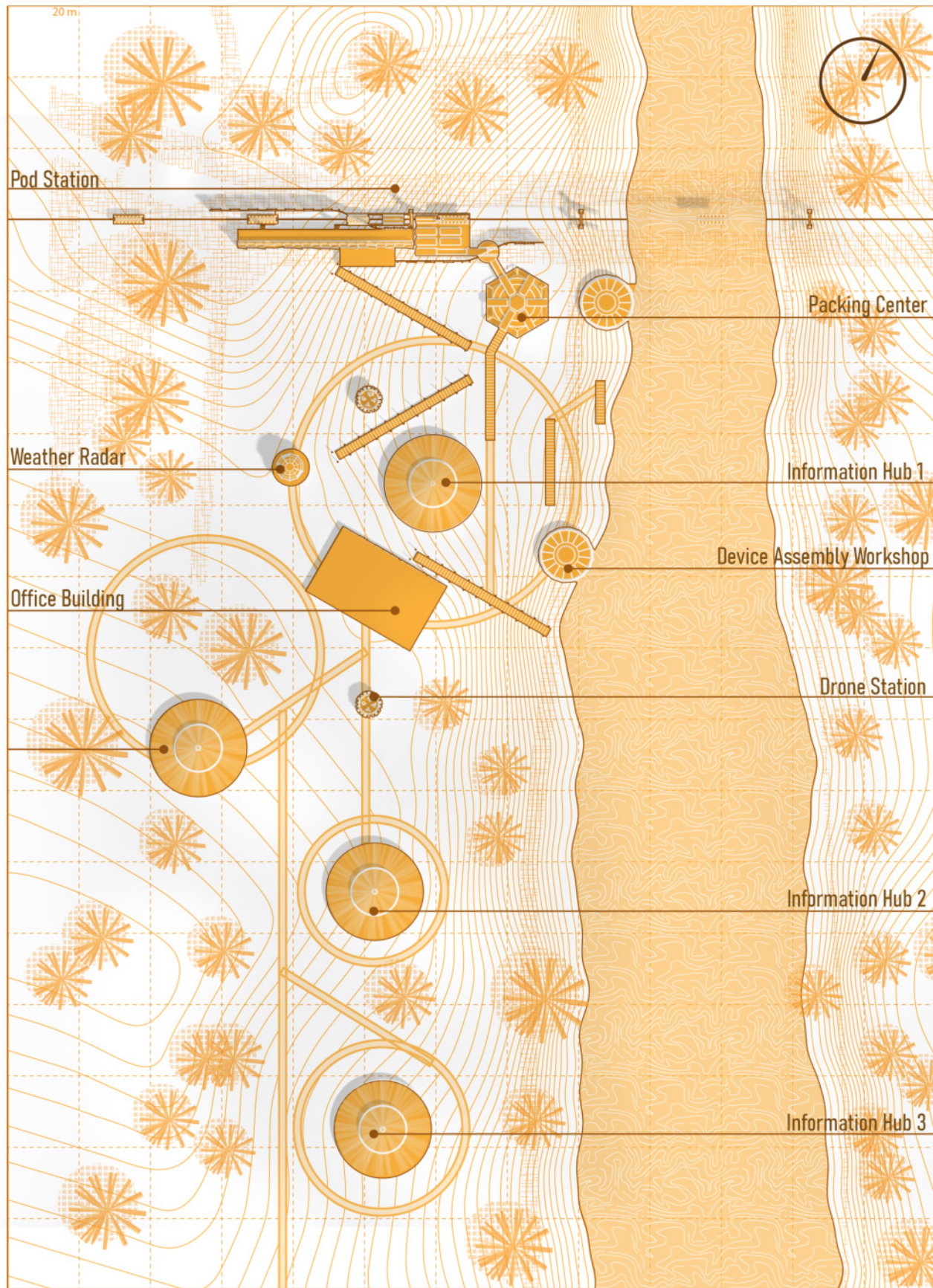
Team: Zhikang Liu, Jingxian Huang

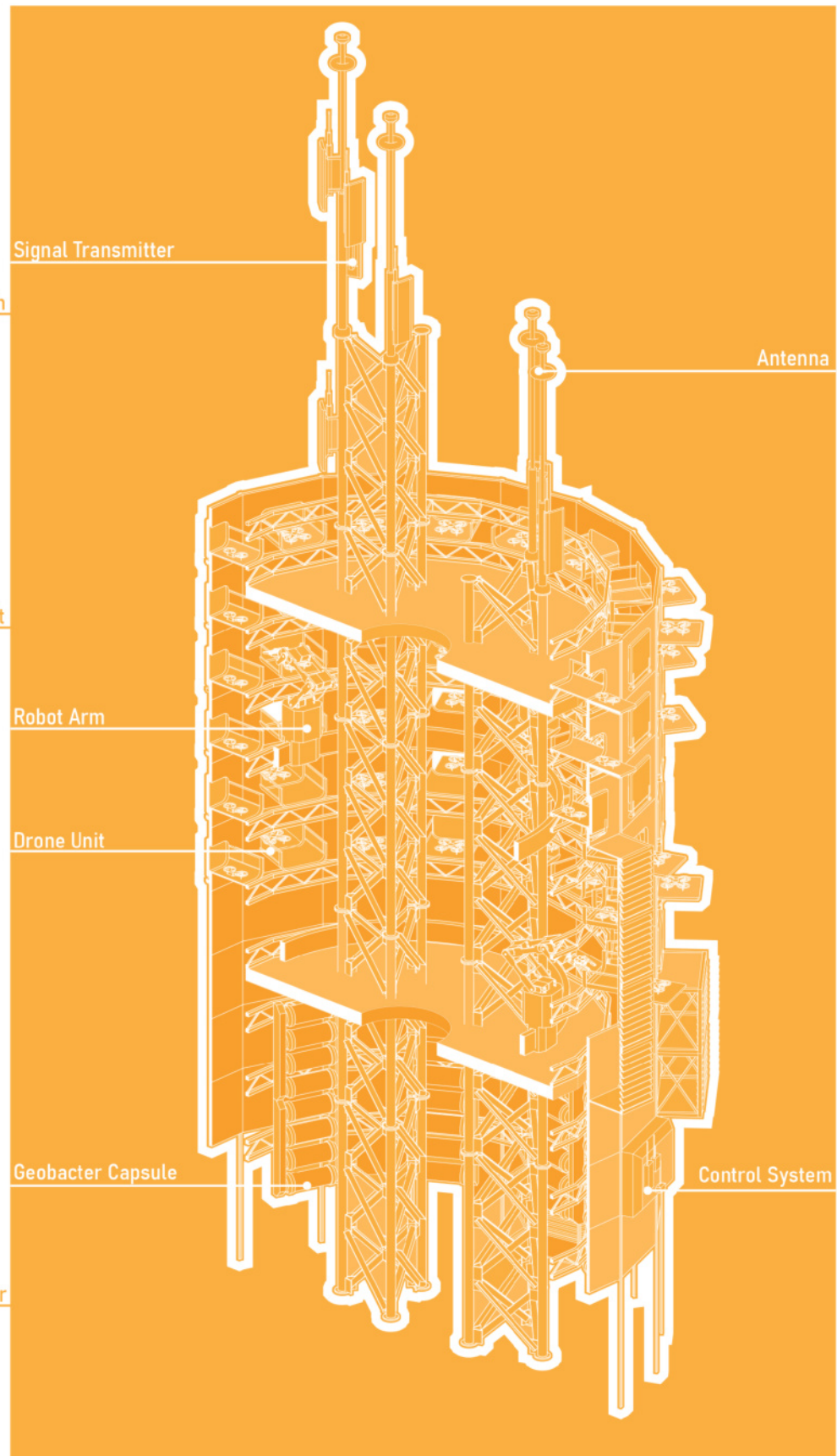
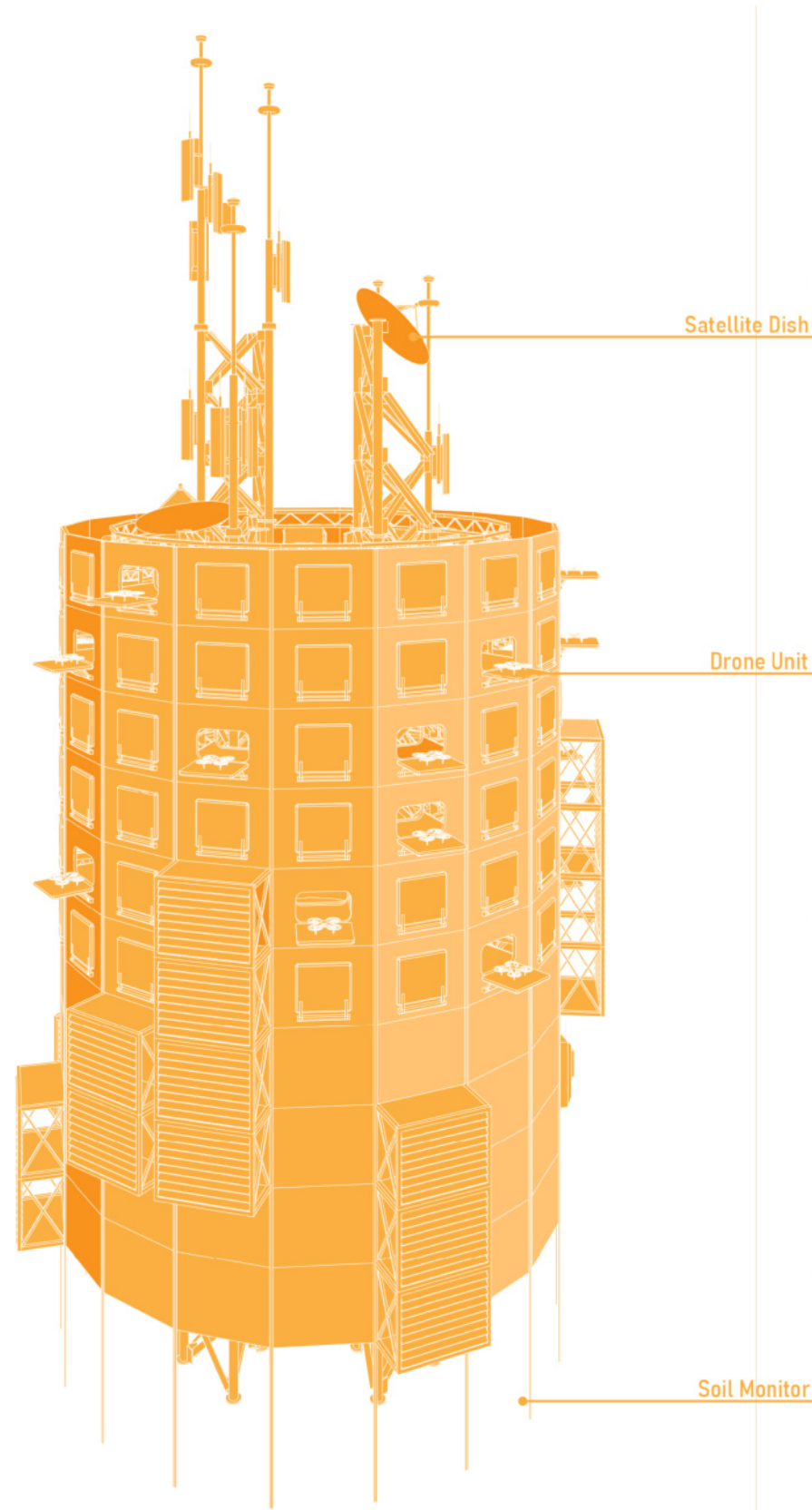
Instructor: Vanessa Keith

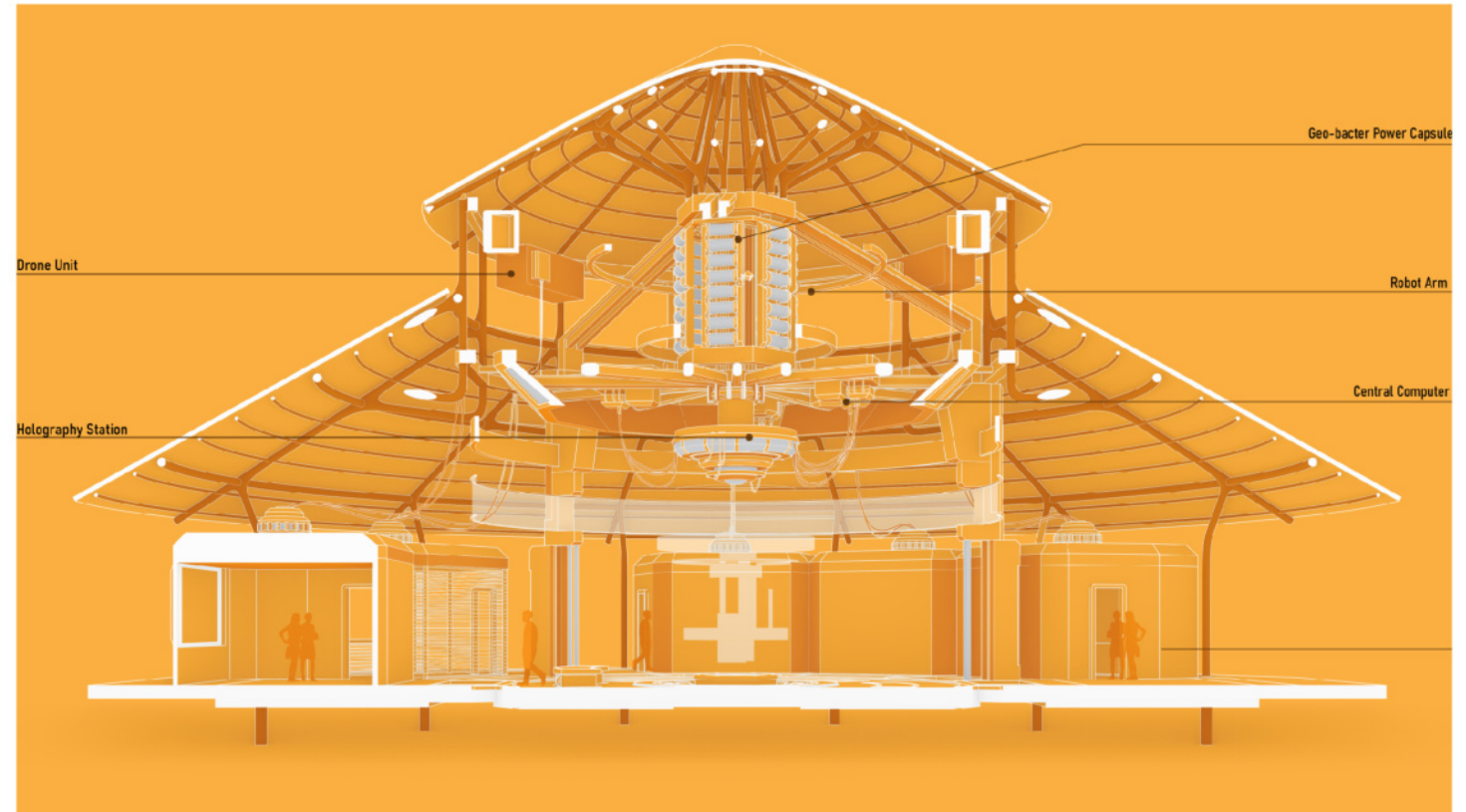
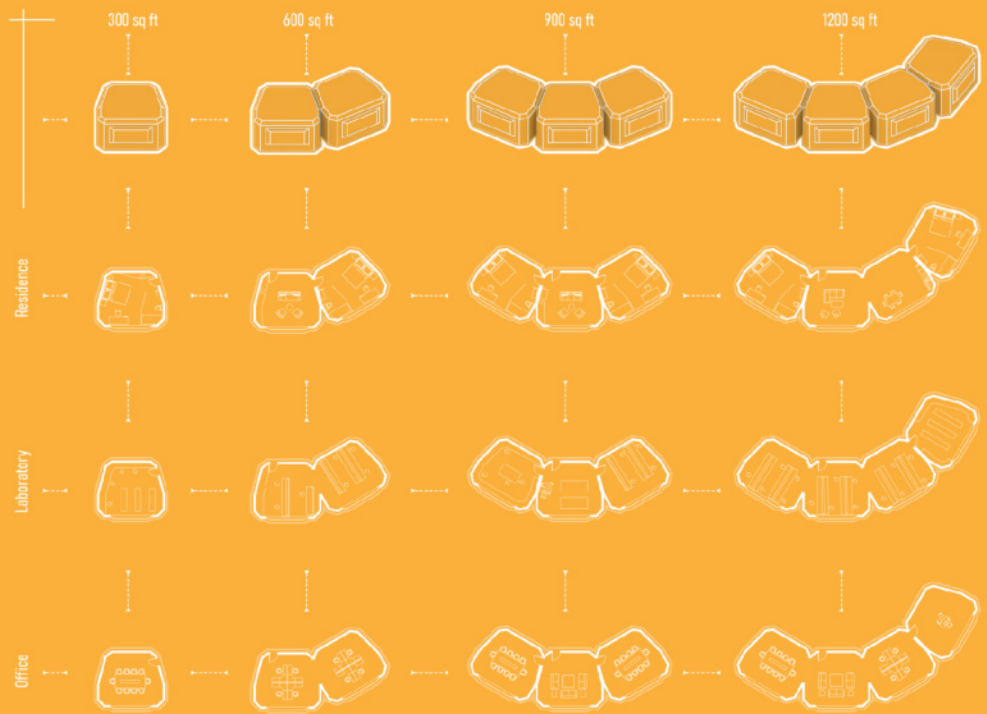
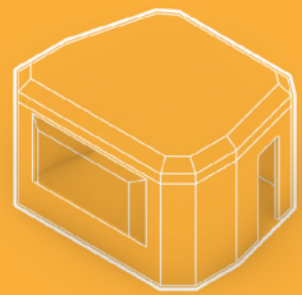
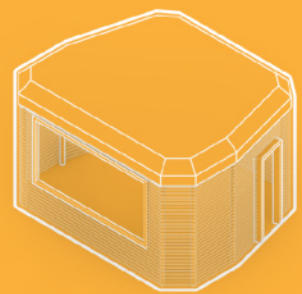
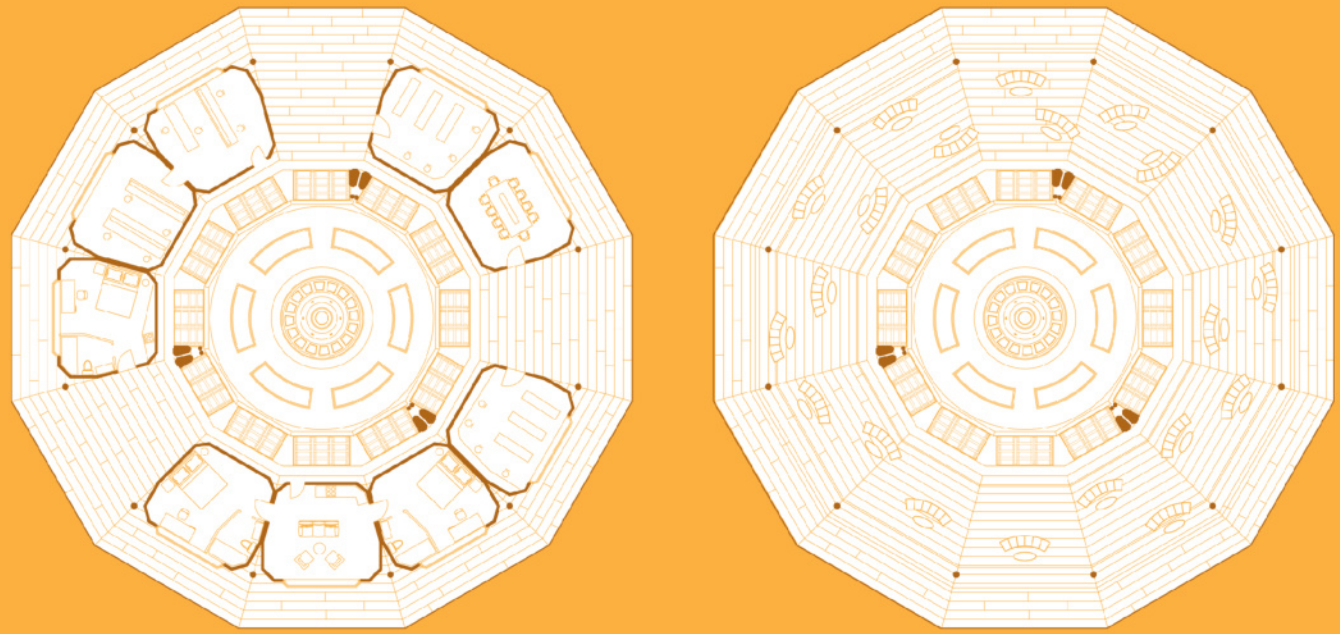
Fall 2022

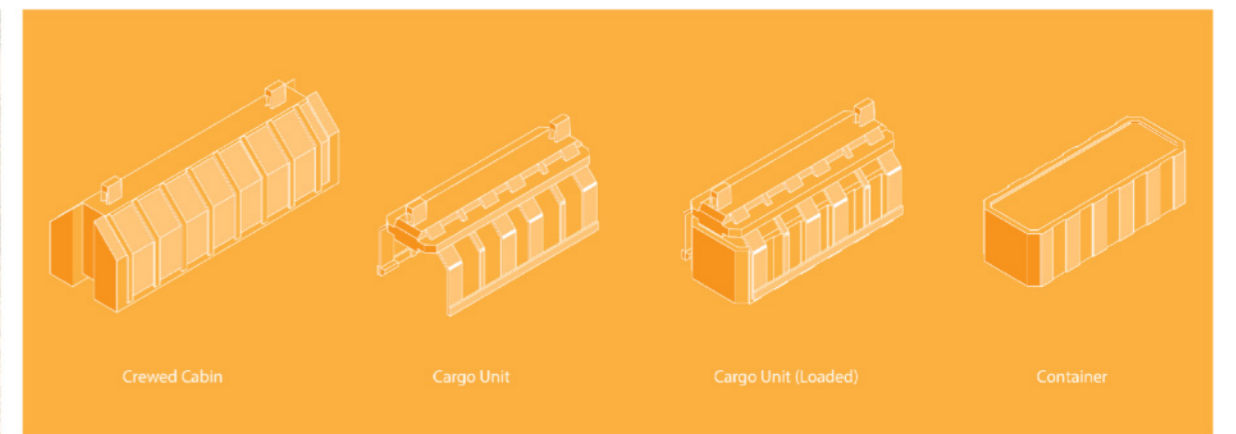
The project aims to connect an indigenous village in the rainforest with a tropical climate research center in São Paulo using drones and the internet. The project also includes drone stations and water purification stations powered by bacteria battery. These facilities, maintained by indigenous villages, will break the monopoly of scientific research institutions on rainforest information.













03

Disabling Modernities

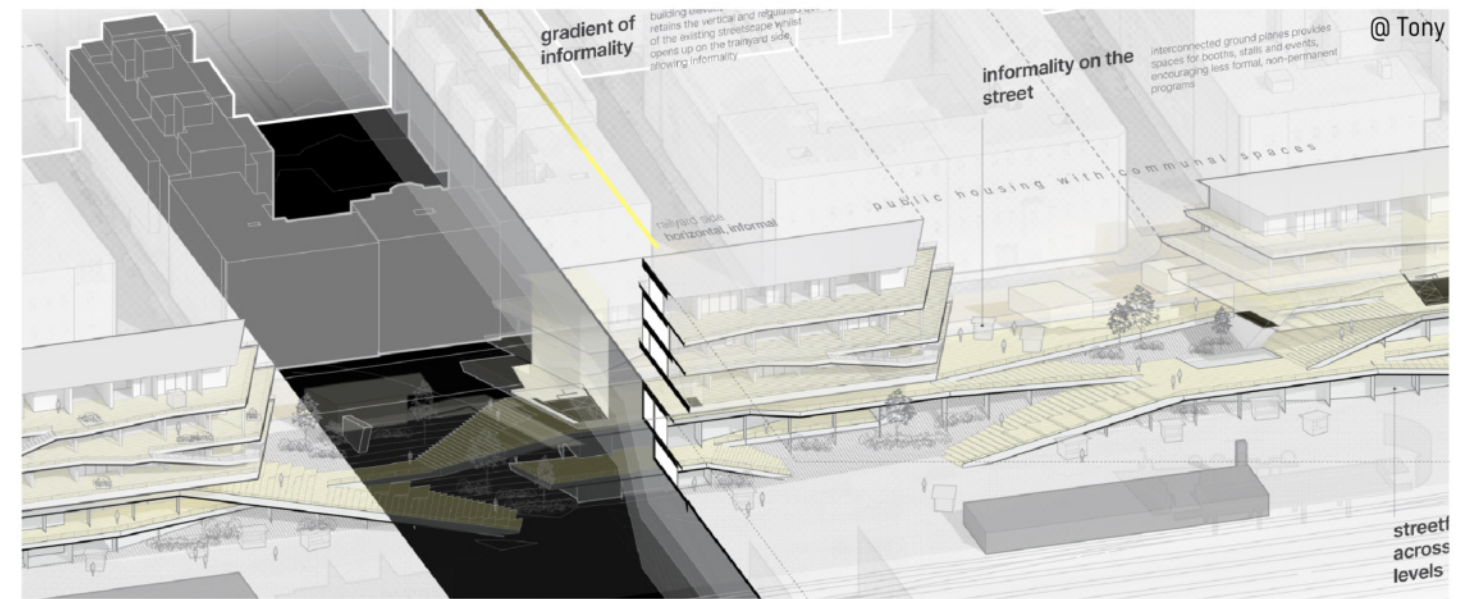
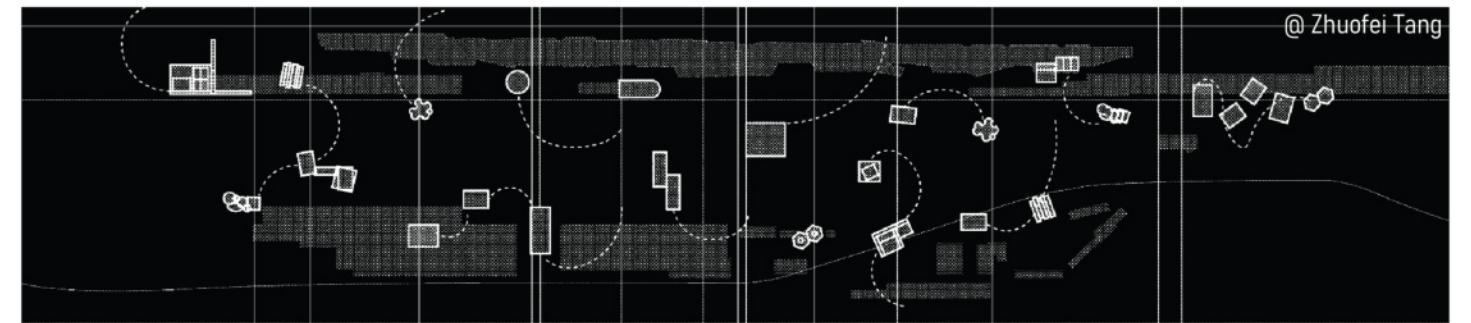
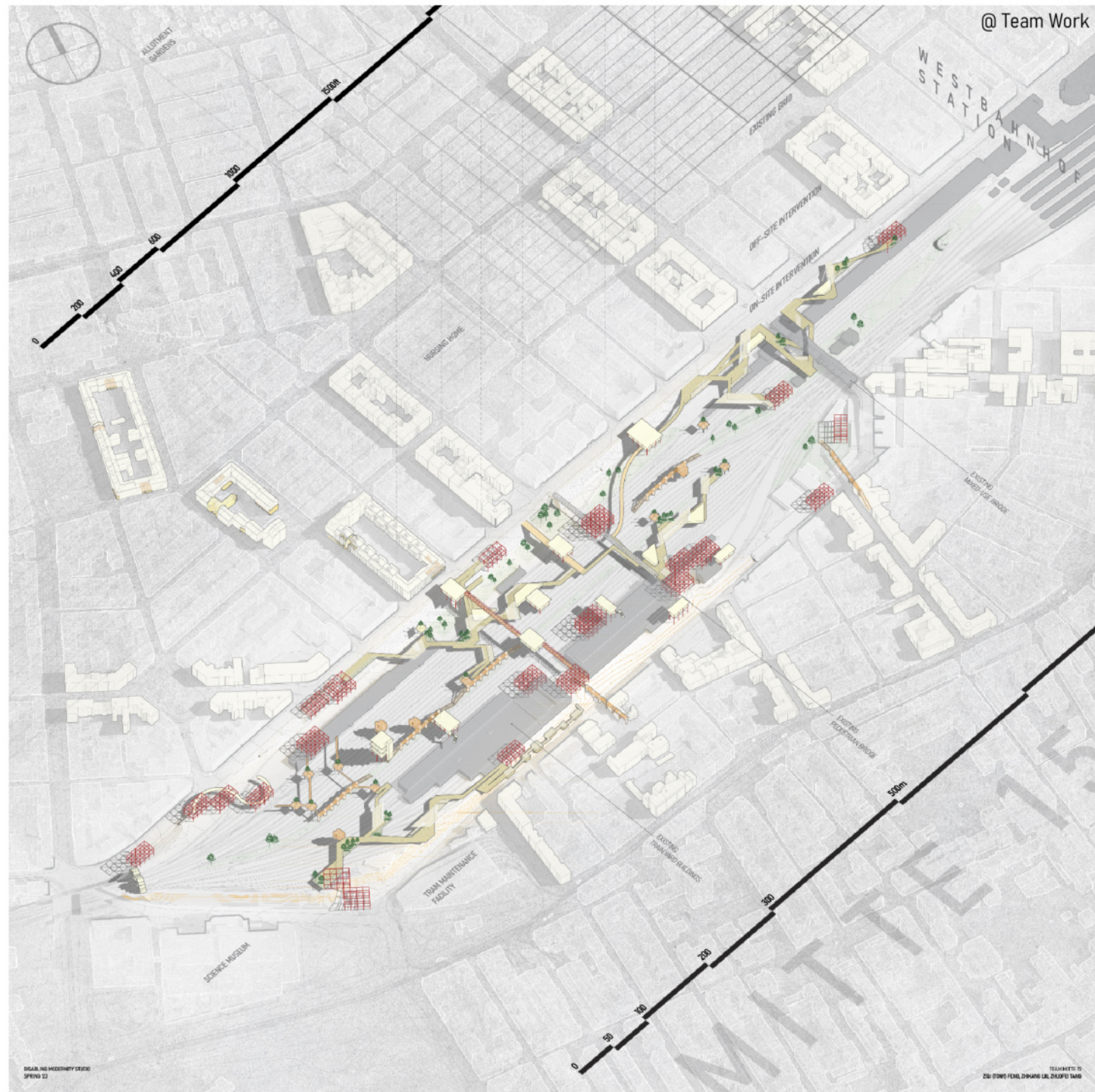
Urban Design, Vienna, Austria

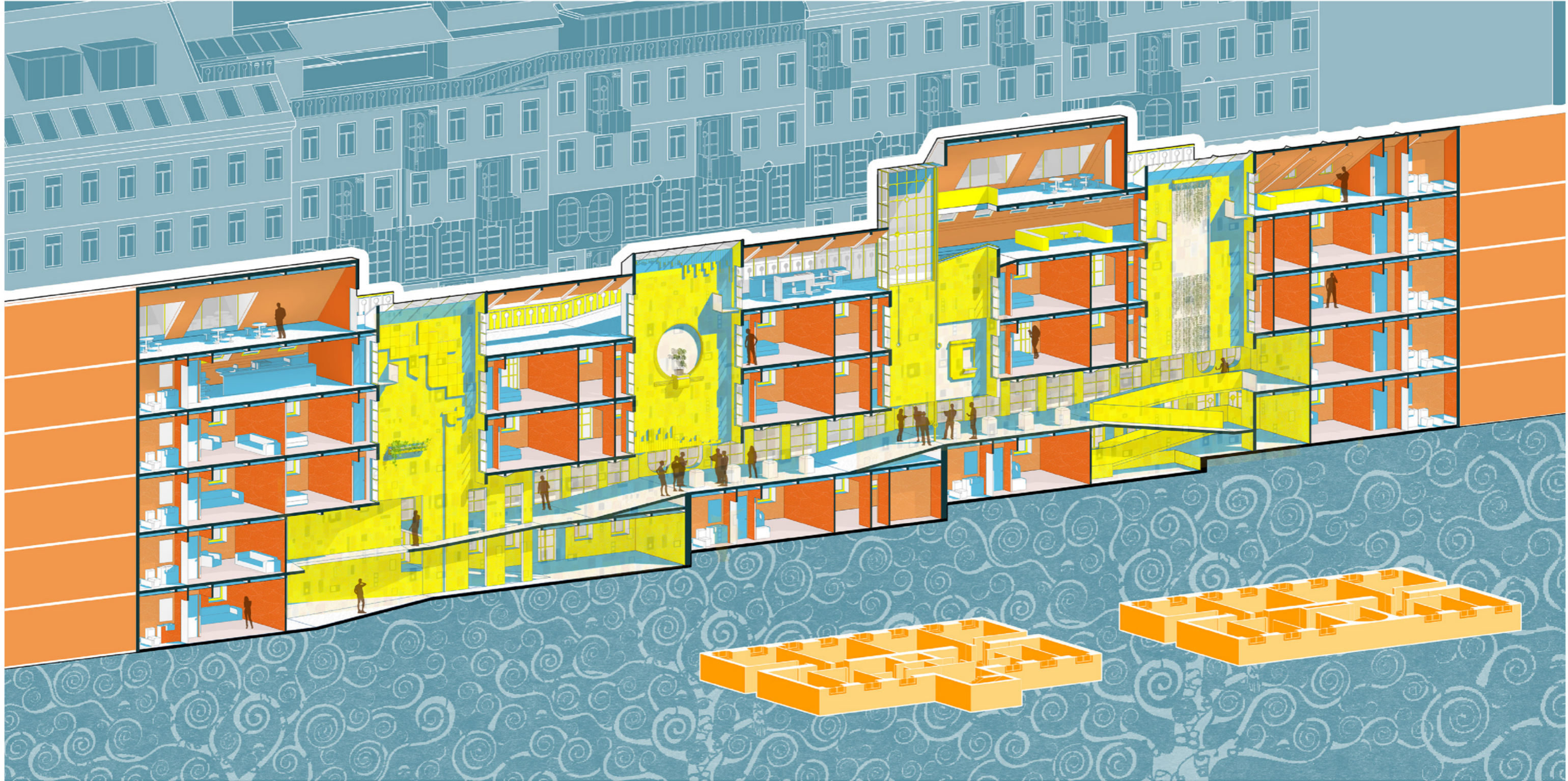
Team: Zhikang Liu, Tony, Zhuofei Tang

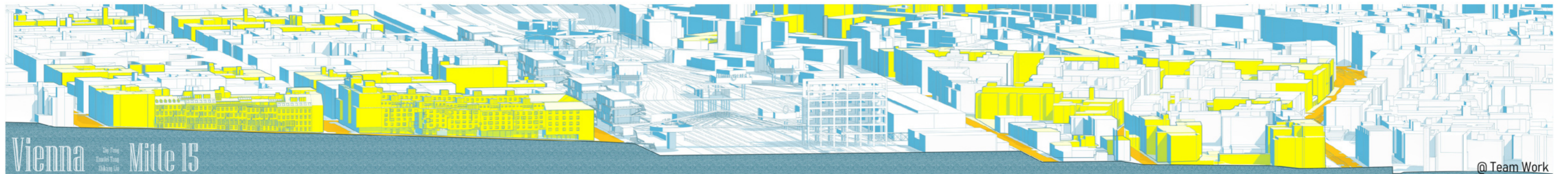
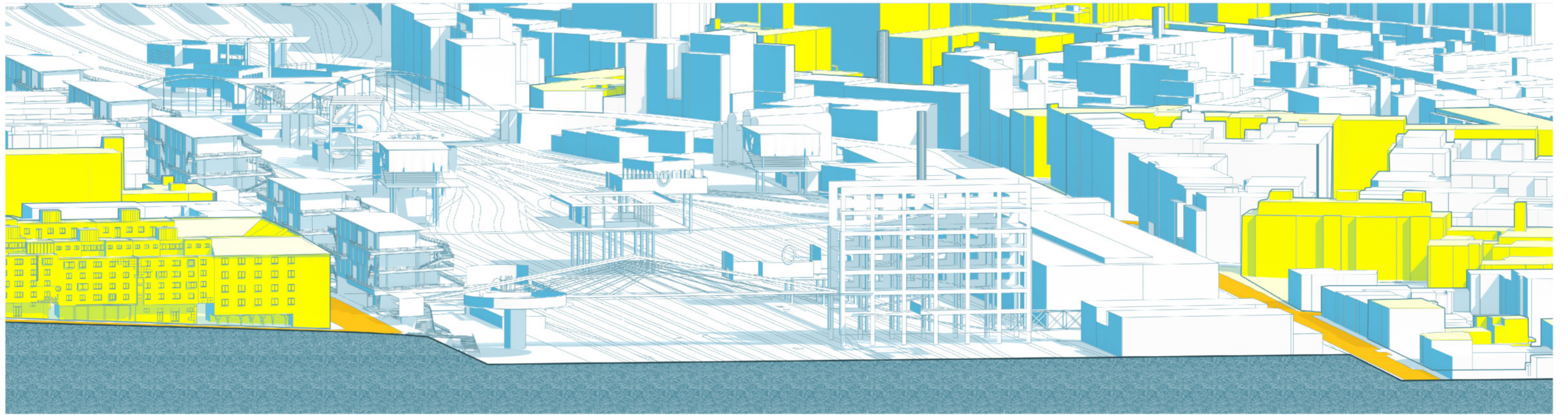
Instructor: David Gissen

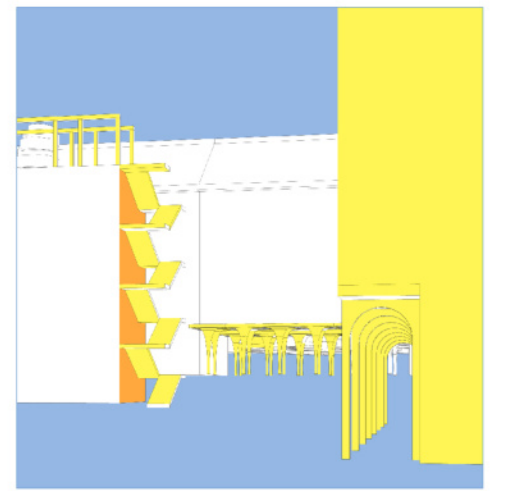
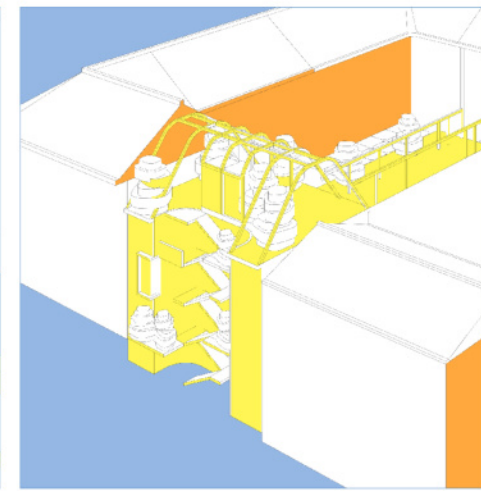
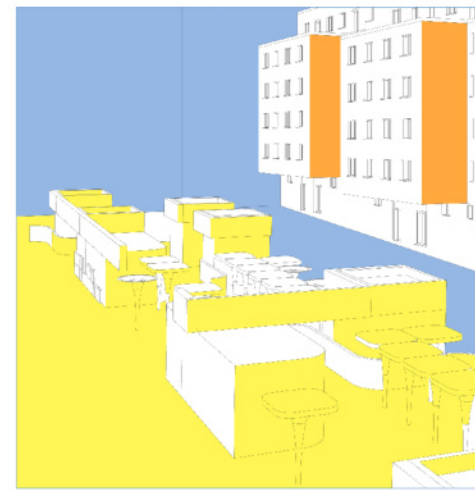
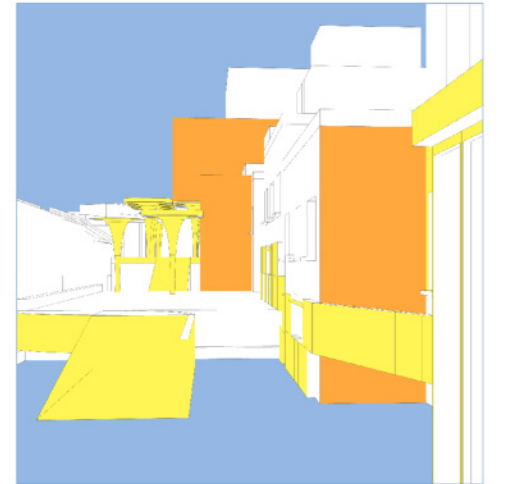
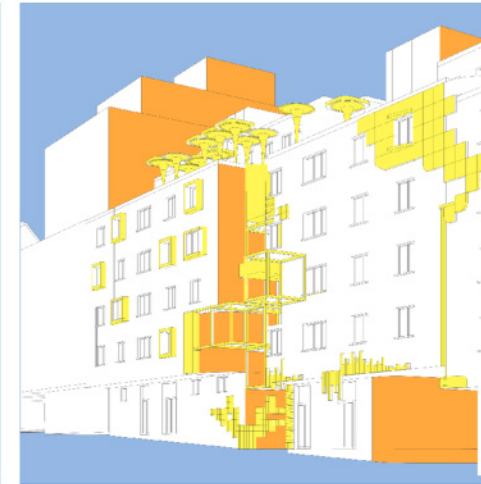
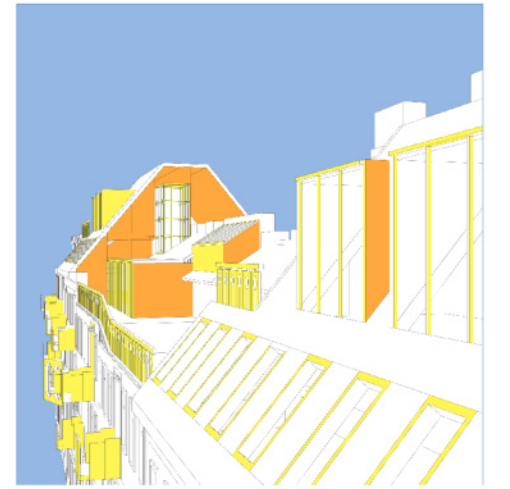
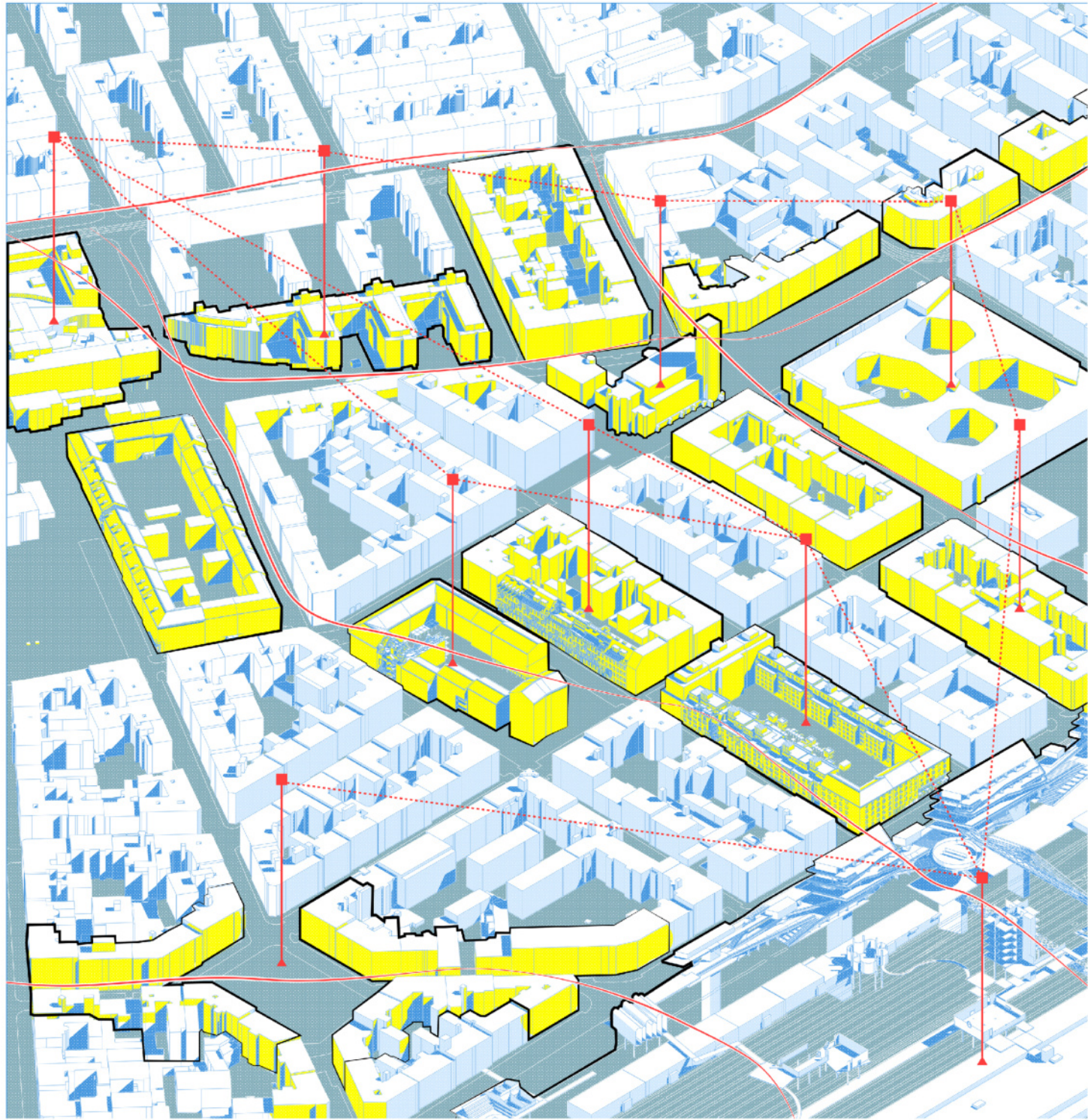
Spring 2023

This project analyzes the separation and contradiction between Vienna's modern large-scale transportation hub buildings and urban communities, and tries to resolve it by reintroducing public space into the train yard. Three strategies were proposed by the group to be applied in different locations. The part I designed is the connection network between the renovated train yard and the important roads in the surrounding cities, using concept from Klimt's paintings.









05

Neon Drift

Game Design, Virtual Architecture

Team: Zhikang Liu, Hetian Guan, Chung-Ying Hor

Instructor: Nitzan Bartov

Spring 2023



04

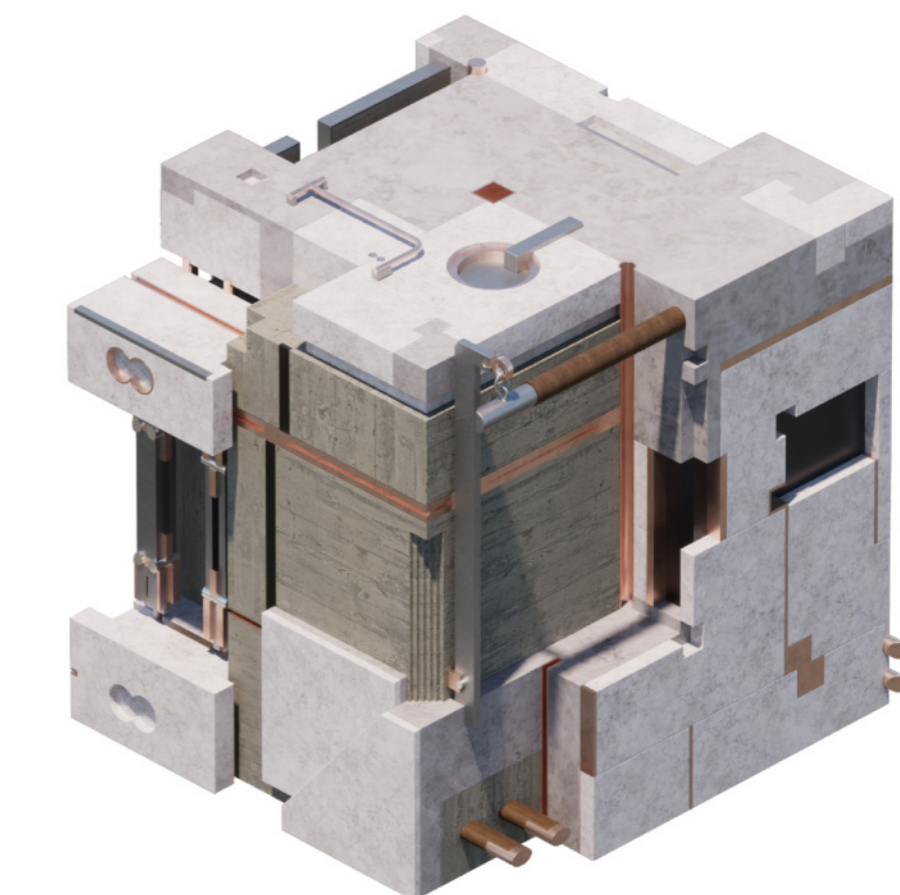
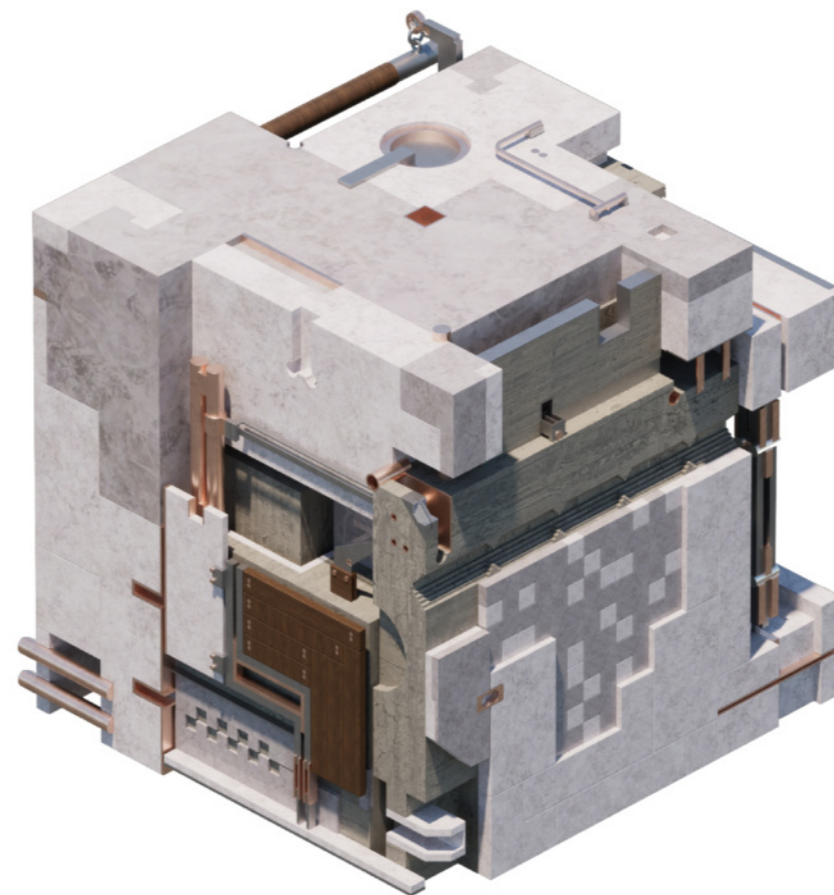
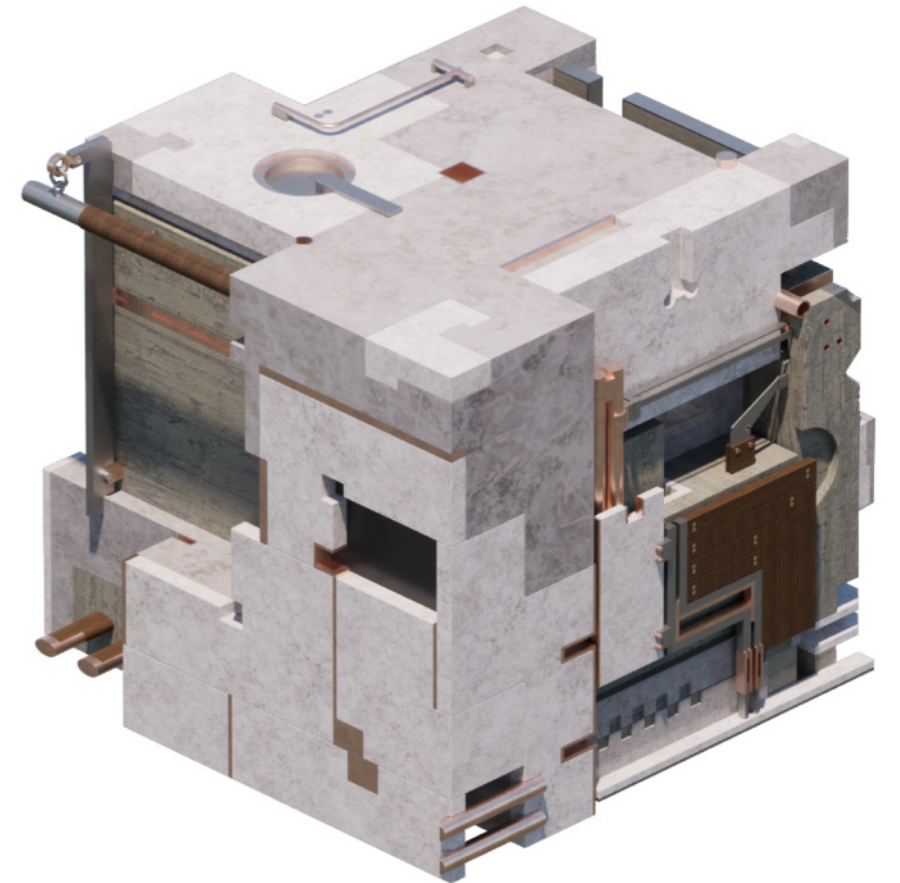
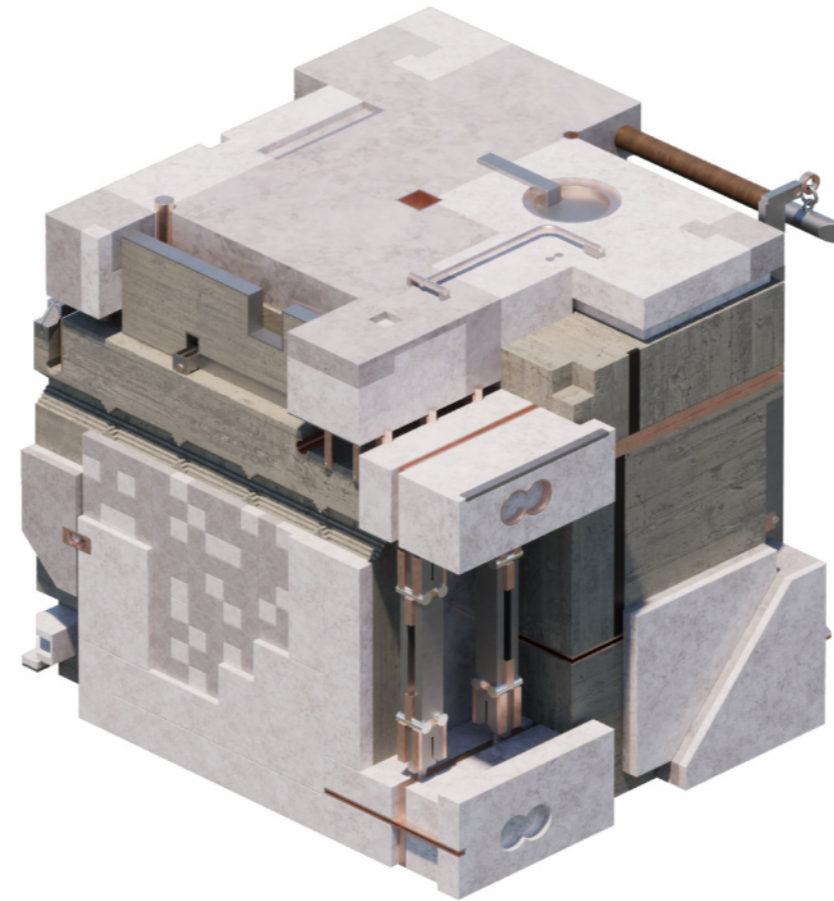
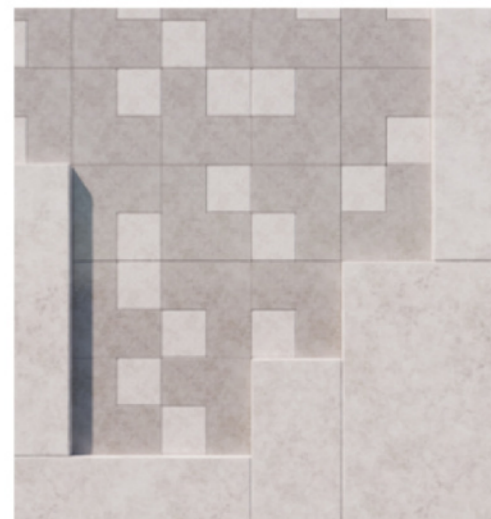
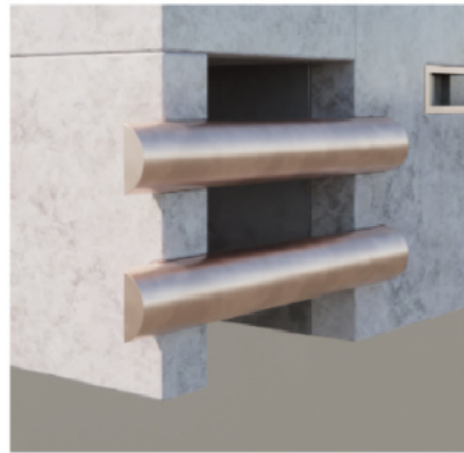
The Scarpa Box

Architecture Apropos Art

Individual Project

Instructor: Steven Holl, Dimitra Tsachrelia

Fall 2022



06

Photography
Architectural Photography
Individual Project
Instructor: Michael Vahrenwald
Spring 2023



Free or Tolls: The American Interstate Highways and Chinese

National Trunk Highway

Zhikang Liu
Architecture, Engineering, and Political Ecology
Professor: Reinhold Martin
Fall, 2022

Abstract:

This paper compares the differences between the US Interstate Highway and the Chinese National Trunk Highway System (NTHS) based on their history about construction, ownership, sources of funding, operating revenues. The U.S. highway system has a long and complex history of construction. Following the Federally Funded Highway Act of 1956, the Interstate and Defense Highway System, based on existing private and public highways, entered a massive construction phase. Most of the highway system is built and maintained through Federal subsidies that are recovered mainly through fuel taxes. In the early 21st century, China began planning NTHS. The central government plans the NTHS. The funding for the NTHS is through a Public Private Partnership, which is recovered from road tolls and shares in infrastructure companies. In these two approaches to the highway system, the power and economics game between private and public interest, local and the federal (or central) government, and city development is different. These differences cannot be attributed only to the context of the times and the country's social system. It also comes from the sophisticated factors, such as inertia of road construction history, population, urban development, efficiency differences of government agencies, landscape, land policies, and market strategies.

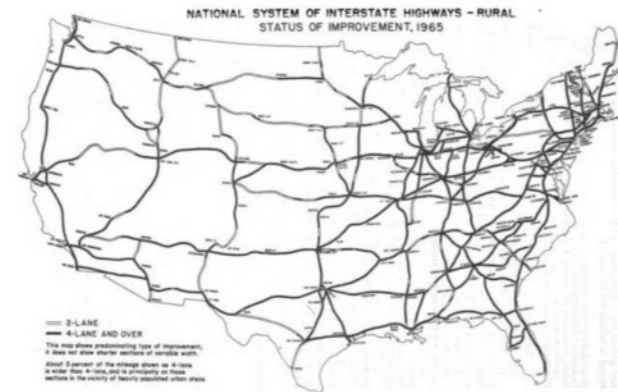
1. Introduction

After the enactment of the Federal Aid Highway Act of 1956, the U.S. Interstate Highway System was established. Forty-nine years later, China's Ministry of Transportation issued The National Highway Network Plan and started to build the National Trunk Highway System (NTHS). By 2021 the length of the Interstate Highway reached 78,456 km, and the length of the NTHS reached 124,000 km¹, becoming the backbone of the highway systems in the U.S. and China. A significant difference in the construction and operation models of these two highway wonders is the funding source for construction and maintenance. This difference cannot be attributed to differences in time. It is because constructing a highway system is a long-term process strongly influenced by social systems, power structures, economy, politics, engineering, urban development, and natural landscape. For example, the high concentration of dense populations in the major cities of eastern China makes it possible for arterial highways to generate significant returns on investment through toll fees. The interest in tolls has enabled local governments to complete all highway construction through joint ventures. The United States, meanwhile, has taken the approach of using fuel taxes to pay for highways.

Through the analysis of the construction history of the Interstate Highway System and the National Truck Highway System, this essay will analyze the differences between the investment and operation modes of the national highway systems of China and the United States and the reasons for them. The next section of this essay will focus on the construction and Funding history of the interstate highway system

in the United States. The Third section will analyze the NTHS construction process in China. The fourth section compares the different natural and social conditions faced by China and the United States in constructing the highway system. Concluding comments will be presented in the Fifth section.

2. Power of Federal Aid Act: The History of U.S. Highway System



National System of Interstate Highways in 1965²

There are several answers to the question of the earliest interstate highways in the United States, depending on the definition of "earliest." The earliest time of construction is one of those definitions. From this perspective, the Pennsylvania Turnpike, which opened on Oct. 1, 1940, was the earliest interstate highway³. Building America's national highway system was a process that included 4 important federal aid acts, several highway agencies, and 90 years of continuous construction and exploration. The Federal Aid Road Act of 1916 and the Federal Aid Highway Act of 1921 gradually placed the responsibility for a national highway system on the government. The Federal Aid Highway Act of 1944

<https://highways.dot.gov/public-roads/summer-1996/three-states-claim-first-interstate-highway>

⁴ Richard F. Weingroff, "Federal Aid Road Act of 1916: Building The Foundation," *Public Road* 60, no. 1 (1996), <https://highways.dot.gov/public-roads/summer-1996/federal-aid-road-act-1916-building-foundation>

⁵ Daniel B. Klein, "Turnpikes and Toll Roads in Nineteenth-Century America," EHnet (Economic History

started the federal support to highways in cities and interstate parts. Those Acts established the original model of federal-state cooperation in building highways. These models eventually led to the Federal-Aid Highway Act of 1956 and Eisenhower's National System of Interstate and Defense Highways or the Interstate Highway System. Construction of this highway system continued for the next 40 years.

Before The Federal Aid Act

Highway construction in the United States dates back to the Good Roads Movement of the 1890s. Before the 20th century, American roads were in poor condition, and transportation carriers were expensive and fragile. Traveling long distances by car is time-consuming, expensive, cumbersome and unreliable.⁴ The poor road condition was due, on the one hand, to the overwhelming dominance of federally funded canals and trains over the rudimentary wagon toll roads of the early 19th century. On the other hand, it was also because early provide roads were generally unprofitable from tolls in sparsely populated areas such as the central and western parts of the country.⁵

In the 1890s, bicyclists riding between cities and the countryside brought about a growing interest in road construction⁶. In 1891 New Jersey became the first state to use state grants to improve road conditions⁷. The state-aid plan did not become a consensus in other states and Congress then. Rural residents also objected to paying taxes for roads because they were built more for wealthy city dwellers (their attitudes changed after Rural Free Delivery became popular in the 20th century). The Office of Road Inquiry (ORI), was funded during this period. ORI primarily aimed to investigate highway

Association, 2010), <https://eh.net/encyclopedia/turnpikes-and-toll-roads-in-nineteenth-century-america/>.

⁶ Bruce E. Seely, "The Early Good Roads Movement, 1890-1905", *Building the American Highway System: Engineers As Policy Makers*. Philadelphia, PA: Temple University Press, 1987.

⁷ Weingroff, "Three States Claim First Interstate Highway"

⁸ Seely, "The early Good Road Movement, 1890-1905"

construction nationwide and provide expert and data-based guidance to local governments.

There was a broader consensus to build roads at the end of the 19th century. But no state significantly improved existing roads or advanced the construction of new ones⁸. Only Pennsylvania, Virginia, and Ohio provide grants to some private road developers. Townships did most of the road construction and operation through various bonds and private companies. Federal grants funded only ORI's research during this period.⁹

Road to The Federal Aid Road Act of 1916

The situation changed in the 20th century. There was an important background: the widespread popularity of Rural Free Delivery (RFD) and the release of the Ford Model T in 1908. The RFD allowed American farmers to become proponents of building postal roads, while the Model T made the cost of car travel affordable for the average family. "Automobile ownership in the United States multiplied in the new century, from 78,000 in 1905 to 2.3 million in 1916. In 1914, a second OPRI road census reported 257,000 miles of improved highway, an increase of 100,000 miles in a decade, with 32,000 miles of brick, concrete, or bituminous macadam paving."¹⁰ 1916 Congress finally broke away from the various proposals for postal roads, agricultural roads, and parkways and passed The Federal Aid Road Act of 1916. OPR's lead engineer, Logan W. Page, was extensively involved in the policy development discussions.

The new Act establishes highway policy and regular federal grants. The federal aid program will focus on farm-to-market roads. The federal

¹ Federal Highway Administration, "Highway Statistics 2020," U.S. Department of Transportation, last modified on December 10, 2021, <https://www.fhwa.dot.gov/policy-information/statistics/2020/hm20.cfm>.

² Public Roads Administration, *National Highway Program* (Washington, DC: U.S. Government Printing Office, 1955).

³ Richard F. Weingroff, "Three States Claim First Interstate Highway," *Public Road* 60, no. 1 (1996),

⁹ Klein, "Turnpikes and Toll Roads in Nineteenth-Century America"

¹⁰ Bruce E. Seely, "The Progressives, Expertise, and Highways, 1905-16", *Building the American Highway System: Engineers As Policy Makers*. Philadelphia, PA: Temple University Press, 1987.

government would interface directly with state governments and provide \$10,000 per mile of the interstate highway (the cost of which would force states to focus on rural areas¹¹). The maximum share of federal grants for road construction is 50%. The states would receive federal aid only when the highway plans were inspected and approved by OPR. A total of 75 million dollars in federal aid was used to encourage states to move toward expert-guided highway development. The federal grants in highways at this time were derived from general fiscal expenditures and were not directly related to highway transportation.¹²

After the WWI: The Federal Aid Highway Act of 1921

Between 1916 and 1921 the federal-aid program was plagued by wartime shortages, construction delays, and tangled administration¹³. There are two significant problems: First, the 1916 Act allowed the federal government to intervene to some extent in state decisions about roads through the OPR. It slowed road construction in some states with incomplete road agencies and created uneven benefits between states. Second, the rapid growth of trucking during World War I destroyed many existing roads and made the BPR ineffective in coordinating the national road system and assisting in distribute federal grant. BPR's new director, Thomas H. MacDonald, repaired the wartime damage to BPR's relationships with state governments through a series of collaborative efforts and bargaining. He was more flexible in taking different cooperative approaches in different states.

This effort to repair relationships eventually led

the state aid program to The Federal Aid Highway Act of 1921. The new act raised federal aid limits, eliminated the policy ambiguity of the previous two decades, specified the scope and percentage of federal aid, and proposed a national interregional highway program. This act ushered in a golden age of highway construction from 1921 to 1936. State car ownership increased 2.5 times in the 1920s, and tax revenues generated from fuel and highway traffic increased sixfold. Even during the Great Depression, highway taxes and expenditures remained steady. Stronger and better-budgeted state highway departments have emerged in the leading states, such as California, Iowa, and Pennsylvania. They provided highway funding in two ways: regular fiscal spending and highway bonds.¹⁴

Interstate Highways and Road in Cities: The Federal-Aid Highway Act of 1944

In the 1930s and 1940s, the BPR and state highway departments faced several problems: increasing congestion in populated urban areas, the Great Depression, and the need for a national highway of high quality brought on by World War II. The BPR's focus on rural secondary roads and its master plan to develop narrow roads on a need's basis lost support in the 1940s. MacDonald also had to turn to supporters of toll roads and urban highways, which accounted for most traffic, to find consensus.¹⁵

For state governments, toll highways become the logical choice for some costly but heavy-duty highways. The success of The Pennsylvania Turnpike and Meridian Parkway as tollways makes the narrow, congested postal roads that run parallel to them look awkward. They are built as modern high-speed heavy-duty highways in the 1930-40s. The highway

was built primarily with highway bonds issued by the Pennsylvania Turnpike Commission (PTC), federal government grants, additional federal treasury funding, and a Reconstruction Finance Corporation loan.¹⁶ The success of these highways led to the rapid spread of toll highways in many states.

Eventually, the Federal Aid Act of 1944 provided a solution. This act allowed federal aid to begin investing in modern urban highways for the first time and authorized a program of interstate highways not to exceed 40,000 miles. The bill also allowed the highway department to acquire more land than was needed for road construction by placing that land under lease in order to repay bonds and loans. The federal aid will not be used to purchase land. Funding for interstate highway aid was implemented in the following 1952 and 1954 aid acts. The allocation formula was further defined as follows: one-half based on population and one-half based on the federal-aid primary formula (one-third on roadway distance, one-third on land area, and one-third on population)¹⁷.

Final Answer: The Federal-Aid Highway Act of 1956

The new Act in 1956 brought an end to the chaotic Federal aid policy and allowed a national interstate program to begin. The Interstate Highway System has since received 90 percent federal aid, while the rights-of-way and ownership of these highways remain with the state governments. The Eisenhower Administration established the Highway Trust Fund, which paid for the construction of the Interstate System through highway use taxes (primarily federal gasoline taxes). Funding for the Interstate System would be distributed to the states

through a ratio of population, highway miles, and acreage. The Interstate System would be designed to a uniform standard, eliminating grade crossings, and all highways must control access. The design would also need to meet the needs of the next 20 years. The Federal Aid also completely rejects the proposal to charge tolls on federally granted highways. But two years later, the Interstate system would also include some toll roads that existed before 1956, such as The Pennsylvania Turnpike, which aimed to eliminate tolls after the tolls pay off bonds and loans.¹⁸

Before 1956, Cash to liquidate previously incurred obligations for the FAHP came from the General Fund of the Treasury. Although taxes on motor fuels and automobile products were in existence, they were not linked to funding for highways. The state government noticed fast-growing tax revenue early on. California first established a trust fund to administer the tax. The 1956 Act indirectly collected it from consumers by taxing manufacturers and importers of transportation vehicles, as well as oil companies, under a user-pays principle. Another important characteristic of the HTF is that it was set up as a pay-as-you-go fund. In other words, there must be enough money in the HTF to make reimbursements. After the 1956 Act, the federal government boosted the amount of federal aid for interstate highways in several other acts. The interstate highways were expanded several times. By 1998, the interstate highway network connecting to highways of Canada and Mexico had been completed.

3. Funding the NTHS: Public Private Partnership in Chinese Version

¹¹ Seely, "The Progressives, Expertise, and Highways, 1905-16"

¹² Highway Trust Fund, "Financing Federal-Aid Highways," Financing Federal-Aid Programs - Highway Trust Fund (The Federal Highway Administration, May 31, 2022), <https://www.fhwa.dot.gov/reports/fifahiwy/fifahi05.htm>.

¹³ Federal Highway Administration, *America's Highways, 1776-1976: A History of the Federal -Aid Program*, Washington, D.C.: Department of Transportation, Federal Highway Administration, 1977

¹⁴ Federal Highway Administration, *America's Highways, 1776-1976: A History of the Federal -Aid Program*

¹⁵ Bruce E. Seely, "Shaping a New Consensus: From

Postwar Struggles to Interstate Highways, 1945-56", *Building the American Highway System: Engineers As Policy Makers*. Philadelphia, PA: Temple University Press, 1987.

¹⁶ Seely, "Shaping a New Consensus: From Postwar Struggles to Interstate Highways, 1945-56".

¹⁷ Federal Highway Administration, *America's Highways,*

1776-1976: A History of the Federal -Aid Program

¹⁸ Federal Highway Administration, "Timeline," Our National Road System's Impact on the U.S. Economy and Way of Life (1916- 2016), Federal Highway Administration, accessed December 18, 2022, <https://www.fhwa.dot.gov/candc/timeline.cfm>.



Chinese National Expressway Network Program in 2005¹⁹

Highway construction in mainland China was more than 50 years later than the United States. It was not until 1984 that the first real highway was built between Liaoning and Dalian. The first freeway opened in 1988, from Shanghai to Jiading, when construction of the U.S. interstate highway system was winding down. China has rapidly expanded its highway system in less than 20 years. The number grew by 99,419 miles between 1984 and 2020, making China's highway network one of the largest in the world.²⁰

Chronologically the mainland's high-speed development was largely in the Reform and Opening-up period and was closely tied to the country's Five-year Plans. The development of highways in mainland China is planned by the National Development and Reform Commission (NDRC) and the Ministry of Transport from the very beginning. Public-Private Partnerships were adopted to build and maintain the highway system.

There are three important stages in the planning history of NTHS. The first phase was the period of national led and provincial-level agency hierarchical road construction prior to the Reform and Opening-up. The second stage is from the 1980s to the beginning of the 21st century. This period was marked by two important road network plans: the 1992 "Five Vertical and Seven Horizontal" plan and the 2005 National Expressway Network Program also known as the "7918 networks". The third stage is another road planning and reform in China after the Asian financial crisis in 2008. This stage has 2013's new plan proposes a "71118 network"

Before the reform and opening up: arterial roads and road maintenance fees

After the country's founding in 1949, the newly established Ministry of Transport conducted a census of the country's roads. There were 50,206 miles of roads in the country, and only 18,765 miles of roads were paved. Of the roads that had pavement, only 186 miles used concrete or asphalt. Unlike the early days of the United States, there was an urgent need to build roads between cities in the new China because Chinese political and economic centers: the Northeast, Beijing-Tianjin-Hebei, and Yangtze River Delta regions, and Chengdu span almost half of China's territory. In 1966, during the Third Five-Year Plan, the Ministry of Transport proposed a central government-led plan for 49,709 miles of trunk roads, also known as the National Highway Plan. By the 1979 census, the country had 543,421 miles of roads, ten times as in 1949²¹. However, the system was disjointed in some defense-important highways. Nearly half of the roads did not meet the plan's quality standards. Some eastern roads were already carrying traffic at several times

their design capacity.

Until the 1980s, the central government would be responsible for constructing cross-regional national trunk roads, and provincial governments would finance local roads. Before the Reform and Opening-up, local governments financed roads only from road maintenance fees and a few central government subsidies. Provincial governments collect the road maintenance fee from authorities and individuals who own carriers in the province and is only used for road maintenance and construction²². It is similar to HTF, but the government does the construction of roads with state-run construction units. Civilian workers from local collective cooperatives also do some road construction labor. Due to the extremely low level of car ownership in the new China, the local government road construction departments were in a chronic state of lack of funds. During the decade of the Cultural Revolution, the country's productive activities were hit hard, and road construction was even slower.

Time of Revolution

In 1978, China began its economic reform. Markets were introduced into the national economic system. Except for critical state-owned enterprises in energy, mining, and military, other state-owned enterprises began to be privatized and contracted. The first modern highway (Shanghai-Jiading) was built mainly with 130 million yuan obtained from local road maintenance fees and 20 million yuan allocated by the central government. However, starting with the national highway, the Beijing-Tianjin-Tangshan Expressway, China began using World Bank loans for inter-provincial highways. In 1992 the Ministry of Transportation proposed the first national trunk highway plan to connect all cities over one million and 93% of cities with populations over 500,000 via five north-

south and seven east-west trunk highways. The 21,747-mile system was finally completed in 2008, 13 years ahead of schedule, connecting all of the country's major commercial ports and economic and political centers and covering 70 percent of the country's urban population²³.

Before 1998, the central government strictly prohibited local governments from using loans for road construction, a restriction discontinued in 1998 in response to the economic crisis when the country adopted a loose monetary policy. After Guangzhou took the lead in using loans to build roads and repaying the loans through tolls, the construction of highways in China entered the era of PPPs. At this stage, local governments and non-state contractors could contract for highway construction and raise funds to build highways by borrowing from banks, issuing bonds, issuing stocks, using foreign capital, and using their funds. In 2004, the Ministry of Transport issued Regulations on Toll Roads. The 1997 amendment to the traffic law also regulated the process of using non-financial grants for road construction.

Highways that take advantage of loans can only spend these amounts on the construction and maintenance of the highways. The repayment highway, where tolls must be removed after the loan is repaid, for a period not exceeding 20 years. The operating highways, whose operators can earn profits after the principal and interest are paid off in no more than 30 years²⁴.

In 2004, the Ministry of Transportation took the lead in completing the planning of the 7918 networks in cooperation with the provincial transportation departments. This name represents seven highways scattered in all directions from Beijing, nine north-south highways, and 18 east-west highways. It the first National Plan for NTHS. The overall size of the 52,816-mile network system will

¹⁹ National Development and Reform Commission and Ministry of Transport, *国家高速公路网规划 2005* [National Expressway Network Program 2005] (Beijing: National Development and Reform Commission, January, 2005).

²⁰ National Development and Reform Commission and Ministry of Transport, *国家高速公路网规划 2020*

[National Expressway Network Program 2020] (Beijing: National Development and Reform Commission, January, 2020).

²¹ Chinese Department of Transport, *关于划定国家干线公路网的通知* [Report of Planning the National Highway Network] (Beijing: Industry and Transportation Office, 1981, 1-2.)

²² Jinyu, Wang, “中美高速公路发展模式比较研究 [The comparison of Chinese and American Highway System development]” (PhD diss., Beijing Jiaotong University, 2012), 11.

²³ Yuan Xue, ed., ““五纵七横”将于年底基本贯通 [The Five Vertical and Seven Horizontal Highway Will Be Completed at The End of This Year],” (The Central People's

Government of PRC, December 18, 2007), http://www.gov.cn/wszb/zhibo186/content_837102.htm.

²⁴ Nanxi Xu, ed., “收费公路管理条例 [Regulations on Toll Roads],” 行政法规库 [Administrative Regulations Archive] (Central People's Government, September 13, 2004), http://www.gov.cn/zhengce/2020-12/27/content_5574564.htm.

connect all cities with a population of over 200,000 in the next 30 years²⁵. This plan creates a dense network of highways in eastern China and connects major cities in the central and western regions. In addition to these trunk highways, provincial governments have greater autonomy in building highways within their provinces.

The loan model also leads to a debt crisis. By 2012, the year of the 12th Five-Year Plan, the national highway construction debt had reached 4 trillion yuan. The proportion of highway construction funds from loans increased rapidly; in 2010, the ratio exceeded 70%²⁶. 2004 tax reform made it more difficult for the government to increase its road investment after the U.S.-like fuel tax gradually replaced road maintenance fees. On the one hand, this is because the central and provincial governments are not in a financial position to support expensive highway construction in China's complex terrain. On the other hand, China's large cross-regional transportation needs can generate toll revenues that provide some relief from debt. Nonetheless, the current size of this debt still makes it challenging to balance revenues.

New Era of NTHS

After the financial crisis in 2008, the central government again used loose monetary policy. In 2009 alone, investment in highways reached 968.8 billion yuan, an increase of 40%. In 2015, 77,050 miles of highways had opened to traffic. The government gradually coordinated the PPPs model for managing Highways. Around 2010, operators of different toll roads in Guangdong province cooperated to eliminate toll lanes between different highways inside the province. China eventually eliminated the majority of inter-provincial toll lanes in 2020. A nationwide networked ETC system and a unified road access management system replaced them.²⁷

The rapidly rising number of cars after 2008 has made highway tolls even more profitable. The early highways have paid off their debts through tolls. However, the

considerable revenue generated by tolls made local governments extend the toll collection period in various ways. The Beijing-Shijiazhuang Expressway, as a repayment expressway, should have been stopped toll in 2001 when the arrears were paid off. However, Beijing highway authorities recalculated the toll collection period until 2030 by changing it to an operating expressway²⁸. The excess tolls were used for expenses such as repayment of other expressways and the high-speed railway project, which has been in the red for a long time. It is a violation of the 2004 Toll Road Regulations that require tolls to be used for road construction and maintenance only.

The NTHS plan for this period was the National Expressway Network Plan 2013-2030, released in 2013. This plan added two north-south highway arteries to the 7918-road network, which became the 71118 road network system. This plan also added expressways in urban clusters to relieve regional traffic pressure. Provincial road departments also began to focus on building and improving roads to villages. Construction also began on the National Highway Plan (not a typical highway), which was adopted in 2009. The plan is to build free, lower-speed, and lower-grade national roads parallel to existing tolled highways.

4. The Difference: More than Tolls

The United States, which focuses on state independence and believes in private capital, ends up building interstate highway systems under national federal funding. Collectivist China, which believes state-owned enterprises should control the national economy, finally let private enterprises and multiple funding take over the most crucial national trunk highway construction. The scenario is full of drama. But it also illustrates that the differences in the construction of highways in these two countries do not appear only in the national governing philosophy

and social systems. The differences between these two highway systems are also far more complex than the presence or absence of tolls.

There are differences in local government power structures. U.S. states are far more independent in highway construction than China's provincial administration. But this has not led to a fractured interstate highway system. These state highway departments work with federal departments (BPR) more like a partnership than a directive. Many wealthy states have accumulated no less experience and adequate funding than the federal sector in their long history of independent highway construction. That is why they could still reach a consensus with the federal government despite the divergence in funding and authority that existed at all times. The Chinese provinces also have the authority to plan provincial highways. However, the central government tempered the final decision and control of the substantive national highway arteries. Before the Reform, provincial highway departments could hardly support highway research and construction through their own revenues. Even after the Reform, only a few cities and provincial government transportation research institutes undertook large-scale transportation planning studies, such as those in Beijing and Shanghai.

The difference in population distribution is also significant. When the Interstate System was established in the United States, the population was 168.9 million. When the NTHS was established in China, the population was 1.296 billion. Population directly affects the number of people traveling through the highway. The distribution of the population directly affects the distribution of the highway system within the country. The concentration of China's population in the

southeastern region has allowed the eastern part of the country to receive a large amount of toll revenue from the highway system built with loans, making it possible to build highways with PPPs. Few areas in the U.S., such as the New York metropolitan area, have similar population densities. The Pennsylvania Turnpike is also established at such densities. U.S. tolls in more states are insufficient to support cost recovery on the toll road. NTHS faces a similar problem for roads in midwest China. China had to support western highways not favored by private enterprises and bank loans through transfer payments, just like federal grants in the U.S.

The differences in Landscape are equally significant. For most of the major cities in the United States, their stable climatic and geological conditions are conducive to the construction of highways. However, the highways linking China's big cities have to use many tunnels through hills and bridges over huge canyons. The engineering and financial resources required to build a highway to the Tibetan plateau are even too enormous for any local administration. The complex Landscape of the East has increased the cost of China's highways and made it more difficult for some local governments to finance construction or conduct engineering studies on their own. The U.S. Interstate system also retains some toll tunnels and bridges, even after the 1956 Act, because the high cost at the construction time led the state to opt for tolls.

Differences in land use policies have led the U.S. and Chinese highway systems to adopt different strategies in the process of land acquisition. In the United States, the land is privately owned, while in China, the land is owned by the nation. It also means that private or even state-owned companies in China can only lease title to the land for a certain period and

²⁵ Professional Committee of Logistics Technology and Equipment, “中国高速公路的前世今生 [The History of Chinese Highway],” The Headline (China Communications and Transportation Association, April 30, 2021),

http://www.56clte.org/2021/zy_0430/11740.html.

²⁶ Wang, “中美高速”, 12.

²⁷ Professional Committee of Logistics Technology and Equipment, “中国高速”

²⁸ Ze Wang and Zhenzhi Bai, eds., “京石高速还清贷款仍继续收费 资金用途存疑 [Beijing-Shijiazhuang Expressway Keeps Charging Drivers after Paid Its Debts The Usage of Profits Is Doubtful],” 人民网 [The People]

(China Central Television, July 15, 2013), <http://politics.people.com.cn/n/2013/0615/c1001-21848407.html>.

cannot own it. When the U.S. highway system affects residents, opposition from residents may directly interrupt the construction of the highway or drastically change the shape of the road. Road planning in China, especially outside the urban areas of major cities, is much freer. The profits generated by road construction make road contractors willing to pay money for the farmland and houses they occupy. This may benefit road construction, but the families enriched by demolition are the result of a clear social injustice.

While building American highways shifted from rural to urban areas, the Chinese highway system first connected densely populated areas of large cities. The progressivist thinking of BPR's American road engineers led them to use farmers' access to highways to proclaim power and equality. It is also true that the dispersed population of the United States made farm-to-market roads more important for some time. During a period of rapid highway development in China, the country was also experiencing a rapid concentration of population in large cities. The extremely urbanization has increased the importance of linkages between cities. The beneficiaries of PPPs also tend to build more densely traveled roads between cities for profit.

The relation between fuel taxes, loans, and highway construction differs in the two highway systems. For the United States, the 1956 Act and the HTF's unique mechanism allow highways to be budgeted and programmed with less than the highway tax revenue in the future. Highway growth is always commensurate with vehicle ownership and fuel consumption corresponding to tax expectations. On the one hand, it limits the pace of development of the interstate system, allowing road improvements to occur later than the actual increase in traffic volumes; on the other hand, it avoids excessive road growth. Toll roads in eastern China are blinded by the enormous tolls interest and the road operators' pursuit of profit. The vast majority of roads can generate

significant revenues as long as they link to cities in the east. In contrast, the ring roads of major cities set up to solve congestion are often deadlocked because of the large compensation payments required for demolition and relocation. Thus, the eastern highways are overgrowing, while the traffic departments are struggling to solve the traffic congestion in the big cities.

5. Conclusion

This essay reviews the history of the Interstate Highway System in the United States and the National Truck Highway in China. The history research reveals differences between the construction process and funding between the two highway systems. These differences cannot be attributed only to the context of the times and the country's structure. It also comes from the inertia of road construction history, population, urban development, efficiency differences of government agencies, landscape, land policies, and market strategies. These factors have led the U.S. and Chinese governments to make development strategies incompatible with their own economic and political systems. In fact, pragmatism is a better way for these two massive highway systems to accomplish their purposes and sustain themselves than the governing philosophy of the nation.

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