Biomimicry

Final Project

Micro-climate
Modification of City

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Thanks to...

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CONTENT

Biomimicry Final Project

Micro-climate Modification of City

Abstract

A sustainable world already exists. Biomimicry is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. The goal of this design project is to create products, processes, and policies for a new ways of living—that are well-adapted to life on earth over the long haul.

MICRO-CLIMATE MODIFICATION OF CITY

OBJECTIVE

- Detoxifying air pollutant for the people in the city

"Taichung is shrouded in haze as high levels of PM 2.5 pollution were registered on Oct. 30 2015 "

FACTORS OF AIR POLLUTION :

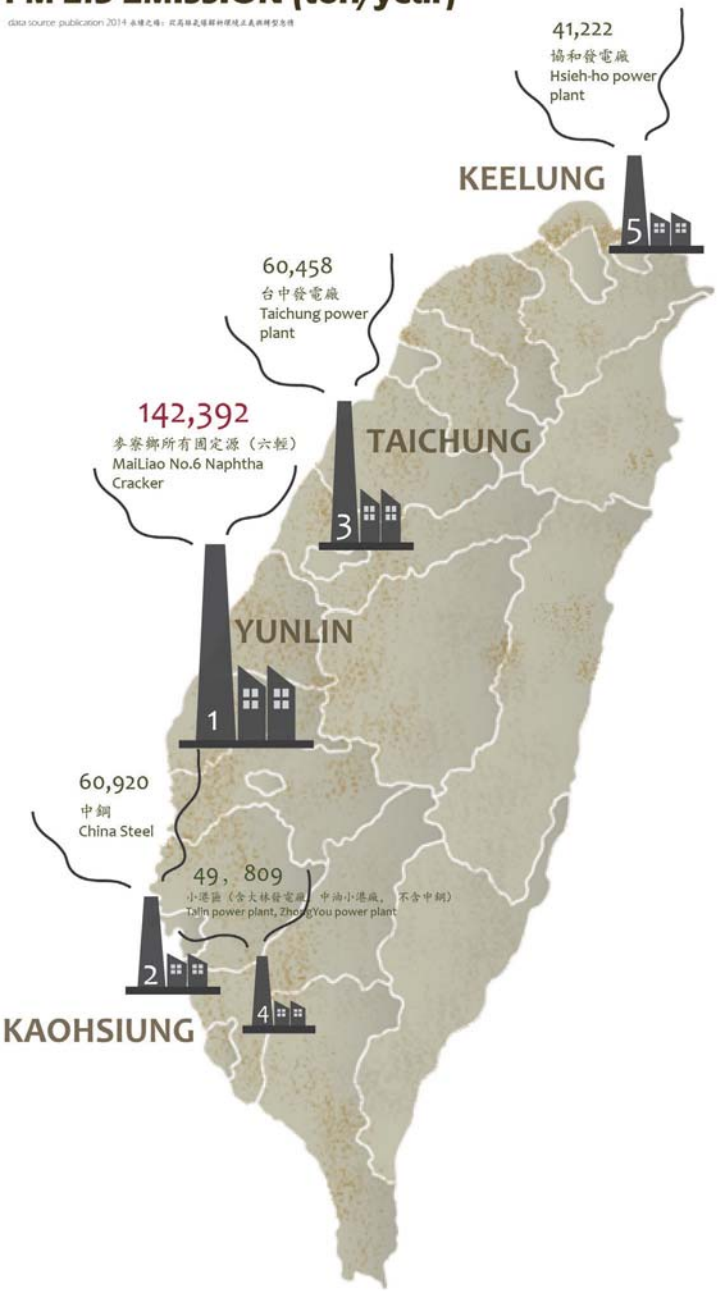
1. Taiwan can partially blame the poor air quality on the winter monsoon and also to the fact of the sweeps China's industrial and natural air pollution across Taiwan during the winter season. In recent years deforestation and environmental degradation in western China have led to an increase in seasonal sand storms that blow across Asia from the Gobi Desert.

2. China can not be blamed for all of Taiwan's poor air quality. Taiwan draws much of its electrical power from six coal-fired power plants. Taichung's coal-fired power plant is the largest in the world and the world's largest single source of carbon-dioxide emissions with over 40million tons of CO2 emissions annually (more than the entire nation of Sweden emits annually).

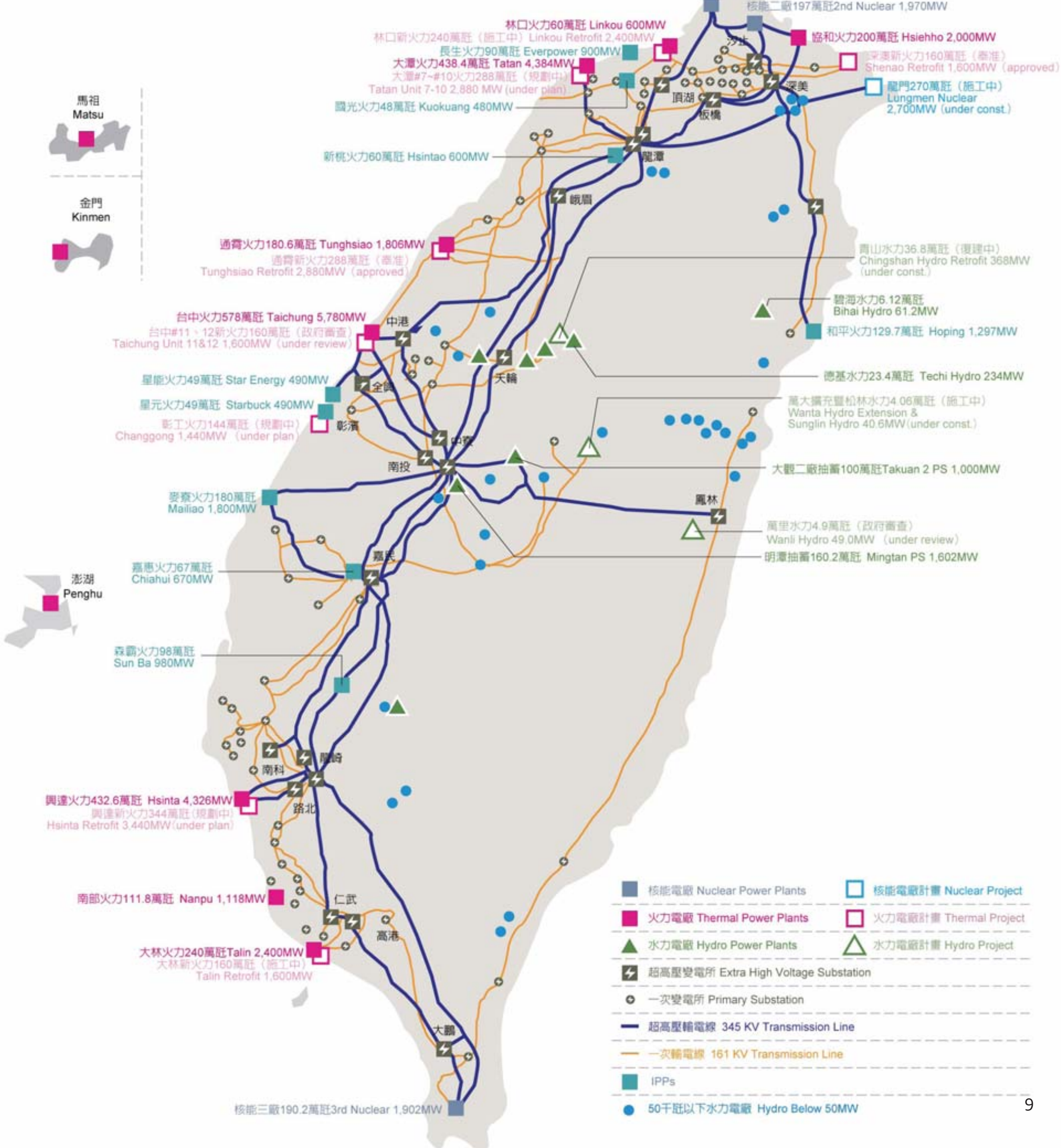
3. Traffic emissions have gotten worse as more Taiwanese take to the roads daily.

TAIWAN TOP 5 LARGEST PM 2.5 EMISSION (ton/year)

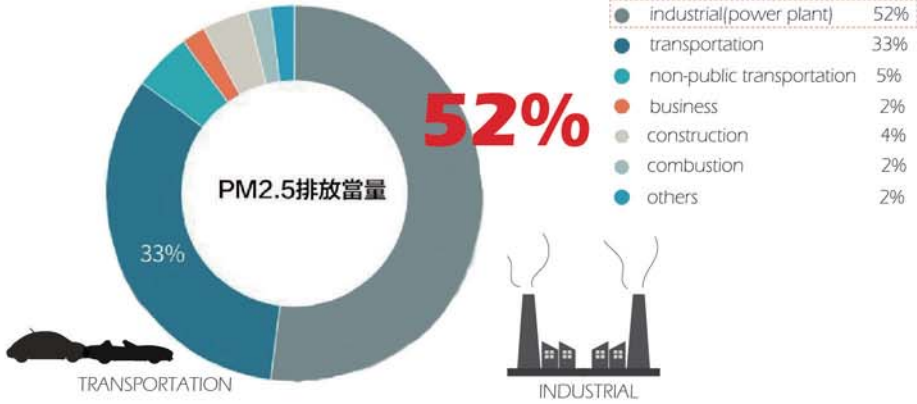
data source: publication 2014



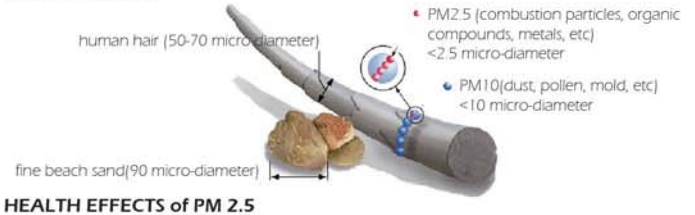
TAIWAN POWER PLANT



TAICHUNG CITY



WHAT IS PM 2.5?

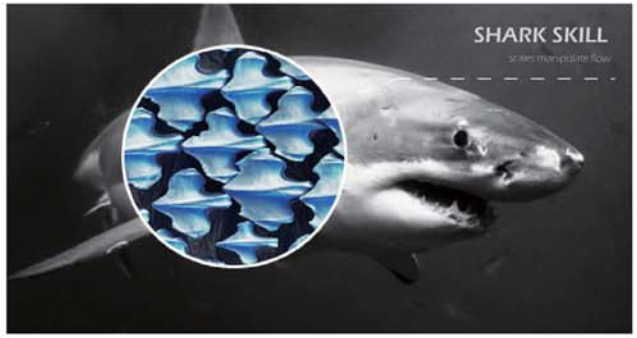


HEALTH EFFECTS of PM 2.5

People with heart or lung diseases, older adults and children are most likely to be affected by particle pollution exposure. However, even if you are healthy, you may feel temporary symptoms if you are exposed to high levels of particle pollution. Numerous scientific studies connect particle pollution exposure to a variety of health issues, including:

- **irritation of the eyes, nose and throat**
- **coughing, chest tightness and shortness of breath**
- **reduced lung function**
- **irregular heartbeat**
- **asthma attacks**
- **heart attacks**
- **premature death in people with heart or lung disease**

BIOMIMICRY BIOLOGICAL INSPIRATION PROCESS & DESIGN



Fish mouths as engineering structures for vortical cross-step filtration.

For some fish have filtering skills mankind has not yet mastered. While our existing filters screen particles out of a stream of fluid, these types of fish (including goldfish, menhaden and basking sharks) filter tiny cells or shrimplike prey from the gallons of water they swallow without clogging the oral filters.

Fish mouths as engineering structures for vortical cross- step filtration. The fish crossflow filter never clogs, even though industrial cross-flow filters always clog.

It can be used to separate particles in a controlled environment, and send them into any desired direction.

Evolutionary solutions to natural problems are often more effective than human designed solutions. Biomimicry allows us to adapt these evolutionary concepts into great engineered designs.

Sharks, For example, have evolved toward extremely high efficiency in traveling through water, meaning reductions in energy usage and increases in speed.

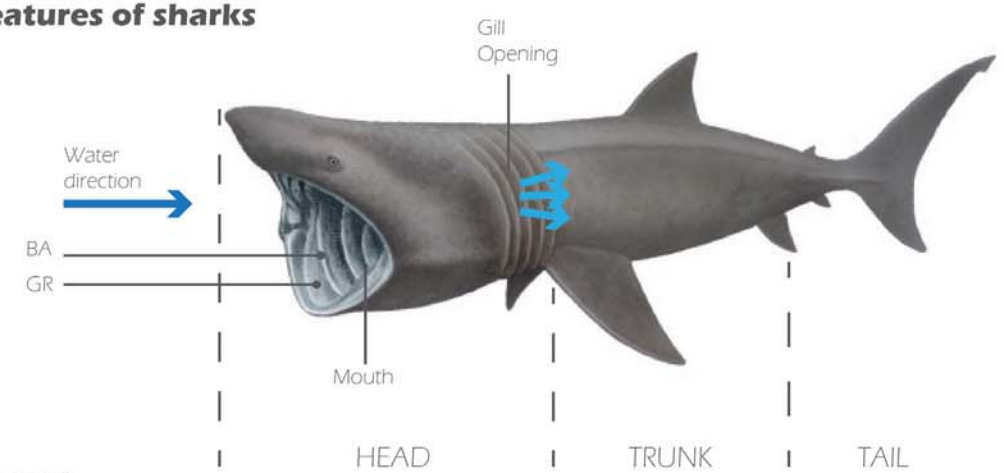
Their physical skin design is lowers drag forces associated with great movement and has shown great potential for application in human transportation.

The mechanism is based on the difference in resistance between laminar and turbulent flows.

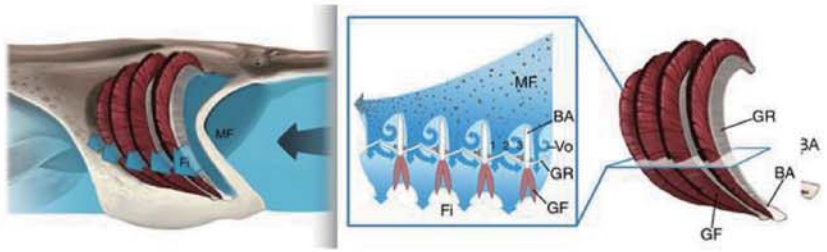
Laminar flow occurs when the movement of fluid past an object is contained in smooth, undisrupted layers.

Turbulent flow is chaotic and occurs when these layers are disrupted.

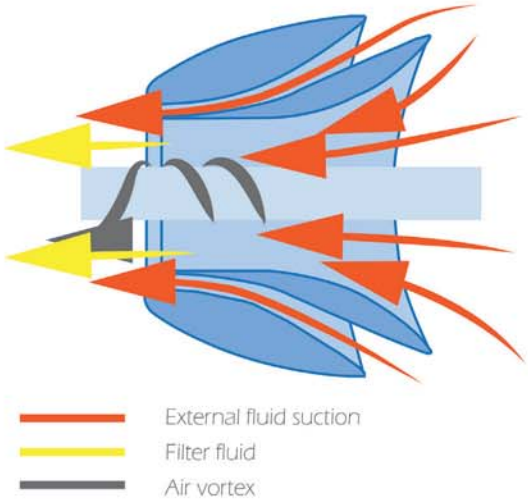
The major features of sharks

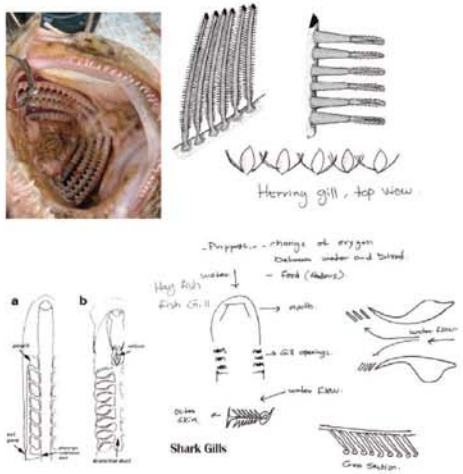


How fish gill works?



Diagram





Real Galapagos shark skin(microscale)

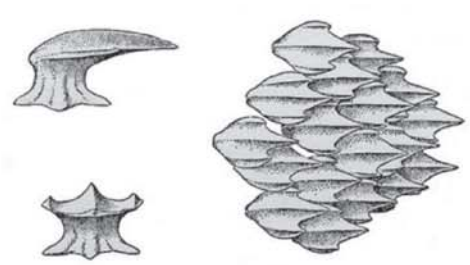
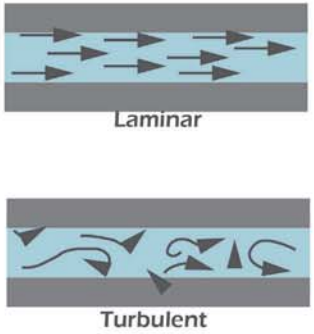


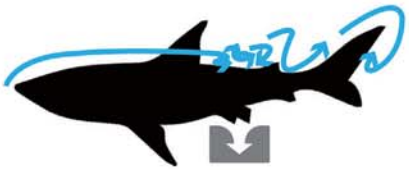
Diagram of skin mechanism



Shark swiming effect in the fluid

1. Lamina boundary layer

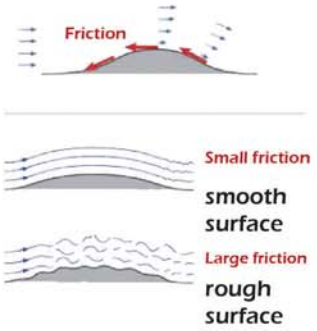
2. Boundary layer separation as shark flexes



3. Denticles lift off the skin like flaps to 'hold' the boundary layer in place

The Dermal denticle patterns on shark skin

Frictional drag



[ATP SYSREM]

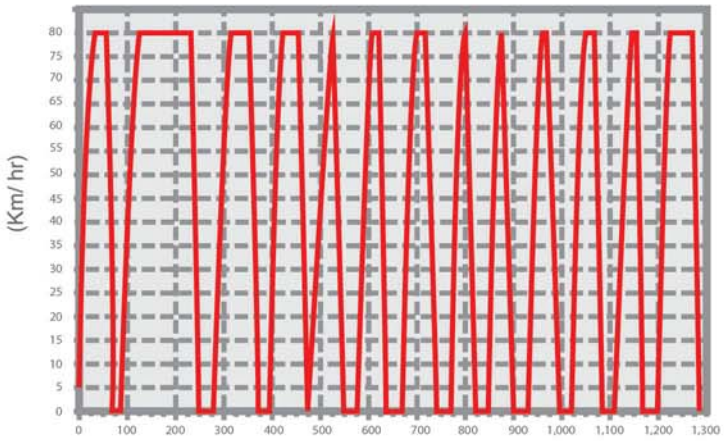
Signalling used on high density metro routes is based on the same principles as main line signalling. The line is divided into blocks and each block is protected by a signal but, for metros, the blocks are shorter so that the number of trains using the line can be increased. They are also usually provided with some sort of automatic supervision to prevent a train passing a stop signal.

[TIME OF METRO IN TAIPEI]

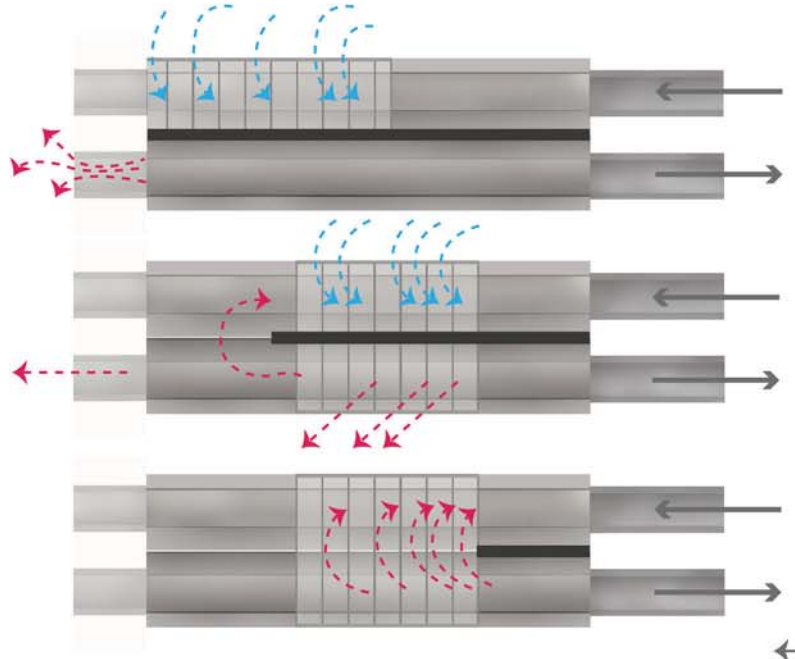
As the graph shows the time of Taipei metro takes from Xinpo station to Kunyang station. Normally, the limite speed of metro is 80km/hr, and the average around 65km/hr. The spending time depends on each station's distance. Moreover metro stay at higher speed longer as the far distance.

[RE-CIRCULATION OF TUNNEL AIR]

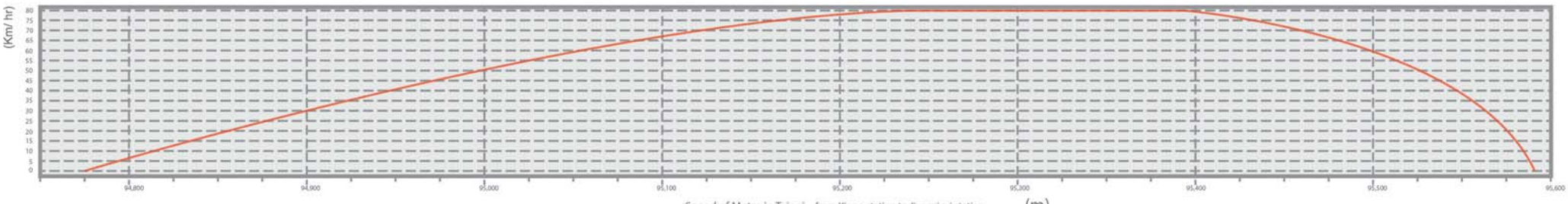
Hoods at portals of rail tunnels have become a common measure to prevent non-acceptable micro-pressure waves at the portals. The hoods have a larger free cross-sectional area than the actual tunnel. Additionally, the hoods are equipped with openings. The hoods lead to less extreme gradients and amplitudes of the pressure waves.



/ Time of Metro in Taipei - from Xinpo station to Kunyang station



Re-circulation of tunnel air in normal double- tube tunnel system



Speed of Metro in Taipei - from Xinpo station to Jiangzicui station

Station

A

In this situation, metro line is bewteen on the buliding and open- area. Most winds comes from the buliding side, non-railing in this section that make winds will pass though the gap to outdoor area.

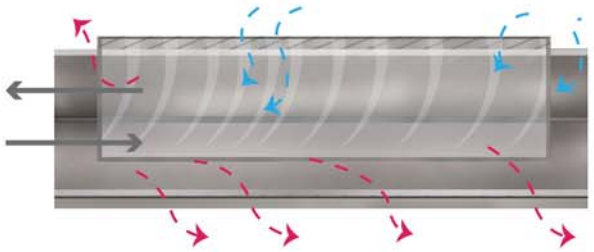
B

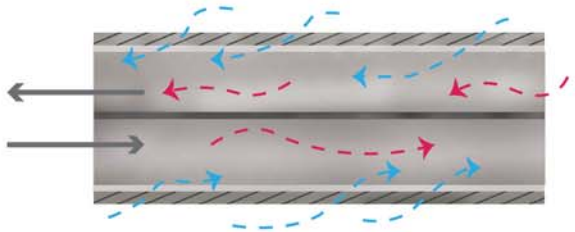
Maximum wind-pressure comes inside as the tram's speed around 80km/hr. Using railings to separate two different way tunnels, then, more clear air goes out.

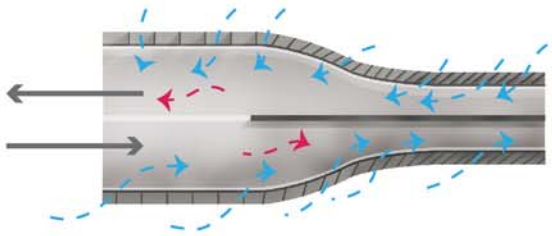
C

As the tram slow down, less winds comes inside. The gap is wider to ensure that re-circulation still working in the station. The railing just higher than the tram.

Station



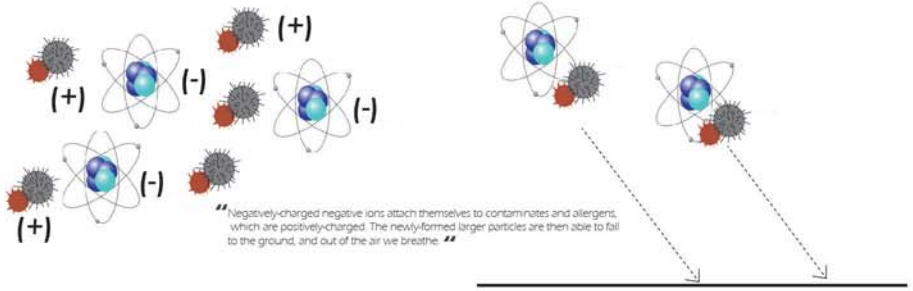




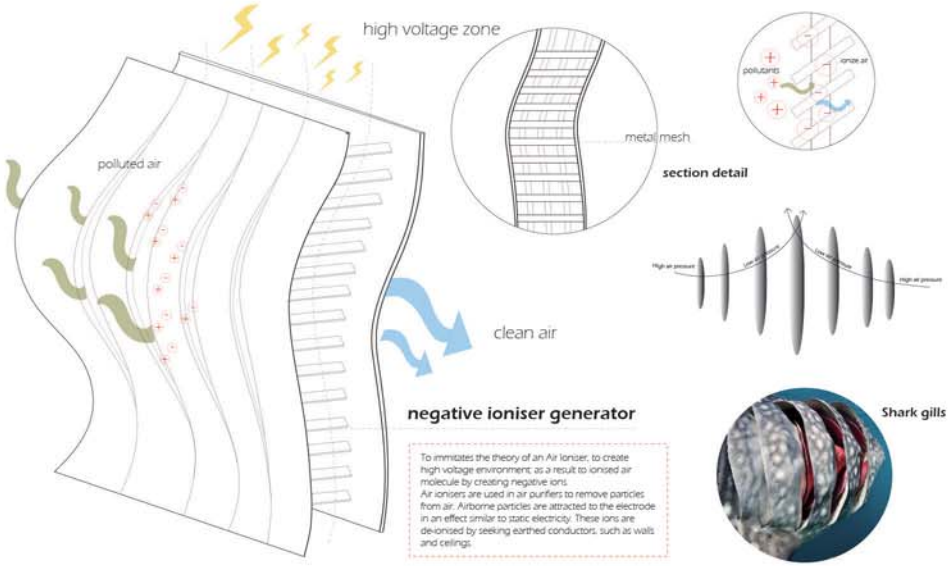
/ Re-circulation of tunnel air in design double- tube tunnel system

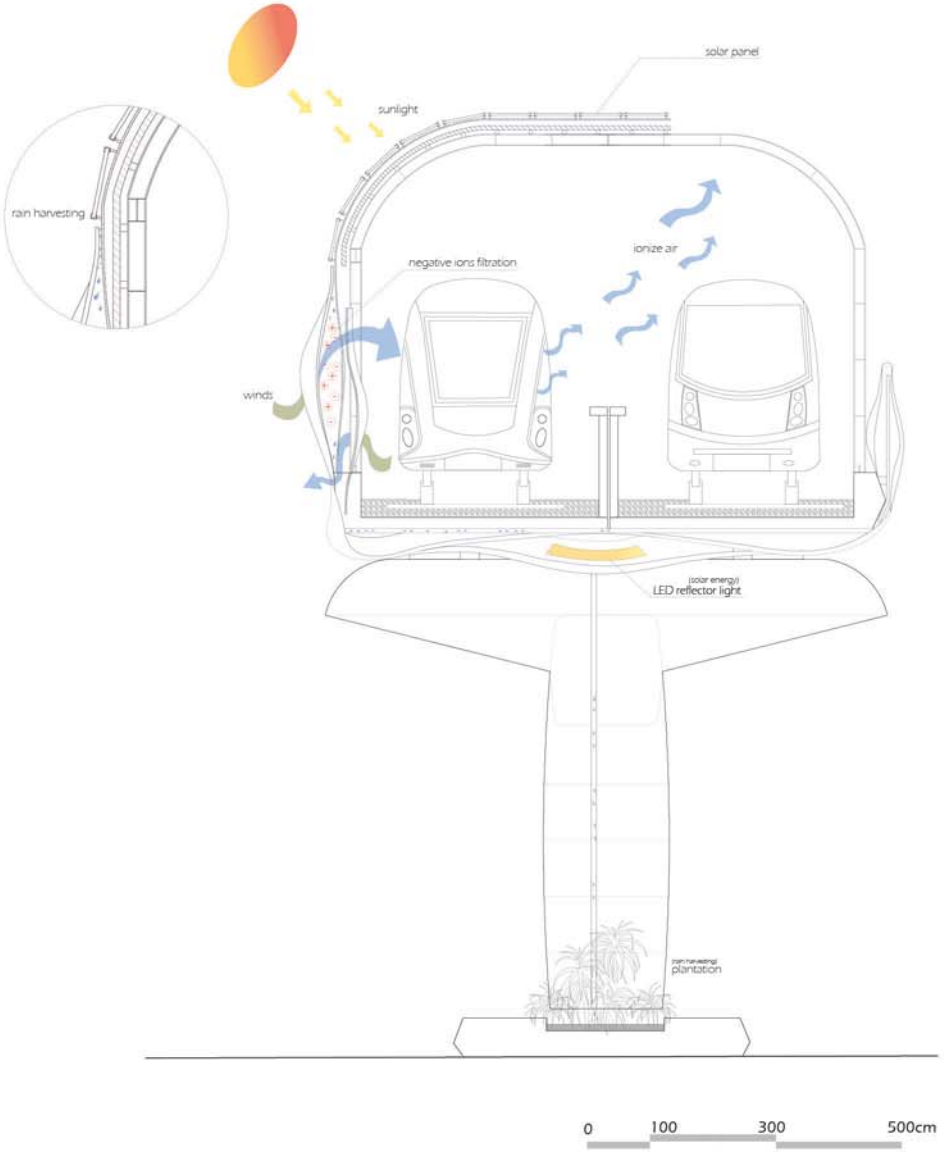
BIOMIMICRY IMPLEMENTATION

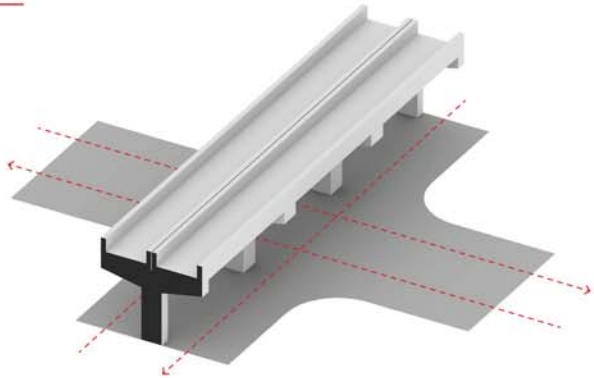
How negative ions remove pollutants from the air?

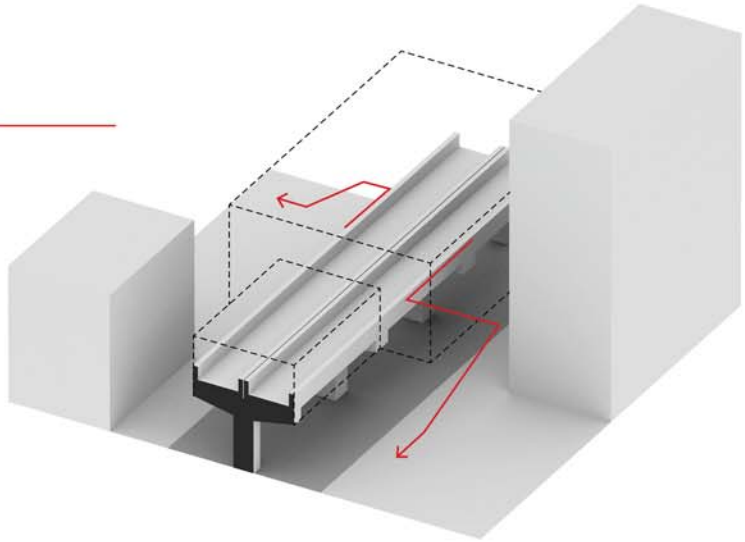


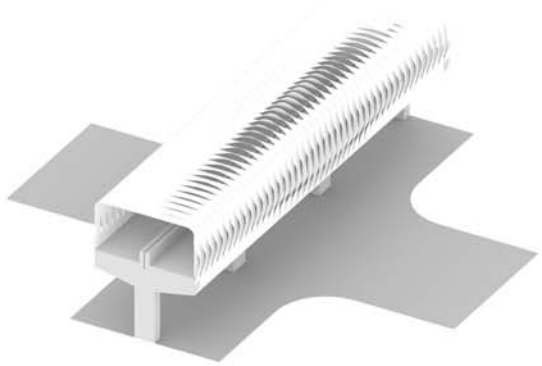
"Negatively-charged negative ions attach themselves to contaminates and allergens, which are positively-charged. The newly-formed larger particles are then able to fall to the ground, and out of the air we breathe."

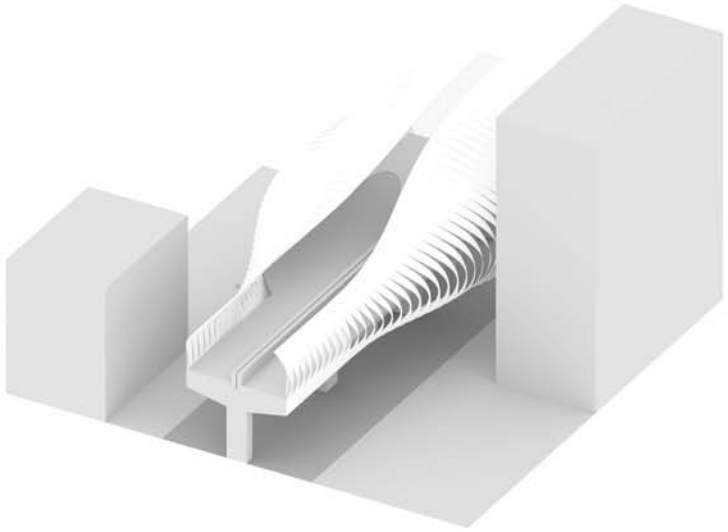


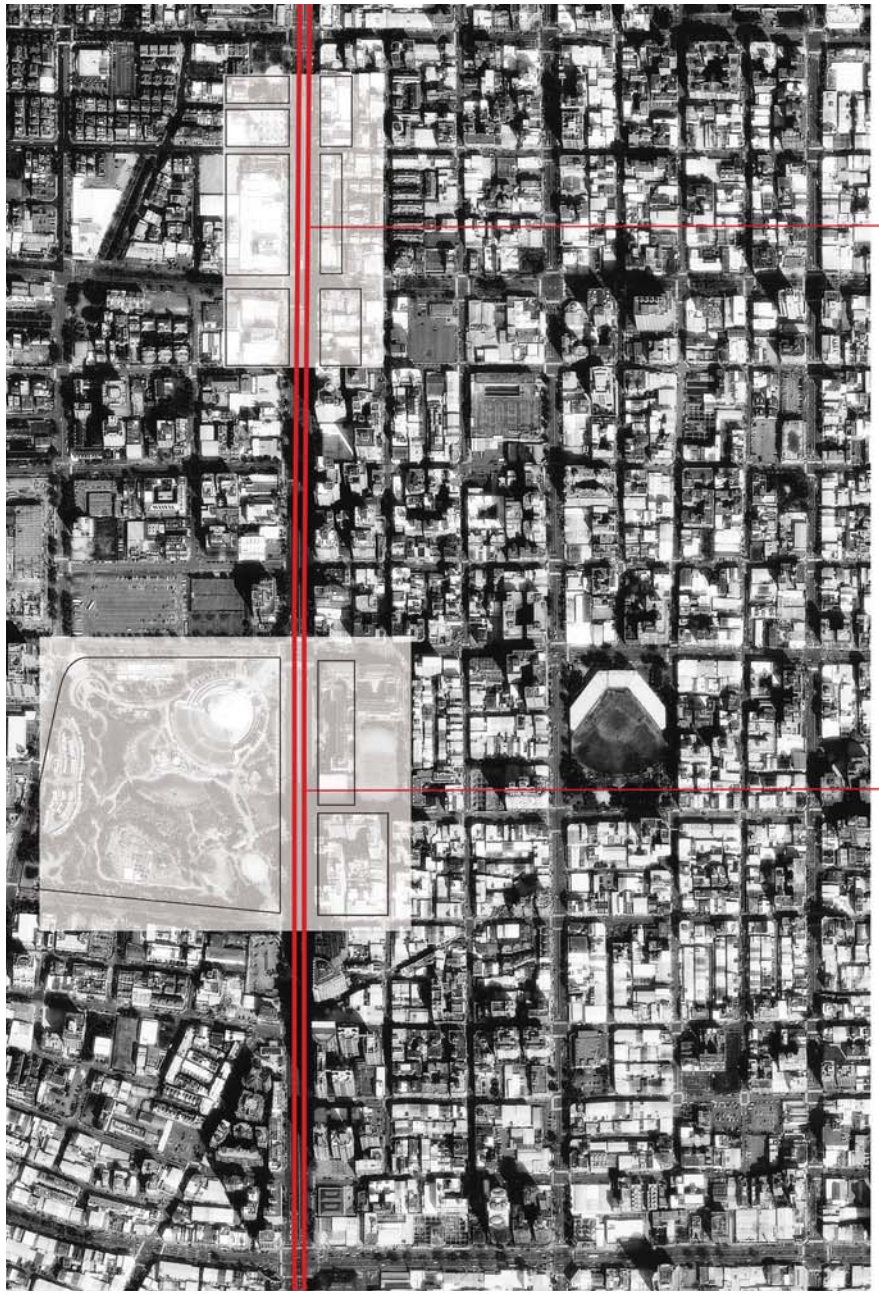


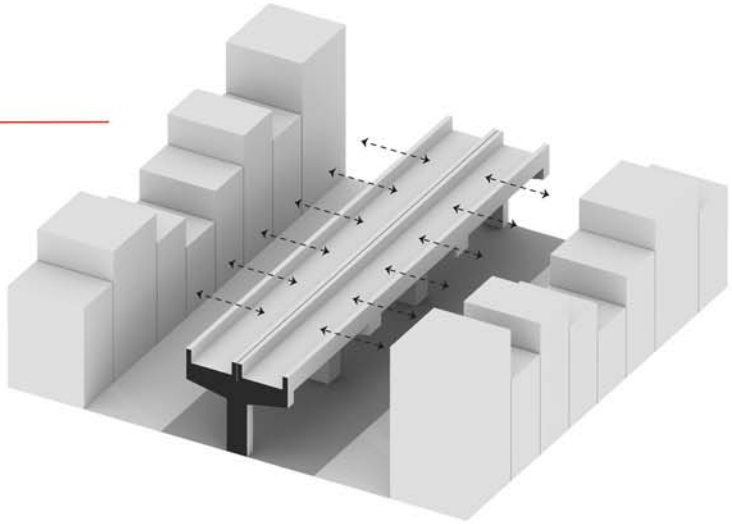


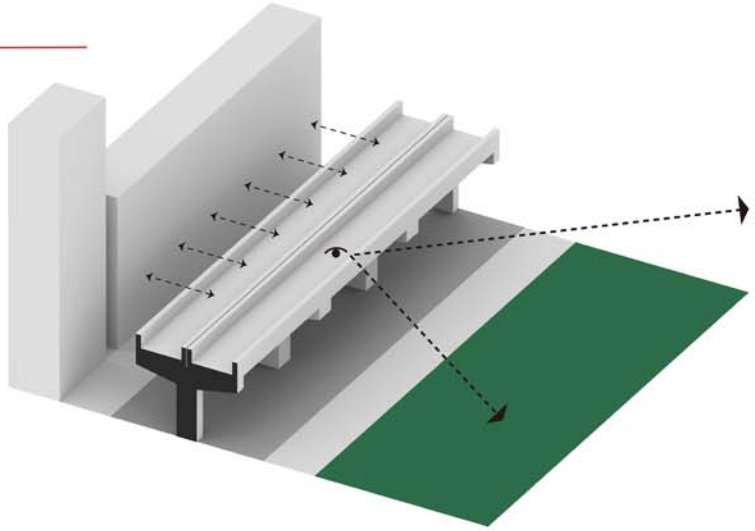


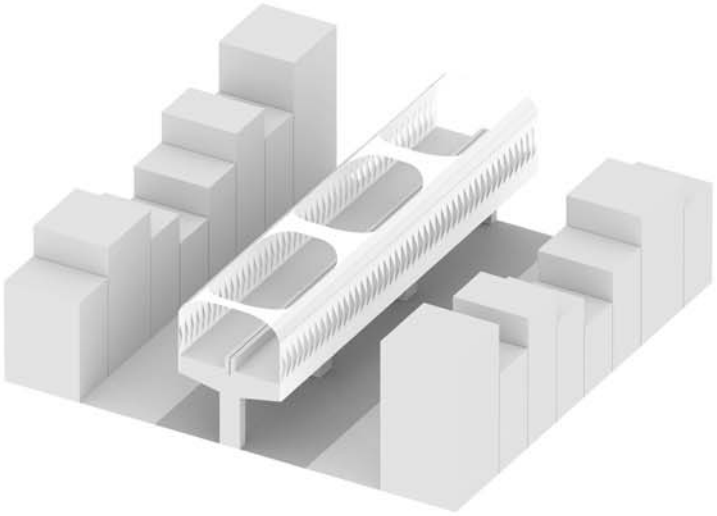


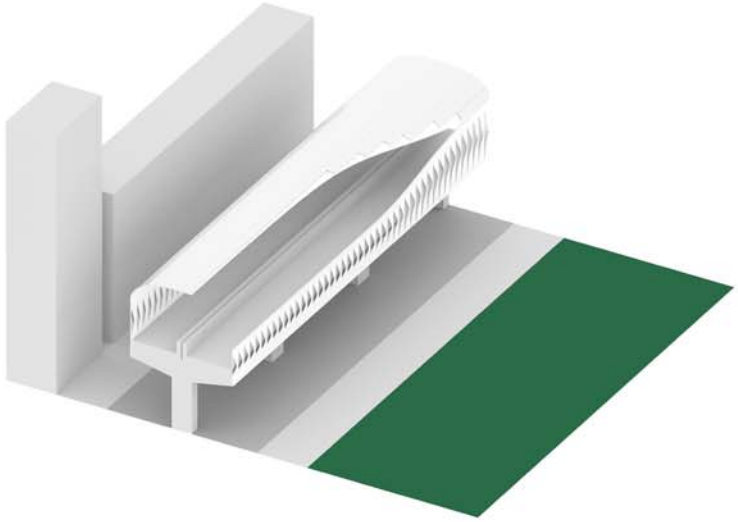


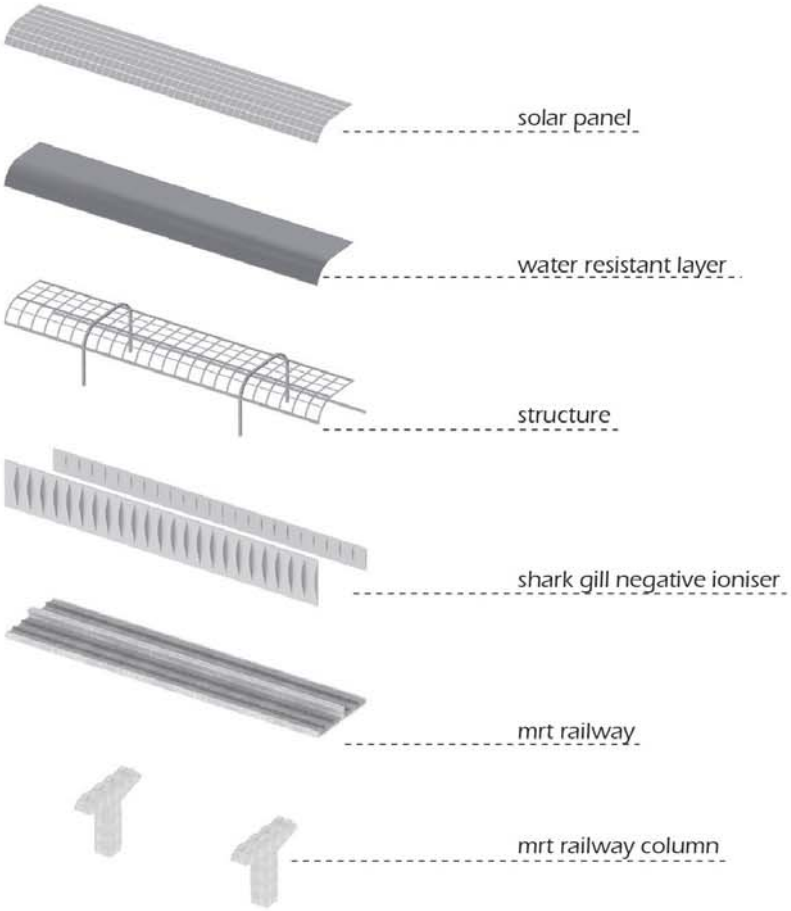




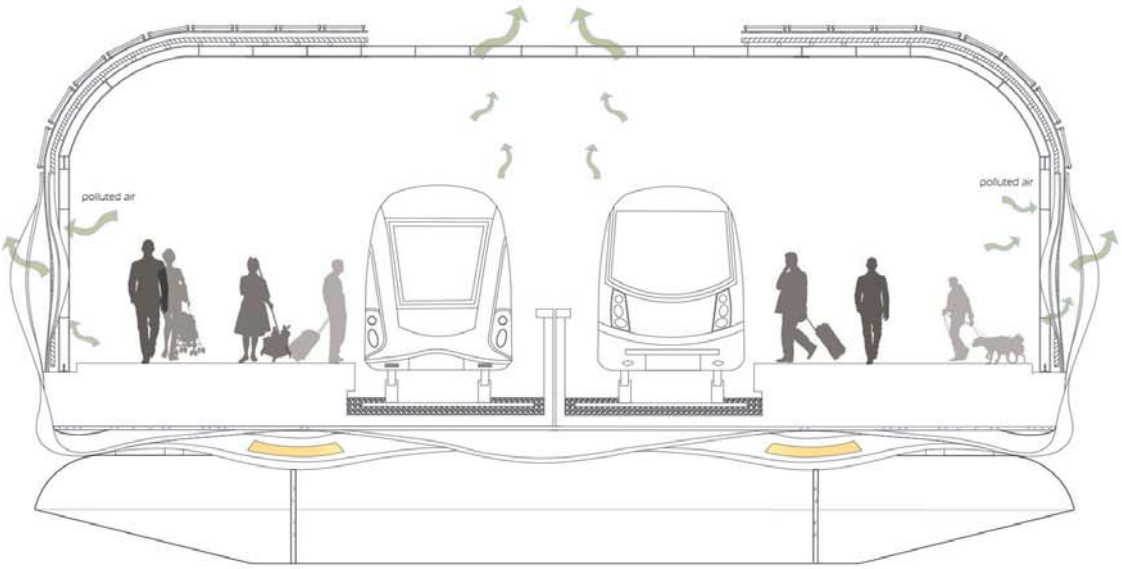


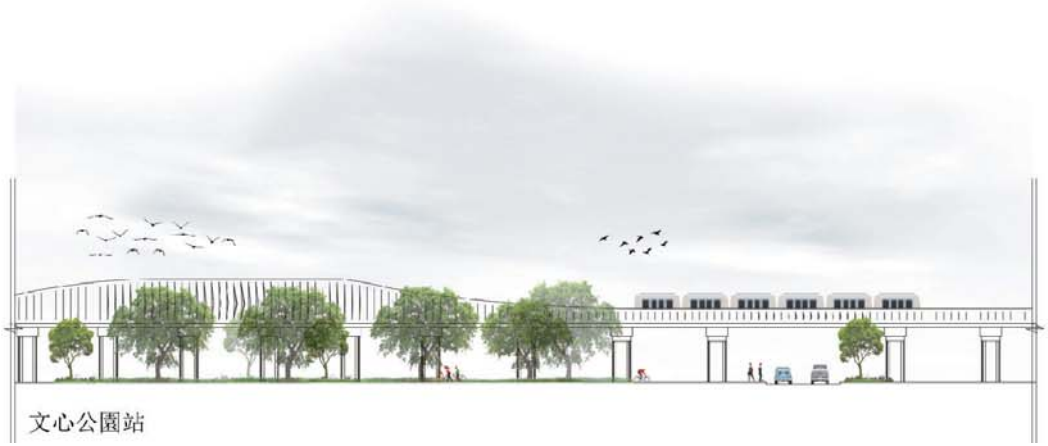






MRT STATION SECTION DIAGRAM



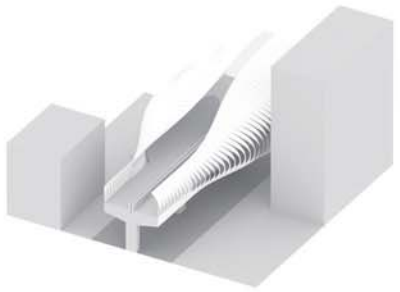

文心公園站


家樂福站

_ MRT Future Location

[Type A]

[Type B]



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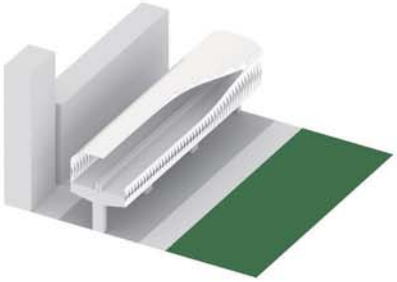

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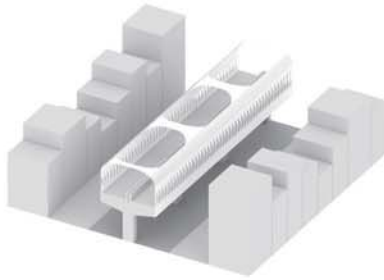
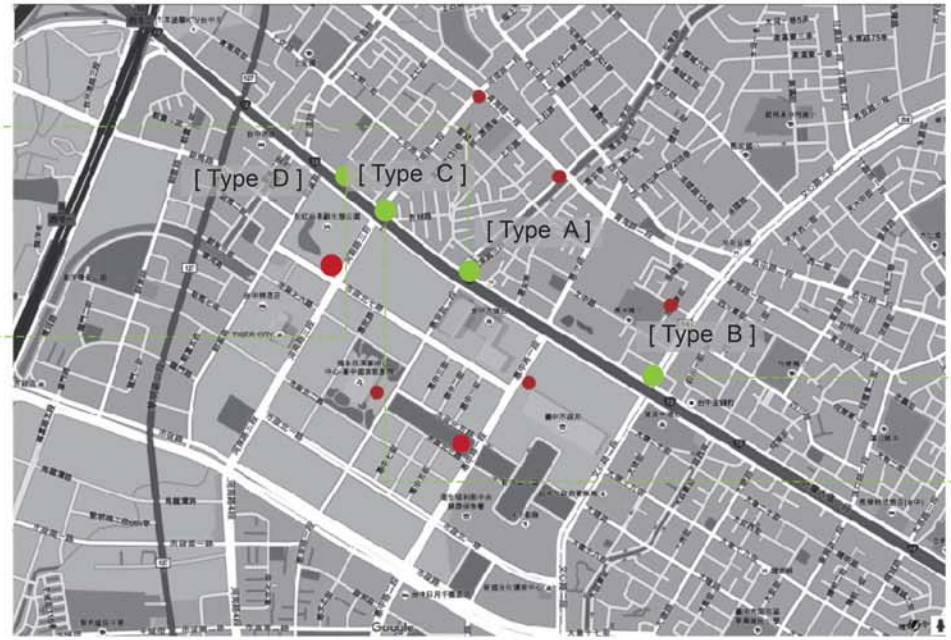
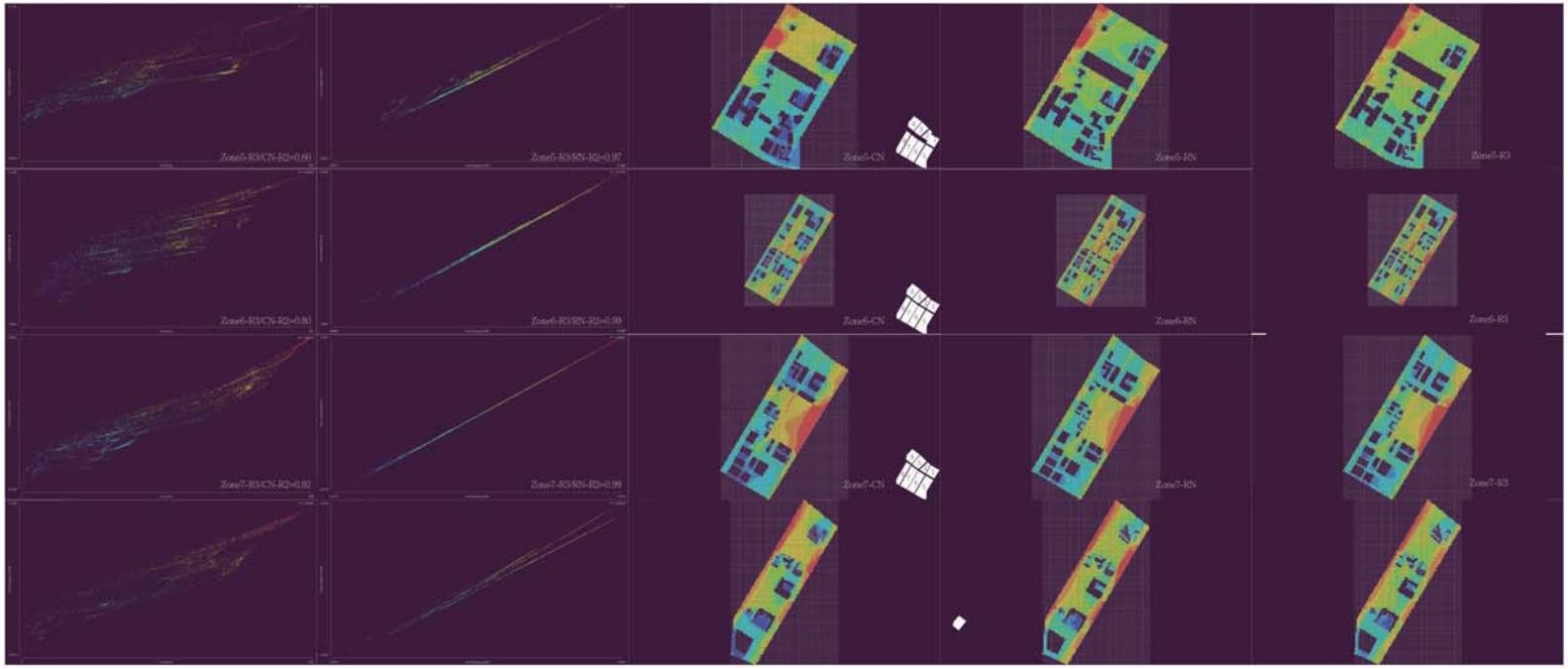




_ Spacesyntax anaylsis



_ Urban mapping

_ MRT Station

Brief

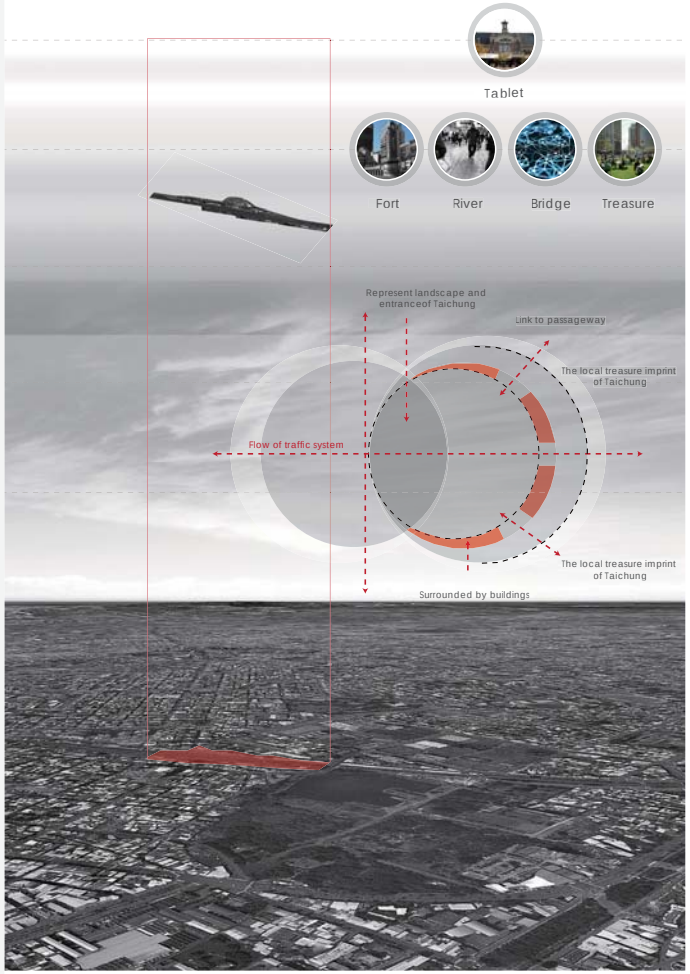
In the periphery of the base of a total of eight street blocks, each property is different. After analysis of spatial discrimination benchmark for floor height,(0.5m) the interaction areas with the highest degree of regional filtering necessarily for those blocks facing Taiwan Boulevard. Therefore, a high degree of small open areas would be necessary to play as a place to link the neocortex of those blocks acting as reference point

The Mughal Game 5 Eelement

Taichung Gateway

Taichung Gateway

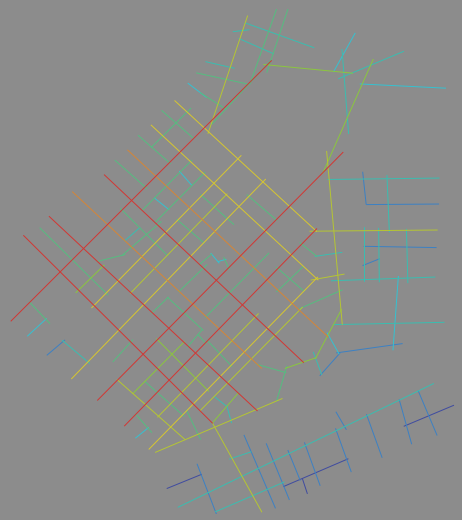
The Mughal Game 5 ELEMENT



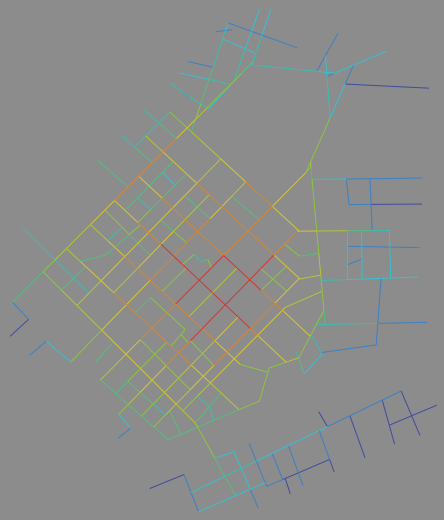
Story Board

Entrance of the city
Symbolized **tablet** refers to the first impression of Taichung
Due to the bustling city and excessive development
Hunting urban texture of natural and historical memory
Remaining dilapidated historical traces
Standing in the train station
Full of high rise buildings surrounding people like a **fortress**
Pedestrian flows like rivers continuing to converge and to interleave with vehicular movements.
Pedestrian movement is to be linked to passageways of bridges.
leading to the local treasure imprint of Taichung products.

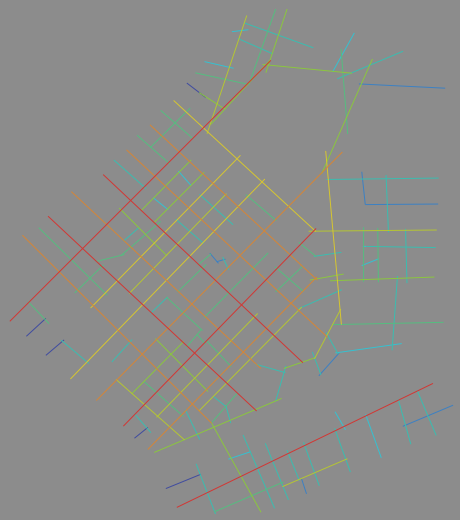
Space syntax analysis



The future urban situation integation(HH)

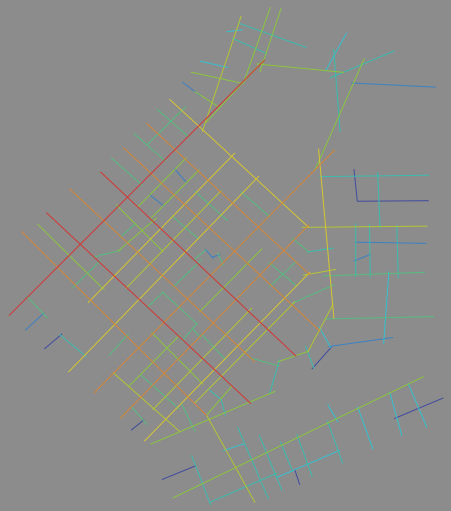


People walk(Integration R700)



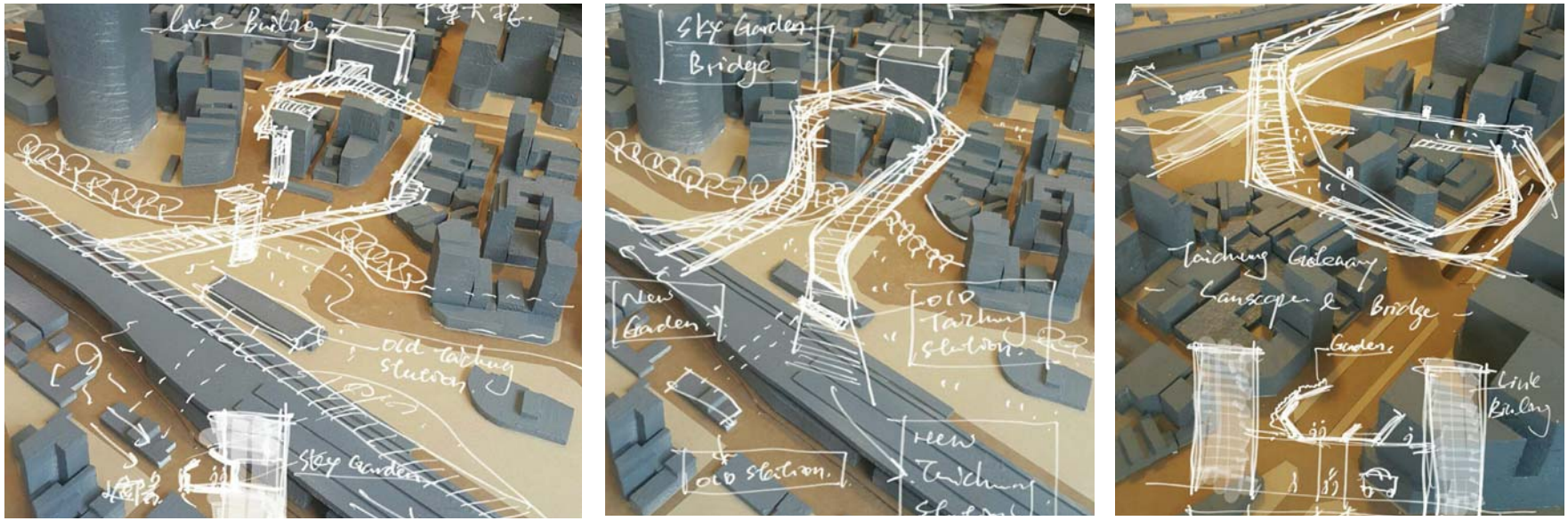
The future urban situation integation(HH R2)

Motorcycle(Integration R6000)



The future urban sitation integation (HH R3)

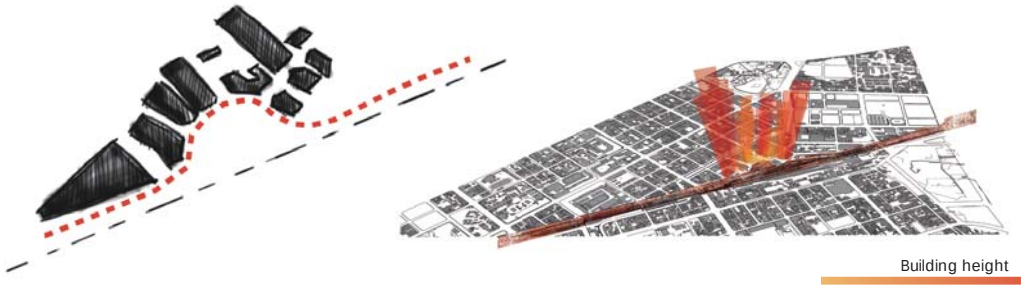
Car(Integration R10000)

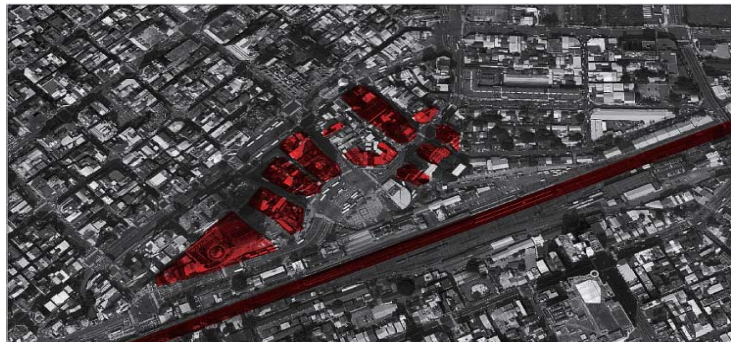


Concept sketches of a link (skywalk) - a hidden bridge

Tablet ⇢ Symbolic ⇢ Represent landscape and entranceof Taichung

Foreigners & local people stagger through places, people gathered and stay here, symbolizing the entrance of the Taichung.



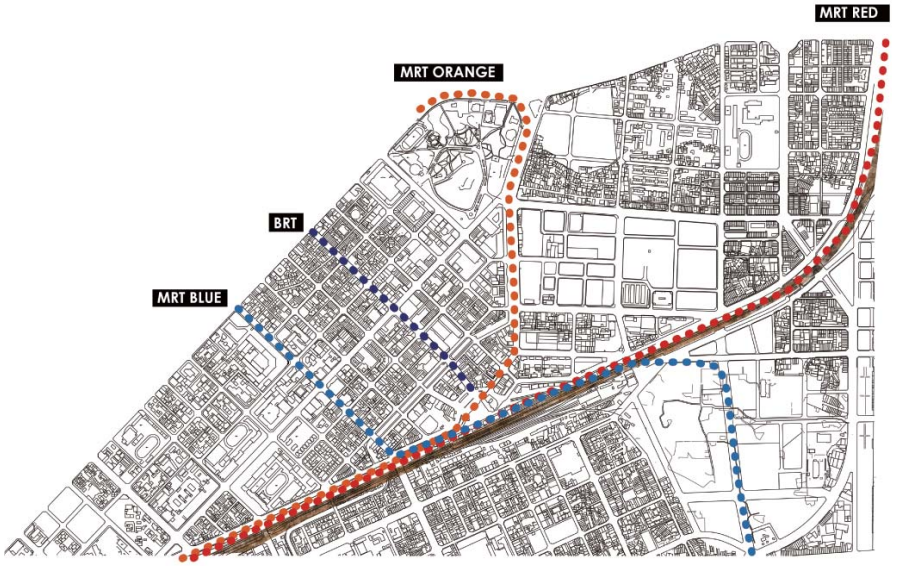


Fort ⇢ Surround ⇢ Surrounded by buildings

With the natural development of the city, changing skyline,
The concrete slowly surrounding the entrance of the city,
The formation of a sense of siege is created.

River → Flows → traffic flowing system of the urban texture

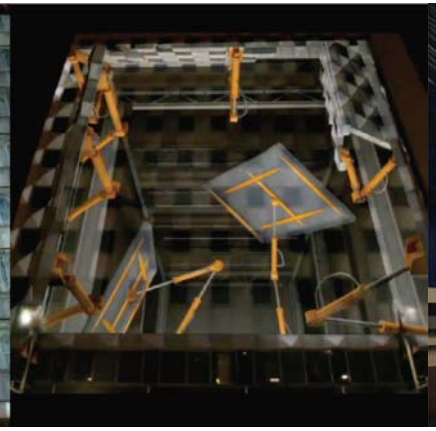
public space in Taichung

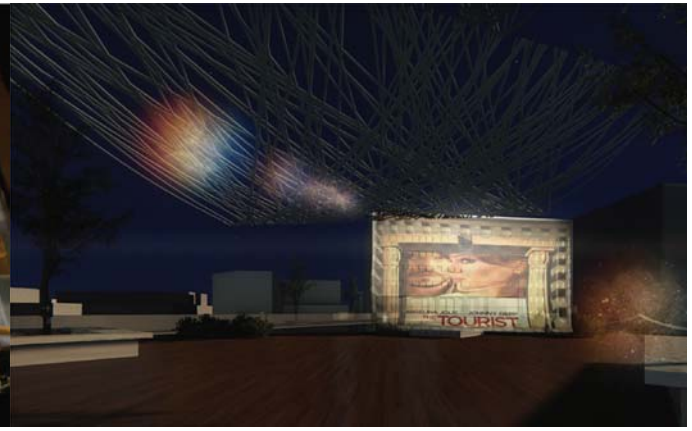


MRT Lines in Taichung

Chian Ye Old building

3D Projection Mapping in facades



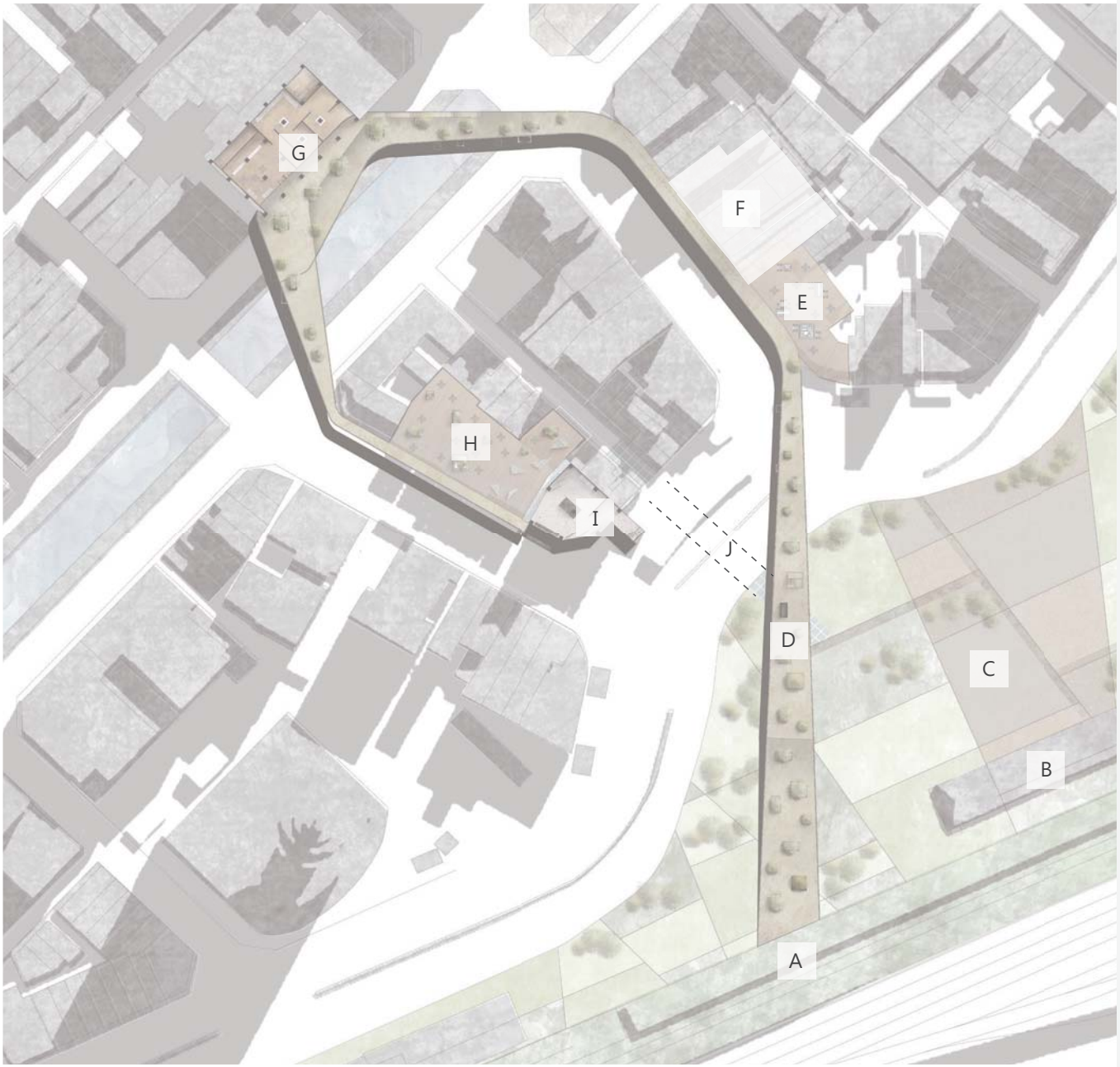


Performance halls / Multi-functional space

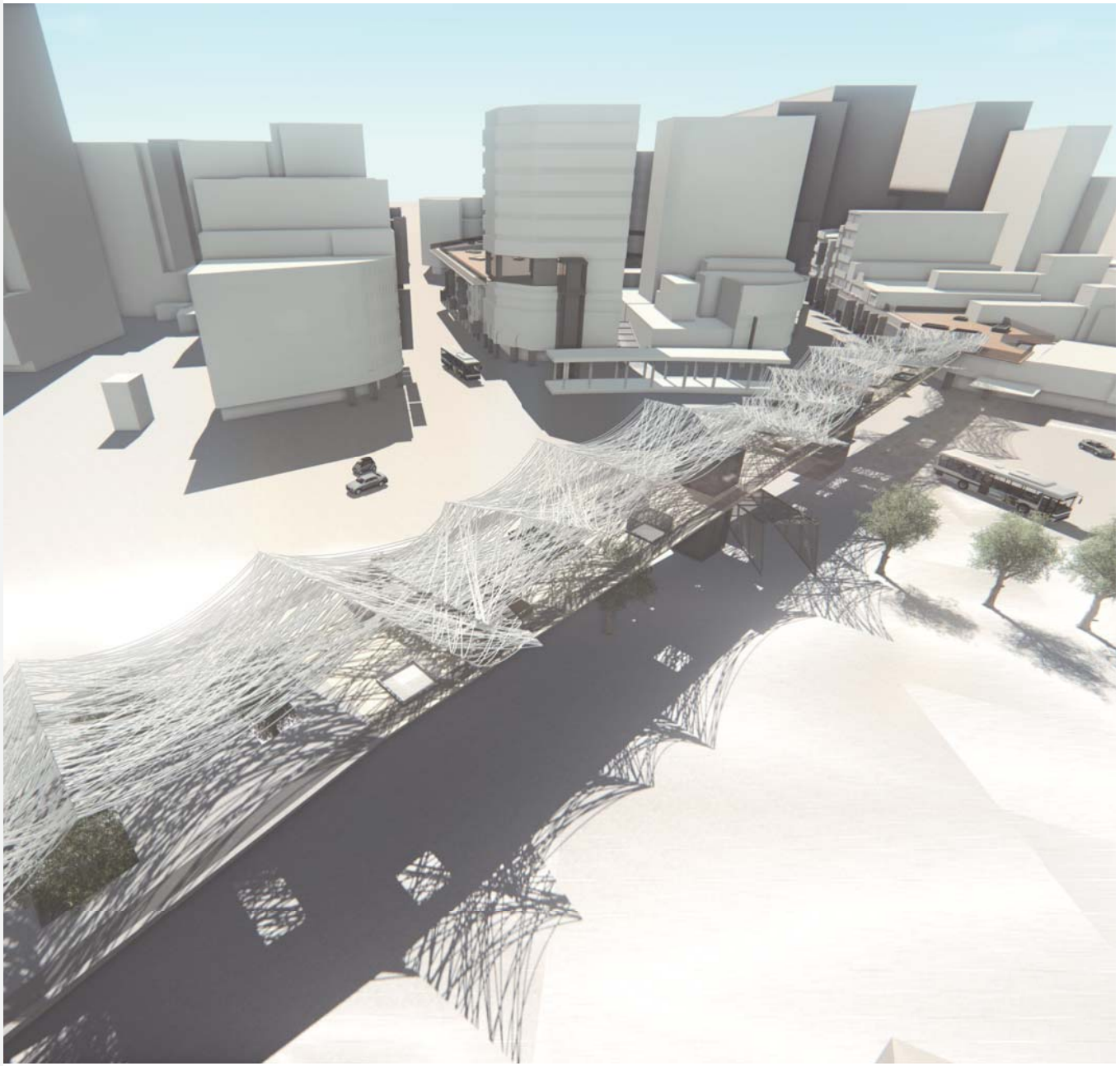
Old Building Regeneration

The Idea

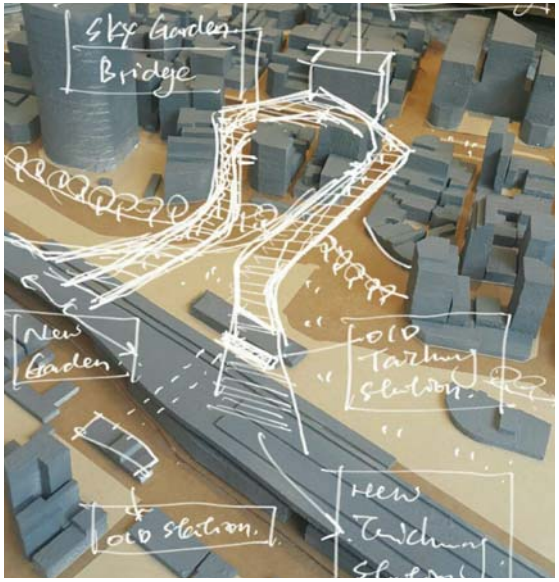
To design a bridge that connects nodes featured with high population activity, becoming a link of passageway in the city. In addition, to treasure the local elements, such as old historical building , to generate an imprint of Taichung City.



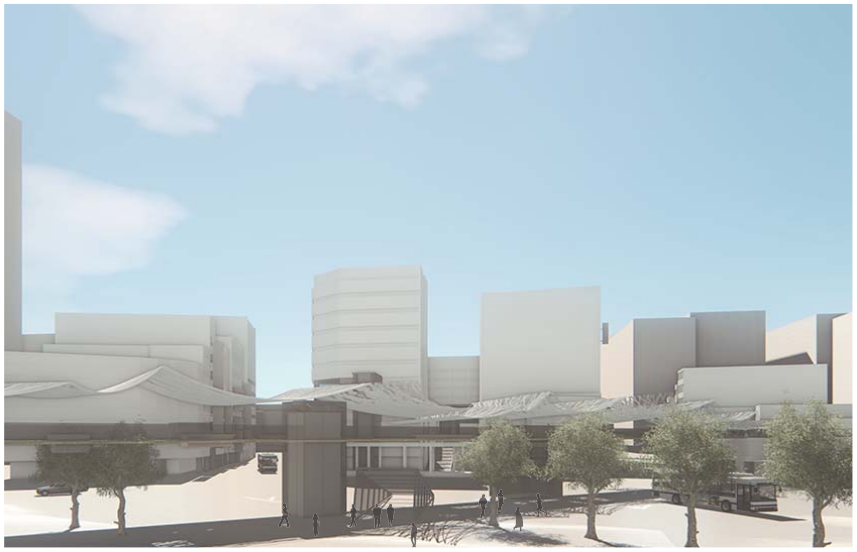
A Green belt
B Taichung old train station
C Piazza
D Skywalk garden
E The rooftop plaza
F Sky shopping street
G Performance halls / Multi-functional space
H The rooftop plaza / Coffee shop / gallery
I Gallery
J Pedestrian subway



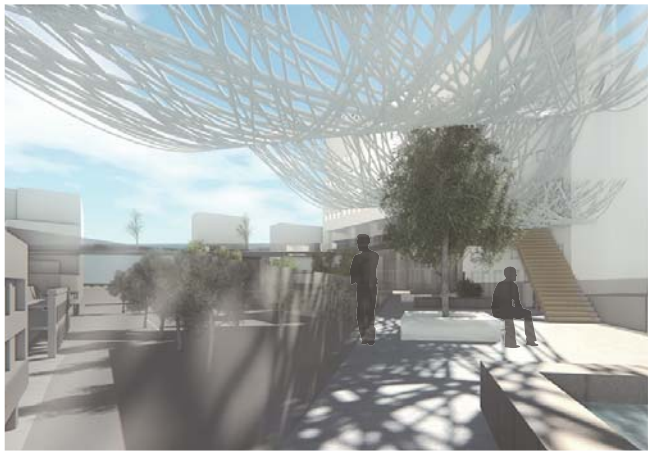
Giving a transparent material to enable light penetrating into the underground walkway

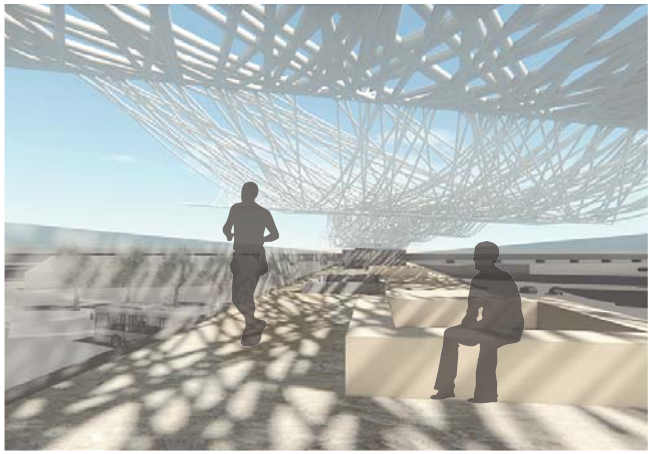


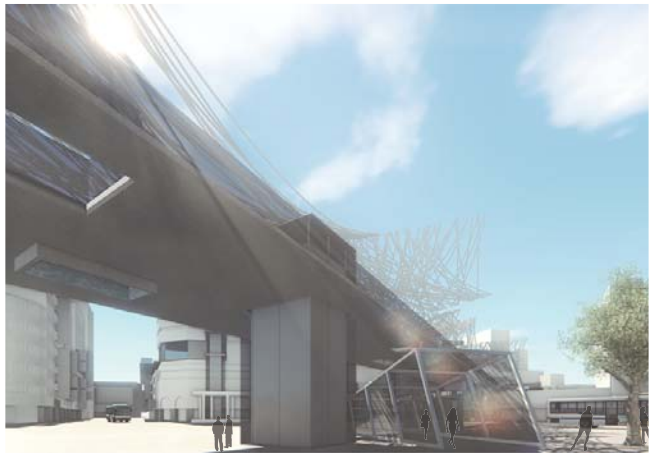
The idea is to connect nodes that encourage activities to occur around the area



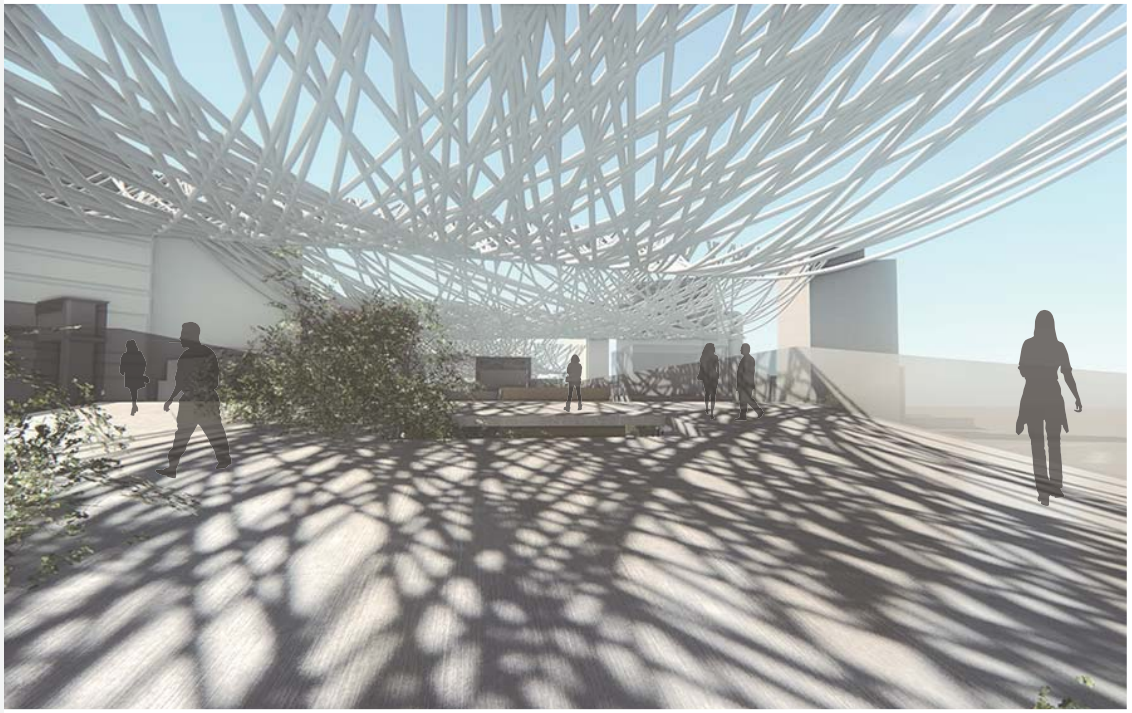
Perspective view of the skywalk from a distance. The shed underneath the skywalk provides opportunities to have more activities during the day, in Asia, people like to hang out in the spaces that are not exposed to the sun. Due to our geographical location, we are scorched by scorching sunlight throughout the







The skywalk is to designed to integrate with the surrounding buildings. The initial idea is to create a green belt within and into the buildings, letting the lanscape integrate the outdoors with the indoors of the buildings. A variety of functions are placed under a large roof shed to create a vivid space that is beneficial for the greens to grow.



Trees planting and light design

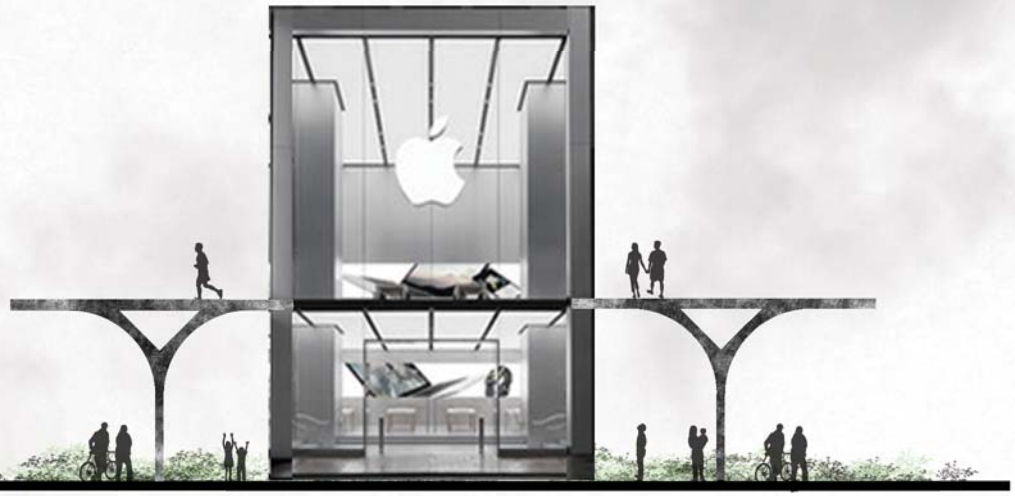
Street furniture and waterfall
Playing with water Place

Public toilets

Landscape open space

Elevators

Taichung local Souvenir shop
Bookstore / Coffee shop



Skywalk garden section

When the second entry appears in the old building
Let the crowd embark on the roof that
provides a more sun shading platform.

Shopping malls or Performance Hall

Skywalk garden is a good place for people to take a walk or lingere around after a meal or shopping in the building, the city should have more public spaces to encourage people to stroll around the city to make the city become a lively space.

1st PAAU Workshop + Forum 2013

UPDAMI Space Syntax Urban Design Workshop in Yi-Lan

The Place

Yilan Train Station

蘭城之星開發計劃 a future plan from local government to create a big city center for local people, tourists, and workers, by connecting two main stations and adding new programs near by the train station.

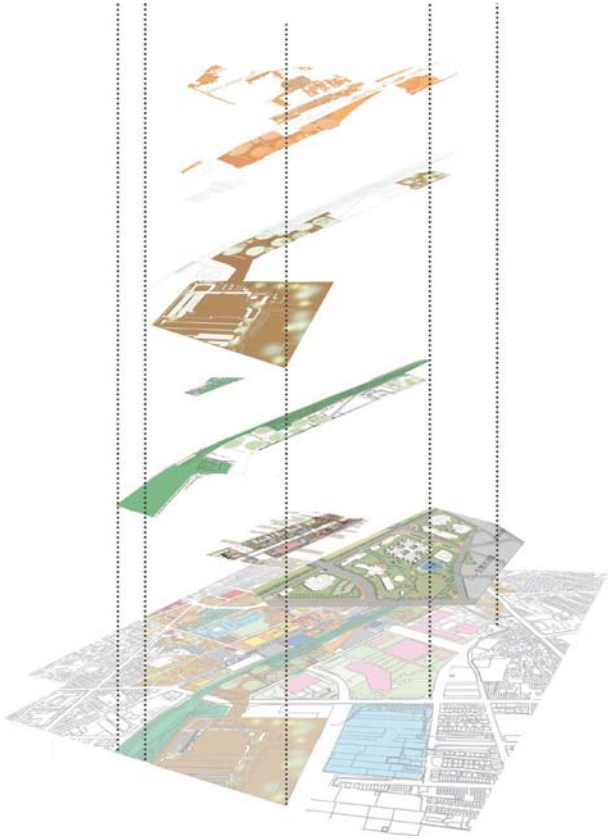
Public link

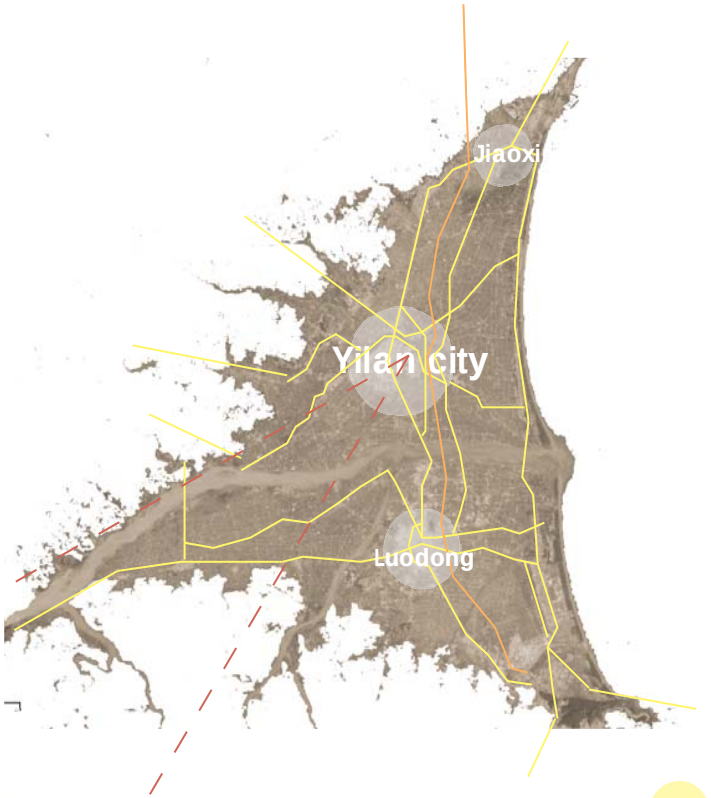
Farming link

Green link

new buildings on
2 sides or railway

Land use map





Main transportation in the town

Main high way in the city

From taipei to yilan is only take 40mins
Yilan 6.5% Jiaoxi 34% Luodong 59.5%

Jimmy park

Diu Diu Dan

Warehouse

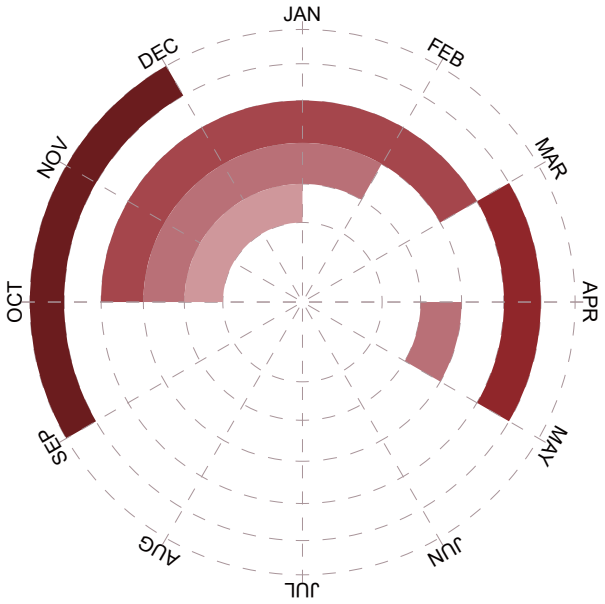
Parking area

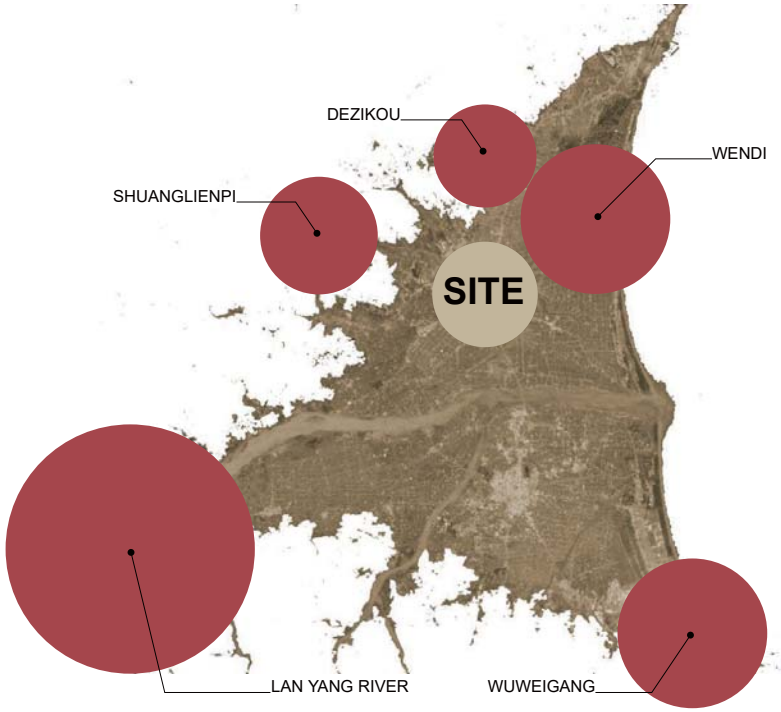
Goverment office

Bus station

Proposed railway exits
Bus station
Proposed market area
Park
Public space
School
Gov ernment area

BIRDS IN YILAN





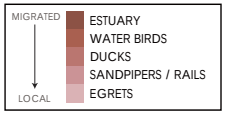
* THE RADIUS OF CIRCLE DEMONSTRATES
THE AMOUNT OF BIRDS ACCORDING TO RESEARCH


EGRETS


DUCKS


SANDPIPERS


RAILS



BIOLOGY CENTER

The East-coast of Taiwan possesses huge area of greens for scientists to preserve our green date, and to prevent the extinction of flora and fauna.

EDUCATION CENTER

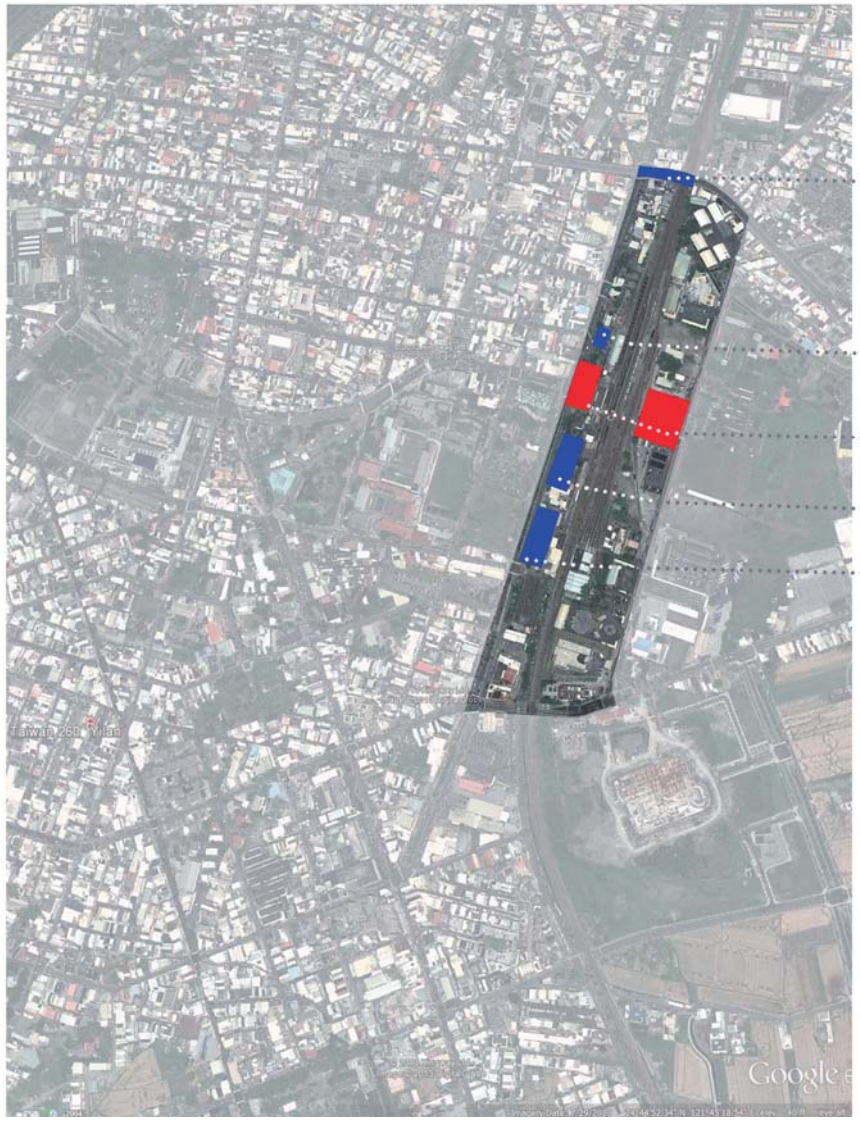
The people requires a better quality of medical treatment the local people should try to promote the countryside environment to the tourist.

DIFFERENT GENERATION

Hotel
workers,tourists,local people
New residents
retired people,foreigners,students
Business area
newcomers,workers,students,
young generation

PARK CENTER

inculding the big nature reintroduced in the city
to link between the birds,trees,and green path.



Important nodes

The immediate context around the train station was studied in detail, four important nodes; the Jimmy park, the Japanese house, the Warehouse and the existing market, were identified. Trying to see how the train station could influence and enhance public activities at these place.

The market spaces are losen and with potential, thus the connections can bring in more people to the old market.

The market closes at 10 am. and the shops remain closed during the rest of the day. If the road of the market has been connected toward the surroundings, it may generate more opportunity for business potential.








landspace | Night market | Jimmy house | Commercial | Elevator | Street furniture

Jimmy park attracts only tourists and not local inhabitants

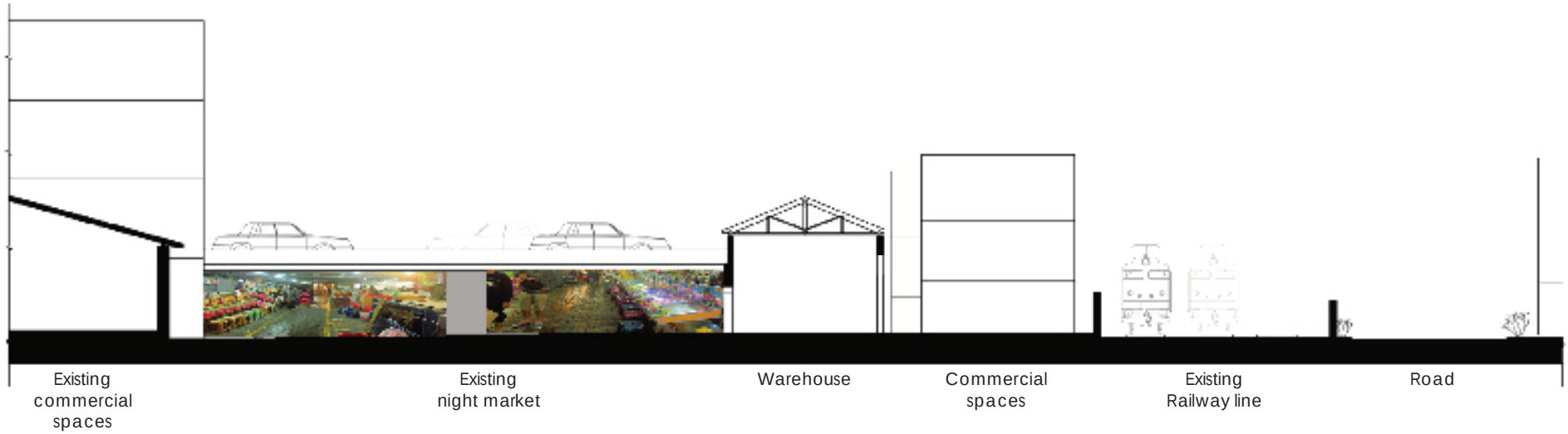
Most of the times the park is empty during the morning hours

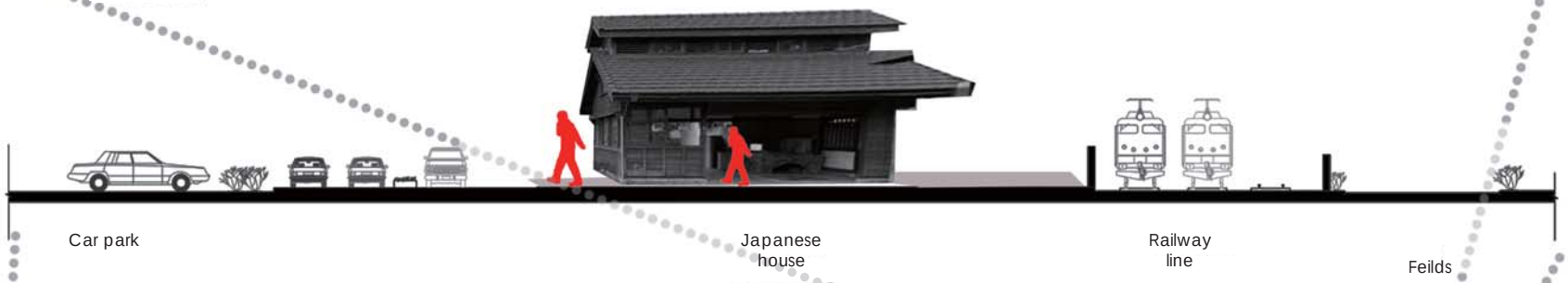
All the tourists who visits the park take pictures and leave. Inspite of benches provided they do not halt at the park.

A few stalls, selling juices and drinks
not many people waiting at the bridge during the day.

Area of night market in the afternoon

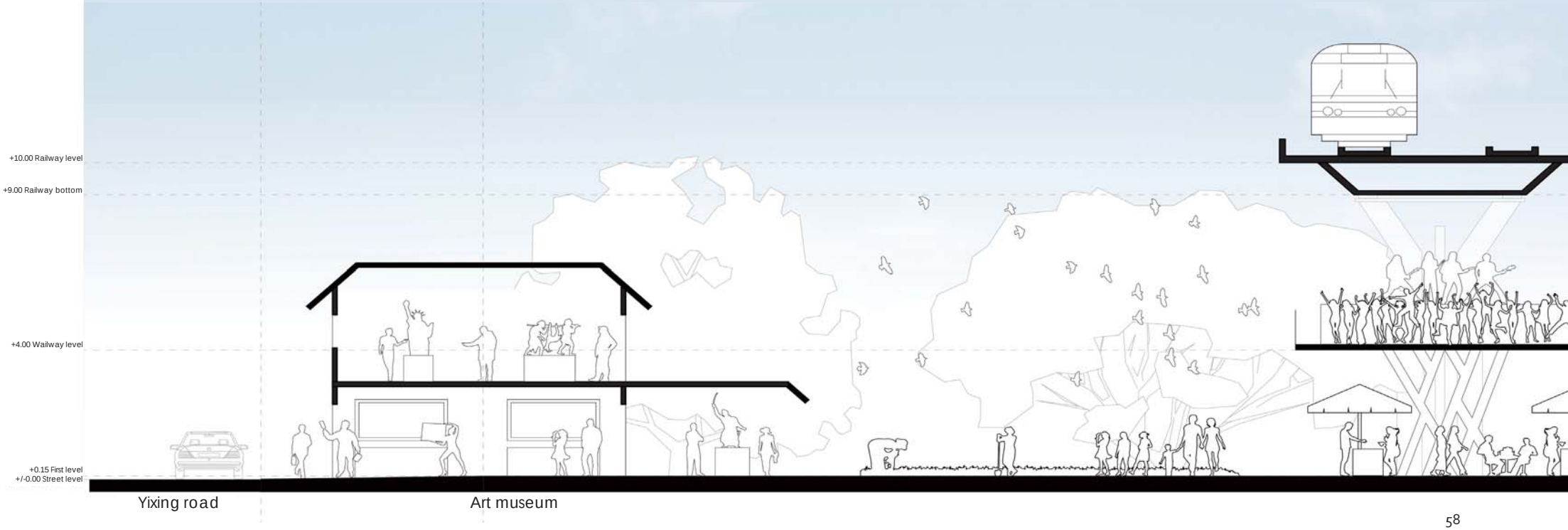
The night market is a little distance away from the Train station and it does not provide car parking space.
The current car park is located at the opposite side of the station. Perhaps,linking the market to the surroundings which can be moreconvenient to local inhabitants and visitors and may even make the train station a lively place.
Moreover, the de-function warehouses can become functional ones again.

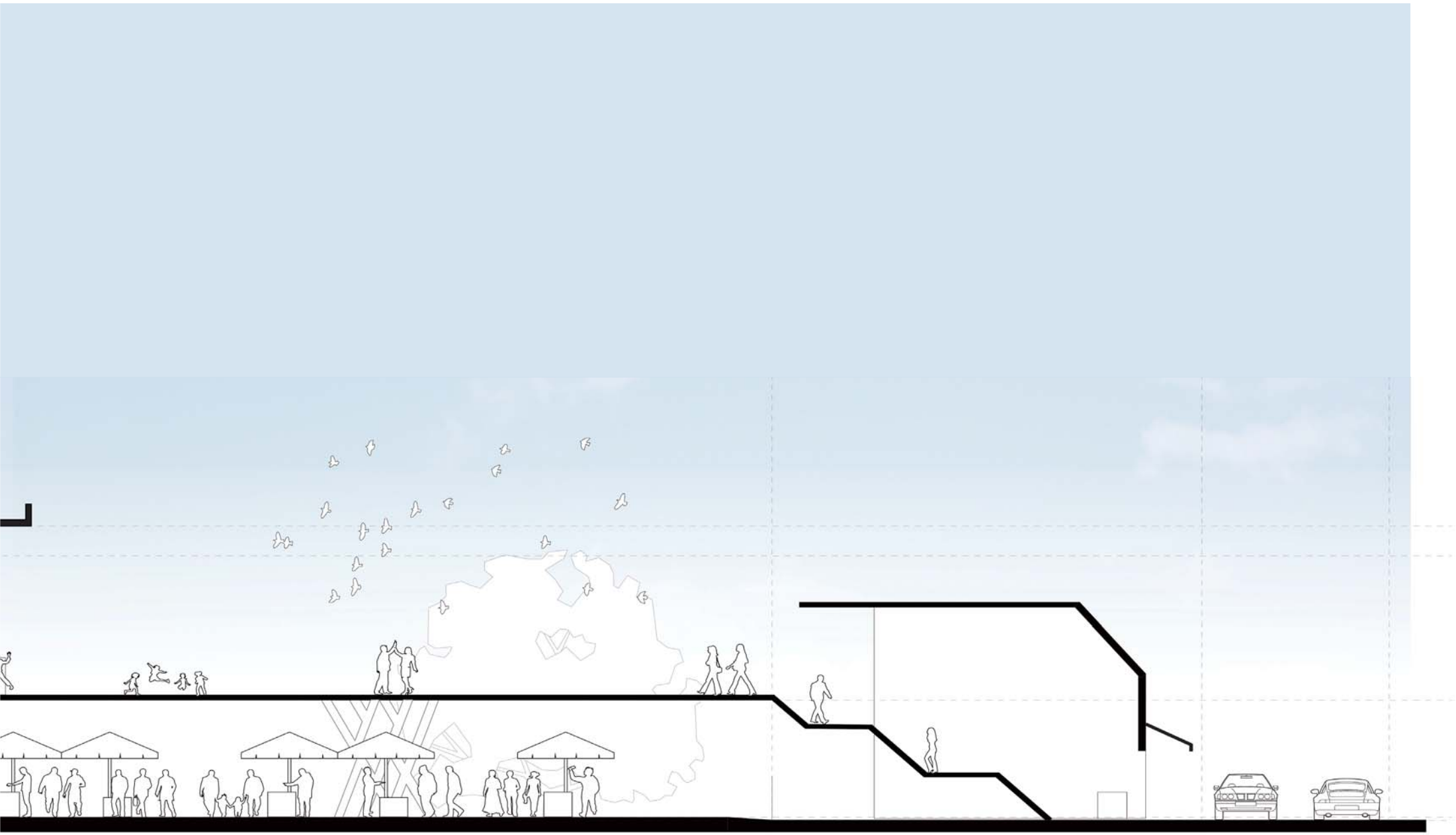




The local people and tourists pass by the Japanese house. The significance of the house has been lost as there is not much activity.
Furthermore, the old bus station Besides it is not functioning either

Section A-A'


+10.00 Railway level
+9.00 Railway bottom
+4.00 Wailway level
+0.15 First level
+/-0.00 Street level
Yixing road
Art museum



Site on exsting railway

Train ticket station

Linsen road

Section B-B'

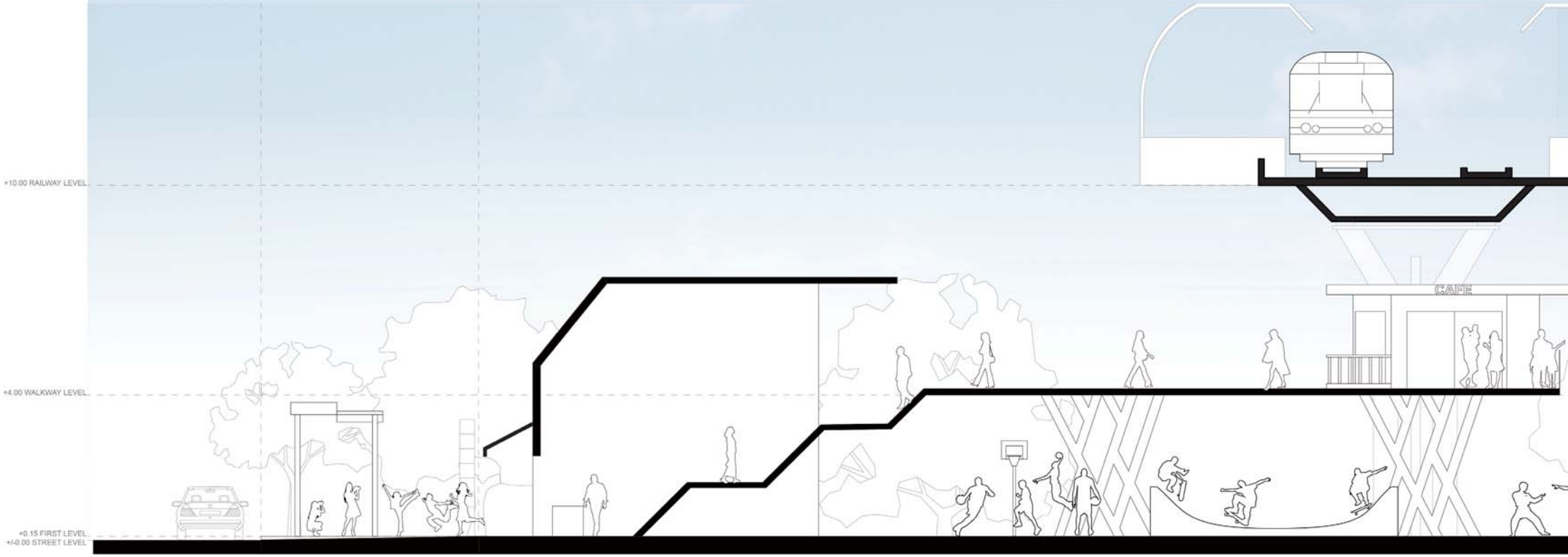

+10.00 Railway level
+4.00 Walkway level
+0.15 First level
+/-0.00 Street level
Yixing road
Old train station

Site on exsting railway

Train ticket station

Linsen road

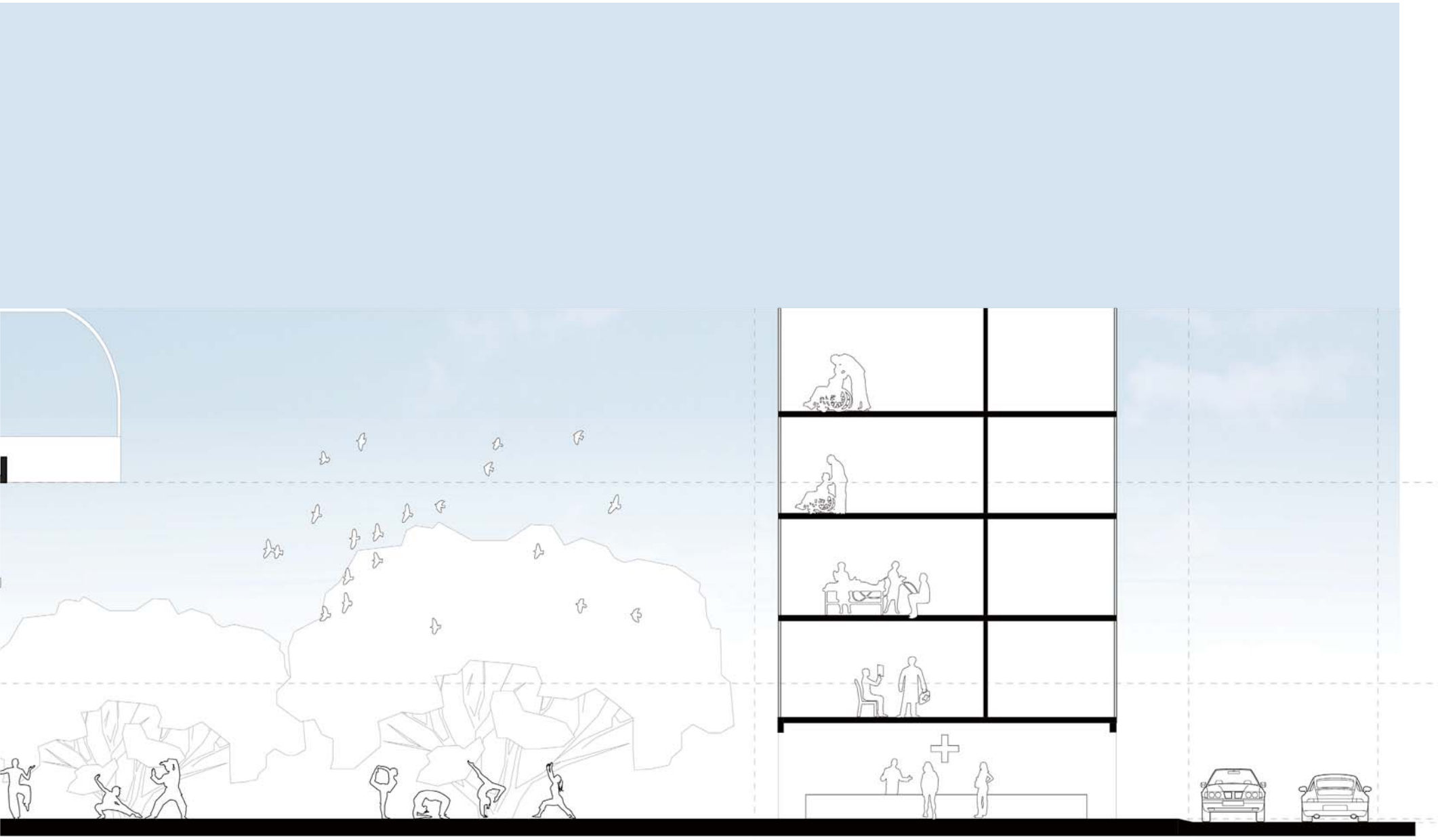
Section C-C'



Yixing road

Jimmy's artwork square

Train ticket station



Site on exsting railway

Hospital

Linsen road

International competition

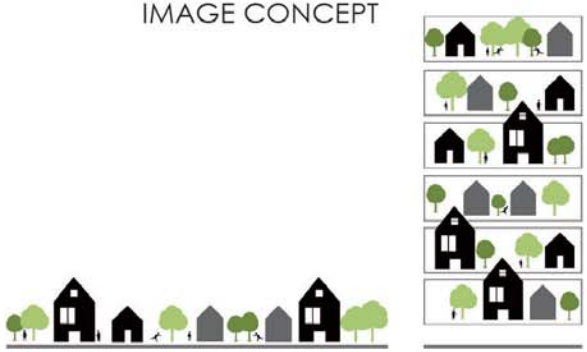
CTBUH Student Competition

Site
Location

Phnom
Penh

CONCEPT SKETCHES

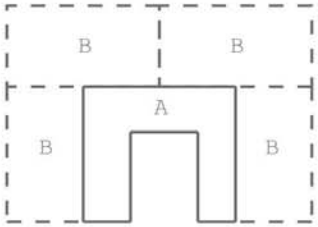
01
IMAGE CONCEPT



Trational villages

Sky tree

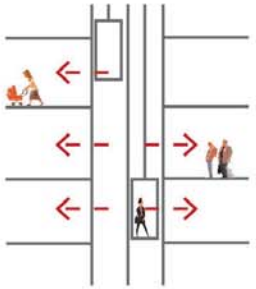
02
PLAN RELATIONSHIP



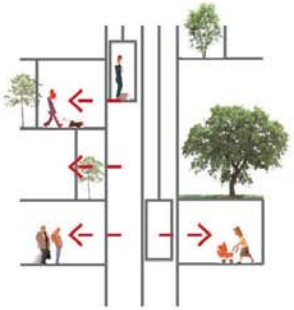
Original plan type

New garden type

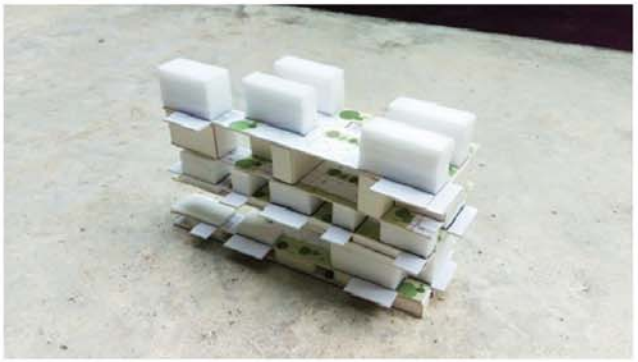
03
SECTION VISUAL

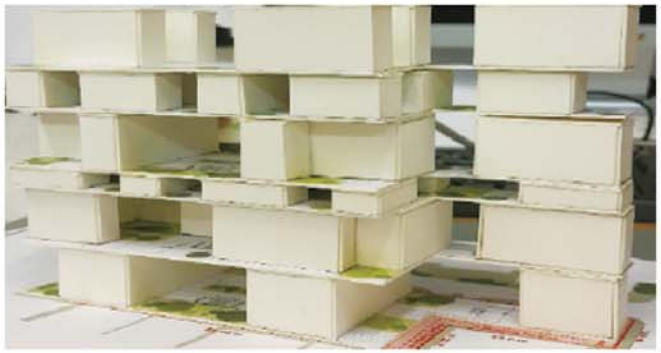


Commom building



Vertical green

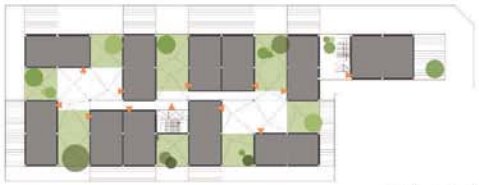




DESIGN PLAN

__Ground Floor

_ 2, 4,15 Floor



_ 3, 8,13 Floor

_ 5 Floor

_ 7,10,14 Floor

_ 9,11 Floor

_ 6, 12 ,16 Floor

DESIGN BRIEF

Cambodia is currently faces faces a lot of construction and is at the beginning of transition, the majority of low-density residential gradually extending to the sky line. Start thinking about the design of local people's habits, and for the local popular housing types or scale to categorize, such as single-family villas. The low density and medium density housing will be breaken up and reassembled in vertical type, like constantly overlapping layer. Imagine the future of collective housing can have more open spaces and green cover rate, improving the normal collective housing's neighbor relationship. Due to stacking of different strata on the building facade, staggered fill the space void space. Greening the city and regulating urban microclimate.

Biomimicry competition

Biomimicry Global Design Challenge

HOME FOOD GARBAGE DECOMPOSER

by Jiaqi Tan / Echo Yang / Rex Chen / Wentao Zhang

350,000,000 tons

global consumer food garbage each year

≈ 10% totally global food supply

1,993,000t

consumer food garbage,Taiwan,2014

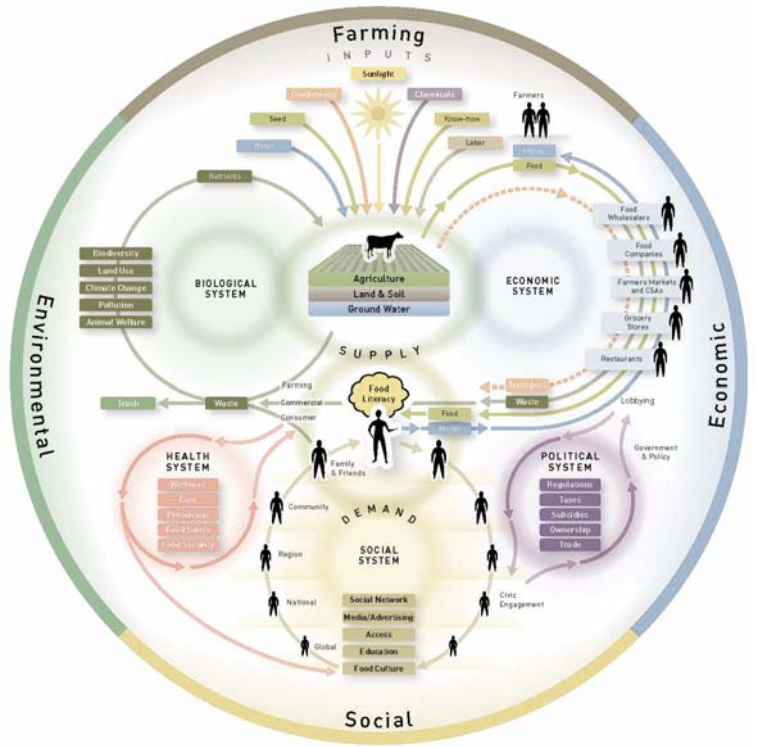
volume ≈ 6 Taipei 101

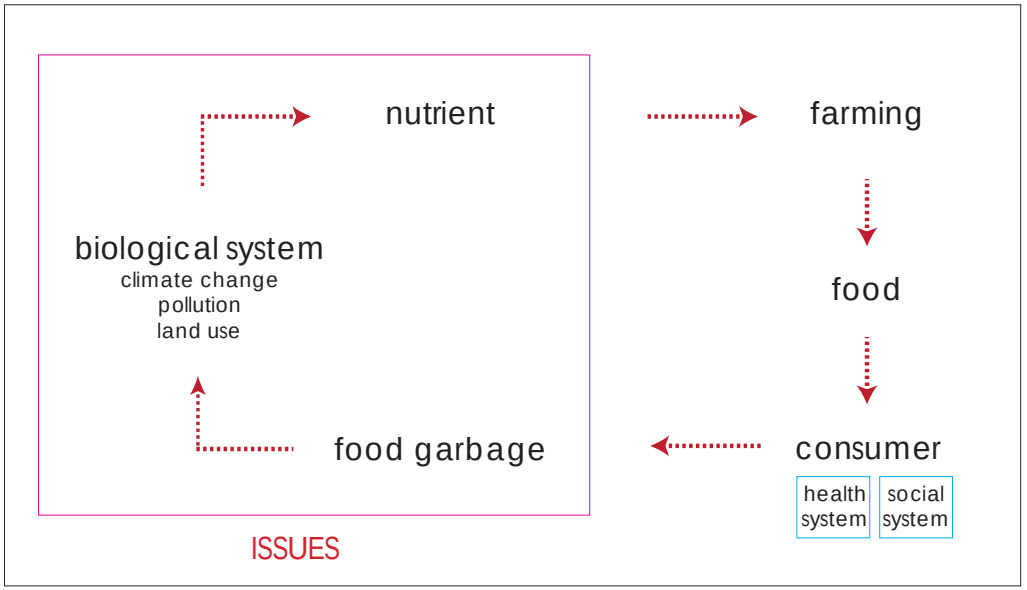
incineration & landfill **60%**

recycle feeding pigs **28%**

recycle compost **12%**

Food garbage issues & strategy in food system





Strategy: Aerobic compost at home

- long-term compost space
- continuously enought oxygen

FOOD GARBAGE RECYCLE MODE IN TAICHUNG

Resident in Taichung creating food garbage compost 5,394 ton each year, in a consequence creating green house gases during the process.

feeding pigs 90%
46,797 t each year

mixture of food garbage + long time transportation

↓

high healthy risk of pigs

↓

high risk of human food security

+

govenment plan: decrease the rate of feeding pigs with food garbege

↓

How to deal with amounts of food garbage in Taichung ?

FOOD GARBAGE TRANSPORTATION PROCESS IN TAICHUNG

food garbage stays in transportation process for 24-48 hours before being dealt with
5,394 t each year

in house

on its way to transfer station

recycling process

in transfer station

on city roads

garbage rotten

↓

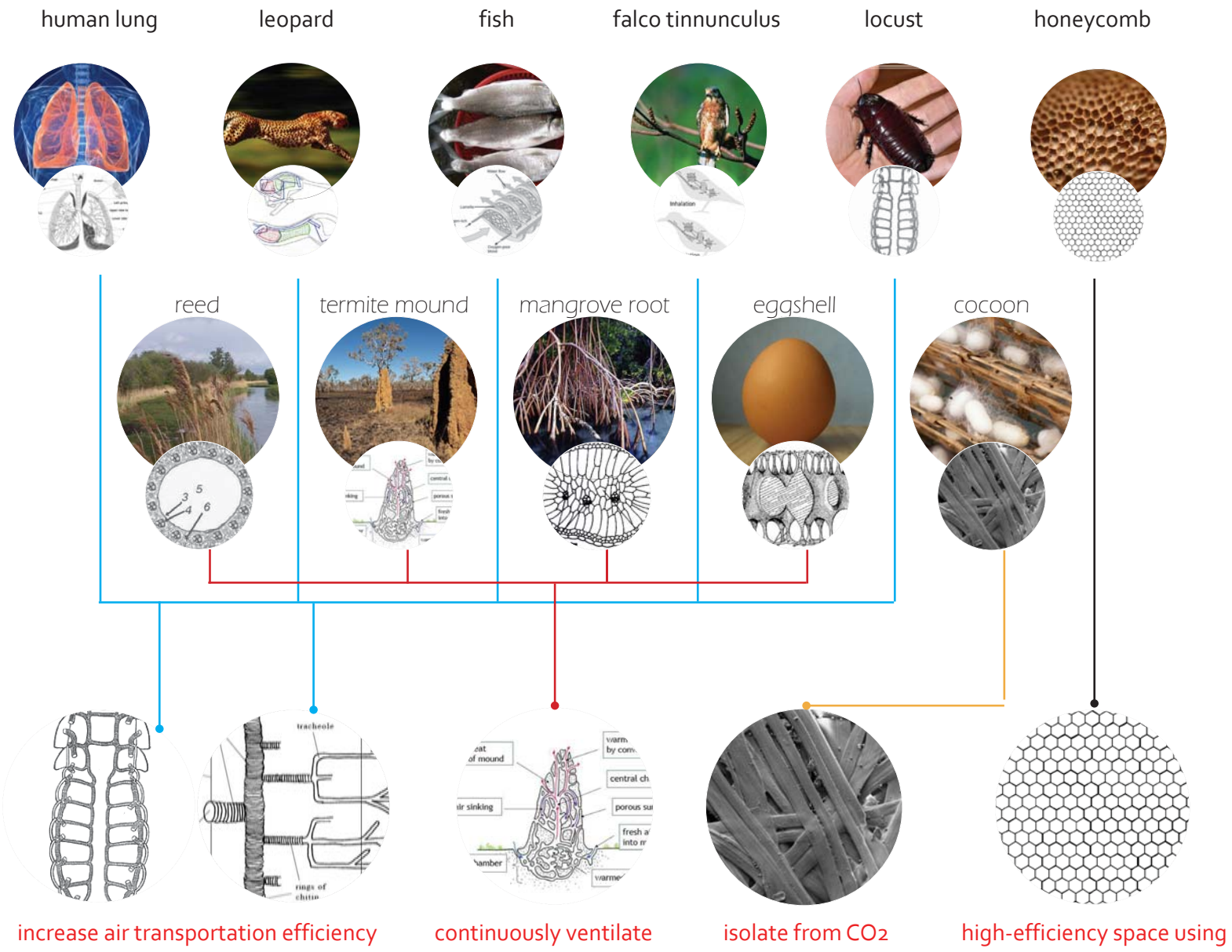
bad smell
+
breeding germs

↓

pollution
+
health risk
+
climate changing

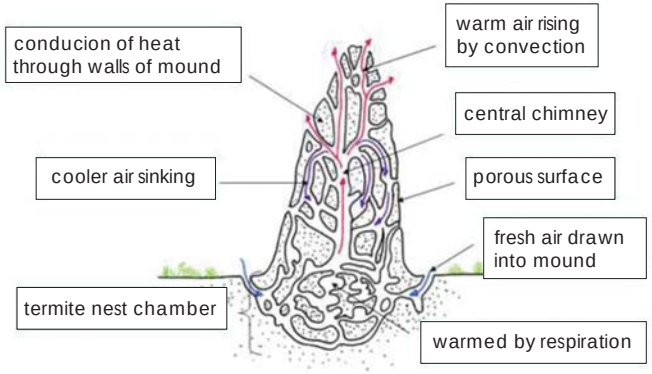
How to deal with negative impacts in transportation process ?

ORGANISMS AND BIOLOGICAL *STRATEGIES*

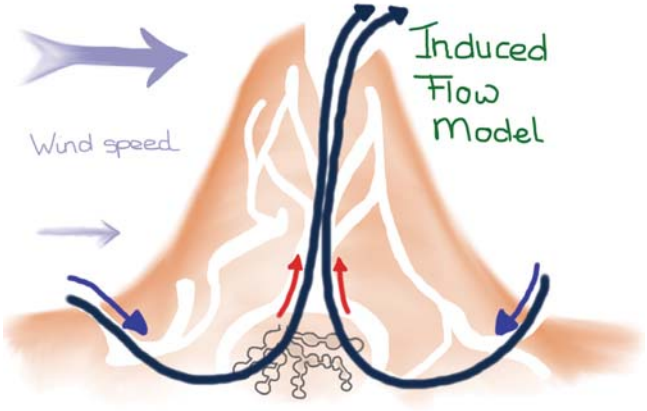


Function: High-efficiency respiration

strategy: continuously ventilation

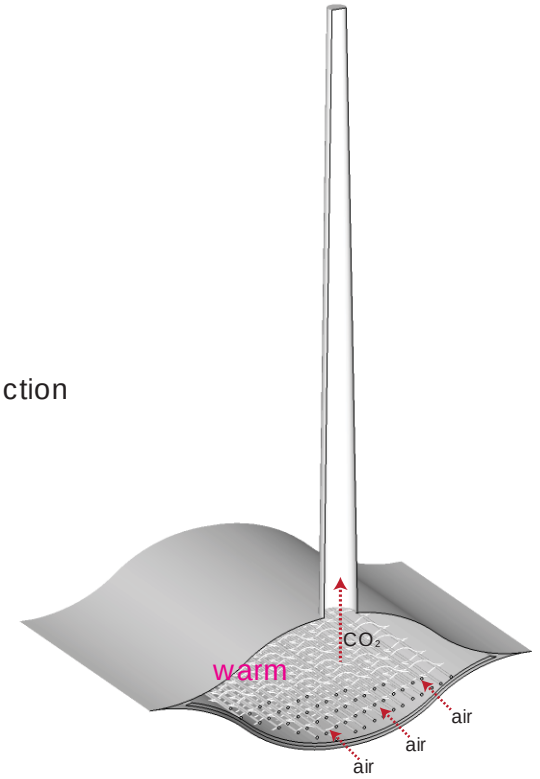


case study: termite mound



case study: thermosiphon flow model

compost unit section



Design intuition

air is coutinuously circulating

air outside is pushed into the unit through tracheas

air pressure inside is lower than outside

air inside flows up and run out of the unit

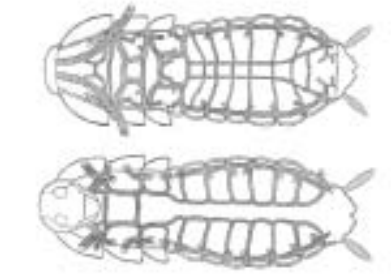
air inside of compost unit becomes warm

composting produces heat

design strategy

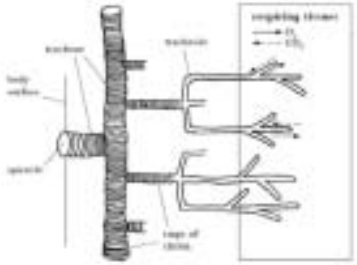
Function: High-efficiency respiration

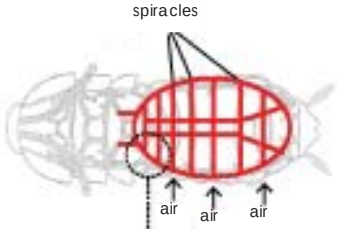
strategy: increase air transportation efficiency



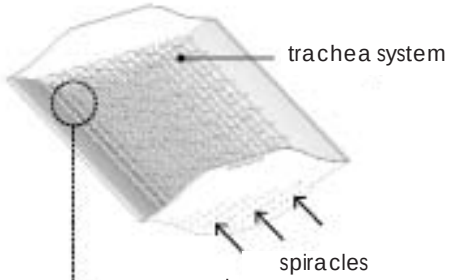
air vascular system of cockroach

the end of air vascular system





air capillaries pattern

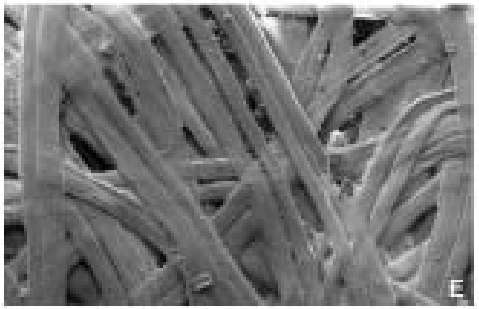


compost unit

air capillaries

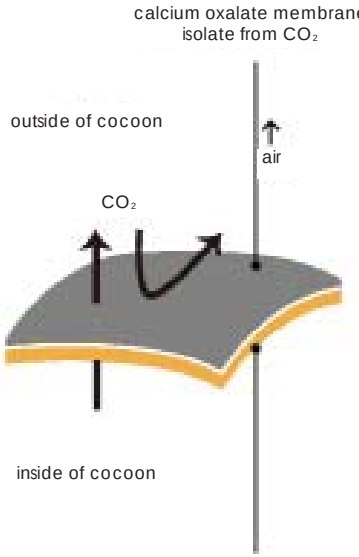
Function: Air purification

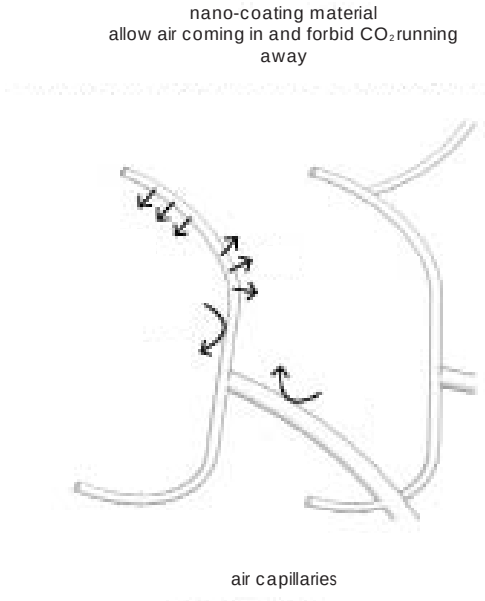
strategy: isolate carbon dioxide



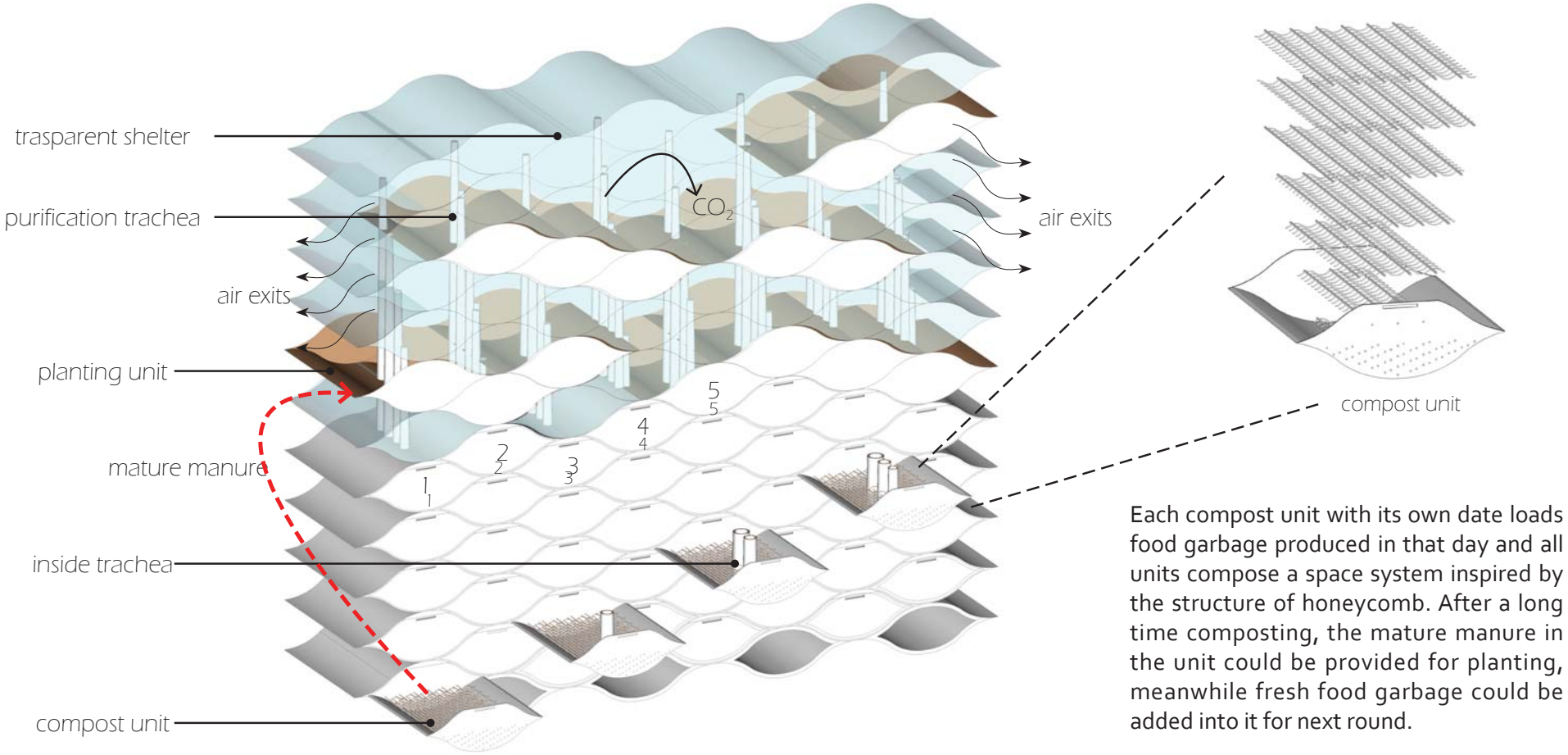
the structure of inner surface

the structure of outer surface





DESIGN MODEL

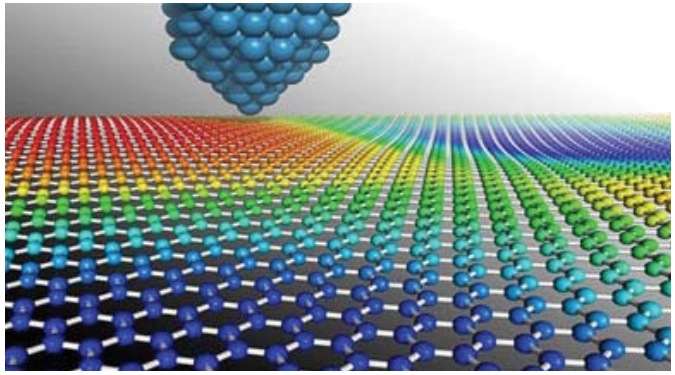


Each compost unit with its own date loads food garbage produced in that day and all units compose a space system inspired by the structure of honeycomb. After a long time composting, the mature manure in the unit could be provided for planting, meanwhile fresh food garbage could be added into it for next round.

Calendar Farming

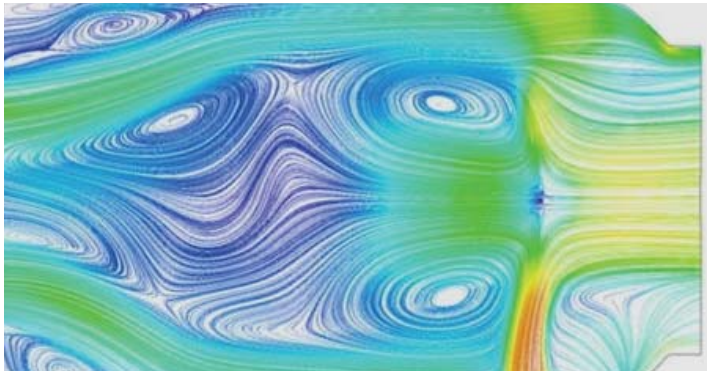
The design mimic the spatial usage of honeycomb to generate the structual system and compost units are all marked with the date representing the date of garbages , such as 1, 2, and so on for composting in order according to the date . After a period of time sufficiently aerobic composting , manure mature can be taken out of the compost units for planting in upper planting units and then new daily garbage is placed into empity unit to create a sustainable food recycling system as well as to beautify the urban

In Future



develope the nano-coating material according to cocoon structure

look for cooperation with the company producing facilities pre-processing(pulverized)food garbage



calculate energy conversion and fluid mechanics of system to confirm the detailed and accurate sizes

Resume

REX CHEN

2004' University Cheng Shiu

2006' CYS. ASDO

2007' Tadao Ando
Architect & Associates

2008' Founder of ZUO Studio

2016' THUC March II