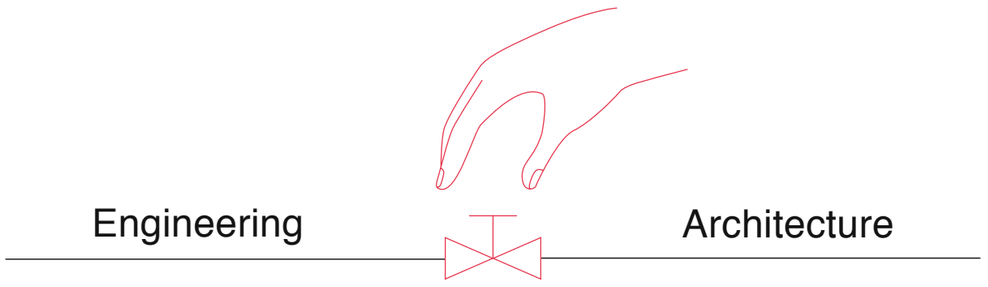
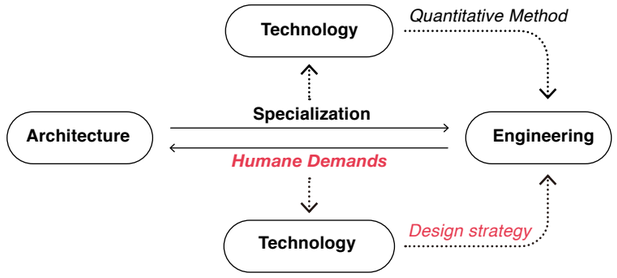


Ruiji Sun

B.Eng. & B.Arch.
Xi'an University of Arch&Tech
Applicant for
Master of Science in Sustainable Design
Carnegie Mellon University



Living Environment. Space as the core issue of architecture, seems to face various declines, compared to the rapid development of modern society. The enormous volume of architecture as well as the subtle space atmosphere seem to go beyond. However, related various flows, material entities and place spirit construction are still of great value and potential for the humane living environment, and are constantly promoting people's life quality.

Technological Engineering. As engineering is an applied technology based on mathematical science, evaluation by quantitative indexes has already been a trend. With the help of advanced computer technology, continuous optimization of engineering design becomes possible, with technological innovation abound. However, for practical application, there are many complicated variables which need to be considered thoroughly. Therefore, the core of the issue is how to transform advanced technology into engineering practice with truly social value.

Escape or shoulder? In the face of increasingly compartmentalized design profession divided into disparate realms of expertise, we are sticking to our own professional barriers, without considering the issues outside our specialties. The complex human problems in the real world reflect not only the contradictions among various groups but also the characteristic of the entire era as well as the development path of human collective civilization. During my undergraduate study in double major, ***humane demand as a link*** between various subjects becomes more and more clear. With the help of advanced technology, there exists an opportunity to use design as an integrated strategy to architect knowledge and skills of various professions and actively construct collective work to solve real problems, meet demands, and assume social responsibility.

CONTENTS

01 Wind Formation

How to quickly generate building forms ***without pedestrian wind?***

1 Week Collaborative Work
"Digital FUTURE" Shanghai Workshop / Summer 2017
Instructor: Phillip F. Yuan / Jingyun Zheng / Jiawei Yao
Collaborator: Ao Li / Shechen Li / Meiting He / Yanling Feng / Qi Zhang
Contribution: Model(20%) / Drawing(50%) / Simulation(20%) / Arduino Control(20%) / Fabrication(50%)

INTRODUCTION I From natural formation to digital formation

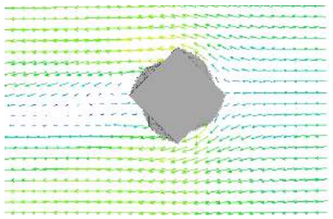
Natural Formation

In nature we experience the invisible effects of the weather differences in atmospheric intensity through their impact on and formation of the materials they interact with in the environment- the rock, dust, water, leaves, grass that are blown, shifted, stirred or ruffled by the wind. This interaction of matter and the intensities of the atmosphere is more a matter of formation than form- what we see are visible formations which organize matter into variable shapes in response to invisible changes in air pressure and speed.

Spilling Breaking Waves

Digital Formation

In architecture, the building material could be considered as having a virtual or digital agent. This agent drives the material to find its best energy state in any given situation in order to achieve a dynamic equilibrium in thermal, structural, or even human interaction. In this searching process, the architect's task becomes how to make use of new tools for visualizing these agents and using them to exploring the formal possibilities made available for architecture. **To establish a new relationship between—virtual design and matter formation.**

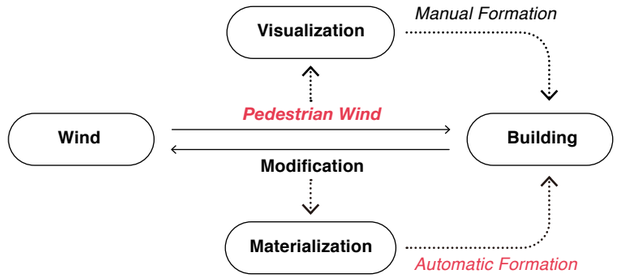


CFD Simulation

Visualization & Materialization

In the aspect of **materialization**, the wind tunnel with sensors is used as the main simulation tool for wind environment, which contributes the related research and conceptual design of the building form. The **interaction between the wind environment data and the building morphology** is generated. Under the condition of comfortable wind speed and temperature, the final architectural geometry will be analyzed and further generated.

In terms of **visualization**, the use of different tools to study the invisible elements of the wind, and the results reflected in the adjustment and design of the building form: the physical aspects that relies on smoke visualization tools to observe the flow around the building; while digital aspects, based on the CFD calculation results, the establishment of AR technology with the customized APP, through the camera to observe the different phenomenon of airflow.



BACKGROUND I Microclimate problems caused by urban block

Shanghai Heat Island Effect

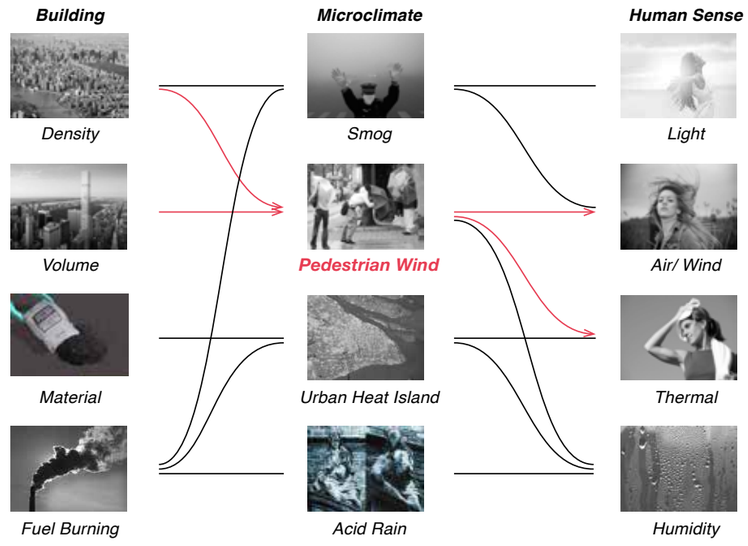
Through the comparison between the satellite image and the infrared image of Shanghai, we can conclude that the urban heat island is correspond to high density urban buildings. Though weather has traditionally been the taboo of architecture, in our present context architecture may need to reflect on and perhaps reinvent its own relations to nature. Like the satellites and computer models created at NASA, are starting to show that humankind's ambitions regarding **urban landscapes can altering local and possibly global climates.**

Satellite Image

Thermal Infrared Image

Microclimate Diagram

The heat island problem is one of the most obvious city climate problems, related to energy and resources issue. Besides, the air quality, related to wind, and the water, light problems are also becoming more and more serious. No doubt, architecture which consumes energy and influences environment significantly, is responsible for these problem. ***We select wind as our research topic,*** so related architecture aspect is volume and density.



Addressing the building's appearance (how it looks) and its performance (what it does) increasingly requires creating environmentally attuned buildings, whose physical forms are shaped by environmental performances in respect to light, heat, energy, movement or sound.

—Branko Kolarevic

Reference:

[1] ROEWU. Weather Formation-An Architectural Meteorology[M]. Taibei Gardencity, 2017.

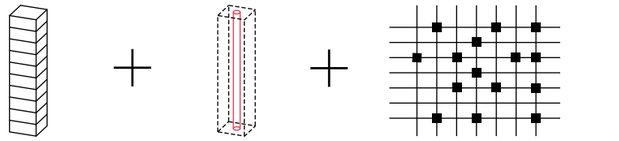
[2] Phillip F. Yuan. From Digrammatic Thinking to Digital Fabricaation[M]. Tongji University Press, 2016.

[3] Milton Van Dyke. An Album Of Fluid Motion[Z]. The Parabolic Press, 1988.

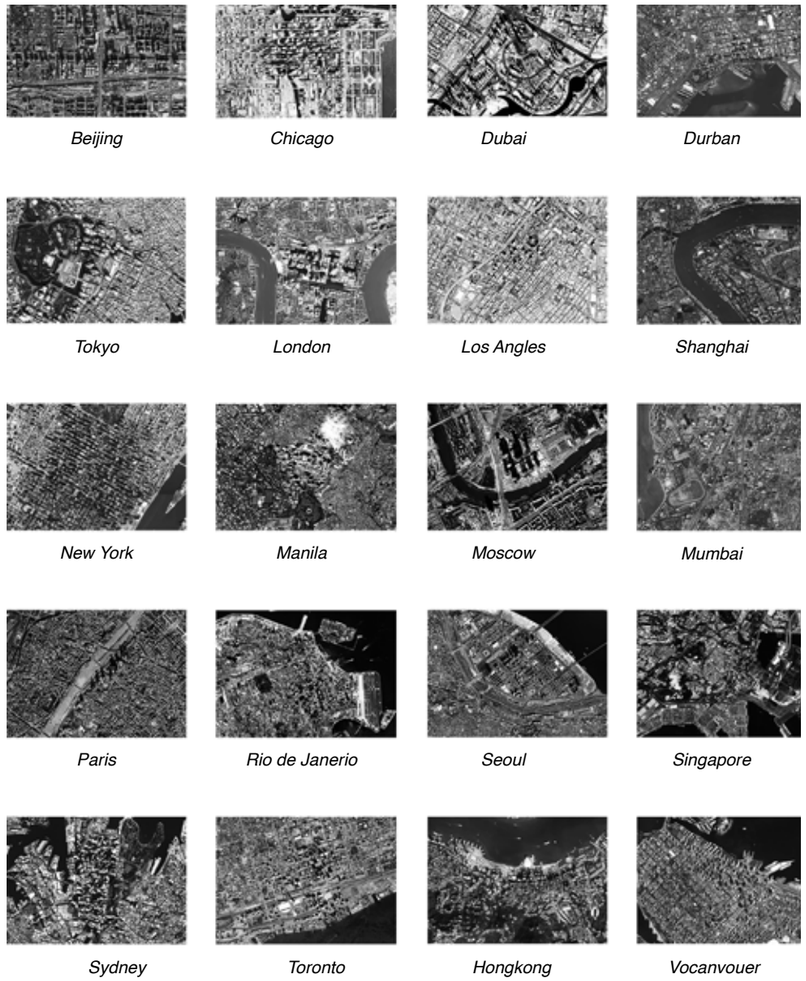
[4] Branko Kolarevic. Architecture in the Digital Age Design and Manufacturing[M]. Spon Press, 2003.

RESEARCH 01 | High density buildings typology

Through the research on the types of high-density blocks in mega cities in the world, the prototype of the basic single high building is summarized as a core tube with multi-square floors, and the arrangement pattern of building groups is like rectangular grid points. At the same time, most of these dense cities are located on the bustling coastlines, the impact of sea wind will be much pronounced for such kind of buildings.



Multi-Square Floors ***Core Tube*** ***Rectangular Grid Composition***



Beijing *Chicago* *Dubai* *Durban*

Tokyo *London* *Los Angles* *Shanghai*

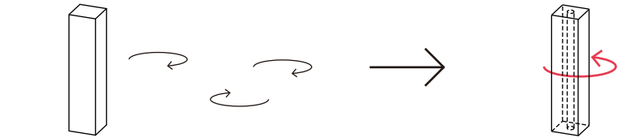
New York *Manila* *Moscow* *Mumbai*

Paris *Rio de Janerio* *Seoul* *Singapore*

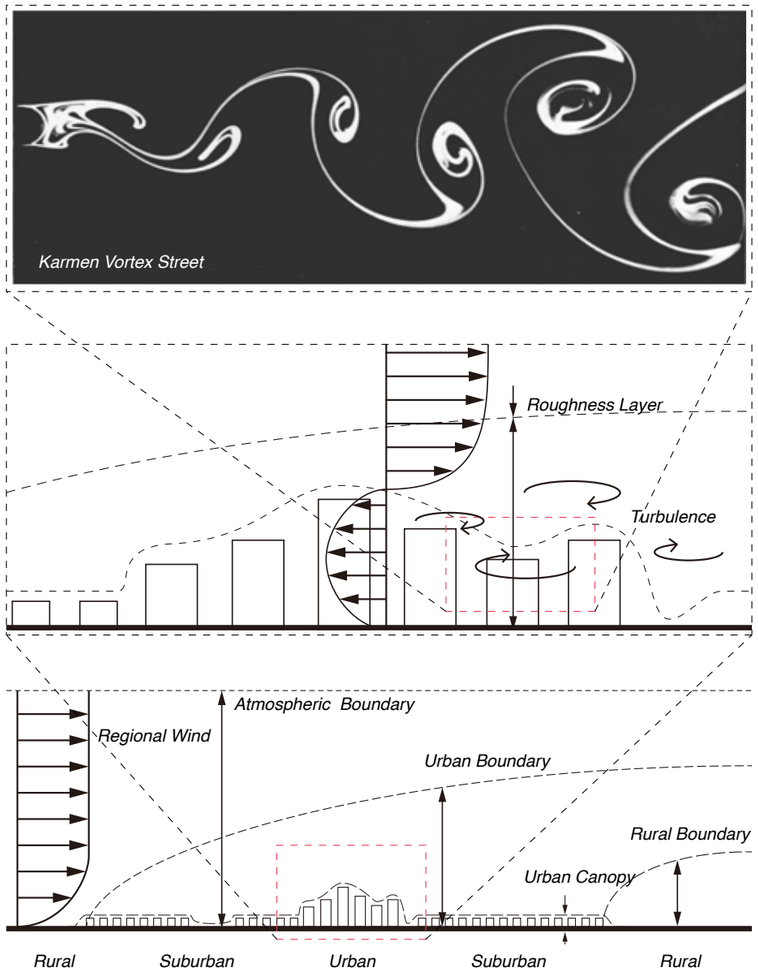
Sydney *Toronto* *Hongkong* *Vocanvouer*

RESEARCH 02 | Fluid mechanics typology

From the perspective of fluid mechanics, we researched the flow characteristic of wind environment in high-density blocks and concluded that air flow around the building is mainly turbulent, and the vortex street can be formed under certain conditions. The uneven air flow between the buildings and the excessive local wind speed ***make pedestrians to feel uncomfortable.*** Therefore, it is reasonable to make a rotate operation, trying to reduce wind influence.



Turbulence and Vortex ***Rotate Operation***



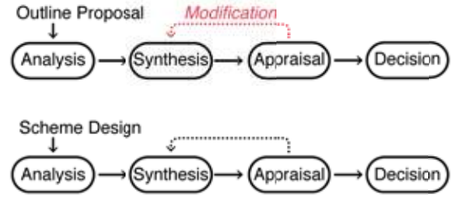
VISUALIZATION | Performance optimizing by CFD and AR

Based on CFD numerical simulation, we generated multi-point pseudo-color map and streamline map, and integrating with AR (augmented reality) technology from above wind environment simulation results bring in "**reality**" to enhance the visual experience of space and environment. We use Unity to establish AR technology with the customized APP, through the camera to observe the different phenomenon of air flow. Researching the invisible elements of the wind, and optimizing the results reflected in the adjustment and design of the building form.

CFD & AR visualization on iPad

MATERIALIZATION | Fast form modification based on mechanical models

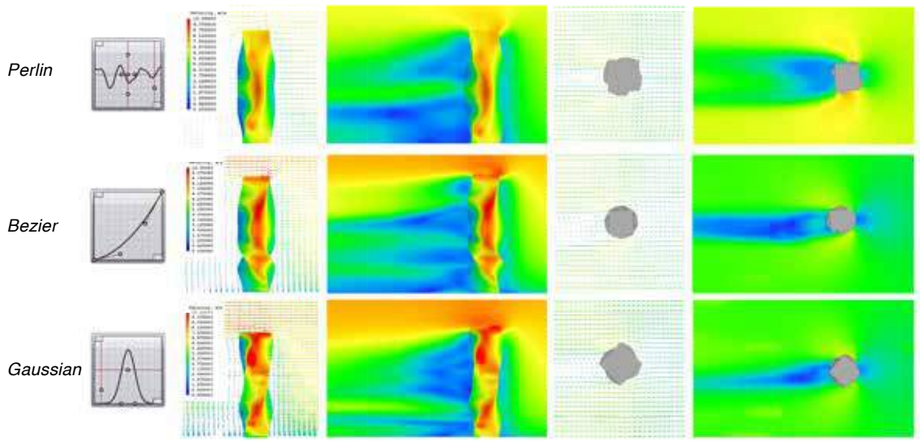
In the early stage of environmental performance driven architectural design, we need to ***modify concept models in a short time.*** The physical wind tunnel can provide an intuitive and fast interaction platform for both qualitative and quantitative simulation of wind built environment. Therefore, it is possible to build an automatic form change mechanical model, and to establish a data-controlled procedure within interactive equipment, and matrix-arranged sensing devices, to iterate the basic architectural geometry and wind environment data to **obtain a basic geometry according to environmental comfort index.**



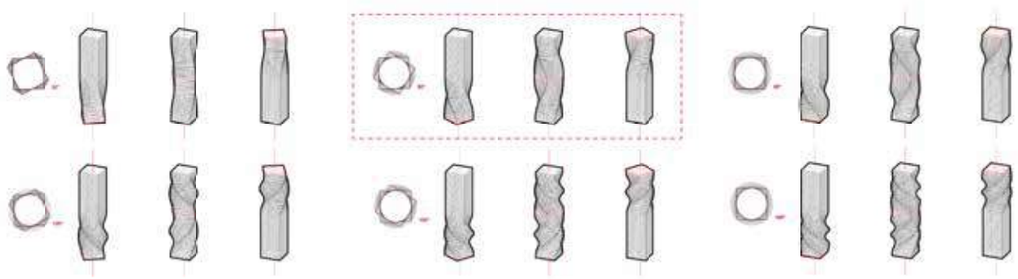
Early Stage of Architecture Design

Digital Model Form Generation

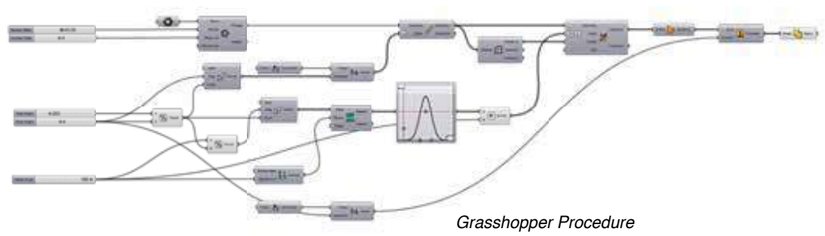
We use Grasshopper to generate a serials of shapes by rotating different angles around the core, following different curve path**,** and we use CFD software to simulate wind environment. According to **environment performance evaluation standard**, we can optimize design projects. The results are shown as follows.



Elevation *Plan*



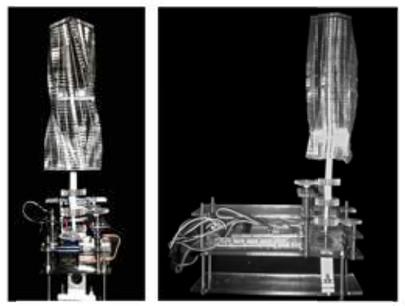
Form Variation



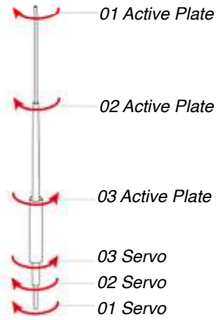
Grasshopper Procedure

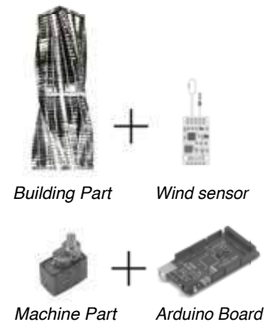
Mechanical Model Form Generation

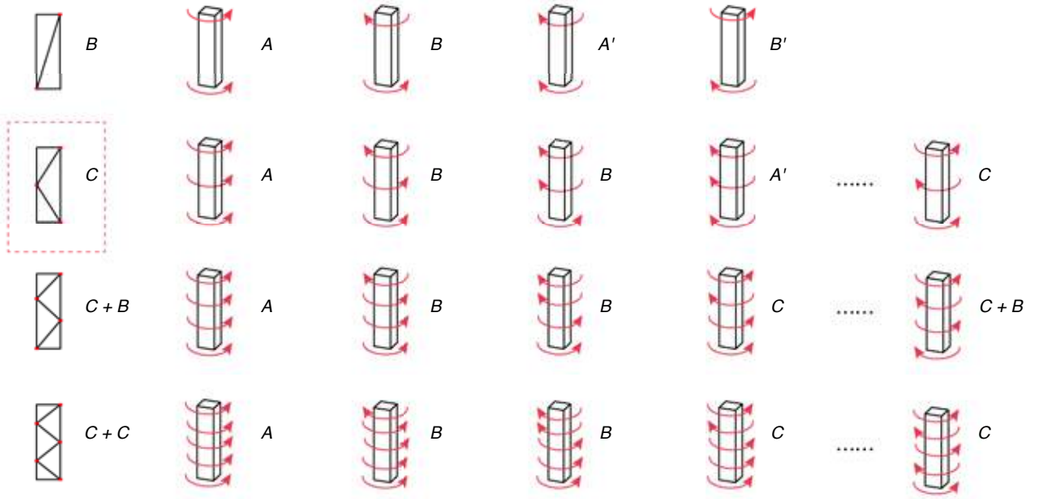
Letter A, B, C represent different form type, the combination of different directions and different numbers of rotation would create a series of shapes. **The most valuable and effective combination** is 3 directions producing C form type, Which we are going to realize in a mechanical model.



Mechanical Model

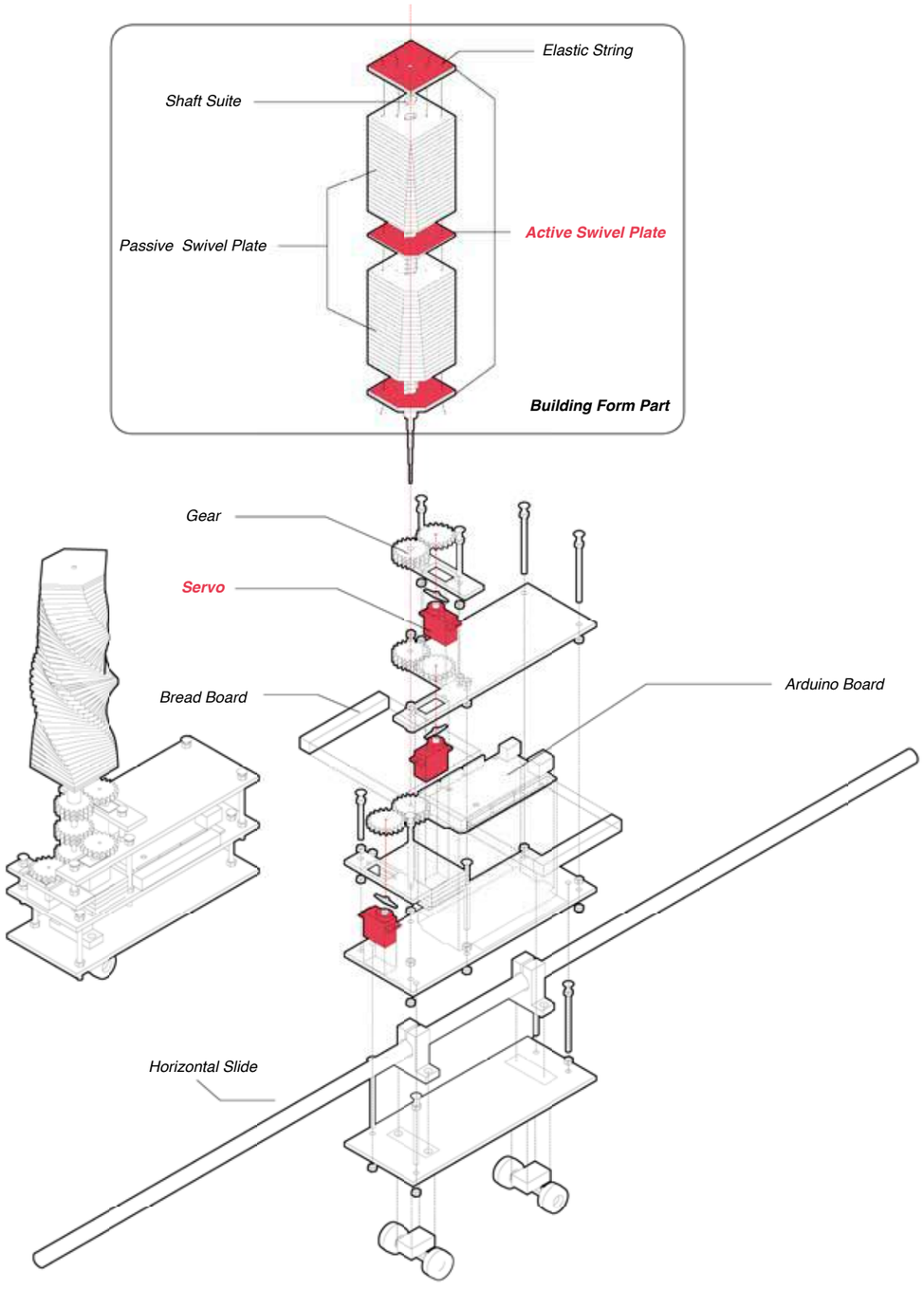






MATERIALIZATION | Automatic form change by servos and sensors

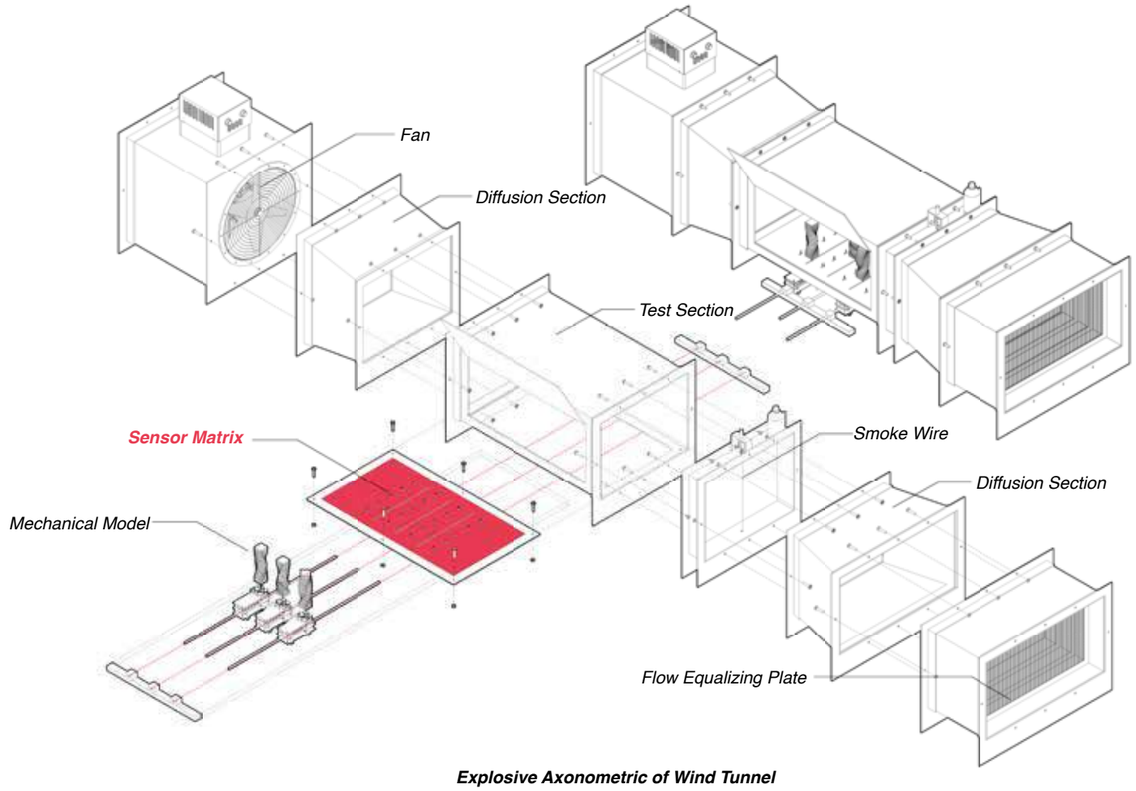
There are three parts of the model, the top part is building form part, the middle part is automatic control part, the bottom part is manual control part. On the building layer, when the 3 servos drive 3 active swivel plates separately, the last passive swivel plates would follow them, with the help of elastic strings. On the automatic control part, servos are placed at different levels for noninterference, and Arduino boards are placed near the servos for wiring convenience. The bottom layer is for moving the model by hand.



Explosive Axonometric of Mechanical Model

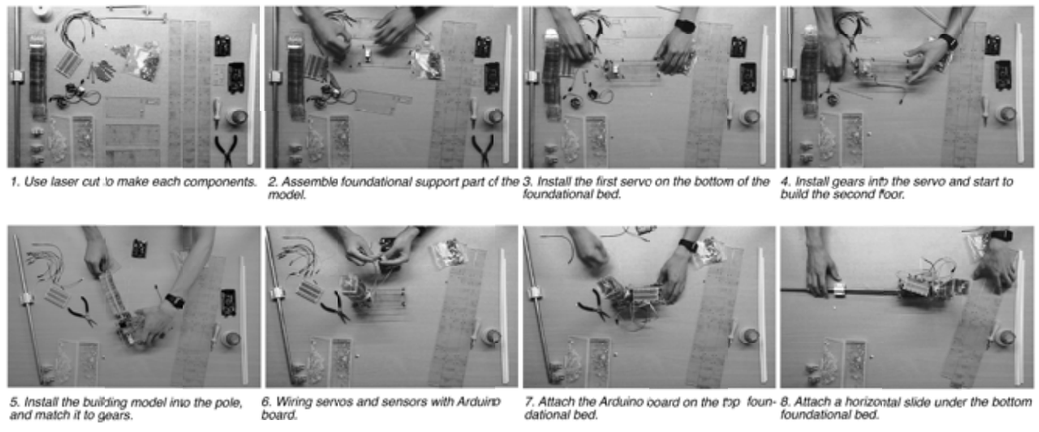
Experiment in customized wind tunnel

With the help of sensors mounted on the bottom of the wind tunnel Arduino procedure, wind velocity and ambient temperature values are recorded and compared with required thermal comfortable values to find the most optimized twisting angle, therefore the automatic shape finding process can be realized. At the same time, **with smoke generation, the airflow path would be visualized.** Besides, the position of the slide can be changed manually, which means that architects can take participate into the automatic form finding process.



Explosive Axonometric of Wind Tunnel

Mechanical Model Assembly Process



1. Use laser cut to make each components.
2. Assemble foundational support part of the model.
3. Install the first servo on the bottom of the foundational bed.
4. Install gears into the servo and start to build the second floor.
5. Install the building model into the pole, and match it to gears.
6. Wiring servos and sensors with Arduino board.
7. Attach the Arduino board on the top foundational bed.
8. Attach a horizontal slide under the bottom foundational bed.

VISUALIZATION & MATERIALIZATION | Automatic form finding process

Put the mechanical models into wind tunnel and use smoke wire system to visualize wind path in real time. As models are able to change their shape automatically, and the wind visualization are synchronous, architects can quickly view the relationship between building forms and surrounding wind environment. Besides, different model compositions can be realized by moving horizontal slides. For each combination group, the most three optimized forms will be found in the end.

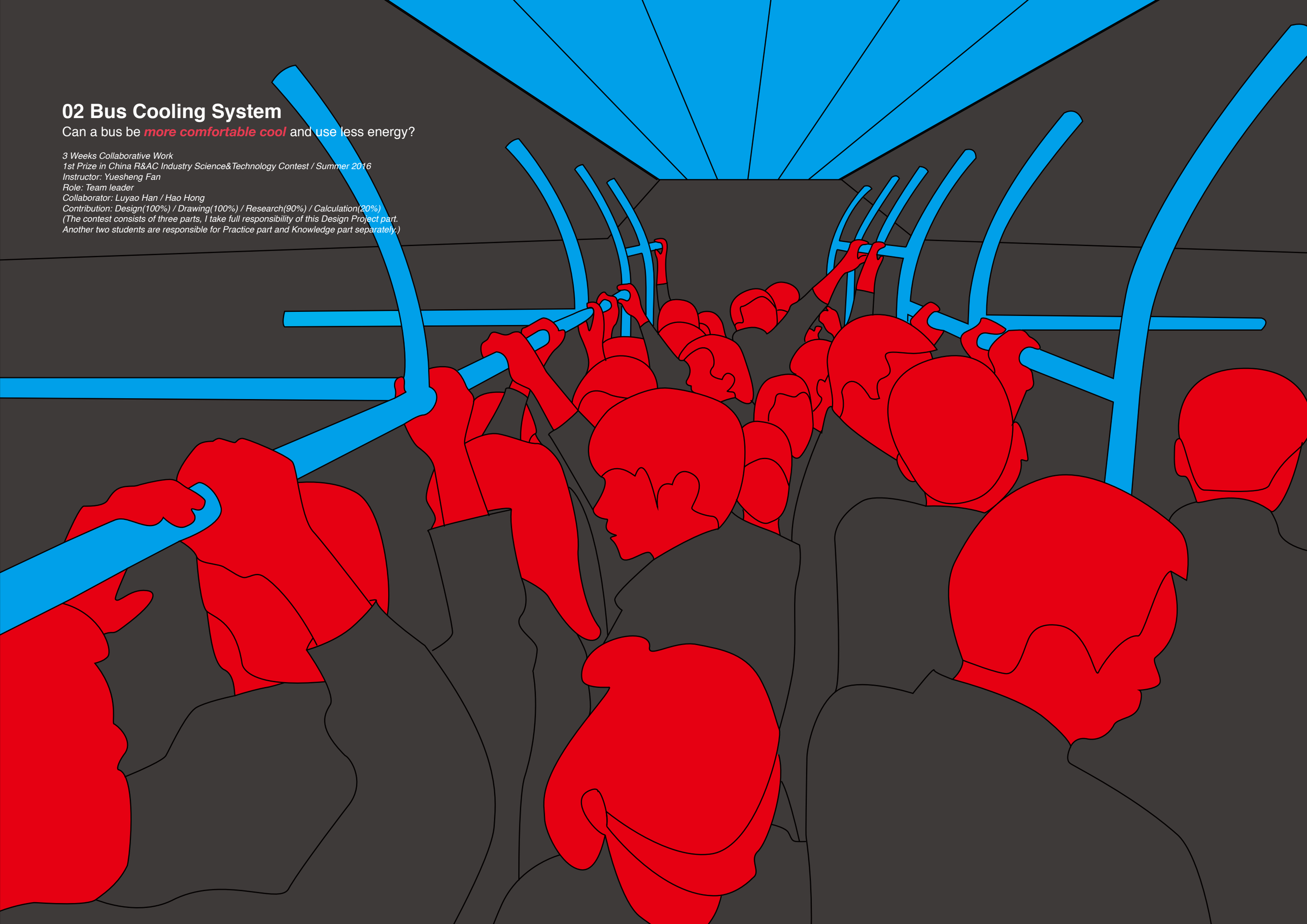
Composition Plan

Best Performance Forms

02 Bus Cooling System

Can a bus be ***more comfortable cool*** and use less energy?

3 Weeks Collaborative Work
1st Prize in China R&AC Industry Science&Technology Contest / Summer 2016
Instructor: Yuesheng Fan
Role: Team leader
Collaborator: Luyao Han / Hao Hong
Contribution: Design(100%) / Drawing(100%) / Research(90%) / Calculation(20%)
(The contest consists of three parts, I take full responsibility of this Design Project part.
Another two students are responsible for Practice part and Knowledge part separately.)



INTRODUCTION I Toward humane HVAC technology

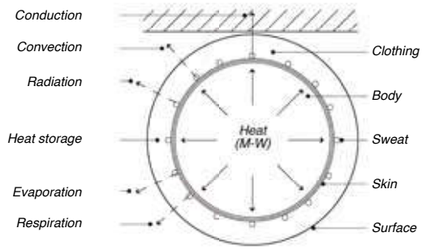
Inhumane HVAC Engineering

Humane means treating people or animals in a way that is not cruel and causes them as little suffering as possible. It seems like we HVAC engineers have absolute authority of controlling building environment. Obviously, we placed **too much emphasis on air conditioning**, including cooling load calculation, thermal and humid process, HVAC equipment selection and so on. However, engineers ***care less about human.*** It is the human beings that live in our controlled building environment, so without thorough humane consideration, the result would be mechanical, ineffective and even counterproductive.

A child against cold AC wind

Thermal Comfort Equation?

The thermal comfort equation is widely used to calculate the human body's energy balance under steady-state conditions and serves as the basis for the design parameters of air-conditioning temperature. However, the body's **thermal comfort is not only about heat balance**, but also depends on the thermal sensation which is both physical and psychological. Influencing factors include vertical temperature stratification, draft sensation, radiation unevenness and dynamic thermal environment reaction. So it is reasonable to **solve the thermal comfort problem from an integrated design strategy.**



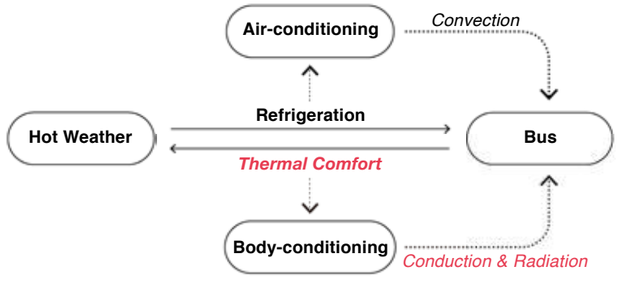
Thermal equation: M-W-D-R-C-S-E=0

We Human Beings

People of different ages, gender, and weight have ***different needs for thermal environment.*** Human body in different activities has different thermal sensation and thermal comfort standards. In addition, the biggest difference between the human body and the non-living things is that the human body has a **body temperature regulating system**, which can actively maintain the body temperature uniform and stable. Therefore, engineers are supposed to deeply understand the potentials of human beings.

Traditional HVAC

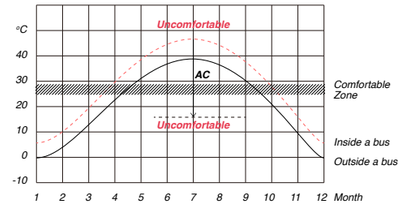
Humane HVAC



PROBLEM I Buses are always uncomfortable

Necessary AC System

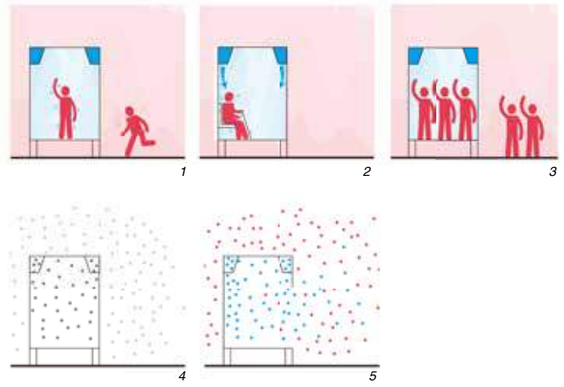
During the summer, Xi'an as a typical modern city experiences extremely hot, because of its climate and heat island effect. In high temperature circumstance, natural ventilation is not useful and even make human hotter, so air conditioning system becomes necessary to control the temperature inside a bus, but it seems like the temperature is always too low and uncomfortable.



Problems of Air-conditioning

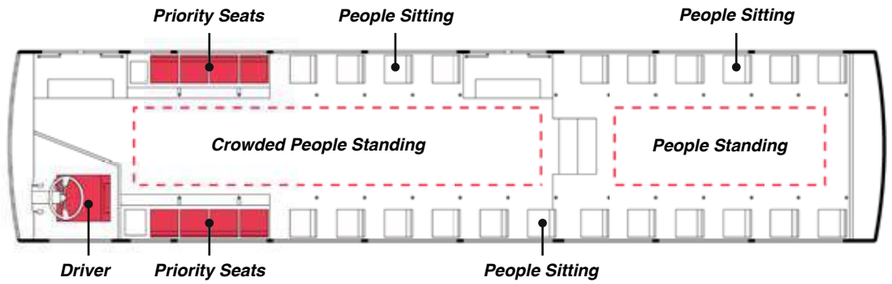
Most of the time, we feel uncomfortable when we are taking the bus, it smells awful because we are not supposed to open the window to ventilate, causing the air quality poor. Importantly, when we get on the bus from outside, we are going to experience extremely cold because of significant temperature change. Also, we feel the cold wind from outlet just blows toward our heads, making us uncomfortable. ***Especially for those who are old and pregnant sitting at priority seats***, it is obvious that this environment would make them ill.

1. Large Temperature Change
2. Cold AC wind blowing
3. Change of Passengers Flow
4. High CO_2 Concentration
5. Frequent Heat Exchange Through Doors



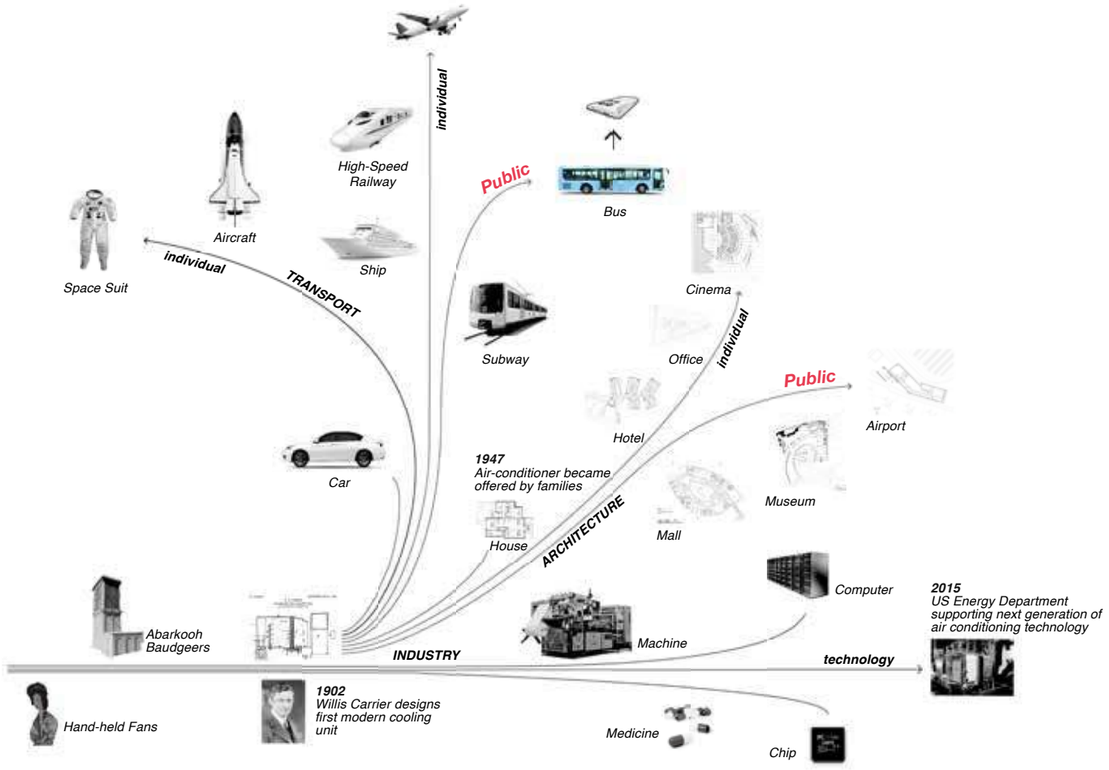
People Mapping

I have noticed that there are 3 kinds of people groups on the bus. The **key people** on the bus that necessitate specific design requirements are **the driver, the disabled, and elderly riders**. Because the driver is responsible for the whole bus passengers' safety and the disabled people needs special concern. Besides, the main people on the bus are standing, they concentrate at central area.



RESEARCH 01 | Air conditioning is not suitable for a public transportation

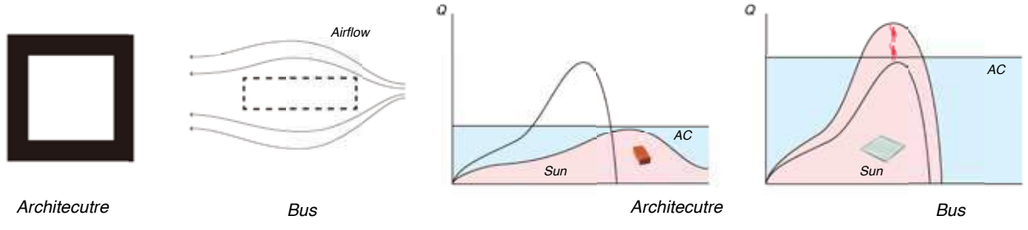
As AC system develops, it was divided into two aspects, one is for industrial use and technology soon boomed, pursuing efficiency and effect. Another aspect is for human being use, to make a comfortable surrounding environment, engineers prefer to use AC systems to cool and to heat. However, it is reasonable to question the rationality of applying one kind of air conditioning technology on different objects, from underground to outer space. It turned out that there are **two types of air conditioning application circumstance,** one is for **individual use**, which is often satisfied easily, another is for **public use**, and for this part, the situation is more complex.



Air-conditioning Application & Development

Bus VS. Architecture

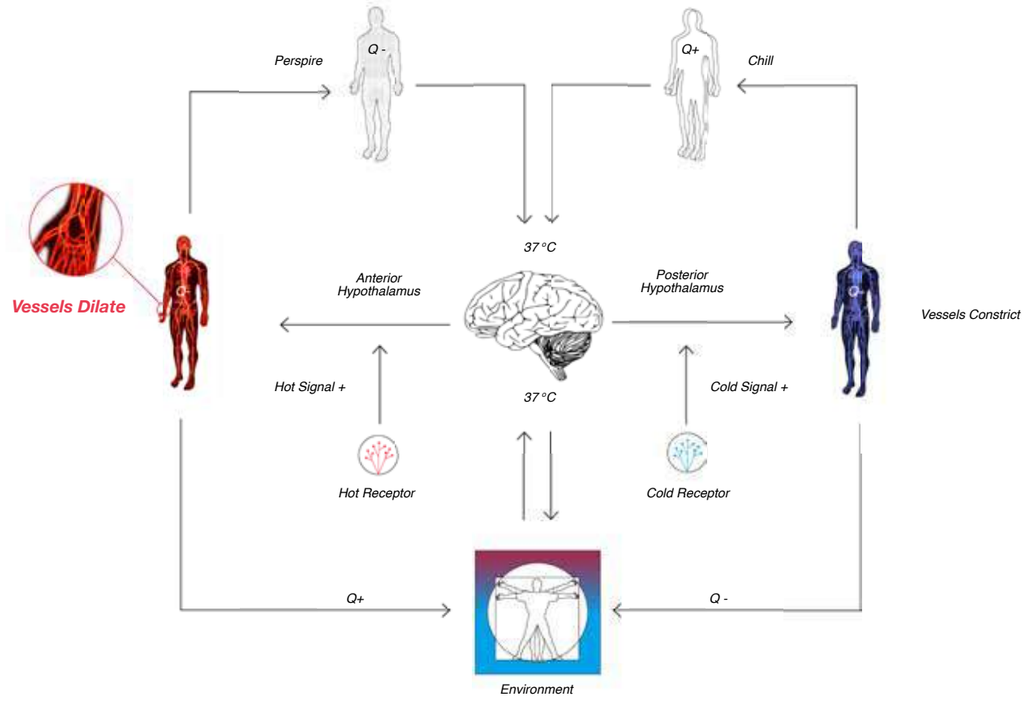
It can be concluded that bus's air conditioning system is come from architecutral environment control pattern. However, there are significant difference between architecture and bus. **Bus is moving and with thinner envelop; people would get on and off the bus every so often; the space is small and crowded; people always stand rather than sit down,** etc. After comparing these aspects, it is reasonable to question that air conditioning system is not suitable for bus.



Architecutre *Bus* *Architecutre* *Bus*

RESEARCH 02 | Body conditioning mechanism has a large potential

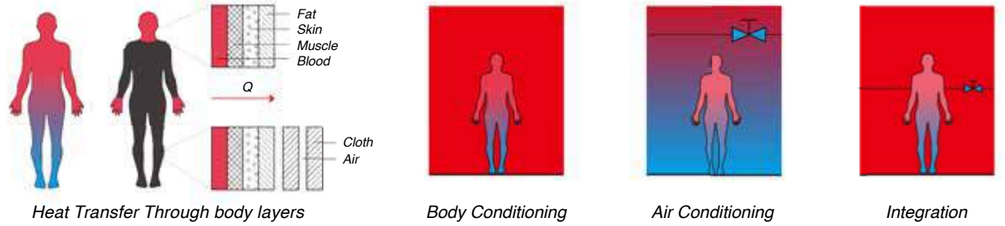
The main function of temperature regulating system is to maintain the core temperature of the human body in a narrow range. Some regulating processes even involve hormonal regulation. Generally speaking, temperature regulating system mainly relies on **neuromodulation** and **humoral regulation**. The main centre that regulates body temperature is mainly in the **hypothalamus**, which controls the body temperature difference between the body temperature and the set point. **The figure 37°C in the below graphic is not constant,** depending on the intensity of work. For example, the body temperature set value will rise when it has a high metabolic rate. The whole regulating process has cold and hot receptors to give hypothalamus hot and cold feeling feedback through electrical signals.



Human Body Temperature Regulation System

Integrate Body Conditioning with HVAC System

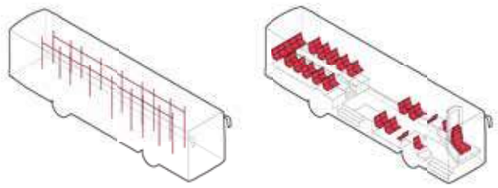
The humoral regulation controls the blood flow volume under skin surface, perspiring volume as well as body heat production, to realize body temperature balance. The heat transfer process is from the blood to the skin surface. The skin surface temperature became higher and then to transfer heat to the surrounding environment. When the human body temperature drops, the subcutaneous blood vessels will shrink to reduce the body surface blood flow. Through mapping, body's blood vessels are not evenly distributed, there are many dense points such as palm and wrists. The body's sweat glands distribution is the same situation. Accordingly, a new design idea about surrounding environment control system is proposed: integrate body's physical characteristics of adjusting temperature with **HVAC system** which is **indeed also a kind of fluid regulation process.**



Heat Transfer Through body layers *Body Conditioning* *Air Conditioning* *Integration*

CONDUCTION I Neglected potential heat transfer method

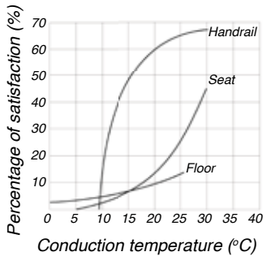
Conductive has great potential for small bus spaces because of large contact surfaces between human body and objects in the bus. Take the handrail as an example, the skin of palm directly wraps around the metal surface of the handrail, and due to the close distance to the aorta at the wrist, dense capillaries are located under the skin surface. Therefore it is possible to cool the surface to a suitable temperature, and then the human blood could be cool, **flowing through the whole body** so as to achieve thermal comfort balance.



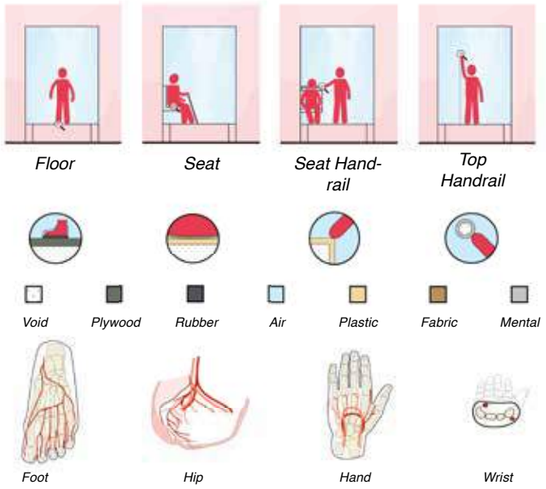
Handrail *Seats*

Thermal Comfort Evaluation

Using TSV (Thermal Sensation Vote) method to preliminary study thermal comfort level of three conductive ways. The result shows that in a 30 ° C **static** thermal environment, the handrail is the most comfortable. Further calculation of the design temperature parameters can refer to the **dynamic** thermal comfort index RWI.



Different Contact Surfaces on Bus

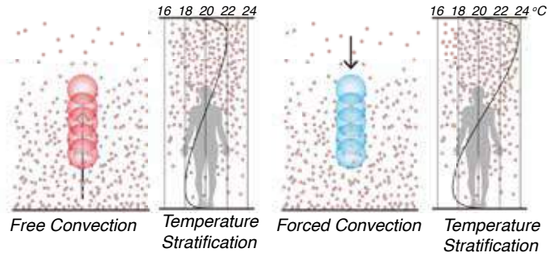


CONVECTION | Not comfortable in a narrow bus space

Convection as a widely used heat transfer way in buildings is not suitable in a bus. First, as the **bus is moving**, air tightness of doors and windows is difficult to guarantee, so forced convective airflow is easy to disorder. The vertical stratification of temperature is uncomfortable , Second, because **the bus space is narrow**, a certain speed of cold airflow can cause **cold wind uncomfortable feelings.**

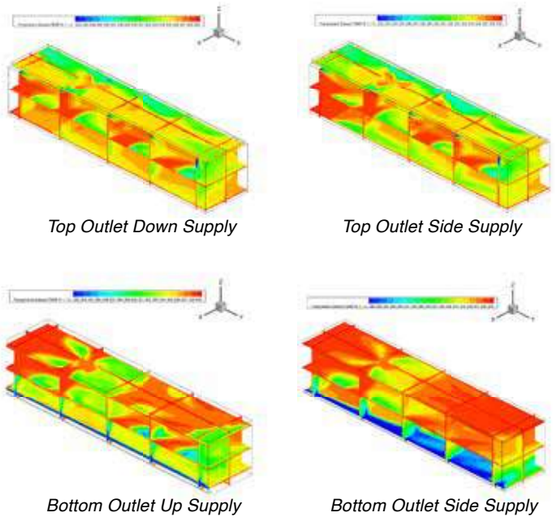
Top Outlet *Bottom Outlet*

Disordered Forced Convection



Simulation of Different Air Supply Patterns

Outlet air velocity: 1.5 m/s, temperature: 18 °C
Window air velocity: 2 m/s, temperature: 33 °C
Wall temperature: 35 °C

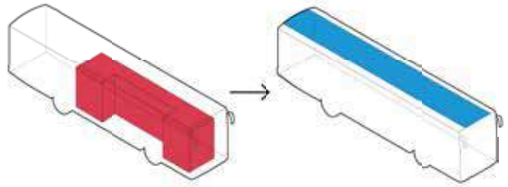


Top Outlet Down Supply *Top Outlet Side Supply*

Bottom Outlet Up Supply *Bottom Outlet Side Supply*

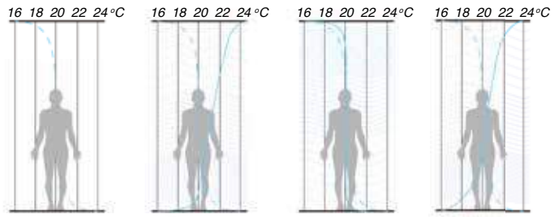
RADIATION | Ceiling radiant cooling is suitable

According to human body's main heat transfer process, radiation is more efficient than convection, and could be more effective and more comfortable than conduction. As the central area in a bus is always crowded, which means large heat gathers there, it is reasonable to use radiant heat transfer method to take the responsibility of this large heat. Then, according to human thermal comfort temperature distribution, the most suitable place of the cooling plate is the roof.



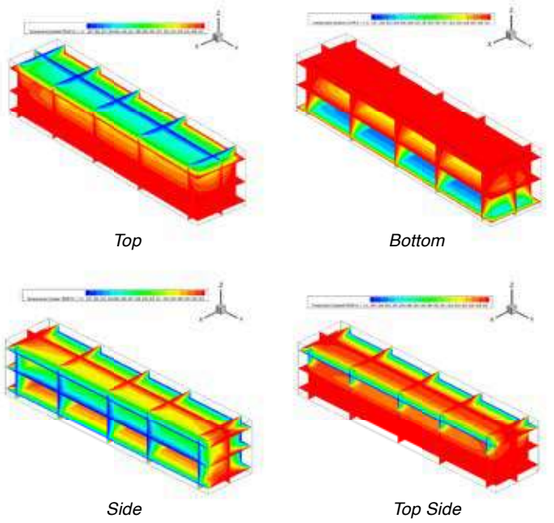
Crowded Hot Area *Ceiling Radiant Cooling Plate*

Vertical Stratification of Temperature



Simulation of Different Cooling Plate Positions

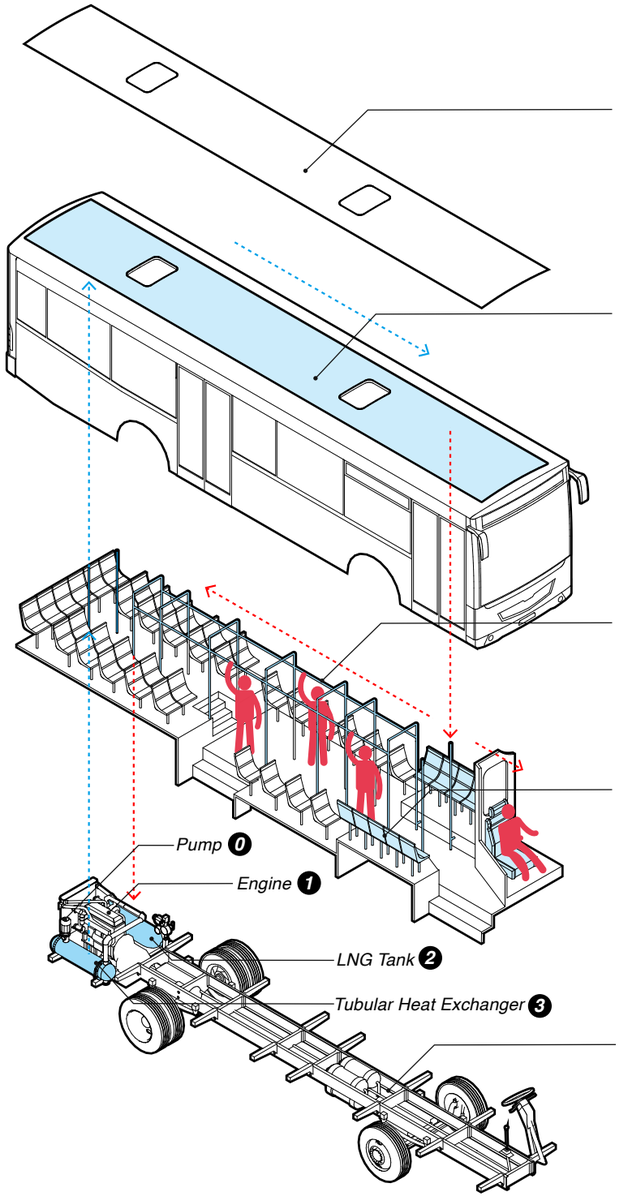
Cooling plate surface temperature: 17 °C
Hot surface temperature: 35 °C



Top *Bottom*

Side *Top Side*

SYNTHESIS | Radiation & Conduction Heat Transfer



Explosive Axonometric of Cooling Bus

Cooling Plate 4

Cooling radiant plate is designed for the majority of people, for the **basic** cooling load. The design temperature is slightly higher than the code requirement to create an environment not hot.

Cooling Handrail 5

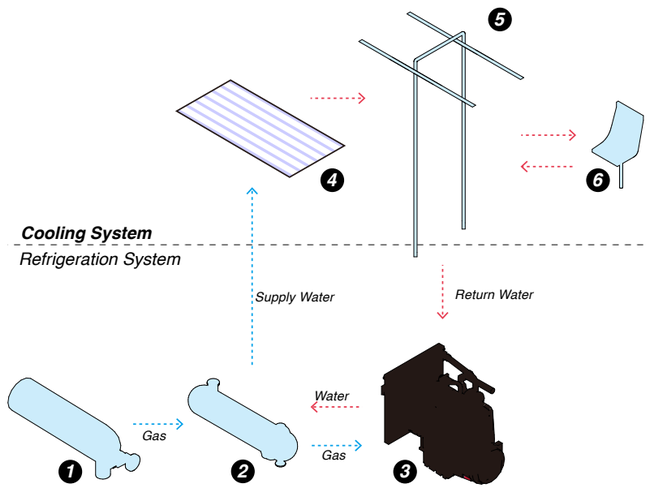
Cold handrail is designed for people with high body temperature, for **additional** cooling load requirements.

Priority Seat (Coil Unit) 6

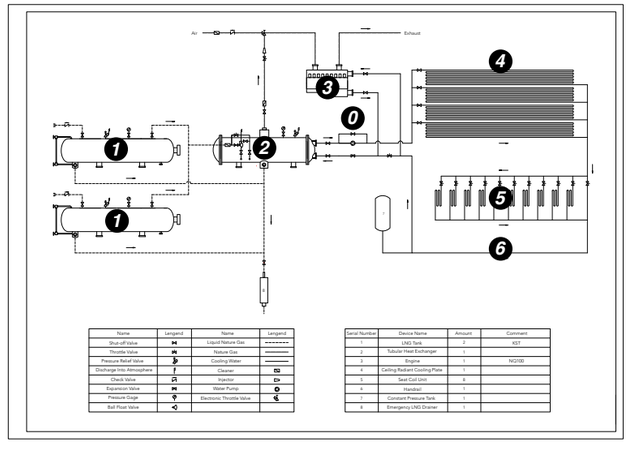
No.6 coil seats are designed for the driver and people needs **modified cold**. Its surface temperature can be changed by regulating the refrigerant flow volume.

Chassis

No.1 liquid natural gas is gasified to a low-temperature natural gas, exchanges heat with refrigerant of the cooling system in the No.2 tubular heat exchanger, and then becomes a normal-temperature gas, for No.3 engine use. While the refrigerant becomes a low-temperature liquid and is sent to cooling system. After heat transfer, it goes to cool engine as a normal-temperature liquid. Finally it goes back into the exchanger with high-temperature.



Cooling and Refrigeration System



Refrigeration System Chart

Cooling Load Calculation

Body-conditioning << Air-conditioning

Even though the cooling capacity that liquid natural gas offers is less than human body's hear production, which means that extra cooling equipment is needed. However, compared to previous air-conditioning system, **this new system didn't need to handle air.** Therefore, without heat transfer through envelop enclosure and doors opening, the whole **cooling capacity can decrease by 30 percents.** Besides, with the addition of LNG's cooling capacity, the efficiency could be even higher.

1. Available Cooling Capacity of LNG

$Q = m \times q \times \eta = 18.5\ kg/h \times 932.3\ kJ/kg \times 0.85 =$ **4.07 kW**

m: Consumption of LNG at rated state, 18.5 kg/h
q: Cooling capacity of LNG per unit mass
η: Heat exchange efficiency, 85%

$q = r + C_P \times \Delta T = 515 + 2.14 \times (305 - 110) = 932.3\ kJ/kg$
r: Latent heat of vaporization at normal atmospheric pressure, 515 kJ/kg
$C_P \times \Delta T$: Sensible heat transfer with environment
(At rated state, based on NQ100 natural gas engine power: 74 kW, the average velocity speed is 40 km/h)

2. Human Body Cooling Load: (Conduction & Radiation Heat Transfer)

$Q1 = (q_{s1} + q_{s2}) \times n \times n' = (61 + 73) \times 50 \times 0.9 =$ **6.03 kW**

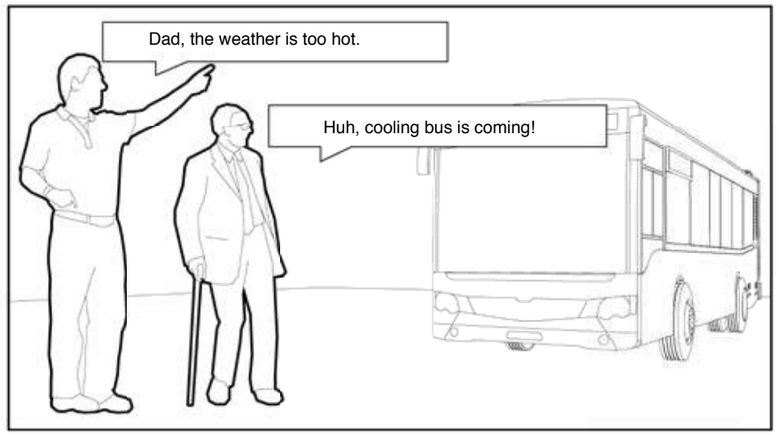
q_{s1}: Sensible heat dissipation, 61W
q_{s2}: Latent heat dissipation, 73W
(q_{s1}, q_{s2} is for 26°C environments, slightly working state)
n: Numbers of people in a bus, 50
n': Percentage of men women and children, 0.9

3. Air-Conditioning Cooling Load: (Convection Heat Transfer)

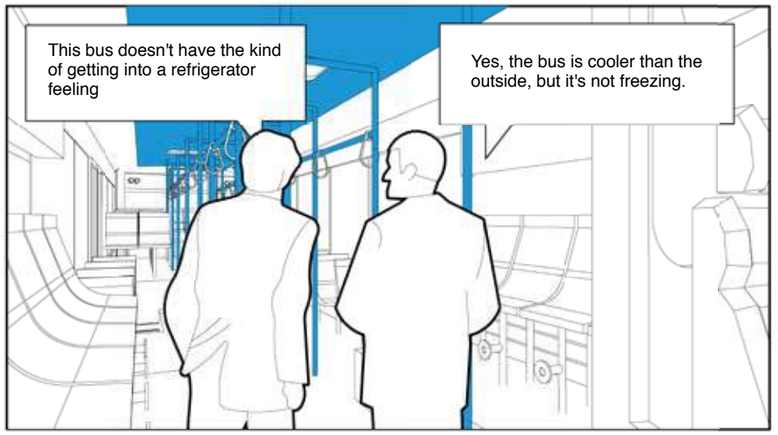
$Q = Q1 + Q2 + Q3 = 6030\ W + 576\ W + 2880\ W =$ **9.49 kW**

Q1: Human bodies' heat production
Q2: Heat transfer through envelop enclosure
Q3: Heat transfer through doors opening

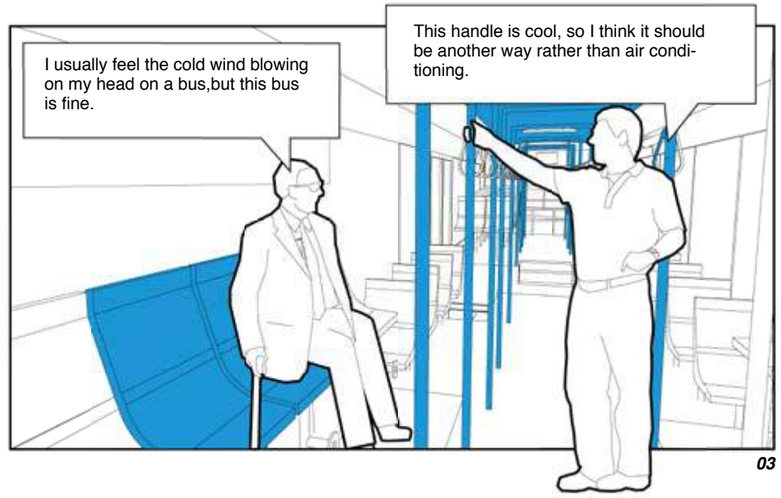
$Q1 = (q_{s1} + q_{s2}) \times n \times n' = (61 + 73) \times 50 \times 0.9 = 6.03\ kW$
q_{s1}: Sensible heat dissipation, 61W
q_{s2}: Latent heat dissipation, 73W
(q_{s1}, q_{s2} is for 26°C environments, slightly working state)
n: Numbers of people in a bus, 50
n': Percentage of men women and children, 0.9
$Q2 = K \times A \times (t_1 - t_2) = 0.921 \times 68 \times (35.2 - 26) = 576\ W$
K: Envelop enclosure's mean heat transfer coefficient, 0.921 W/(m^2/K)
A: Envelop enclosure's area, 68m^2
t_1: Outside temperature, 35.2°C
t_2: Inside temperature, 26°C
$Q3 = 5 \times Q1 = 5 \times 576 = 2.88\ kW$



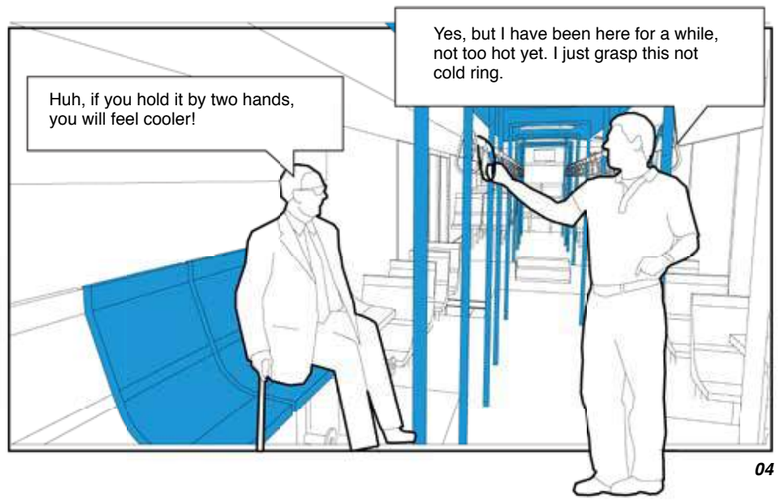
01



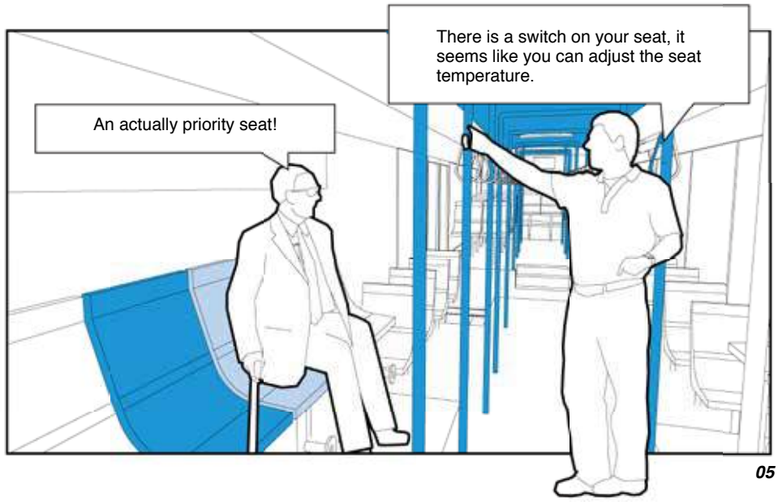
02



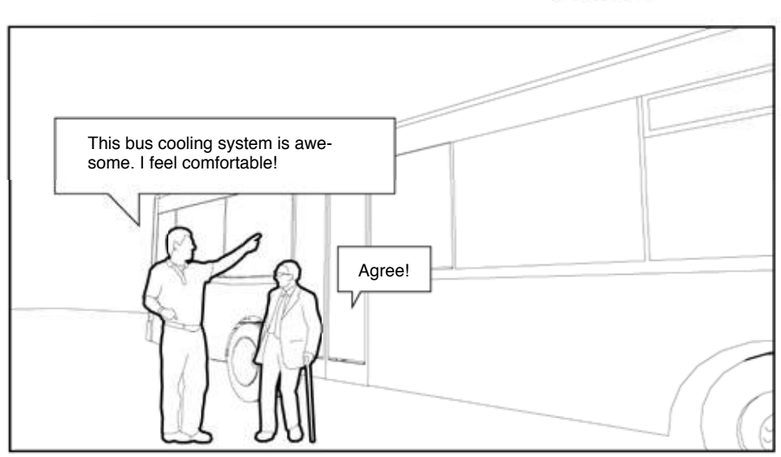
03



04



05



06

03 Piston Wind Visualization

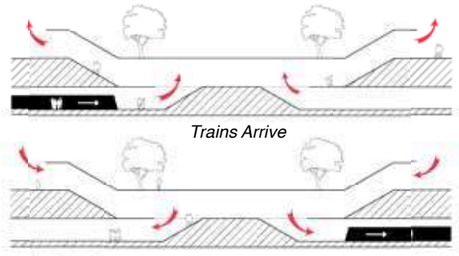
How does piston wind blow ***fire smoke*** through a subway station?

3 Months Academic Work
Building Environment & Energy Engineering Graduate Dissertation / Spring 2017
Instructor: Angui Li / Ying Zhang
Collaborator: Hongna Deng / Pin Gao
Contribution: Design(90%) / Fabrication(70%) / Drawing(100%) / Research(100%) / Experiment(100%)
(I took full responsibility for the model design and fabrication, using techniques from Architecture,
Then we conduct different individual experiment separately)

INTRODUCTION I Why we research piston wind?

Piston wind is unstable and invisible

This movement of air by the subway train in a tunnel is analogous to the operation of a mechanical piston inside a reciprocating compressor gas pump, known as **'piston effect'.** As the air is invisible, coming and going without a trace, we can hardly detect the track. In addition, the gas itself is extremely unstable. The law of air movement in a subway station space is complicated and elusive. For me, experiencing the architectural space from the perspective of the air molecules, and researching their laws of flow in space gives me a wealth of imagination and reflection. The whole process is as interesting as Sherlock Holmes detective.



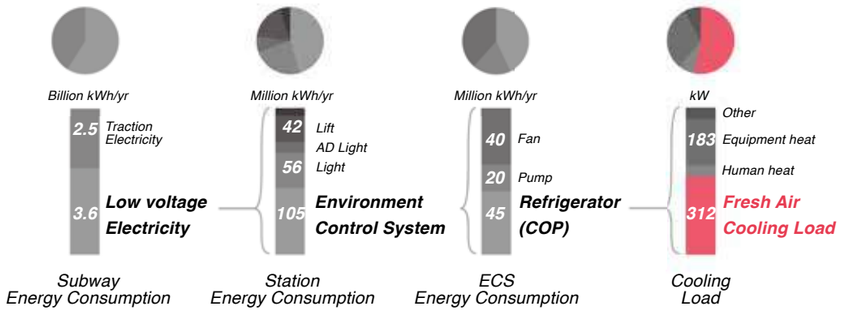
Trains Arrive

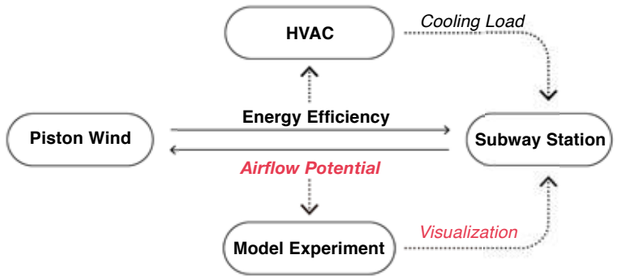
Trains Leave

A subway train arrives at Bell Tower Station (Xi'an metro)

Piston wind influences environment control system significantly

Piston wind helps the natural ventilation of tunnels between stations. On the one hand, when trains get into stations, piston wind will bring heat from tunnels into platform, and at the same time, the cold air in the station will be pushed outside. On the other hand, when trains get off the stations, piston wind will bring cold air form platform into tunnels, and also, outside air will be inhaled into station. Therefore, piston wind **causes huge energy waste, and impacts AC system' s air supply**. Particularly, in the circumstance of ***fire***, underground tunnel and platform are really dangerous because of the closed and crowded space. It is essential to know how piston wind interacts with mechanical smoke extraction system.

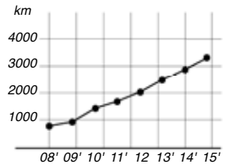




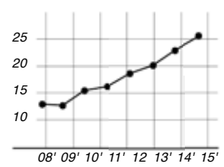
RESEARCH I The most typical station is four-export and two-level

Fast-paced Development of Rail Transport

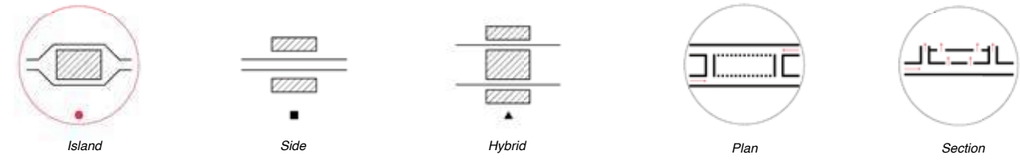
Less than 20 years ago, only three cities in China had subways. Today, there are more than 1,255 metro lines in 25 cities, making subterranean transit accessible to about 291 million people. The total number of stations is 2,255. With the domestication of core technology such as shield machine, a subway construction mode of “much faster and better” has gradually been taken shape. Through the study of metro stations across cities in China, it has been found that most metro stations are four-export and two-level island station. Therefore, we use this type as the experimental model to research air environment in a subway station.



Total Length

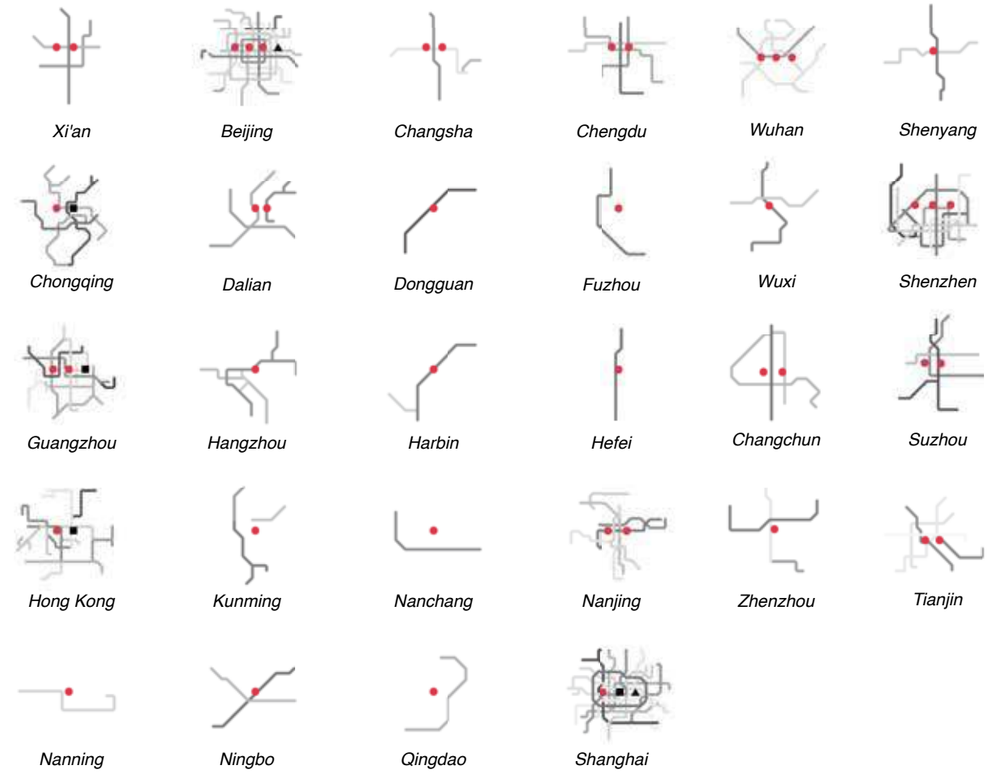


Cities With Subway



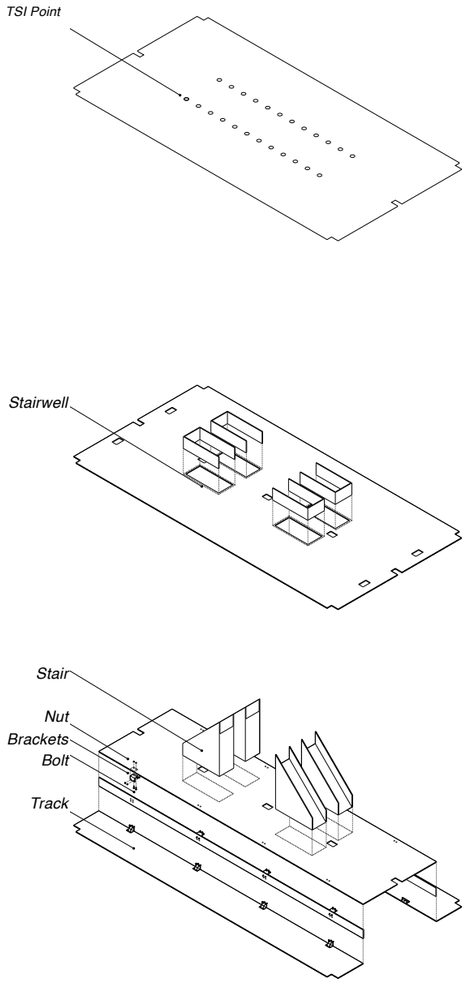
Subway Platform Type

Airflow Diagram

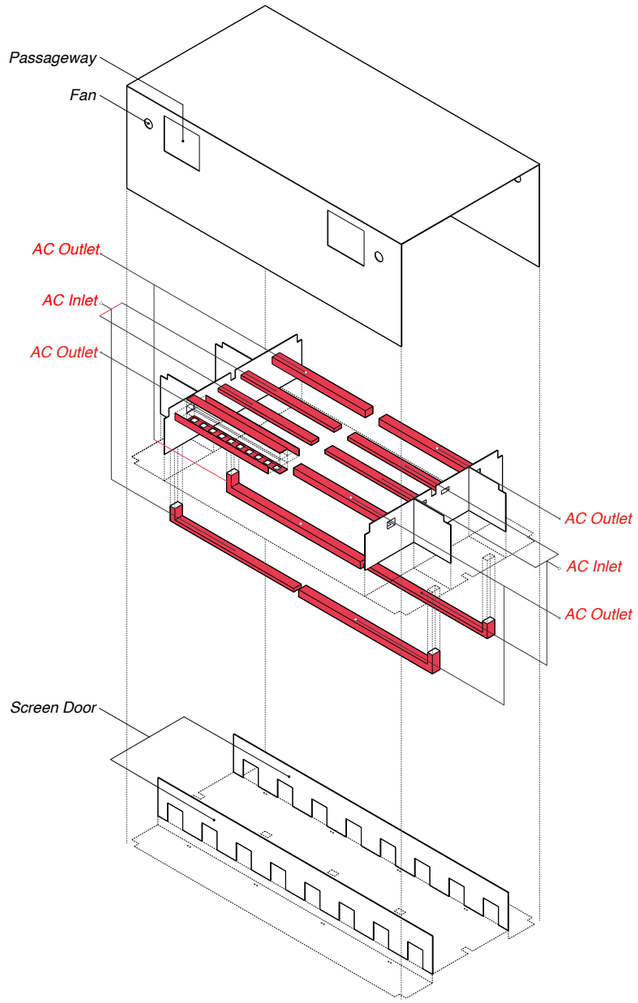


MODEL I Subway station model for piston wind visualization

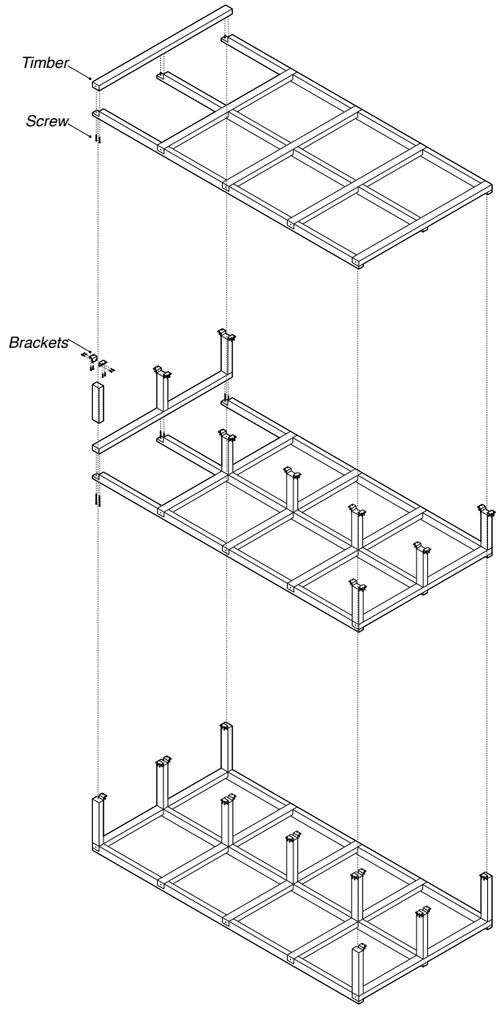
Opaque floor

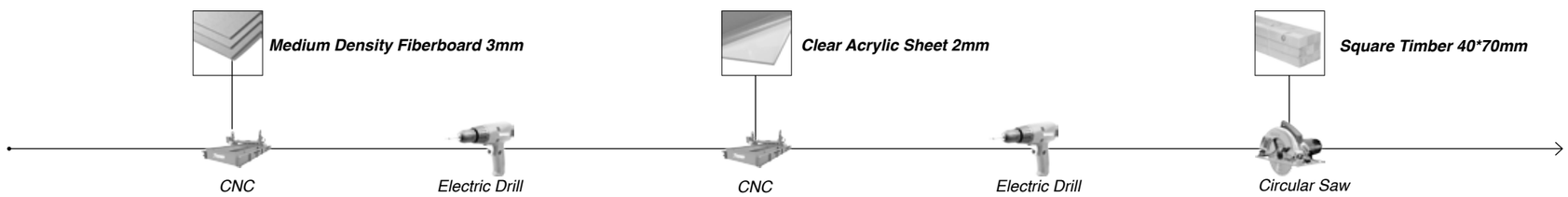


Transparent surface



Bearing Structure





The density fiberboard is cheaper than clear acrylic sheet, and is good at bearing light things, so it is a suitable material for making floors as background.

As it is the most expensive material, I only use it at the places where need to be seen. Generally speaking, the envelope needs to be transparent.

The wood timber is a cheap material, and is good at bearing weight. So I choose it for making the structure of this subway station.

Ground Layer

The subway station roof is close to the ground layer. There are four exports between hall layer and the ground layer. For wind velocity measurement, there are two different boards are prepared. One is density fiberboard with TSI points, and another is transparent acrylic board for visualization experiment.

Station Hall Layer

Passengers buy tickets on this floor, and there are four staircases between the hall layer and platform layer. The air-conditioning system is mainly on this floor, and supply cold wind to the platform layer by ducts.

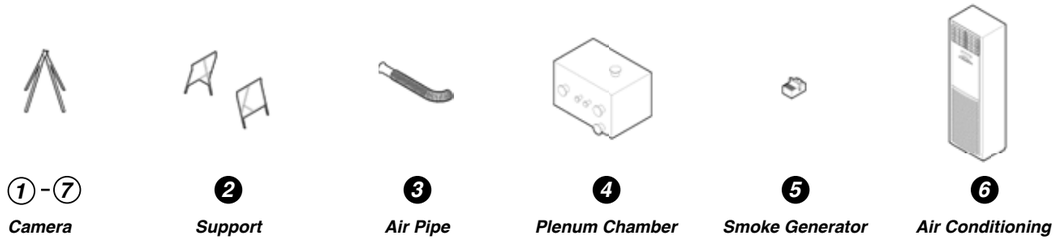
Platform Layer

Passengers will be waiting for subway trains here, standing on the platform. There are four tunnel exports around the platform.

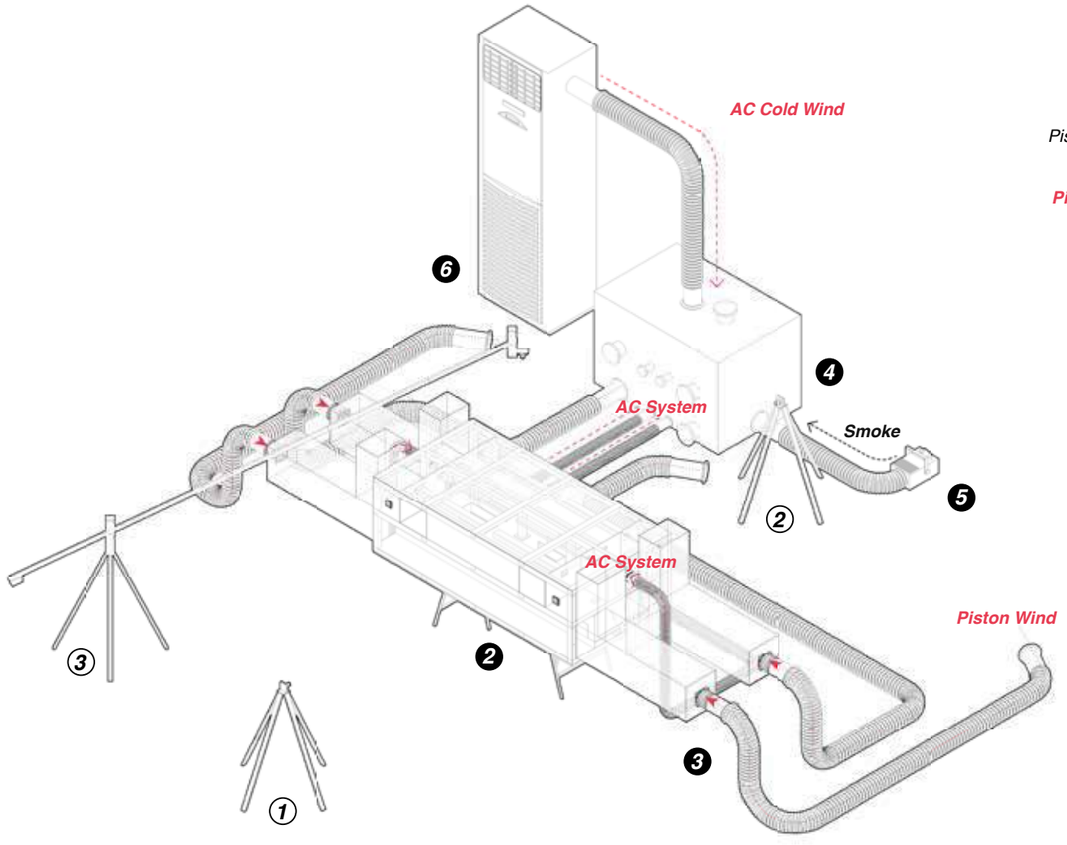
Model Making Process

EXPERIMENT I Visualization equipment & methodology

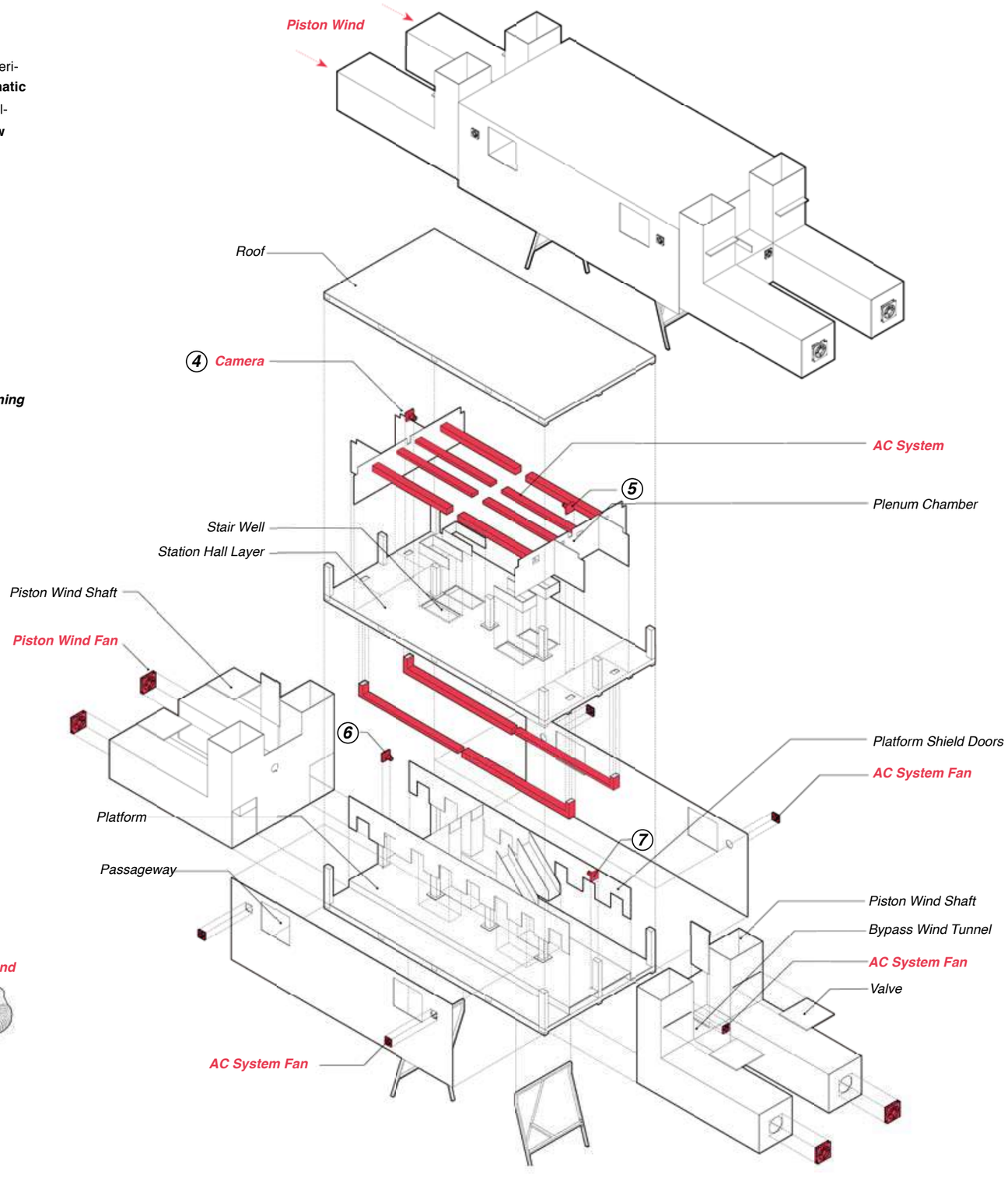
Presently, the main ways of researching the piston wind in a subway station include field measurement, theoretical calculation, numerical simulation and model experiment. We chose the model experiment method. By satisfying the **geometrical similarity and kinematic similarity**, we can realize similar flow field characteristics between the model and the prototypes. Colored smoke was used to visualize airflow and a TSI anemometer was used to measure the airflow velocity. Therefore we can research **change rules of the airflow streamline and velocity** inside a subway station.



①-⑦ ***Camera*** ❷ ***Support*** ❸ ***Air Pipe*** ❹ ***Plenum Chamber*** ❺ ***Smoke Generator*** ❻ ***Air Conditioning***

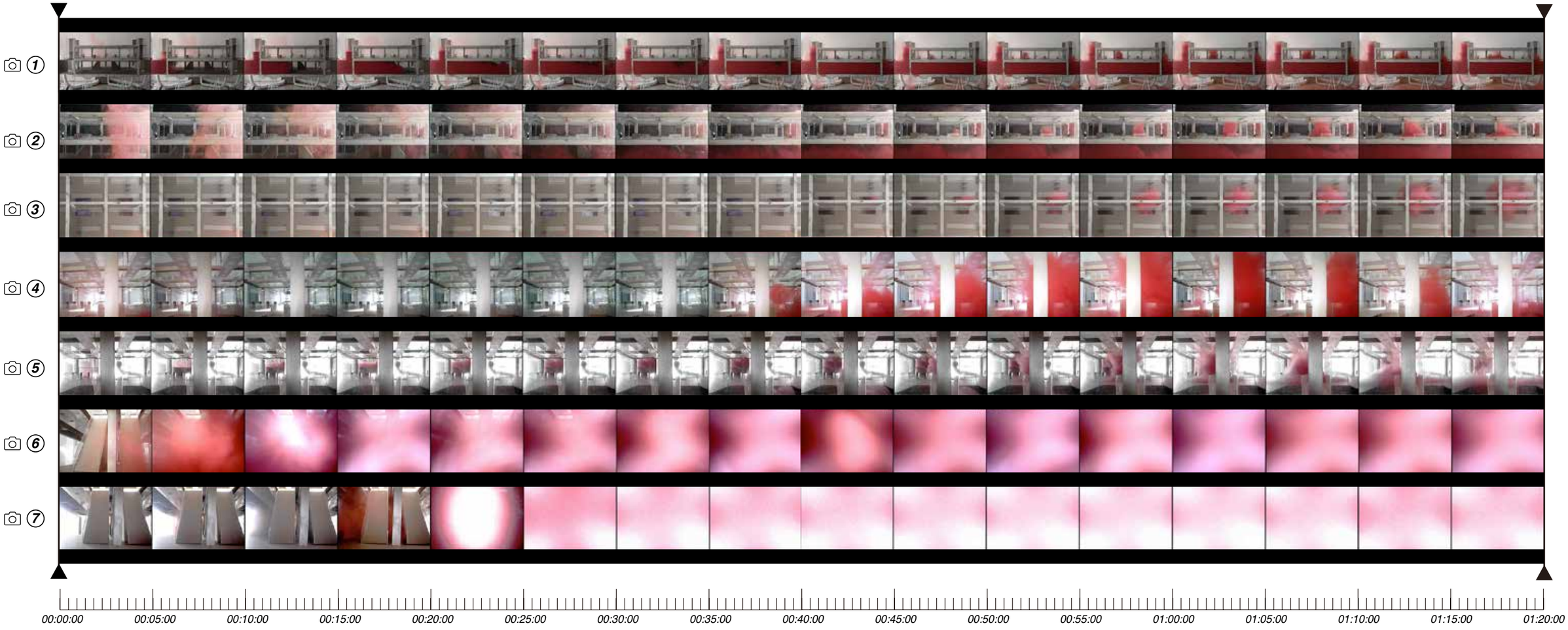


Axonometric of Visualization Experiment Installation

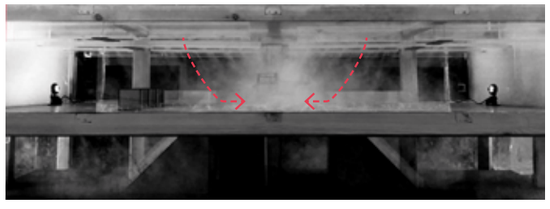


Explosive Axonometric of Subway Station Model

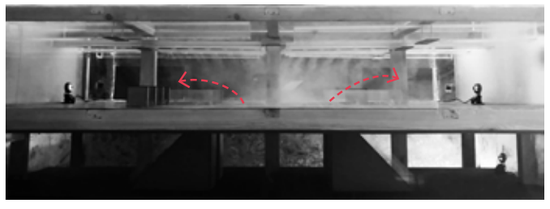
VISUALIZATION I Piston wind flowing through the subway station when tunnel fires



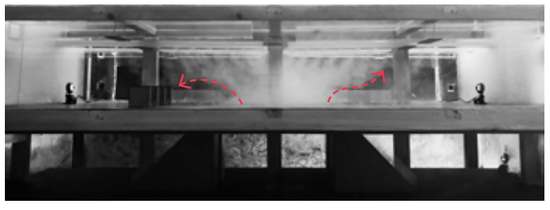
CONCLUSION I Piston wind's impact on hall level AC supply air (Camera ②)



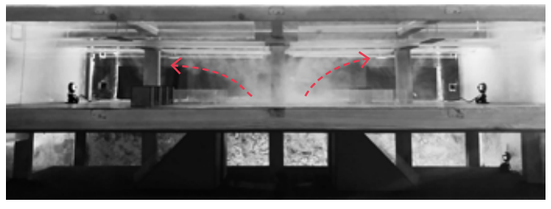
HVAC System Airflow Trajectory (0.4m/s)



Single Piston Wind's Impact (0.4m/s)



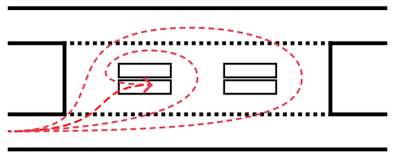
Single Piston Wind's Impact (0.5m/s)



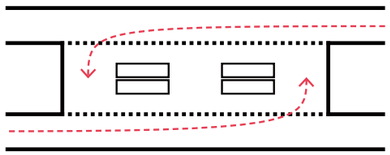
Double Piston Wind's Impact (0.5m/s)

CONCLUSION I Piston wind's flow pattern

After researching the law of airflow in a model metro station, I generate some possible ideas of applying piston wind to HVAC or architectural design. **From an HVAC point of view**, the model experiment can be verified with the CFD simulation proofreading, making the simulation results more accurate. Besides, according to the flow rule of piston wind, engineers can achieve reasonable airflow organization by adjusting the **position, height, direction and volume of the air supply of the HVAC system.** In this way, it can both satisfy human thermal comfort and reduce the station energy consumption. **From the perspective of architectural design**, the most critical point regarding to airflow in the station space is the ***stairwell.*** Therefore, by designing stairs with different directions, shapes or sizes, it is possible to influence the piston wind flow path in the large space of the station, so as to create an special experience with body-speed perception.



Single Piston Wind (0.5m/s)



Double Piston Wind (0.5m/s)

04 Dormitory Bed Desk

How to improve students' *life quality* in 8-bed dormitory rooms?

Personal Practice Work
Furniture Start-up / 2015—2016
Role: Founder & Leader
Partner: Qi Zhou / Hongye Yan
Contribution: Design(100%) / Drawing(100%) / Marketing Strategy (90%) / Fabrication Organization(90%)

BACKGROUND I More than 10 million students are living in old campus

In the freshmen year, we lived in the **new campus**, although it is sparsely populated and the information is blocked, the dormitory room satisfies a normal standard, with each student has their own loft bed and the desk under it. However, by the end of sophomore year, the school moved us collectively to **old campus** without consultation. Apart from the noisiness and smog of the city, the most unacceptable thing is the dormitory quality. The narrow dark corridor exudes all kinds of strange odor, and the eight-person dorm is too crowded to allow all students write assignments at the same time. There is no independent bathroom, no air conditioning and hot water. The contrast of before and after living conditions form a huge gap, so it became difficult for us to face the next day.

Before

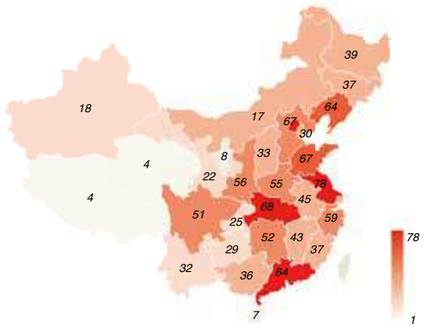
one room, 20m²

Now

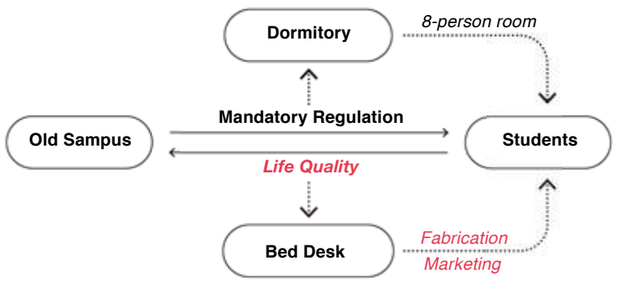
one room, 21m²

Anachronistic, inconvenient and inhumane

In the past years we have witnessed a **frenzied expansion** of colleges and universities in China. Many schools, however, have just focused on scale expansion, but neglected quality improvement, especially students' life quality. Most universities prefer to allocate more funds on scientific research projects. Through preliminary estimation, there are more than 10 million students now are living in 8-person or 6-person dormitory rooms. The poor living quality directly ***harms each individual student, both physically and psychologically.*** With economic growth and raising standards of living, the crowded dormitory is considered anachronistic, inconvenient and inhumane.

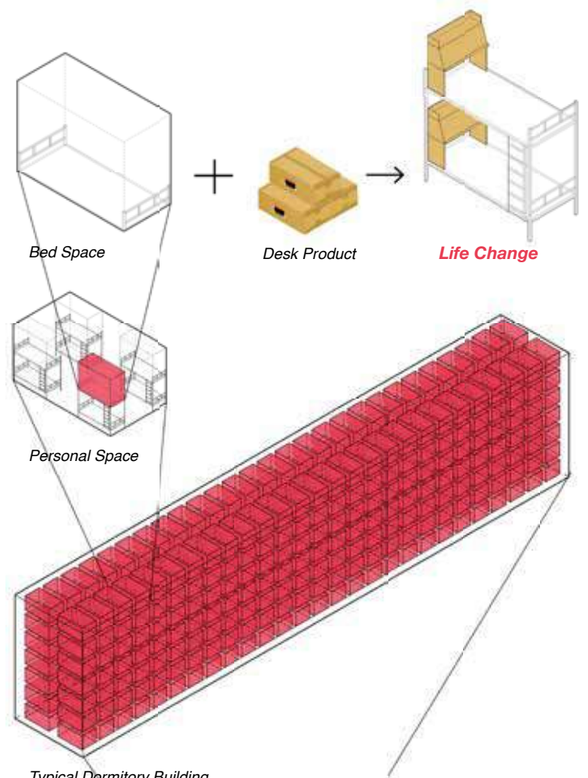


2015 Universities Distribution in China

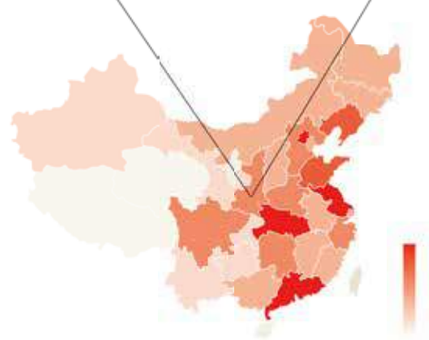


STRATEGY I Minimum material intervention, maximum life quality improvement

Through a “downgrading” strategy, the huge complex problem is resolved into multiple, repetitive small units, starting from point to line and to surface, in response to the existing difficult-to-change eight-person accommodation system and old dormitory buildings. The only possible private space in a dormitory was on the bed, and since the bed desk has the most impact on the use of this space, I begin to design at this point. With the help of Online shopping and convenient logistics services, this product could be accepted by the school leadership and the majority of students at the same time. With minimal material intervention, it can improve students’ life quality in dormitories as much as possible, and become **a mode that can be extended throughout the country to address existing problems.**



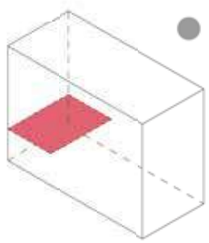
Typical Dormitory Building



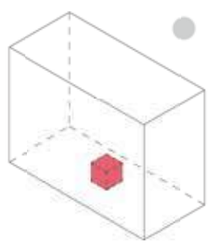
Old Campus Distribution

RESEARCH | Work surface is the most need

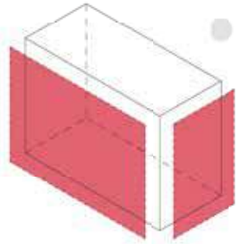
By looking at four representative college students' life, and analyzing the extent of three different requirement, It could be concluded that **the most general and strong demand is an enough large work surface,** which is related to most typical behaviors in bed space. Then is storage, the least is the privacy. Based on such kind of researches, it is not difficult to design for these behaviors.



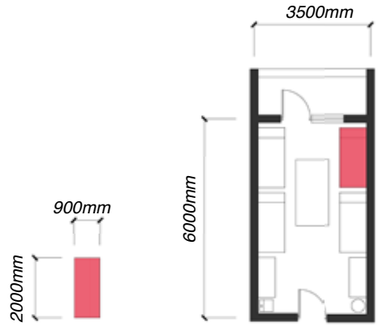
Large Work Surface



Enough Storage Space

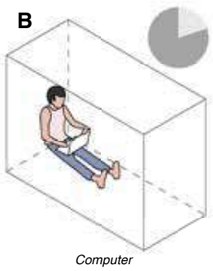


Some Privacy

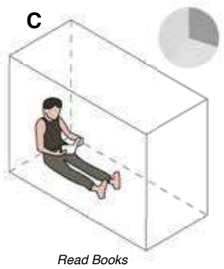


8-Person Room Plan

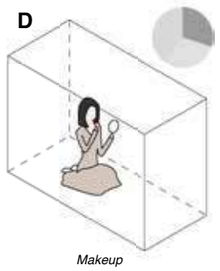
Wear Clothes



Computer



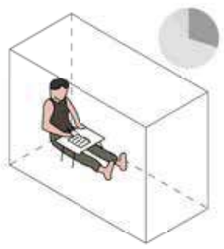
Read Books



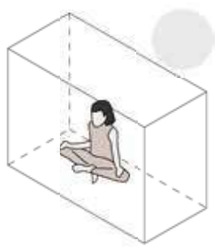
Makeup

Play iPhone

Play iPad

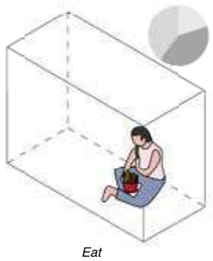


Write

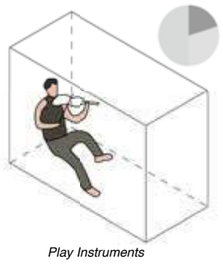


Meditate

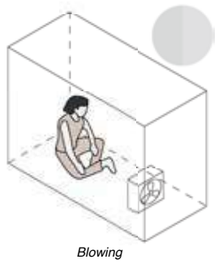
Sleep



Eat



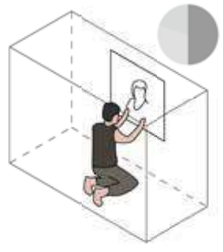
Play Instruments



Blowing

Jerk Off

Drink



Up

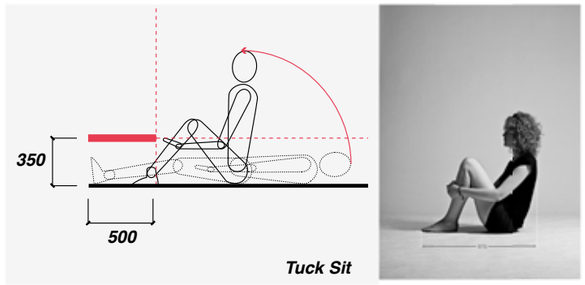
Chat

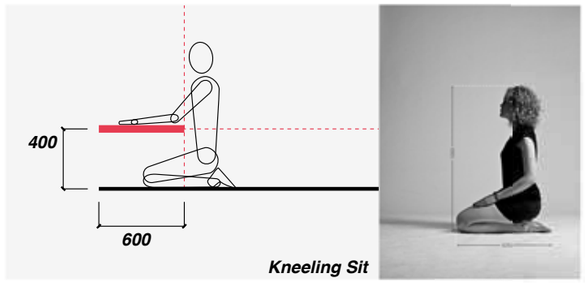
Student **A is a learning tyrant**, with eccentric character. He usually stays in the library and study rooms, and only goes to sleep in the dormitory. For him, the dorm needs a good sleeping environment.

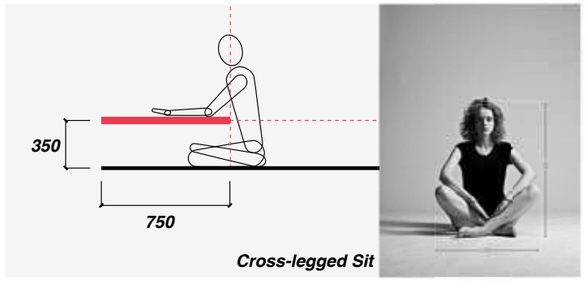
Student **B is a otaku**, like playing computer games. Except attending courses every day, most of the time he would be in the dormitory. He likes to eat fried foods and drink carbonated drinks. For him, the dormitory is a place for relaxation and entertainment, so there needs to be enough space for entertainment.

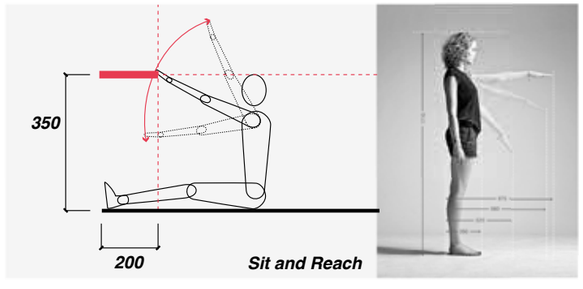
Student **C is an artistic youth** who loves reading books and playing instruments, pursuing happiness in life. The side wall of his bed is full of film posters. For him, sufficient private space for self-cultivation is needed.

Students **D is a typical girl**, always making up in the dorm room, and chatting with her girlfriends. For her, there needs to be enough space to accommodate various commodities.









Human scale on a bed

Determine appropriate depth, width, and height of the bed desk by measuring the spatial dimensions of different human limb movements, to achieve body comfort.

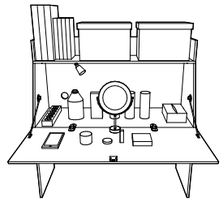
SYNTHESIS I Endowed bed desk with multiple roles & combinations

Multiple Roles

In a college student's dormitory life, there are many different circumstances. Take a girl as an example, sometimes she would like to play computer games, which means that she need a extra mechanical keyboard. And sometimes she might need to write school assignments, so at that time, she would use the desk to study. Or most of the time, she makes up on the desk. Therefore, it is critical for a desk to satisfy requirement in these circumstances.

Write Assignments

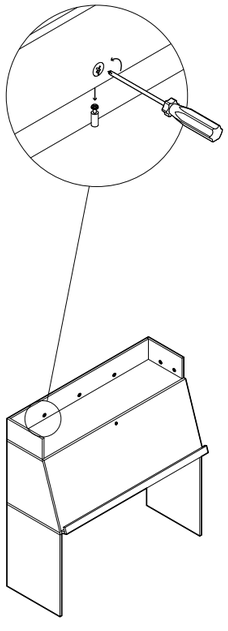
Play Computer



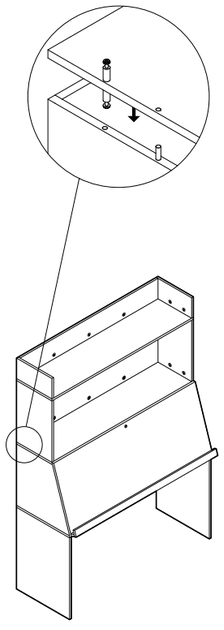
Make Up

Additional Shelves for Expanding Storage Space

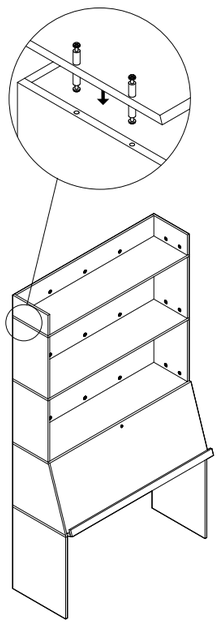
On the basis of meeting general needs, I further considered different demand extent and economic capabilities of students. The storage layer is designed to be flexible. It could be installed and disassembled easily, so students can purchased additional storage layers to achieve storage space expansion.



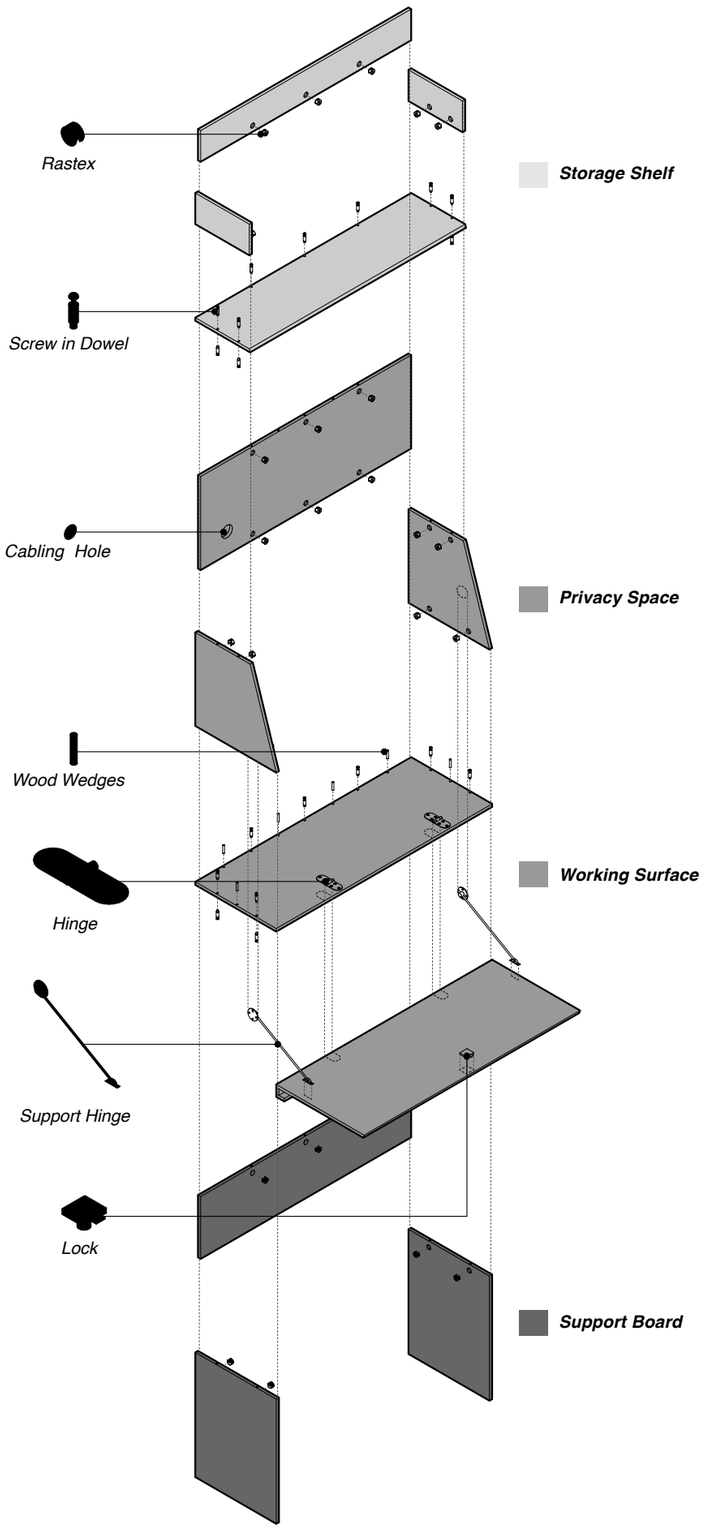
Standard Version



Enhanced Version



Luxury Version



Explosive Axonometric of Bed Desk 2.0

Bed desk 2.0 sample

The large desk area after unfolding could serve all kinds of objects, such as a mirror and various cosmetics when making up, mechanical keyboard when playing computer, and a A1 size paper when working on draws.

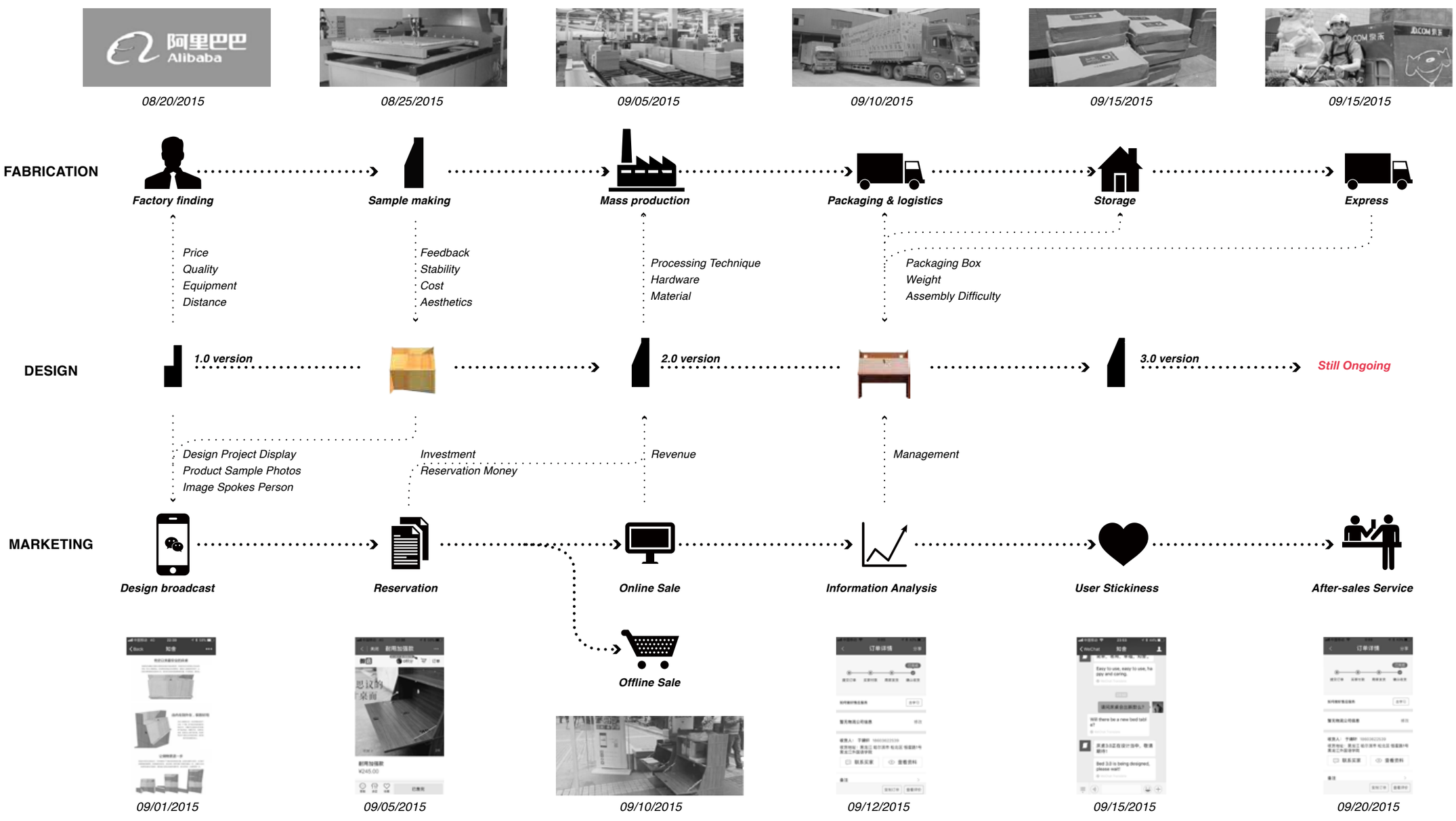
The design of hinge and tension rod can promise load-bearing, and all hardware fittings' place was considered thoroughly to be reasonable. The quality and the price is balanced.

Privacy is considered, personal things will not be seen after desk board folding. Furthermore, there is a lock offering security for expensive objects. When you finishing works on your computer, you can just easily close the desk and lock it.

After folding, the large desk surface will cover a small area, without any influence on other activities on a bed. Also, the folding angle and the groove were designed to prevent desk board falling down, the security and convenience are satisfied at the same time. Groove can also be used for reading books, i Pad or guitar scores.

PRACTICE I Desk 3.0 has been sole more than 1,000 pieces

I want to realize the design into real life, so I integrated fabrication, design and marketing, establishing a startup company with my friends. Though the project was temporarily stopped as time limited. I have been receiving a few purchase requests from users. Therefore, in 2018, I decide to redesign the bed desk and launch 3.0, targeting **student living in old dormitories across the whole country**. Further consideration will be given to specific living demands such as **water, food and air**, improving life quality with more concise and effective design, and realizing **convenient transport and installation by reconsidering material and structure.**



05 Jinfeng Academic Architecture Design

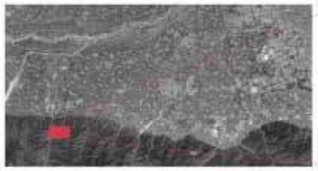
How to create a new way of *experiencing* natural environment?

4 Months Professional Work
Internship Project / Summer 2016
Instructor: Qili Yang, Yan Bai
Collaborator: Dong Wang / Fang Li / Wen Zhang / Lina Ma / Liye Fan / Fan Wu
Contribution: Design(30%) / Research(50%) / Drawing(40%) / Model(100%)
(Most of the sky walk is my design. And I took full responsibility of all physical models and part of digital models.)

SITE ANALYSIS I Surrounding thick trees and the Qinling mountain view

Party A of the project is Qinling National Botanical Garden, hoping that we can design **a similar ancient Chinese academy,** for tourists to rest, study and relax here. Compared to a fast-paced urban life, they hope us to create an atmosphere of flowers and trees, pen and ink so that **modern people's restless heart will be calm and peaceful here.**

The base is located at the northern foot of Qinling Mountain, about 3 hours drive from the center of Xi'an city. It is surrounded by trees, beautiful scenery and fresh air. One of the original two buildings is a rammed earth house, which has been demolished. And there is a new two-story house at its east side. Standing on the roof of the house, we can view over the trees' top, **an open thick, and sea-like landscape. The Qinling Mountains in the distance is quite nice and beautiful.**

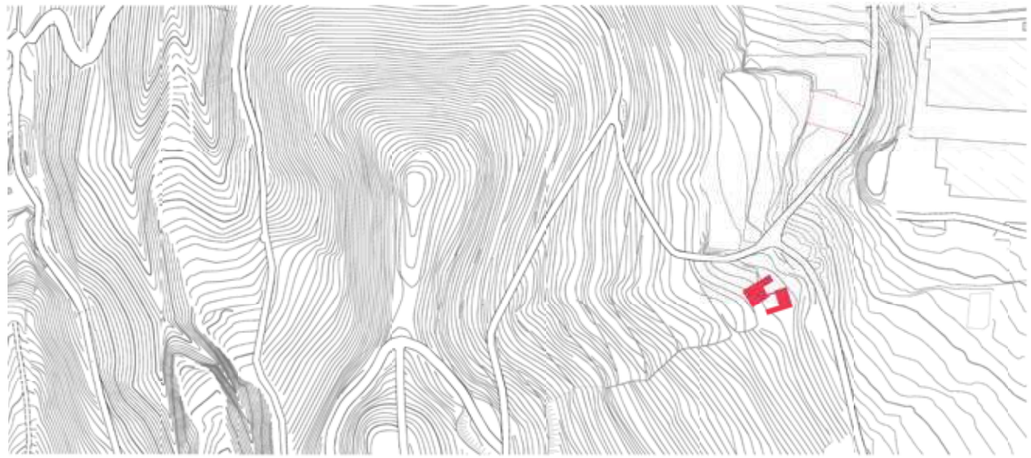


Xi'an City

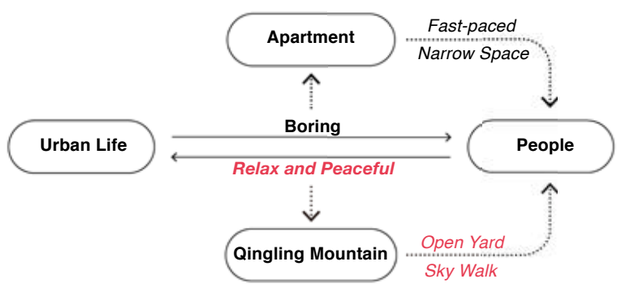
Qinling Mountain

Jinfeng House

Panoramic View In Front Of The Old House



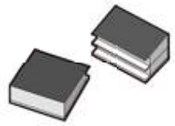
Site Plan 1/5000



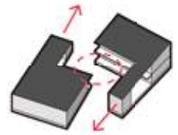
FORMING I Space generation for various sightseeing views

Concept Development

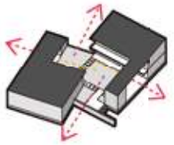
Step 1
Old House



Step 2
Books Image



Step 3
Yard Forming



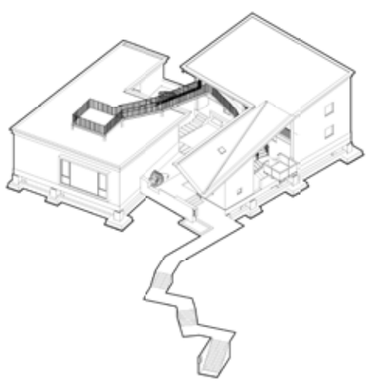
Step 4
Four Views

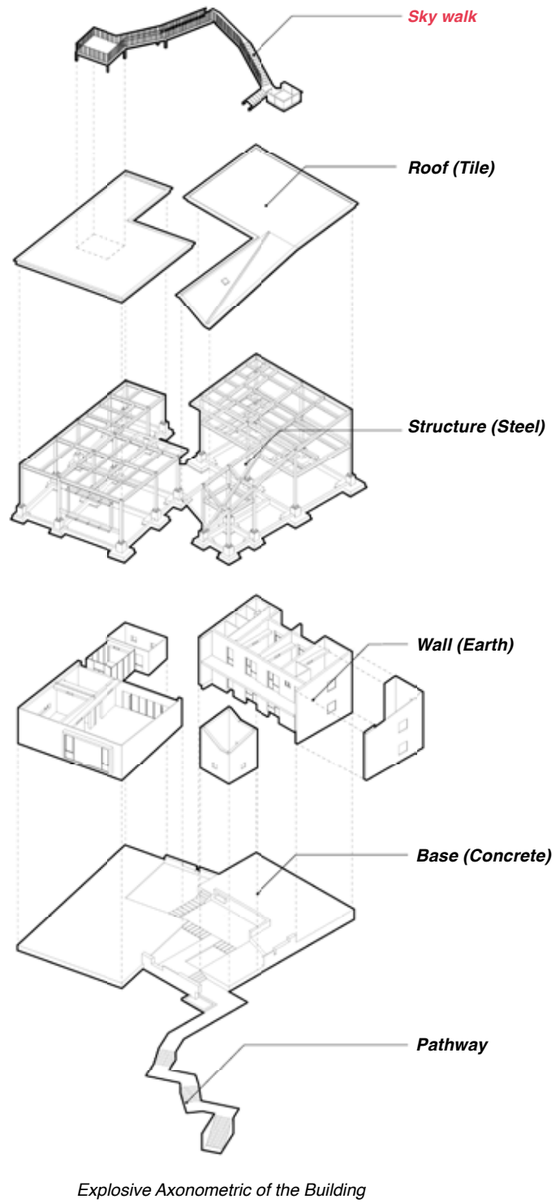
Step 5
Pathway

We hope to **not destroy original trees on the site**, so we plan to design the new architecture within the precious base area. At the beginning, we conduct some morphological operations based on the original house volume. Then, referencing the courtyard concept in traditional Shaanxi architectural culture, we tried to create a new courtyard form for sight viewing. Besides, I think of the **bridge element in classical Chinese garden, and want to integrate it with stairs,** which could give people a new architectural experience.

Landscapes of the Four Seasons

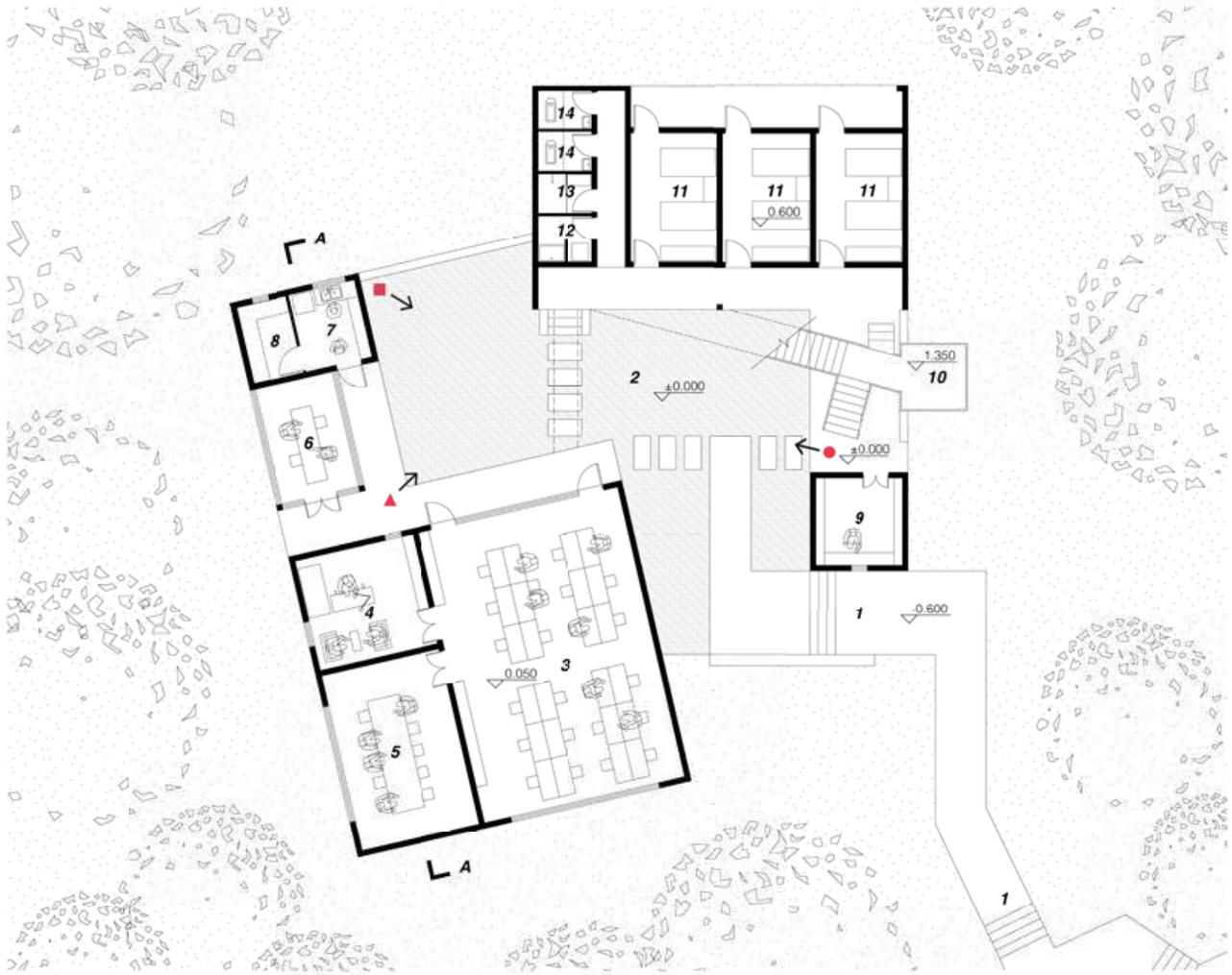
Physical Model





Explosive Axonometric of the Building

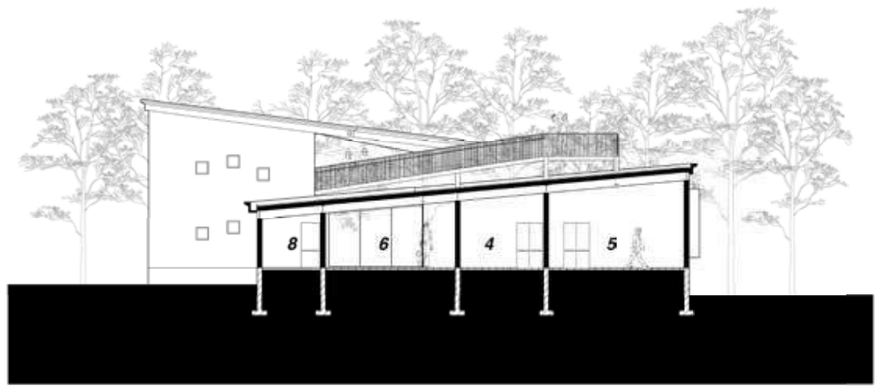
FLOOR 1 | Scenery change by space volume



Floor 1 Plan 1/200

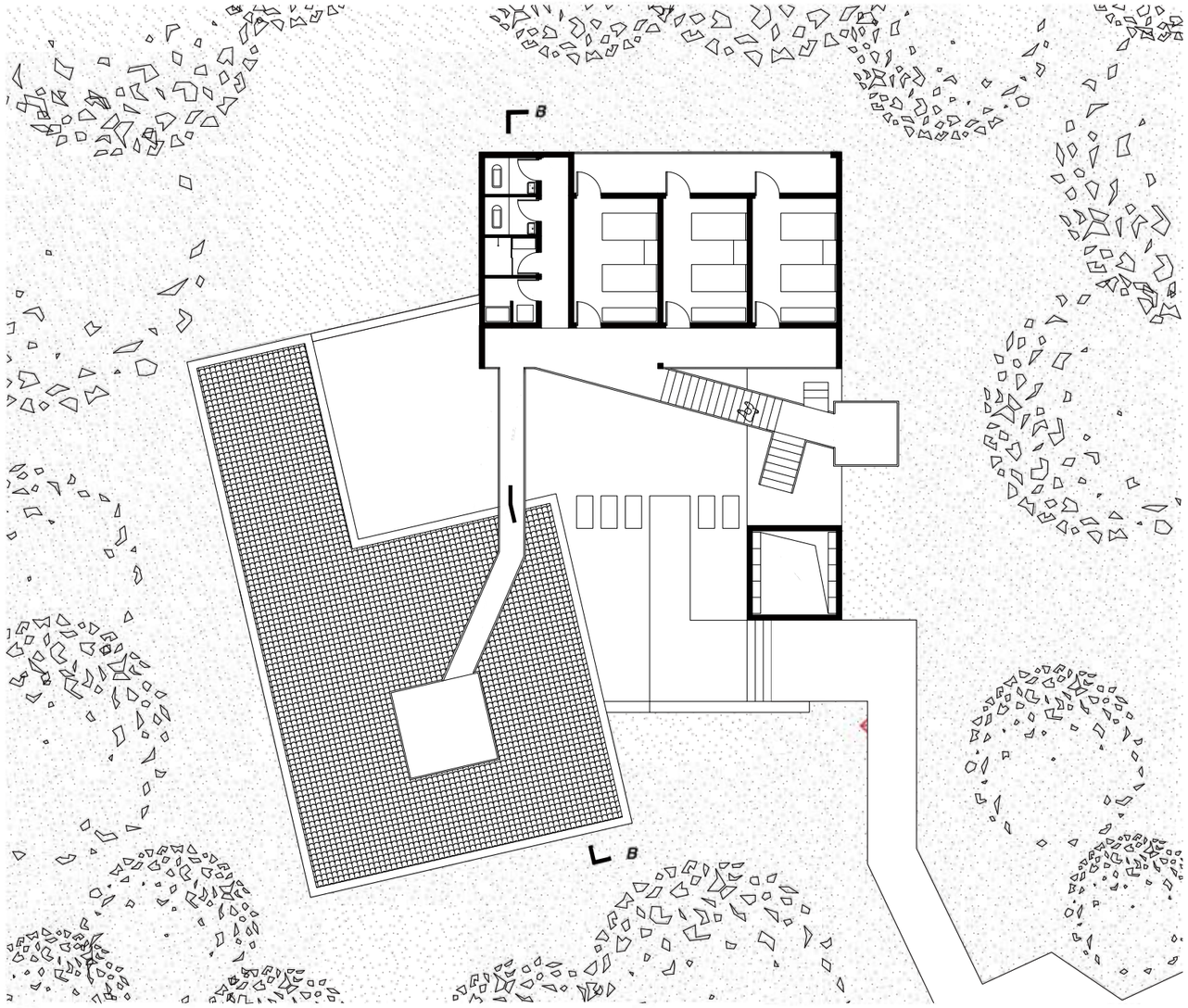
1 *Entrance*
2 *Courtyard*
3 *Studio*
4 *Office*
5 *Conference room*
6 *Dining room*
7 *Kitchen*
8 *Storage Space*
9 *Library*
10 *Tree-side Terrace*
11 *Bedroom*
12 *Washroom*
13 *Bathroom*
14 *Toilet*

The space of courtyard is **zigzag**, attracting people to go into the courtyard. By operating the volume from a traditional and closed Shaanxi dwellings typology to a irregular and open space, people would experience **new views of surrounding natural environment** when they are walking in the yard. As the building is surrounded by trees, the relationship between the trees and people would also be interesting, especially when people step to the second floor.



A-A Section 1/200

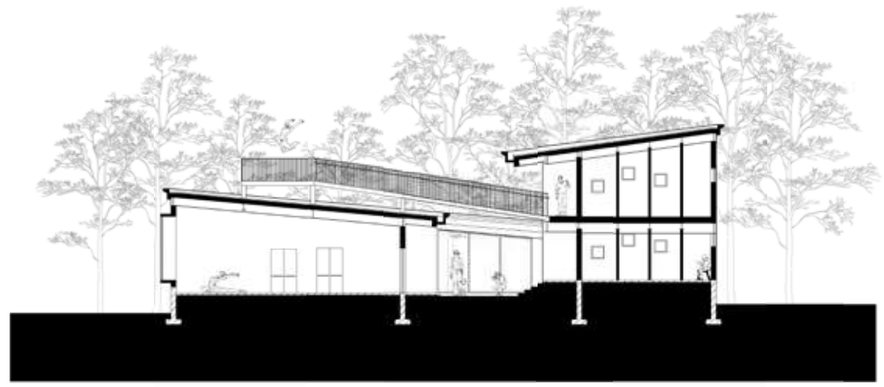
FLOOR 2 | Glorious Sight & Extraordinary Meditation



Floor 2 Plan 1/200

1 *Sky Terrace*
2 *Sky walk*
3 *Bedroom*
4 *Washroom*
5 *Bathroom*
6 *Toilet*
7 *Tree-side Terrace*
8 *Library*

Walking up the stairs along the pathway, as the height increases, people's perspective becomes more and more wide. When finally reaching the sky terrace, people can see **panoramic view of the Qinling Mountain**, feeling free and happy. At the same time, the green tile roof under the terrace would make people **think of traditional scenes, and be lost in meditation.**



B-B Section 1/200

06 Dormitory Further Design

How to create a space for both *singles and couples*?

Personal Design Work I Since 2016

Canoodling Couples

Inhumane Dormitory Management

Chinese inhumane dormitory management system has caused many problems. For example, there are nearly 3,000 students living in the building, but there is only **one entrance and exit,** because of the convenience of school management. During night, especially one or two hours before the dormitory was closed, a large amounts of couples would like to have a final hug before they leaving each other, but this is inevitably embarrassing as too many people are there. On the other hand, for singles, such behavior is an eyesore and make them sad.

A Bachelor

"Once I went to get hot water, my thermos bottle was on the floor in front of the door, and there was a couple hugging and cuddling, I was too embarrassed to get my bottle."

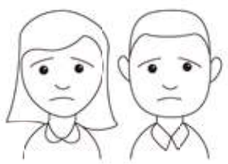
Not only the moment when we get hot water, during the intensive semester, everyone would study in the library or study rooms until the dormitory was closed. It is **embarrassed to walk through the cuddling couples.** Some people might think of a sorrowful memory; some people even generate an envy mind. People are generally dissatisfied with this, but they can not say anything.

Bachelor's Facepalm

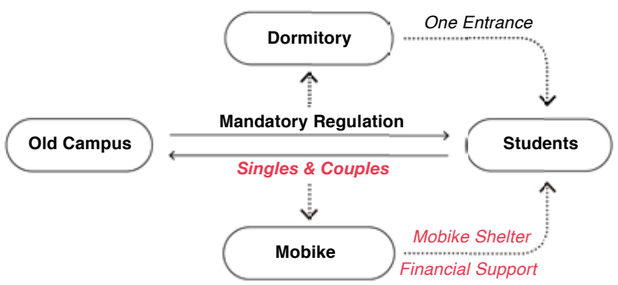
A Couple:

"At first he will send me until the dormitory door, and will hold me for a while when we leave apart, but now he is reluctant to appear more in front of our dormitory, saying that there are a lot of people looking at it and feeling particularly awkward. I am not sure whether he still love me?

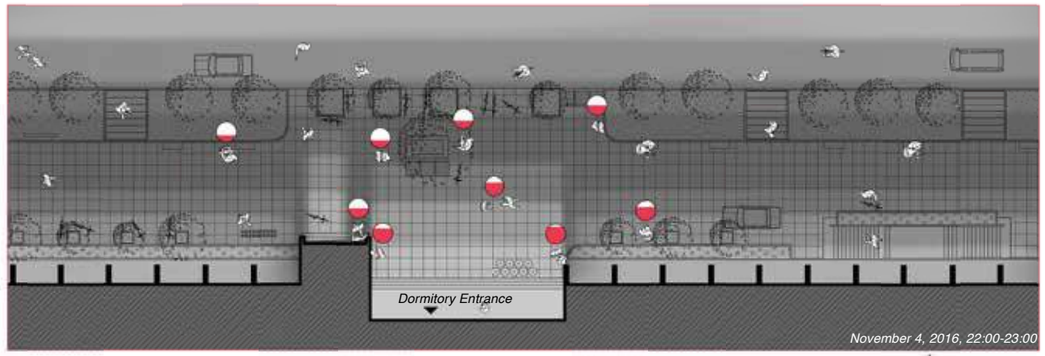
For couples in love, boys often have the obligation to send girls back to their dormitories at night, and until the dormitory door is the end, as a sign of the women only. So at the last moment of leaving, it is inevitable that they are reluctant, **whispering of love and sweet words, which is human nature.**



Couples' Sorrow



Site Research: The most critical factor of canoodling place is distance

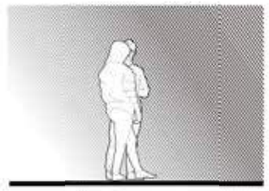


Site Plan 1/500

Frequency of Canoodling Place Recording

Through observing couples cuddling place, and recording the frequency of appearance. I found that there are three types of spaces where they would like to stay. So, design could be developed in these directions. However, the most critical factor is the distance, in front of the dormitory door, **there are much more couples than other places**, even though there are not many suitable spaces.

At Boundary



In Shadow

Under Tree

Behavior Research: the most indiscriminate behavior is riding a Mobike

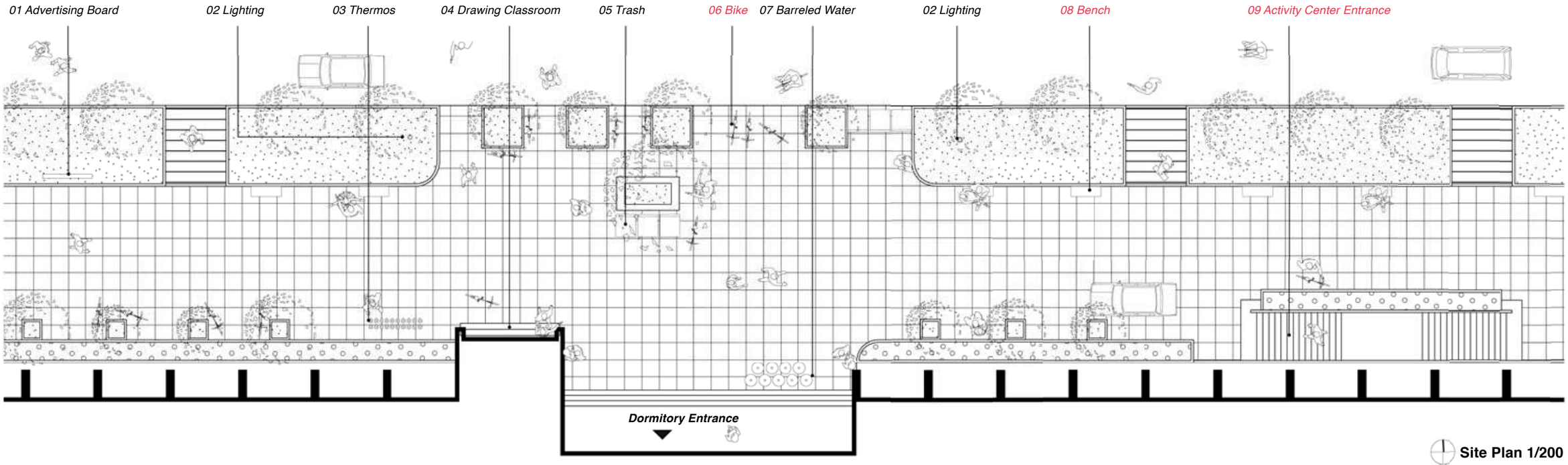
Because of the obvious difference between bachelors and couples, the same behavior might be somehow harmful. So it is necessary to figure out which kind of behavior would be allowed in the same space to benefit both two groups. It turned out that Mobike is the most suitable, which is a new kind of shared bike based on Internet. As a bicycle has only one seat, not matter singles or couples have to take the bicycle alone.

Mobike

Get Hot Water

Drink

Play i Phone

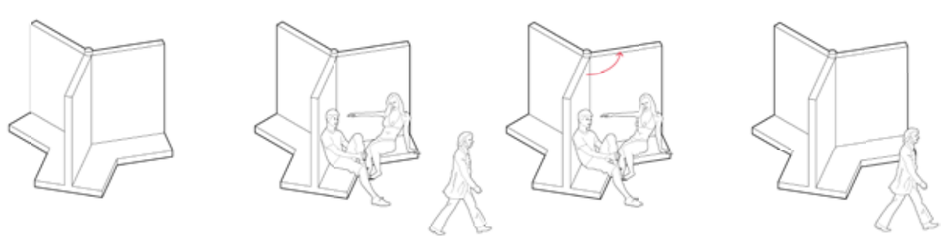


Site Plan 1/200

Design Evolution

Summer/2016

Step1 Too Obvious Design Purpose



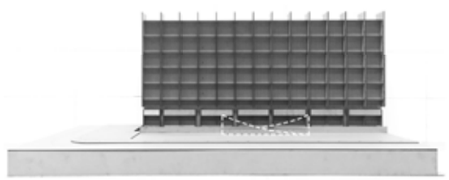
08 Rotatable Bench

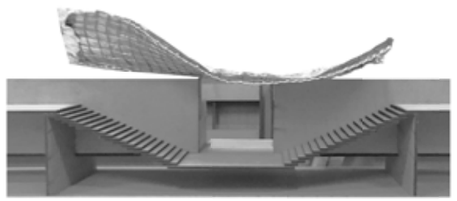
At the beginning, my focus was on physical entities, trying to block the sight of single people by designing seats or installations to provide canoodling space for couples.

However, the operation of the placing a new material on the site is too conspicuous, in other words, **the purpose of design is too obvious.** Perhaps it will make people not see intimate behaviors of lovers. However, in fact when people passing by the installation, they might be psychologically aware of what happened behind the surface. So **this feeling of embarrassment is actually strengthened.**

Spring/2017

Step2 Elsewhere Strategy



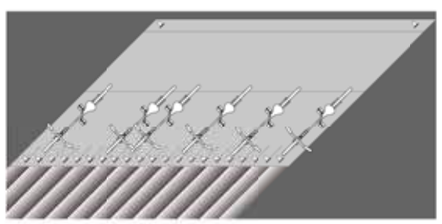


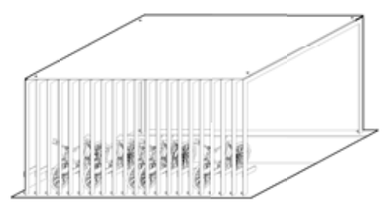
09 Entrance Canopy

Later, I adopted a strategy of **"making a feint to the east and attacking in the west"**, resolving the conspicuous design purpose problem. I noticed that the student activity center's entrance is underground, without an identity, so I designed a canopy for the entrance space here, catching attention by activating space, then the events in front of the door would be dispelled. In addition, such a more provide underground space can also provide a canoodling space for couples when there is no activity. However, **This project might not have expected effect as the distance** between it and the dormitory entrance is too long.

Winter/2017

Step3 Behind Bike Shed





06 Mobike Shed

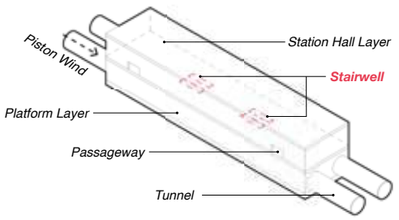
Recently, I tried to integrate my previous thoughts. The final strategy is **creating shadow space by an other entity with additional function**. I noticed that the shared bikes as a popular public product suffering rain and snow, and it is obvious that a bike shed can not only help prevent this, but also make it more convenient for people to use. By designing a special grating enclosure to create directional shadow, spaces with different brightness can be generated, then singles and couples can be served at the same time. Then I would like to **show this project to Mobike company and propose for sponsorship**. I hope to realize this project in 2018.

Still Ongoing

07 Piston Wind Further Research

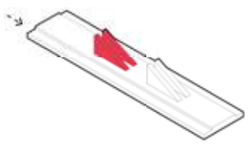
If I changed the stairs' direction, what will the piston wind be like?

Personal Work / Summer 2017



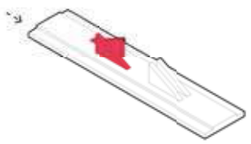
Experiment Model

This small metro station model is similar to the ***03 Piston Wind Visualization project***. During that project,I found that the stairwell is the most critical point for the air environment inside a metro station, as it is **the smallest cross-section point on the piston wind flow path**. So I want research more about the stairs, to see how different stair shapes influence the air environment. The visualization method is blow cigarette smoke into the pipe, simulating piston wind. At the same time, we can see the airflow path inside the model.



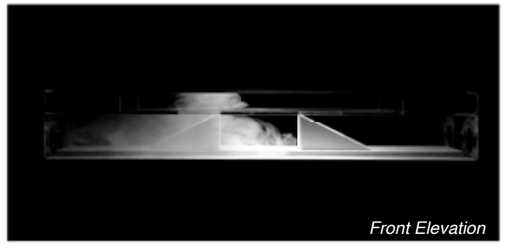
Experiment 01

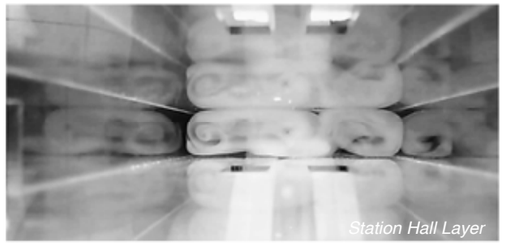
Experiment 02



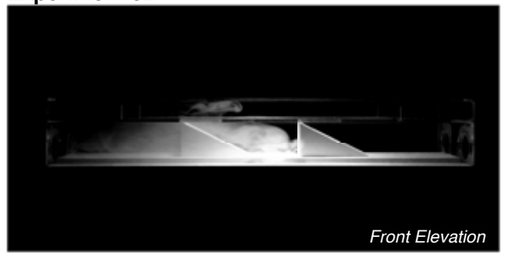
Experiment 03

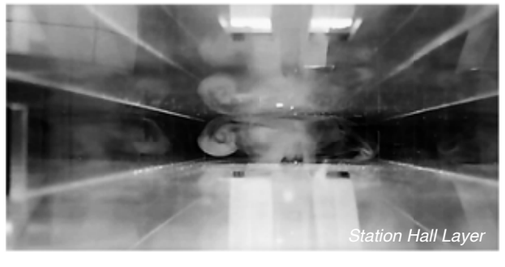
Experiment 01



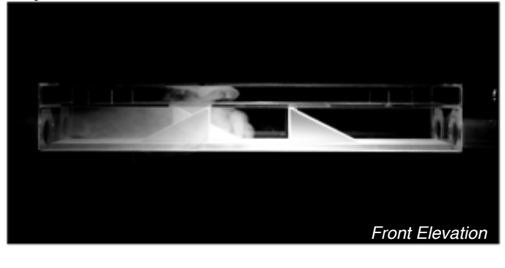


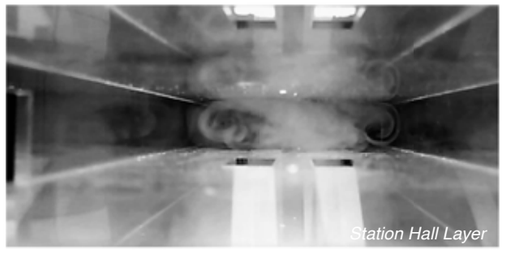
Experiment 02





Experiment 03

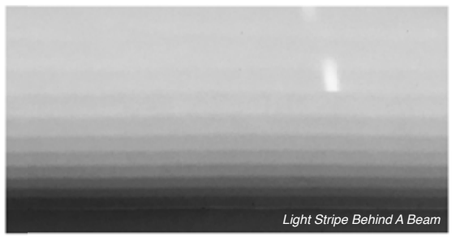




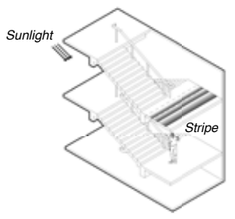
08 Light Stripe Research

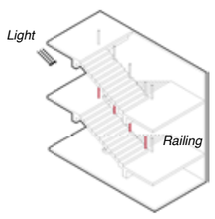
How does the light stripe form behind beams?

Personal Work / Summer 2016— Winter 2017

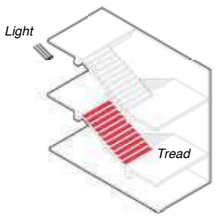


One day, in the morning, I finished my courses in the South Classroom. When I was going downstairs, I suddenly found an amazing light pattern behind the beam, which made me think of the **interference fringes** in my physics experiment class. I was particularly curious about that the pattern appeared too close to the beam, so it did not seem like it was caused by simple reflection. After that, I conducted several experiments, trying to figure out the reason for such a pattern. The result shows that the **tread is the reason.** Then, next step I am going to figure out the specific light path.

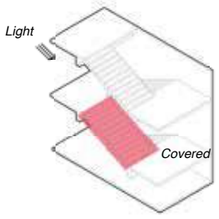




Experiment 01

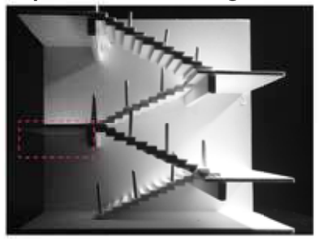


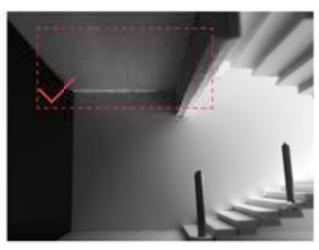
Experiment 02



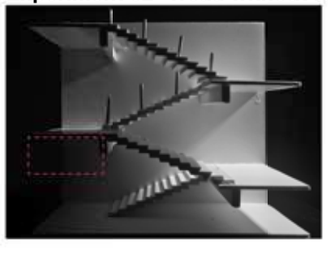
Experiment 03

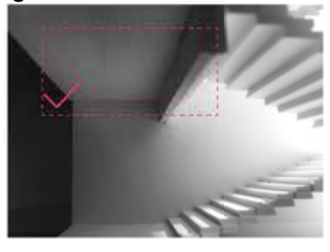
Experiment 01- Railing with tread

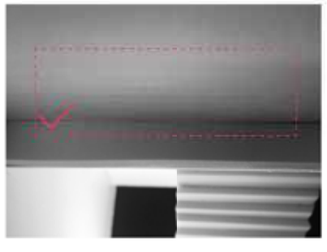




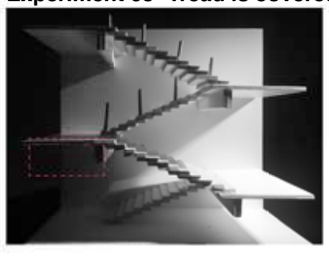
Experiment 02- Tread without railing

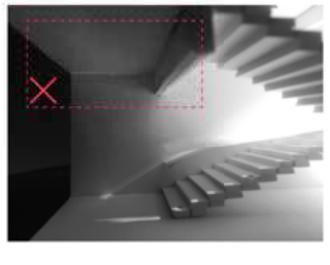


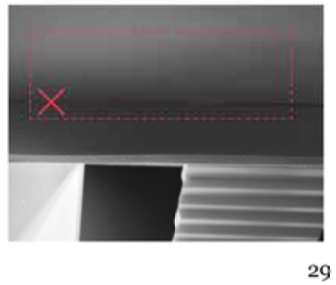




Experiment 03- Tread is covered







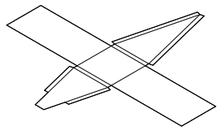
09 A Gift

How to make a birthday gift that can represent my friend Red

Personal Work | Spring 2017

Red is one of my teammate in the Bus Cooling System project, a warm, sweet, and energetic girl. We keep a good friendship all the time. For her birthday gift, I bought a red candle and a tray from IKEA, cause I think the color is really like her characteristic. Then I made this gift box by my own, using paperboards with white exterior face and black internal surface. I want to **create the inner space like an architecture church**, and the process of opening it would be full of ritual sense.

Candle & Tray



Paperboard

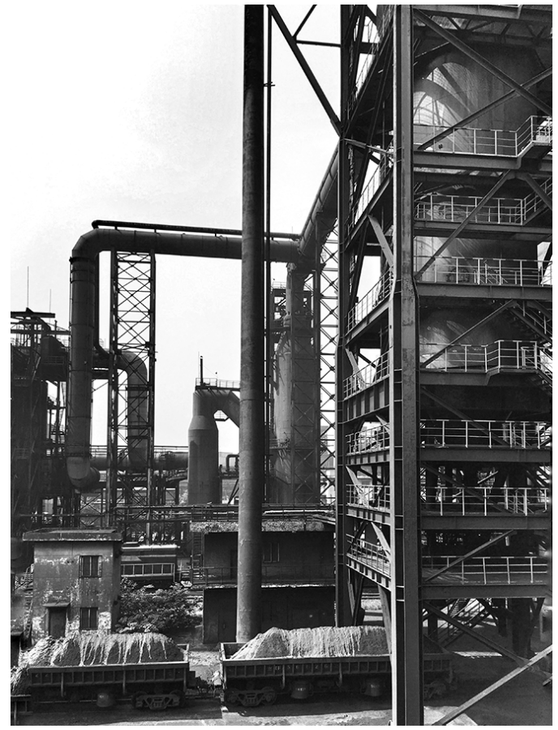
Gift Box

10 Photography

The emotion when I saw those machines.

Personal Work | Autumn 2016

In the final year, we were required to take an engineering practice in Wuhan Iron and Steel Corp, working in the factory area for nearly a month. Besides HVAC engineering knowledge and skills gained during the process, the most impressive thing is the **bleak industrial scenes.** There were lots of huge steel air ducts, thick concrete pillars going through each other. All things were covered by a dust surface and gave me a brutal feeling. People had to wear masks all the time and scarcely talk with each other. Here machines become the main role and human beings seem like to serve them, which is ridiculous and makes me **want to make technology and engineering *humane* more strongly.**



Resume

EDUCATION

Xi'an University of Architecture and Technology I Xi'an, China I 2013–2017

Bachelor of Energy Engineering
Bachelor of Architecture

PROFESSIONAL EXPERIENCE

Tumushi Architects I Xi'an, China I May 2016—Sep 2016

Jinfeng Academic Project I Assisted designing the architecture. Designed the Sky Walk. Met clients and represented the project. Produced 3D models with SketchUp. Produced topography, concept, and detailed physical models.
Mudan Park Project I Assisted architecture design with thermal and fluid mechanics knowledge. Generated project reference with Adobe Photoshop. Produced topography, concept, and detailed physical models.
Qinling Hotel Project I Helped develop design options. Helped administering construction process. Delivered construction drawings. Produced topography and concept physical models.
Office Interior I Responsible for moving the company to a new office. Renovated the studio interior space and supervised the construction.

Engineering Practice I Xi'an & Wuhan, China I Sep 2016—Jan 2017

Wuhan Iron and Steel Corp. I Witnessed de-dusting system of different technological processes during the production of iron and steel making. Visited a gas-steam combination cycle power plant.
Sijichun Clean Energy Corp. I Researched advanced hot dry rock heating technology and argued the practicality with experienced engineers. Fostered an interest of phase change material as efficient refrigerant.
Xi'an Xianyang International Airport I Assisted in recording data of ice storage cooling system. Specialized in radiation cooling method for energy efficiency in a large space.
Xi'an Subway Station I Measured wind velocity at different places in a subway station. Specialized in HVAC system in underground spaces. Researched the influence of piston wind.

ADDITIONAL EXPERIENCES

Tongji University Workshop I Shanghai, China I Aug 2017
Assisted Arduino program design and mechanical model design. Produced wind environment simulation.
Solar Decathlon China I Dezhou, China I May 2017
Assisted designing HVAC system. Created a new bed with fan coil units.
Capol International City Camp I Shenzhen, China I July 2016
Participated in architectural production lines and learned advanced PC technology.
ZHISHE Furniture Startup I Xi'an, China I Sep 2015
Designed a new desk on bed for student dormitories. Created a company for marketing.
Peking University Summer School I Beijing, China I July 2014
Studied plant development and molecular biology. Discussed ecology architecture design with biology professors.

HONORS & AWARDS

1st Prize in China R&AC Industry Science&Technology Contest I July 2016
As the team leader, designed a creative bus cooling system with energy efficient refrigeration technology.
3rd Prize in National Tournament of Green Building Innovation I Sep 2015
As the team leader, designed a green hotel building with natural ventilation and heat storage wall.
Xi'an University of Architecture and Technology Innovative Scholarship I 2014—2016
Awarded for innovative design work in the science and technology field.

SOFTWARE SKILLS

CFD, Arduino, AutoCAD, SketchUp, Rhinoceros, Photoshop, Illustrator, InDesign, Microsoft Office.

Dance has been a key part of my life. The first time I danced without a mirror, I found myself concentrating on the subtle changes in my body. I felt my upper and lower pores struggling to open, and the waves of heat rising on my skin with vapor. I was spreading and pooling energy and matter with every breath. The air began to dance around me, **following my limbs like a Karmen vortex street!** This experience led me to imagine the possibilities of air in a building.

Ruiji Sun
No.13, Yanta Road
710055, Xi'an, Shaanxi, China
sunarctec@outlook.com
+86 158 2935 9817