Jinan, formerly romanized as Tsinan, is the capital of Shandong province in Eastern China. The city is located in the middle of Huabei Plain.

The downtown area is located in Quancheng Square. In the city, there are 3 main railway stations and an international airport around the site. Six main attractions are recommended to you, helping you know the city better.
CLIMATE
Hot summer and cold winter, big annual temperature gap, concentrated rainfall, four distinct seasons, less annual precipitation, strong continental climate.

TEMPERATURE
In winter, under the control of continental climate, the average temperature in the coldest month is below 0˚C in the south.

PRECIPITATION
Precipitation here increases from south to north, the annual precipitation is around 200-400 mm, 300~600 mm in the north. Most precipitation concentrates in summer and another three seasons has almost no rain. It also has occasional snowfall in winter.
Town Annual Climate Summary

SEMI-HUMID CONTINENTAL MONSOON CLIMATE

It has a clear monsoonal character and four distinct seasons. It is dry with less rain in spring, rainy with high temperature in summer, cooler in autumn and much cold in winter. Average annual rainfall is 672.7mm; The annual peak in July with an average of 201.3 mm. Rains of Jinan in summer are more frequent than other northern cities, in addition to topography that it is embraced on three side by mountains and back-flow and gathering of hot air, contributes to high temperature and moist heat in summer.

1. Average Relative Humidity of Jinan, Shandong (%)
2. Average Precipitation of Jinan, Shandong (mm)
3. Average High/Low Temperature of Jinan, Shandong (°C)
4. Average Wind Speed of Jinan, Shandong (m/s)

SOURCE
http://data.cma.cn/
Wind Speed/Direction

**Dominant wind direction**
most are southwest/northeast (then east/north and south, rare northwest)

**Summer**
prevailing southwest/south/southeast wind, form hot and humid summer, concentrated precipitation, more thunderstorm weather

**Spring/Autumn**
transition season of winter monsoon and summer monsoon, variable wind direction. Dry and windy in spring and cooler in autumn

**Winter**
prevailing northwest/north/northeast wind, dry and cold in winter with sunny and less rainy weather

SOURCE
http://data.cma.cn/
The average annual minimum temperatures in China vary widely in different regions, ranging from -25˚C to 20˚C. As is shown in the map, different colors represent different temperature regions: the more bluish, the colder; reddish, warmer. The temperature of each zone is the annual average minimum temperature adaptation for the plant cultivation.

Plant hardiness zone map can be used as a guide for plant introduction. From the map, crops planted in most area of Jinan can tolerate a minimum temperature of -15˚C to -12.2˚C while planted in the middle of Jinan only can withstand a minimum temperature of -12.2˚C to -9.4˚C, which means crops planted here can tolerate the temperature under −15˚C and above. If the temperature under −15˚C, crops shouldn’t be planted here.

**SOURCE**
Agriculture in Shandong province is very developed because it has fine weather and good soil. It is also called ‘One of the world’s three biggest garden’. Jinan is the core area of the garden, which named ‘China vegetable basket’.

The available area of soil is accounted for 70.72% in Jinan and most of the soil is brown type which has long age, clear layer, deep soil, rich covered diluvium and high curing degree. Brown soil is suitable for farming because it can keep water and fertilizer, and has active soil microbial in the exuberant.

The soil pH is around 6.5 to 8.5 which means crops, peanut, potato, etc. are suitable to plant here.

SOURCE
Distribution of Soil pH in Shandong Province
Geochemical characteristics and environmental quality of soil elements in Jinan City
Photograph from Google
Comfortable Zone

This is an annual psychrometric chart of Jinan, Shandong, China, showing comfort indoors plot of a year. The time that human beings feel comfortable and not be affected by any factors - such as sun shading of windows, natural ventilation cooling, humidification - is around 6.6%, which means the comfortable time is 577 out of 8760 hours a year.

**LEGEND**

**COMFORT INDOORS**

7% **COMFORTABLE**

93% **NOT COMFORTABLE**

**SOURCE**

Climate consultant 6.0 (B8)
From the psychrometric chart we can get:

**Wet Bulb temperature:** 60.4°F - 72°F
(15.8°C - 22.2°C)

**Dew point:** 53.6°F - 66.4°F
WATER

Location Diagram

This map shows the locations of D&I and surrounding area.

1. 设计创意学院三期 D&I
2. 设计创意学院二期 D&I
3. 设计创意学院创意工场 D&I Innovation Factory
4. 同济建筑设计院停车场 TJAD parking lot
5. 同济建筑设计院 TJAD
6. 上海设计之都办公室 SPCD Office
7. 同济联合广场C楼 Tongji United Plaza C
8. 同济君禧大酒店 Kingswell Hotel Tongji
9. 上海市建设工程检测行业协会培训中心 Shanghai Construction Engineering Testing Industry Association Training Center
Water Information Diagram

This is the feed/drain water line map of D&I and surrounding area. This map shows how feed water and rain water come and go in this area.
Orientation For Winds & Passive Cooling

Site Plan

Hengshengbanshan Residence, build in the new town of east Jinan, is located on the north side of Shidong Road, southwest side of Snow Mountain, neighboring Shandong Provincial Institute of Land Surveying and Mapping, Convenience Supermarket.

The building we choose is Hengshengbanshan Redidence 3#, highlighting in yellow square of the Aerial view below and marking in red of the right map.

SOURCE
http://map.qq.com/
The current orientation of Hengshengbanshan Building is southwest.

In winter, southwest wind in Jinan has highest frequency and fastest velocity of the whole year. It seems like the current orientation is quite good. However, during China Thermal Partition map, we find that Jinan, Shandong Province belongs to cold area, which means warmer southeast wind can help the building keep a certain amount of heat in winter. When summer comes, the southeast wind can bring cooler wind.

So we adjust the orientation and let the building faces the southeast instead of southwest. And after adding three windows (the yellow one), ventilation gets improved and stagnant corners disappears. There are more mixings here.

1. Current Orientation of Hengshengbanshan
2. Improved Orientation of Hengshengbanshan

SOURCE
http://sustainabilityworkshop.autodesk.com/buildings/massing-orientation-daylighting
Stack Ventilation

Stack ventilation uses temperature differences to move air. Hot air rises because it is lower pressure. After wind ventilation, stack ventilation is the most commonly used form of passive ventilation.

Stack ventilation and Bernoulli’s principle can be extremely effective and inexpensive to implement. Typically, at night, wind speeds are slower, so ventilation strategies driven by wind is less effective.

Therefore, stack ventilation is an important strategy.

1. Wind Rose Map of Jinan
2. Stack Ventilation (elevation)
3. Stack Ventilation (plan)

SOURCE
http://sustainabilityworkshop.autodesk.com/buildings/
stack-ventilation-and-bernoullis-principle
Massing Strategies for Passive Heating

Sun Path

Sun path is regular. We find the whole year data of sun path, do analysis work and choose four typical days to show the track and height of sun at noon. This is the basis of sun path, solar gains and day lighting indicating.

1. Diagram of Sun Path and Sun Light of Hengshengbanshan in Jinan
2. Sun path in equinox and solstice day and the height of the sun at noon

SOURCE
Sun Path

This diagram shows the range and extreme value point of sun path and sun light of Hengsheng-banshan in Jinan throughout the year.
In summer, we get the maximum angle of the height of the sun. Usually, it happens on summer solstice day, the angle can reach 70˚ (or even larger, for example, 77˚). Thus, we get short daylighting in the room at noon.

In winter, we get the minimum angle of the height of the sun. Usually, it happens on winter solstice day, the angle can reach nearly 30˚. Thus, we get long daylighting in the room at noon.

SOURCE
Sun path, light & Ventilation

From diagram1, we can see the southwest side of Residence 3# gets most heat and daylight of the whole day because it can get the highest height of sun at noon, the least solar gain is from the north orientation.

The building has windows on the southwest side and the northeast side, so this two orientation may have glare during the day.

Diagram2 shows solar gains, natural ventilation and openings. The higher the building, more frequent the wind. There is a large area on the top of the building, so it can get more heat from the solar to keep warm (to remain the building temperature in a proper range).
Your Ecological Footprint...
If everyone lived the same lifestyle as you, we would require the regenerative capacity of 1.3 planets each year.

How does your Footprint compare?
To support your lifestyle, it takes 2.3 global hectares of the Earth’s productive area.

Which areas of your Footprint are the largest?

How do I change my Footprint?
How can we all live well within the means of one planet?

The test result is that if everyone lived the same lifestyle as me, we would require the regenerative capacity of 1.3 planet each year.

My footprint is 2.3 global hectares because I’m still a student, having no car and any income. The largest part is Goods, the second is Food.

Carbon FoodPrint Calculator

From the calculator I find a way to change my footprint.

You have reduced your Ecological Footprint from 2.1 global hectares to 1.7 global hectares.
If everyone lived the same lifestyle as you, we would require the regenerative capacity of 0.9 planets each year.

How does your new Footprint compare?

Food  Shelter  Mobility  Goods  Services  Governance

global hectares

Personal Ecological Footprint

Total Ecological Footprint

Your Ecological Footprint

SOURCE
http://slaveryfootprint.org/my-footprint/results

20 // SOCIETY // CARBON FOODPRINT CALCULATOR
I would be very strict to selection of ingredients because I am in the fitness. when prepare each meal of a day, I made carbohydrates, protein, vegetables in correct proportion and cooked them with less oil.
Slavery Footprint

The test result is that there are 46 slaves working for me to meet my daily needs. It is too many so I should cut my purchases to end slavery.

46 SLAVES WORK FOR YOU

Let's be honest, 1 is too many. Would you like to do something about it? Us too! We are Made In A Free World. We are consumers, organizations, and businesses who leverage our purchases to end slavery. We want everyone to know their footprint, and to buy with freedom. We need your help! Below are some simple steps you can take to build a free world.

SOURCE
http://slaveryfootprint.org/my-footprint#results
Documentation of Clothing

Garments that I have on are produced all over the world. I choose one hoodie, a pair of shoes and one bucket hat, they are made in Indonesia, the U.S.A. and Korea. From the word map we can see that all three country are very far away from Shanghai (the city I live in), China.
Carbon FoodPrint Calculator

From the calculator I find a way to change my footprint.

My current ecological footprint is 1.9 global hectares. If I want to reduce my footprint by 15%, my eating habit and buying habit should be improved. Then I made some adjustments of my habit and lower my global hectares to 1.6. Thus my new results is if everyone lived the same lifestyle as me, we would require the regenerative capacity of 0.9 planets each year.

SOURCE
http://slaveryfootprint.org/my-footprint#results
SOCIETY

Carbon FoodPrint Calculator

The test result shows that if everyone lived the same lifestyle as me, we would require the regenerative capacity of 1 planet each year.

My footprint is 1.9 global hectares because I'm still a student, having no car and any income. The largest part is Goods, the second is Food.
The test result is that there are 30 slaves work for me to meet my daily needs. From the test, I found that I have too many clothes in my closet, some of which has been forgotten for a long time while I’m going on buy new ones. Maybe I should arrange my closet to reduce waste.

SOURCE
http://slaveryfootprint.org/my-footprint#results
Documentation of Clothing

Garments that I have on are mostly produced in Southeast Asia. I choose one sweater, one T-Shirt and one long-sleeved Shirt, they are made in Korea, guangzhou and vietnam. From the word map we can see that all three places of production are very far away from Shanghai (the city I live in), China.
The test result is that if everyone lived the same lifestyle as me, we would require the regenerative capacity of 1 planet each year.

My footprint is 1.9 global hectares because I'm still a student, having no car and any income. The largest part is Goods, the second is Food.

SOURCE
From the calculator I find a way to change my footprint. My current ecological footprint is 1.9 global hectares. If I want to reduce my footprint by 20%, my eating habit and buying habit should be improved. So I adjust four aspects of my habit (showing on the right side) and lower my global hectares to 1.5. Thus my new results is if everyone lived the same lifestyle as me, we would require the regenerative capacity of 0.8 planets each year. And my new footprint is below average footprint of china. That’s cool!
This week, I pay much attention to my diet. I choose to eat less meat, more vegetables and grains. Moreover, I buy no cloth, no maintenance and have no entertainment.

Then my result is if everyone lived the same lifestyle as me, we would require the regenerative capacity of 0.7 planet each year. Besides, to support my lifestyle, it takes 1.3 global hectares of the Earth's productive area.

Carbon FoodPrint Calculator

<table>
<thead>
<tr>
<th>Eating (CNY)</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>juice, flapjack</td>
<td>mushroom, tofu</td>
<td>milk, bread</td>
<td>milk, bread</td>
<td>mushroom, tofu</td>
</tr>
<tr>
<td>Noon</td>
<td>rice, fish, lettuce</td>
<td>rice, fried egg, beef</td>
<td>tomato, noodle, egg</td>
<td>pork wonton</td>
<td>tomato, noodle, egg</td>
</tr>
<tr>
<td>Evening</td>
<td>soybean steambread</td>
<td>tomato, noodle, egg</td>
<td>pork wonton</td>
<td>pork, lettuce</td>
<td>milk, sandwich</td>
</tr>
<tr>
<td>Buying (CNY)</td>
<td>Cloth</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Entertainment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Maintenance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

SOURCE
The test result is that there are 18 slaves working for me to meet my daily needs. Although my score is lower than the average score for women my age, scores for others from Shanghai, scores for women from U.K., one is too many.

During the test, I just find that I have too many electronic products which may have been replaced by the smart phone and I also buy four phones during the past five years. Maybe I should reduce the purchase of electronic products.
Documentation of Clothing

Garments that I have on are mostly produced in Southeast Asia. I choose one Gap Shirt, one Polo Shirt and one Nike T-Shirt, they are made in India, Sri Lanka and Vietnam. From the word map we can see that all three country are very far away from Shanghai (the city I live in), China.
This is the whole system map of electric kettle. An electric kettle is used to boiling cold water. Due to the tradition of drinking tea, almost every family in China has at least one electric kettle at home. It is very efficient and useful.

Every single product can do impacts on the environment in many aspects, during the process of production.
We take the electric kettle apart and find out the items, materials and the proportion of each kind of the material.

The length of the color tape is used to represent the proportion of each element. From the color tape, we can see that the kettle is mainly made up of three types of materials - plastic, rubber and metal.
To sum up all the impacts of electric kettle’s life cycle, we create an inventory of everything within the kettle boundaries that causes an environmental impact. After understanding the product and the system, we make a sheet on the right to show some lifecycle phases and get our electric kettle data.

Then we use product data and environmental data to calculate the okala millipoints and make a bar chart to tell the impacts that each lifecycle phase does to the environment.

Based on our calculations, we can see that Disposal is the most important impact to our environment, then comes the Production, and it should be reduced more. So we would like to set these two parts as our goals.

### Inventory of Electric Kettle & LCA Chart

To sum up all the impacts of electric kettle’s life cycle, we create an inventory of everything within the kettle boundaries that causes an environmental impact. After understanding the product and the system, we make a sheet on the right to show some lifecycle phases and get our electric kettle data.

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### Material

<table>
<thead>
<tr>
<th>Material</th>
<th>kg</th>
<th>lbs</th>
<th>%</th>
<th>Where used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene</td>
<td>0.304</td>
<td>0.669</td>
<td>23%</td>
<td>body of the kettle</td>
</tr>
<tr>
<td>ABS plastic</td>
<td>0.079</td>
<td>0.174</td>
<td>6%</td>
<td>control segment</td>
</tr>
<tr>
<td>PVC plastic</td>
<td>0.040</td>
<td>0.088</td>
<td>3%</td>
<td>interior structure</td>
</tr>
<tr>
<td>Copper, primary</td>
<td>0.001</td>
<td>0.003</td>
<td>0.1%</td>
<td>wire</td>
</tr>
<tr>
<td>Rubber, synthetic</td>
<td>0.007</td>
<td>0.015</td>
<td>0.5%</td>
<td>seals</td>
</tr>
<tr>
<td>Propene Polymer</td>
<td>0.384</td>
<td>0.845</td>
<td>29%</td>
<td>body of the kettle</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>0.375</td>
<td>0.825</td>
<td>28.4%</td>
<td>body of the kettle</td>
</tr>
<tr>
<td>PET plastic</td>
<td>0.066</td>
<td>0.145</td>
<td>5%</td>
<td>connector</td>
</tr>
<tr>
<td>Other materials</td>
<td>0.066</td>
<td>0.145</td>
<td>5%</td>
<td>Misc.</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>1.320</td>
<td>2.904</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

### Manufacturing

- Plastic Injection molding
- Copper drawing

### Use

- **Lifetime**: 5 years
- **Hours / Day Use**: 0.5 hours
- **Power Required**: 1500 watts
- **Yearly Power Use**: 275 kwh

### Transport

- Truck: 50 km

### Disposal

- Landfill
- Incineration

---

**SOURCE**

Brainstorming

During the brainstorming, we propose three ways to reach our goals.

1. During the Production (and Manufacture) process, we can use clean energy, such as solar energy, wind energy or biogas energy.
2. During the Production (and Manufacture) process, we can half size the kettle in order to reduce boiling times and water (and materials) waste. Add insulation layer and using all-round heating mode are another two ways of reduce boiling times and water waste, it can improve efficiency.
3. During the Disposal process, we can re-cycle some parts of the kettle, such as copper wire, rubber ring.
After brainstorming, we recalculate the okala millipoints. Half size the container of the kettle is more useful than adding insulation layer or using all-round heating mode in reducing production okala millipoints and Disposal okala millipoints because the other two plans need more materials. The result came to be almost half lower than the existing product in the use part. And plan 2 we try to find ways to reduce the impact of production and transport part, the total points of plan 2 is the lowest of the three plans.
Before designing with Life’s Principals, we try to find some cool creatures as our research objects on the ‘ask-nature’ website.

Then we choose Lady’s mantle plant, pinecone and dragon fly. After discussion, each of us have a basic idea of three objects. We fill in three entire charts and pick the pinecone out as the final object.

SOURCE
https://asknature.org/
Observe & Strategy

Observe
Dry days, pine cones scales will open; on the contrary, if the pine cones scales closed, it is going to rain.

Strategy
Ying’s thought: The scales of pine cone flex passively in response to change in moisture levels.

Zhao’s thought: The function of pine cone can be use as fuel and decoration; it is also the food of squirrel, the form of its appearance is easy for squirrel to eat.

Li’s thought: Pine corn is the raw materials of leather and paint industry, its shell can be made into dye, activated carbon, etc.

Deeper Research
The soakage of the woods on both sides of the scales is different. The outside wood is looser that it will absorb more water than the inside one. So it will expand more. As a result, the scale will close.

Conclusive Strategy
The scale of pine cone will change over humidity of the environment; when wet, it closed; dry, open.
Life's Principles

be locally attuned and responsive
uses readily available materials and energy

adapt to changing conditions
embody resilience through variation, redundancy, and decentralization
Each small piece of pinecone consists of two layers. When wet, the outer layer extend longer than the inner part, so the scale bend inward and the pinecone shut down. When dry, it return to the original state and the pinecone open.

Thus, we think that we can use two kinds of materials, which scales are changing over the environment, to control the opening and closing.

Who would care about/apply this strategy?
People who live in the humidity-changing area.
<table>
<thead>
<tr>
<th>Environmental Organization</th>
<th>WEBSITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IUCN</td>
<td><a href="https://www.iucn.org/">https://www.iucn.org/</a></td>
</tr>
<tr>
<td>WORLD ANIMAL PROTECTION</td>
<td><a href="https://www.worldanimalprotection.org/">https://www.worldanimalprotection.org/</a></td>
</tr>
<tr>
<td>friends of the earth</td>
<td><a href="http://www.foe.org.hk/">http://www.foe.org.hk/</a></td>
</tr>
<tr>
<td>CPVS</td>
<td><a href="http://www.cpvs.org.cn/">http://www.cpvs.org.cn/</a></td>
</tr>
<tr>
<td>国家可再生能源中心</td>
<td><a href="http://www.cnrec.org.cn/">http://www.cnrec.org.cn/</a></td>
</tr>
<tr>
<td>绿色和平</td>
<td><a href="http://www.greenpeace.org/usa/">http://www.greenpeace.org/usa/</a></td>
</tr>
<tr>
<td>NYC</td>
<td><a href="http://www.nyc.gov/">http://www.nyc.gov/</a></td>
</tr>
<tr>
<td>The Nature Conservancy</td>
<td><a href="http://www.tnc.org.cn/">http://www.tnc.org.cn/</a></td>
</tr>
<tr>
<td>环境商会</td>
<td><a href="http://www.cecc-china.org/">http://www.cecc-china.org/</a></td>
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<tr>
<td>环境生态网</td>
<td><a href="http://www.eedu.org.cn/">http://www.eedu.org.cn/</a></td>
</tr>
</tbody>
</table>
After finishing of these intensive tasks for sustainable design course we have a insight of environmental design from a new perspective. At first, we have chosen our hometown as a research place to explore the site, climate, including its rainfall and wind, hardiness zone and comfortable zone and so on. Then we shrink the range into a block of buildings to research the ventilation and solar heat of the buildings and then to promote its air circle and sun exposure. Only in this step we began to realize the nature environment condition has a big effect on specific environmental design. Then we made a research on water and sewage system around our collage. Then we moved into a more microcosmic and specific level from the macroscopical environment to do some design and research. We even looked back ourselves to explore individual behaviors’ impact on environment. We are designers for environment, products and even systems, but surprised to find that we did leave so many carbon footprints and resource waste that harms the planet. When it comes task8 we made LCA of a certain product to draw the outline of the whole product system to assess its sustainable level aiming at a more scientific design method, and in the meanwhile we got a new methodology to guide design that has nothing to do with its outlook and market. At the end we return to nature to discover life principals and strategies to get nature design skills. The secrets of design stems actually from the nature and environment we live in.