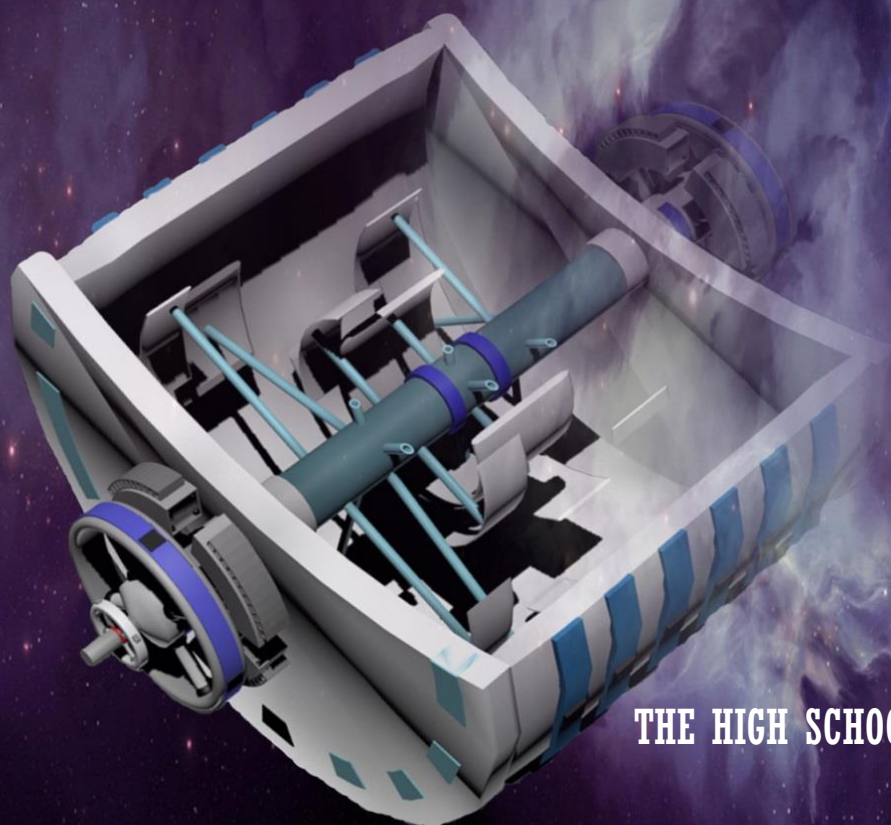


# COLUMBIAT

## PROPOSAL OF SPACESETTLEMENT

By Team HUSKIES SPARKS



THE HIGH SCHOOL AFFILIATED TO RENMIN UNIVERSITY

BEIJING, CHINA

## 21st Annual International Space Settlement Design Competition Proposing Team Data 2014

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I understand that if our Team qualifies for the International Space Settlement Design Finalist Competition July 25-28, we will be expected to finance our own travel to/from Titusville,

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2014.04.16

Responsible Teacher/Advisor Signature
Date

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# 1.0 Executive Summary

We, human, are born explorers.

As an important step in human's space age, Columbiat bears the responsibility of the development and exploration, carrying the hopes of many people. In that case, we positioned Columbiat as a highly modern and ecological integrated space city. It will assume piles of duty—providing a safe and comfortable environment for residents to live in, providing a suitable environment and physical conditions to meet the needs of industrial and agricultural production and researches, providing a **highly developed transportation, logistics and communications**, and providing **an efficient manner for passengers through the station and for outbound traffic**.

Therefore, in our design, the whole Columbiat will be **highly systematic and exchangeable**.

Structurally, **the living, commercial, industrial and agricultural production and research areas are integrated in one body area so there will be fewer stress point**, the biosphere and the atmosphere are **communicated**, the transport traffic are **three-dimensional** so it is **not far** between the various regions and is **convenient for logistics**. Material can be **completely recycled**, so there is nearly no real garbage in the traditional sense. Considering safety and comfort of lives, we also have a lot of nice designs.

For safety, we have a complete set of equipment and solutions to deal with emergencies. We not only have **policing robots** to maintain peace and **emergency escape evacuation systems**, but also have **emergency supplies** such as food, water, fuel reserves and system to prevent pressure loss.

For lives, we focus on comfort and convenience of living. We have a perfect ecosystem; the landscape and the surface are very similar to Earth, a 24-hour cycle of day and night cycle system that enables residents to live comfortably in them, so that they have **a sense of belonging**. On housing, there are different residences, from personal apartment to villas, on the purpose of meeting the needs of different people. As for transporting, **personal vehicles** and **public transportation** are perfectly combined, people could reach anywhere they want **in 30 minutes**. As for logistic, it is efficient and orderly, both residents and producers could got benefits from the material recycling. In service, each resident will have a **smart watch**, which is a small portable computer; residents can connect with the cloud anywhere and anytime, and could deal with all the problems they meet, such as booking a hotel, checking the frequencies of ships. In other words, the smart watch is a personal terminal station to connect to the whole space station, and provide high degree of conveniences for residents. The industrial and agricultural production areas to provide market products, we also strive to make it efficient, non-polluted and automated.

As for agricultural production, we use **soilless-culture** techniques, **spray-culture** techniques to cultivate a variety of plants to provide plant-based materials and fruits and vegetables. As for meat production, we use humane but efficient method——**Tissue culture technology** to produce various meat products. As for industrial production, we strictly control the treatment and reuse of pollutants, completely prevent contaminants from entering the atmosphere and biosphere.

As for the energy, we use **different kinds of method to provide energy**, such as reactors, solar energy and hydrogen energy, which makes it no worry about blackouts due to partial failure. Also it has storage facility.

And as for the automation part, we use a large amount of **intelligent robots**. And different kinds of robot are used in industry, agriculture, public facility and in domestic part.

We positioned Columbiat as a high tech space station, a business center in space, and a space settlement to meet the corresponding demand for service and residential expansion. It perfectly shows human's ambition to explorer the immense outer space and there is no doubt that it will be a pioneer to explore the universe.



## 2.0 Structure

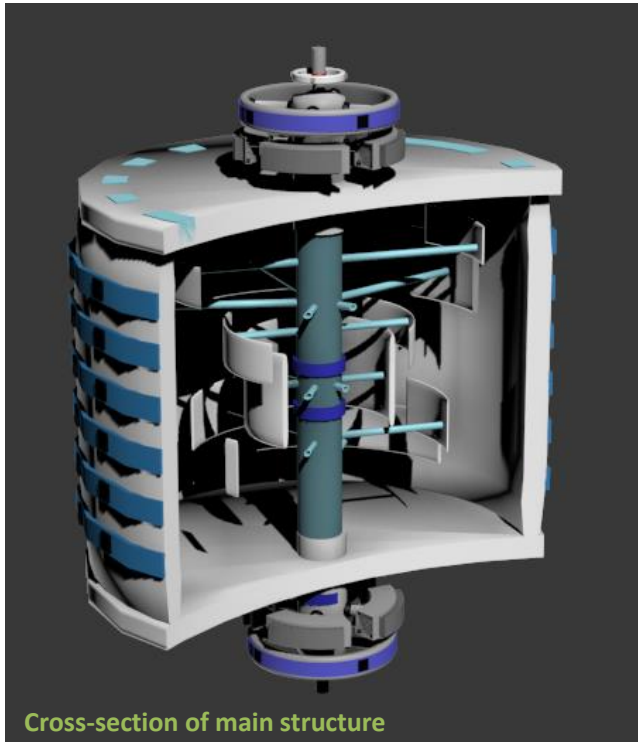


Fig.2.0-1

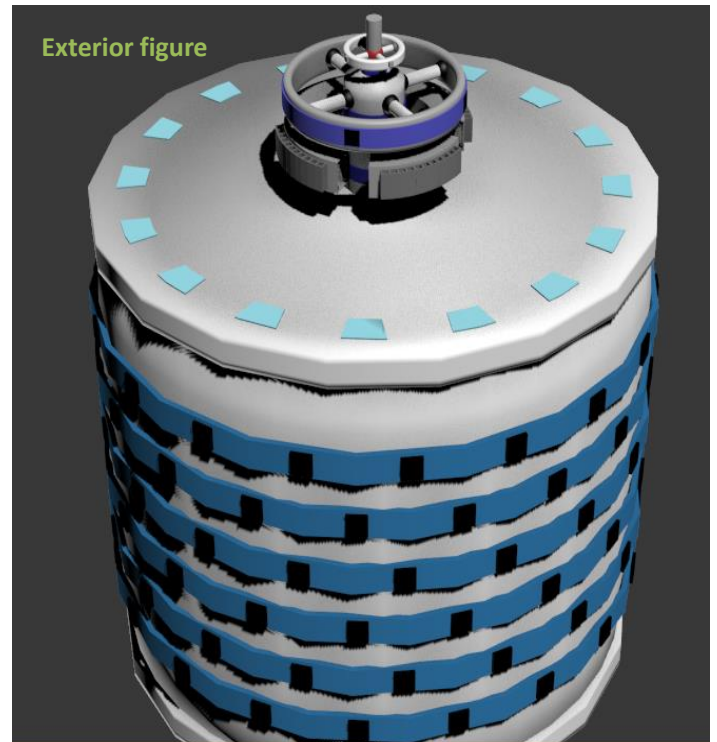


Fig.2.0-2

## 2.1 External Configuration

### 2.1.1 Summary of external configuration

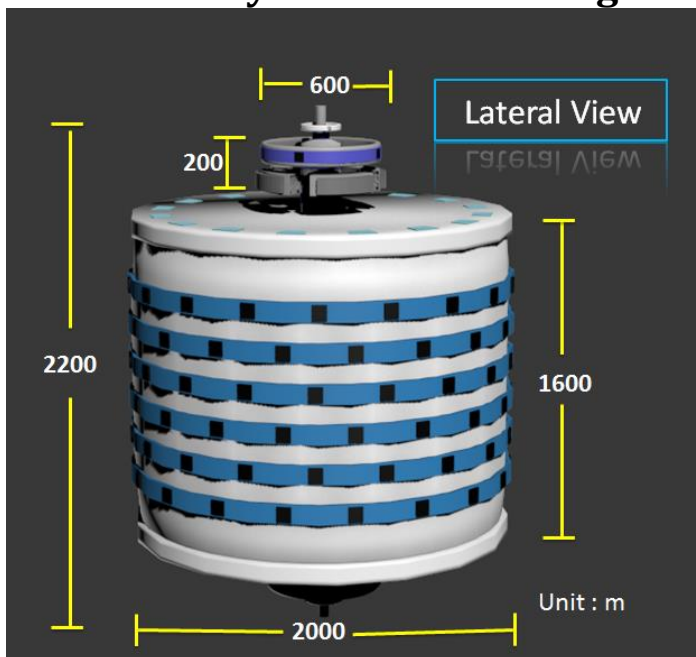


Fig.2.1.1-1

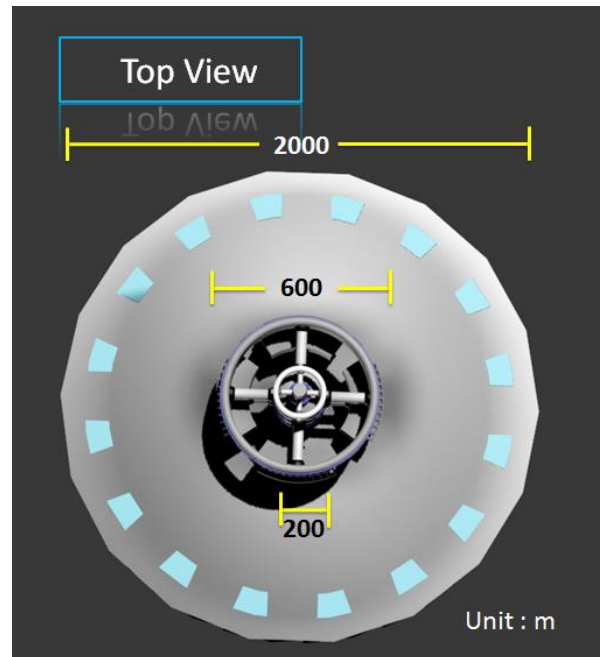


Fig.2.1.1-2

Columbiat is located at the Earth-Moon L1 vibration point, it has a space elevator connect to the lunar surface, and at the same time there has a corresponding elevator head to the earth in order to balance the force. All sections which provide gravity by rotating have a same angular velocity (using the right-hand rule to judge the direction of " $\omega$ "), the external configuration is a Centro symmetric structure, in that case, each part shares a same force, so the structure and operation of the settlement will be extremely stable.

The whole space station is composed of a large body area, two port areas, two reception areas, a principal axis and the space elevator.

## 2.1.2 Details of each part

### 2.1.2.1 The body area

#### 2.1.2.1.1 Duty and function

Provide a safe, comfortable and natural environment for 23 000 to 25 000 to live in, the body area is for residents to live and work, and will provide all the necessary stuffs and knowledge resources. We will construct stable and diverse biological, water, and atmospheric circulation, not only make the interior environment more comfortable, but help to keep the balance of CO<sub>2</sub> and O<sub>2</sub>. We would also provide a living environment combined with culture and technologies, the whole body area is divided reasonably and efficiently, in the purpose of providing convenience promoting service and improving living quality by using human-based design.

To meet the need of all the companies' business demands, The CBD has a perfect infrastructure and is located near populated areas. While the technology research area and the agricultural and industrial area are not far from it, it has the ability to provide a efficiently transportation and material transporting, form a chain of research-commerce-industry, greatly improving the efficiency of business operation and scale.

To meet the need of agricultural and industrial production and material circulation, the mass of the body area is constant, most garbage will be classified used, the same to the water. In that case, there is no absolute rubbish but resources waited to be used in the next step. Agricultural and industrial producing is efficiently in order to content residents' lives. Markets are also near the populated area, integrating production and marketing.

To meet the need of research, the body area could furnish various conditions from zero gravity to 1.1gravity, and no radiation to space radiation required condition.

Internal arrangements are decided according to the difference of gravity, for instance, the 1g area is for living, low-g area is for producing. The whole body area will be constructed to be a three-dimensional city which has a convenient transportation; reasonable arrangements make space utilization greatly improved.

#### 2.1.2.1.2 Structure

Table 2.1.2-1 The Body Area

	Outer radius/m	Height/m	Angular velocity	Period/s	Value of gravity at the down surface /g	Area of the bottom surface/km <sup>2</sup>	Air pressure/kPa
Value	1 000	1 600	0.1	62.8	1	10.048	101

### 2.1.2.2 Principal Axis

#### 2.1.2.2.1 Function and duty

Connect all the sections of the space settlement and the elevators which head to the moon and the earth, provide transporting passageways to link the body area, port area and serving area.

The principal axis has a angular velocity, different parts of the axis have different angular velocity, the connected parts share a same velocity, the different parts which have imparity velocity are connected by the Connection Cabin, the detailed introduction are mentioned in 2.1.2.4

#### 2.1.2.2.2 Structure

Table 2.1.2-2 The Principal Axis

	Outer radius/m	Height/m	Angular velocity	Period/s	Value of gravity at the down surface /g	Area of the bottom surface/km <sup>2</sup>	Air pressure/kPa
Value	100	2 200	Determined according to the connected portion	Determined according to the connected portion	Determined according to the connected portion	—	101

### 2.1.2.3 The arrival/departure area

#### 2.1.2.3.1 Duty and function

Offer a safe and comfortable environment which is in normal gravity condition to place temporary people, so that they don't have

to contact with residents and don't have to enter the body area.

The details are mentioned in 4.4

#### 2.1.2.3.2 Structure

**Table 2.1.2-3 The Arrival/Departure Area**

	Outer radius/m	Height/m	Angular velocity	Period/s	Value of gravity at the down surface /g	Area of the bottom surface/km <sup>2</sup>	Air pressure/kPa
<b>Value</b>	300	100	0.182 5	34.41	1	0.188 4	101

#### 2.1.2.4 Connection Cabins

Each connection point consists of an outer layer and an inner layer. The space between the outer layer and the inner layer is pressure-free, and one atom of air pressure will be maintained in the space inside the inner layer.

The Outer layer is a tube that will connect to the rotating Volume. The Inner layer is a “cylinder deliverer” (CD) connected to the non-rotating Pathway. The air pressure of one atom will be maintained inside the CD. When vehicles carrying either wares or residents travel from the rotating Volume to the non-rotating Pathway, they will enter the CD that is now connected to the rotating Volume. After the vehicles enter, the airlock gate will be closed. The rotation rate of CD will gradually decrease to zero, and it will move to the non-rotating Pathway.

#### Friction

As the friction between rotating and non-rotating cannot be ignored, strong magnetic forces will be used

#### 2.1.2.5 Ports

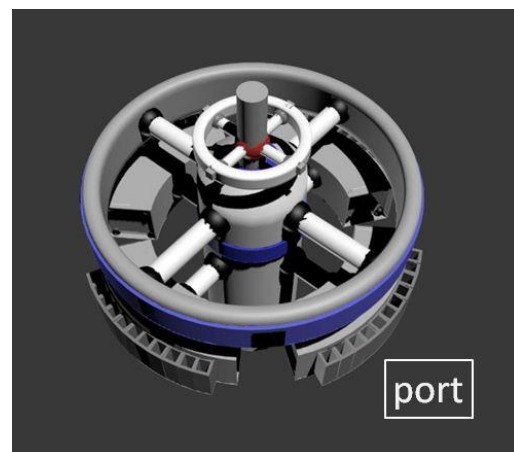


Fig.2.1.2-1

**Table 2.1.2-4 Ports**

	outer radius/m	height/m	angular velocity	period/s	Value of gravity at the down surface /g	Area of the bottom surface/km <sup>2</sup>	air pressure/kPa
<b>value</b>	100	50	Changing	Changing	—	—	101

The details are mentioned in 2.4

#### 2.1.2.6 Space elevator

**Table 2.1.2-5 Space elevator**

	outer radius/m	height/m	angular velocity	period/s	Value of gravity at the down surface /g	Area of the bottom surface/km <sup>2</sup>	air pressure/kPa
<b>value</b>	4	61 500 000	0	0	—	—	—

The details are mentioned in 2.5

## 2.1.3 The artificial gravity

#### 2.1.3.1 The Centrifugal force

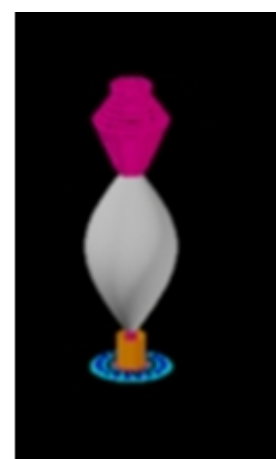
We use rotation to create centrifugal force and simulate gravity. The formulas:

$$g = a = w^2 \cdot R \quad w = 2\pi / T \quad g1: g2 = R1: R2$$

#### 2.1.3.2 The angular momentum

Considering about the living areas that are rotated to produce gravity and its angular momentum is constant, thus, all the axes of different rotatable sections are perpendicular to the orbital plane. It could prevent the angular momentum from being changed and is convenient for space ships to get in and out.

#### 2.1.3.3 The maintenance of angular velocity



Thruster

Fig.2.1.3-1



To provide thrust, we use sustainable nuclear fusion reaction thruster. It will be fixed on the outer sphere of all mentioned zone and its huge power will produce centrifugal force to simulate gravity and keep zones a certain angular momentum. The fuel of the propulsion is deuterium and tritium which is abundant in space, so the supply of fuel is ongoing.

## 2.1.4 The pressure

### 2.1.4.1 The component of air

Basically same as the earth's atmosphere, 21% oxygen, 78.5% nitrogen and a small amount of water vapor and carbon dioxide.

### 2.1.4.2 The pressure value and distribution

All areas have a air pressure. Open space's pressure: the body area, reception area and the transporting area remain at the standard atmosphere pressure, the pressure in principal axis and research area is a little smaller.

## 2.1.5 The emergency escape system

There will be 108 emergency evacuation units located on the outer surface of the main function area. The distance of adjacent two units will be 300 meters. Every emergency evacuation system can carry 200 people, and supplies for people to live for 3 days. It also can pop out quickly after filling sheltering people and get away from main function part and have the ability to move short distance in three dimensions space to finish transferring.

## 2.2 Internal Arrangement

Since some part of the settlement is tridimensional, we mark the down surface tridimensional.

### 2.2.1 Main Part

Inside the main part there are different kinds of tridimensional part due to different gravity zone. Residential area is on the 1g zone, produce area and scientific area are on those arcs due to the need of the gravity. For the reason that some of the produce area and scientific are need no gravity, there is a cylinder which is non-rotate.

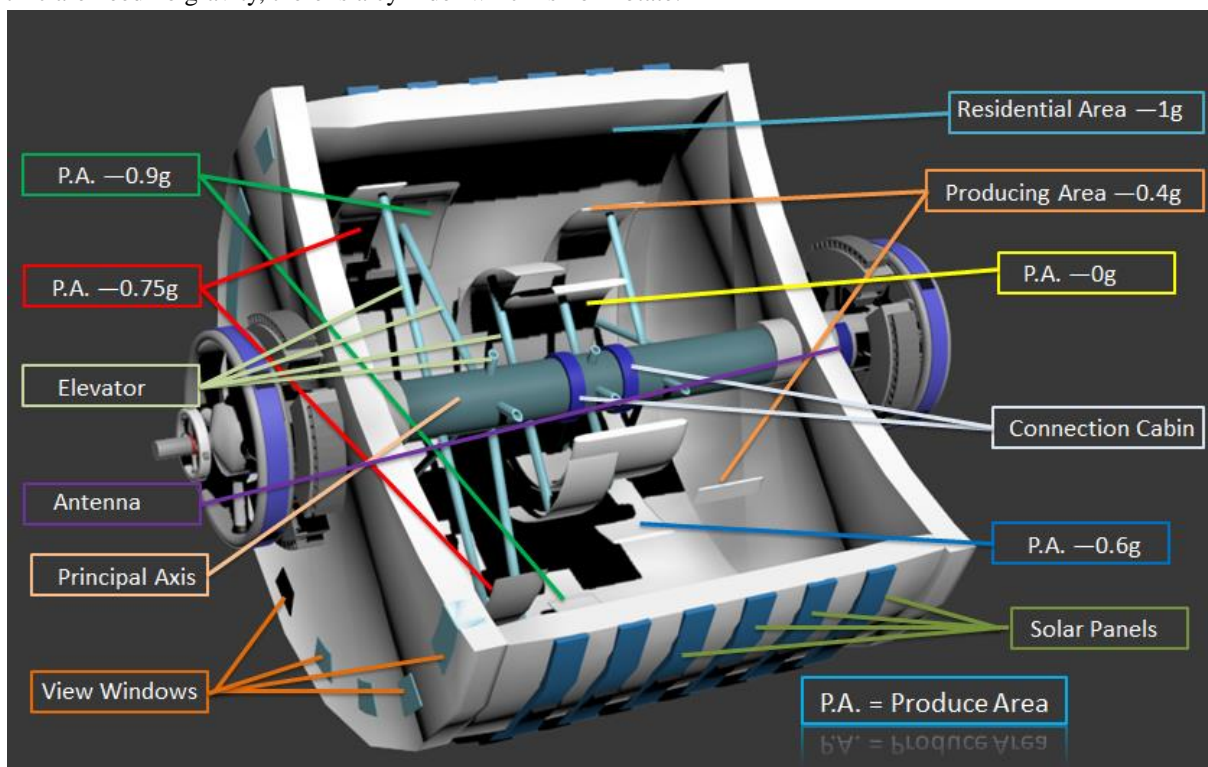


Fig.2.2.1-1

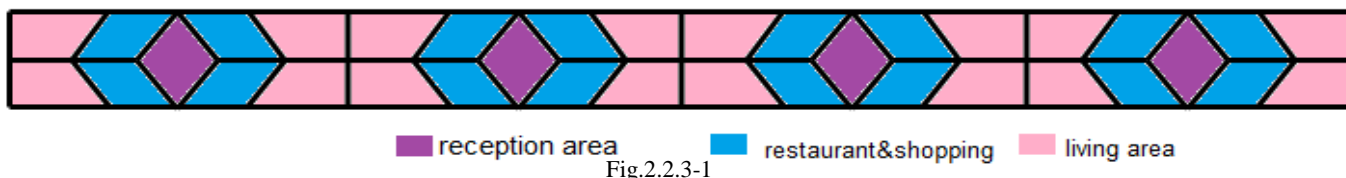
## 2.2.2 Main Axis

For the purpose of transport cargos and passengers fast and efficiently, the main axis will act as the transportation road between different zones. Elevators are connected between the main axis and the arcs.

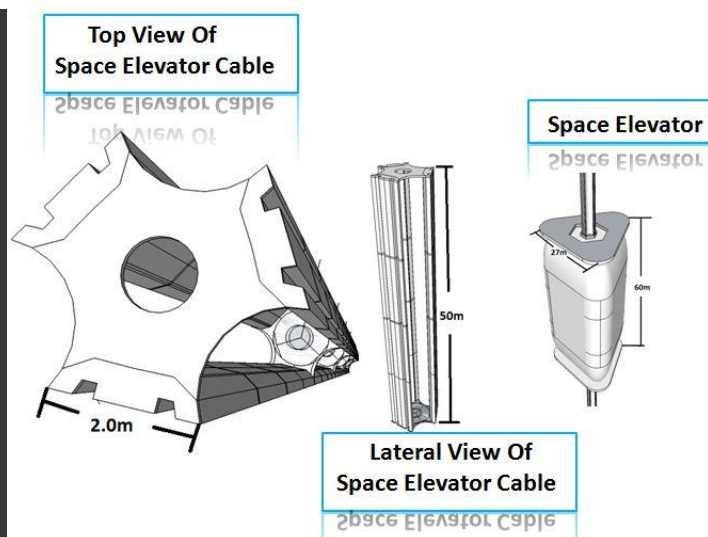
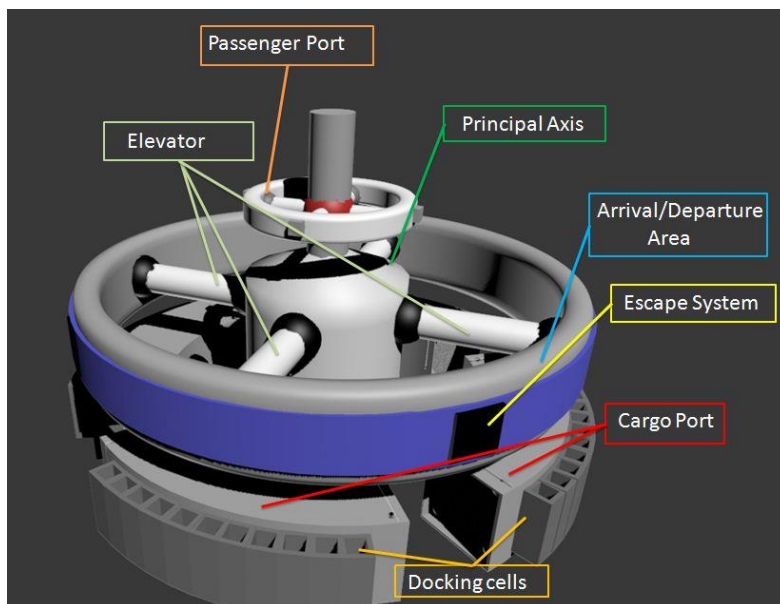
## 2.2.3 Reception Area

Details refer to 4.4

The usage of the down surface of the reception is designed as the picture shows.



## 2.2.4 Docking Port & Space Elevator



Details refer to 2.4 & 2.5

## 2.3 construction process

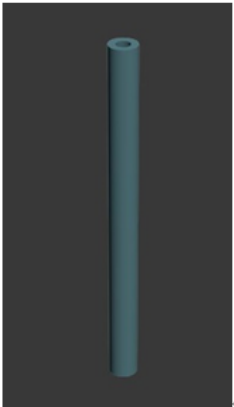


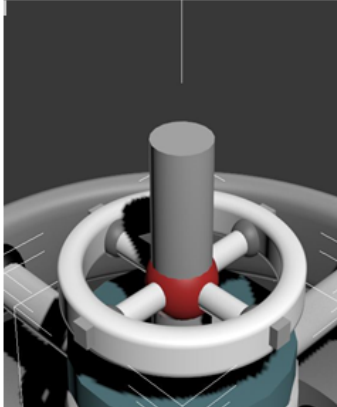
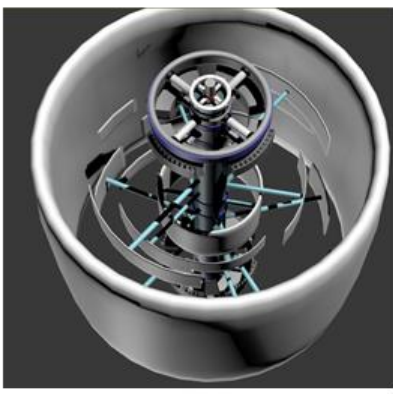
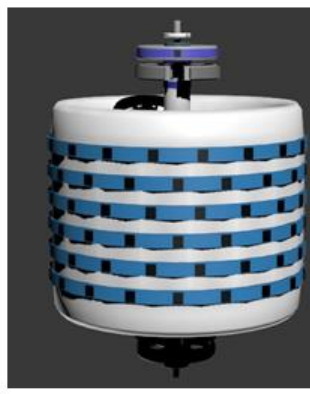
 <p><b>Step1</b> Build the principal axis.</p>	 <p><b>Step2</b> Construct the Connection Cabin in the whole principal axis (besides the port part).</p>	 <p><b>Step3</b> Build the 2 ports in the 2 side of the principal axis.</p>	 <p><b>Step4</b> Assemble the space lift on the side of moon and the equal distance above Columbiat as counterbalance.</p>
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Fig.2.3-1



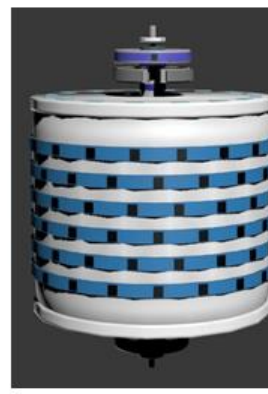
#### Step5

At the same time of STEP 4, build the 0g area, agricultural area, industrial area and residential area. Except the 0g area, other part all needs artificial gravity (because it is all rotating).



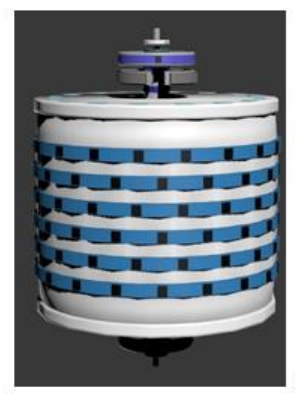
#### Step6

Set up all the Escape cabin and Solar panels in the outside of the residential area.



#### Step7

Set up the cover on each side of the settlement (contain view window). Adjust the air pressure.



#### Step8

Start the rotation (agricultural area, industrial area and residential area), their angular velocity is the same.

Fig.2.3-2

## 2.4 port facilities

### 2.4.1 Basic construction

The basic construction of this port is in the graph displayed on the right. This structure has 3 main parts: down torus, middle torus and upper torus. The down torus is a place where cargo ships load, **cargo port**. This is the **entrance (orange spot)** of the structure, and this is the **exit (red spot)** of the structure. When the ships go into the entrance, they go through the torus, unload/load their cargo **here (green spot)** and go to the exit to leave.

There are two parts for loading and two parts for unloading. The loading part is on one diagonal and unloading part is on the other. It is convenient to handle the traffic. The cargo go to the main column through the connect column and go into the settlement.

And the cells is where ships can dock, **docking cells**. It is for the long-term docking ships' repairing and recharge. (Refer to 2.4.4)

The middle torus is the place for foreign people to live and be received by the people live in the settlement, **arrival/departure area**. It is rotating (rotating rate  $\omega = \sqrt{g/r} = 1/\sqrt{30}$ ) and could offer temporary residents for the passengers. We offer them basic living supplement (refer to 4.4). People go into the torus by the connect column too. (more details in 2.4.3). And it also offer emergency evacuation (black parts on the blue part, refer to 2.1.5).

Passenger ships can land on the upper torus, **passenger port**. It is used to landing ships (in the gray cuboid) and people go into the settlement or the arrival/departure area through the main column (more details are showed in 2.4.3). The 2 port in one diagonal is entrances and other two is exit. Ships only go into entrance to unload people and go to exit to load people, like the cargo port. They can go through the torus.

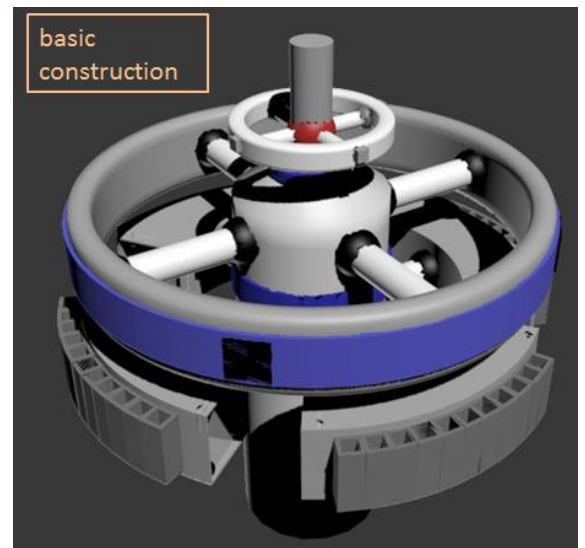


Fig.2.4-1

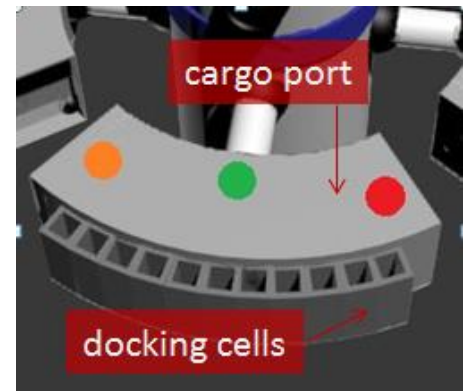


Fig.2.4.1-1

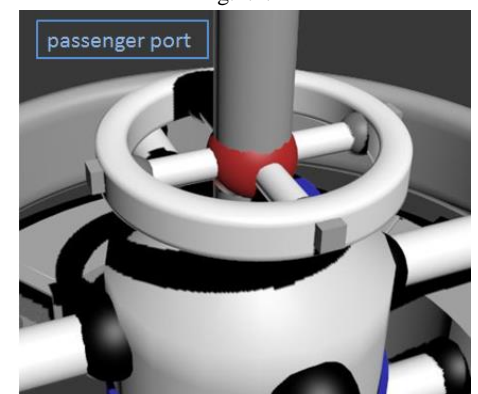


Fig.2.4.1-2



## 2.4.2 Connection area

This is our port's connection between non-rotating and rotating parts (refer to 2.1.2.4). But it is not completely like it. Because there are no people or cargo lifting in this part (refer to 2.4.3). So the usage of this part is only to connect the different angular velocity (0 and  $1/\sqrt{30}$ ) parts.

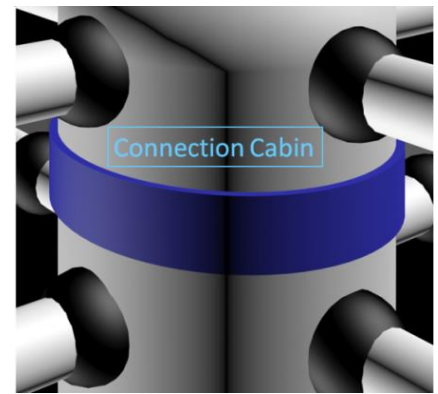


Fig.2.4.2-1

## 2.4.3 Inner transportation (electric lift)

This is the principal axis's inner structure. The picture in the right is the sectional drawing of the principal axis. There's strong electromagnetic force between the red cylinder and the gray cylinder in the middle. And the red part and the gray part are made by magnetic isolation material. There are 5 electric lifts. Above the connection cabin (arrival/departure area), these 5 lifts are all for people transport. And beneath the connection cabin (cargo port), there are 4 lifts for cargo transport and 1 lift for people. In this picture, the outer cells is for cargo (people) lifting, inner space (in the gray cylinder) is only for people lifting. The outer cells are for cargo to go into or go out of the settlement or people who want to go to the arrival/departure area. And the middle cylinder is for people who want to go into the settlement or the space elevator.

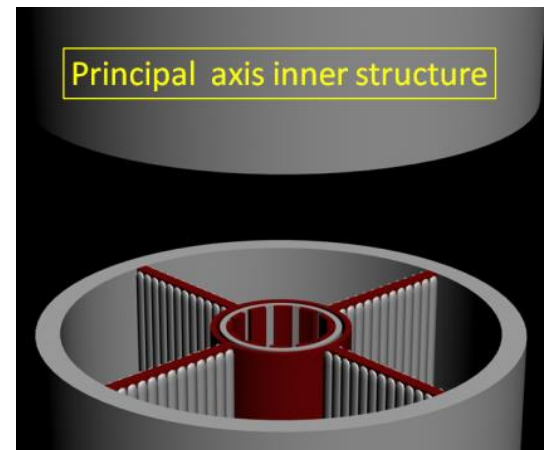


Fig.2.4.3-1

## 2.4.4 Long-term docking part.

This is the long-term docking part(**docking cells**). It has 11 cells in each sequence for ships docking and 4 sequences in total. The ships can go in and out and they docked in the room. There is one loading place attached on the white place (in the right picture). Both sides can load ships (upside and downside). Each room can afford 1 ship to dock (anchor) at once. There're no people but robot.

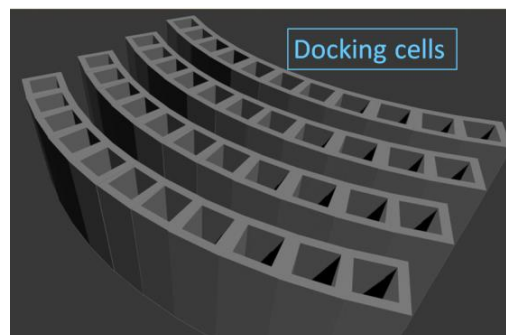


Fig.2.4.4-1

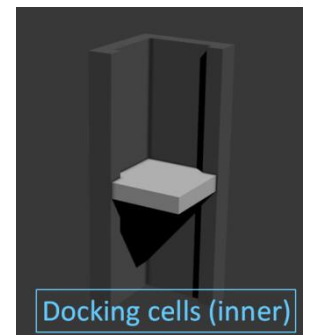


Fig.2.4.4-2

## 2.4.5 The size of the port

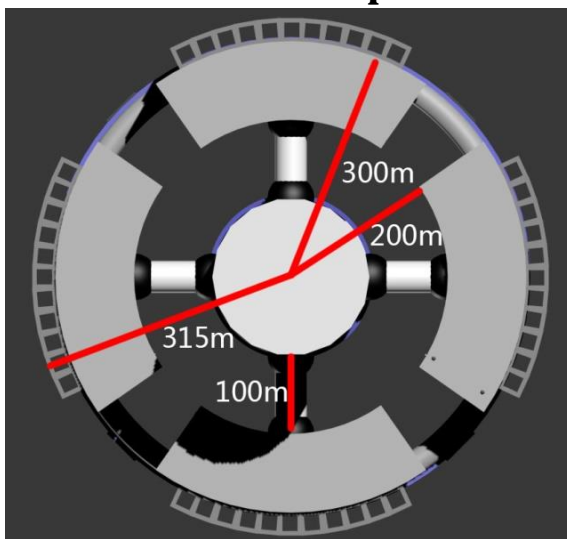


Fig.2.4.5-1

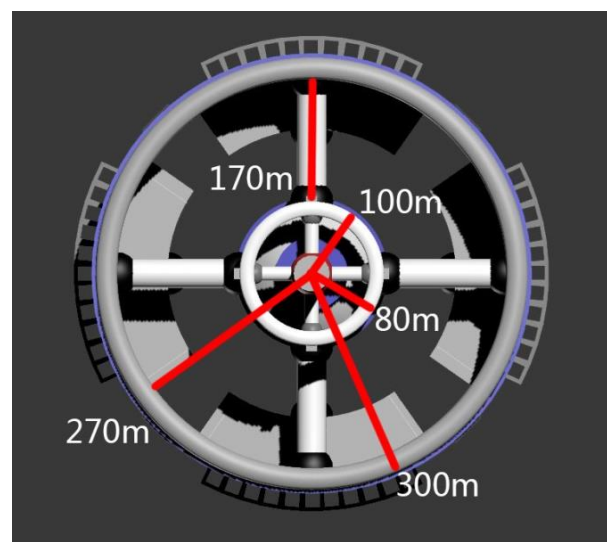


Fig.2.4.5-2

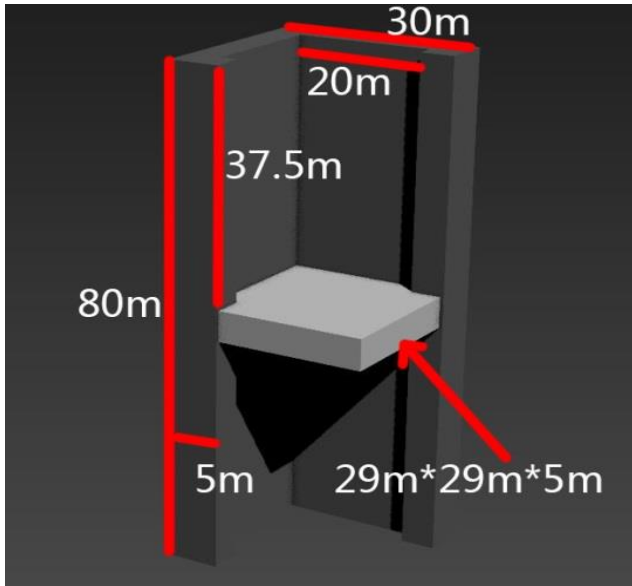


Fig.2.4.5-3

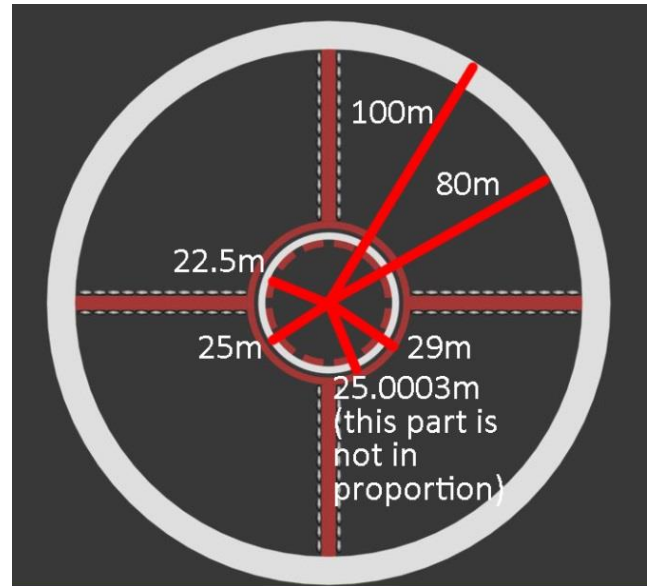


Fig.2.4.5-4

## 2.4.6 Connection with the whole structure

Because the port is non-rotating, we designed a connection place like 2.4.2 to connect the port with the whole structure (refer to 2.1.2.4).

## 2.4.7 Future expansion

It's easy for this structure to expand its capability of dock and load/unload ships. We can add as many docking part and residential part as we want through the connect column.

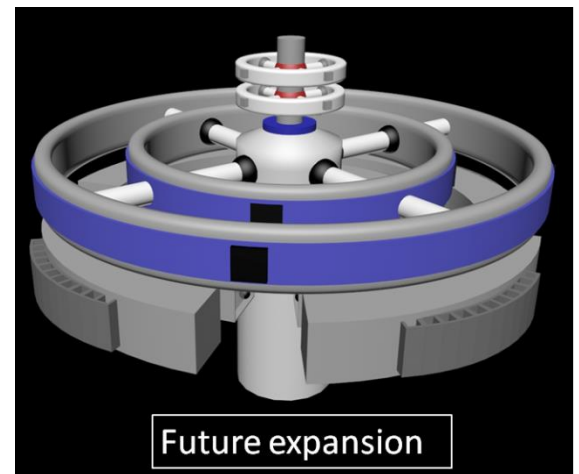


Fig.2.4.7-1

## 2.5 Space Elevator

Columbiat will acts as one of the terminus for the Lunar Space Elevator. There are three space elevator rails on the cable and only one elevator will run on it.

### 2.5.1 Space Elevator Cable

#### 2.5.1.1 Overview of the Cable

The whole ribbon is 61500 km, and the three rails are combined by a section of reinforcement supporter per 50 meters.

#### 2.5.1.2 Material of the Cable

The cable is made up by several parts: Curved Silicon Buckystructure Ribbon, Reinforce Layer, Elevator Rail, Superconductive Electric Cable and Pipeline Transport Tunnel.

##### 2.5.1.2.1 Curved Silicon Buckystructure Ribbon

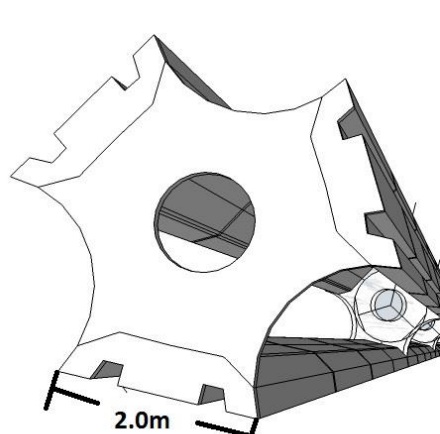


Fig.2.5.1-1

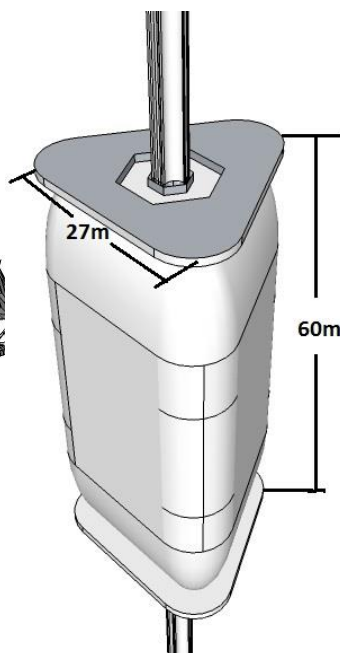


Fig.2.5.1-2

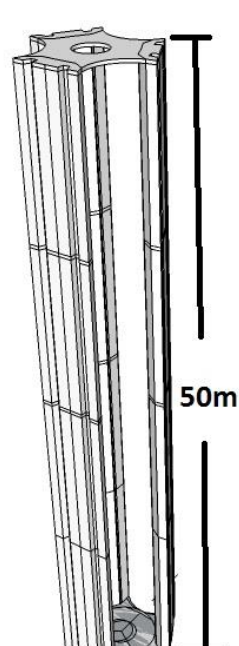


Fig.2.5.1-3



The main part of the ribbon is made of ten layers of silicon Buckystructure ribbon (1 meter wide and 10 cm thick), and for reinforcement there is composite segments with Buckystructure nanotube and thicker support ribs. The ribbon is made curved to reduce micrometeor damage.

#### 2.5.1.2.2 Reinforce Layer:

This part is for the case of ribbon damages, with the ability to share the force with the main ribbon.

#### 2.5.1.2.3 Elevator Rail:

Elevator Rail is for the elevator to grab on, as well as the place where electric is transport to the cab. The rail is connected to the “engine” of the elevator, which is an Electromagnetic launch system. The Mag lifter is used in the rail to move the cab up and down, with the ability to accelerate to any allowed speed.

#### 2.5.1.2.4 Superconductive Electric Cable:

Electric Cable is for transporting electricity from the space settlement to the moon or the opposite direction, as well as offer the power to the elevator cab.

#### 2.5.1.2.5 Pipeline Transport Tunnel:

The Pipeline Transport Tunnel is for the future updating progress which can transport some cargo without the elevator cab but just in this tunnel.

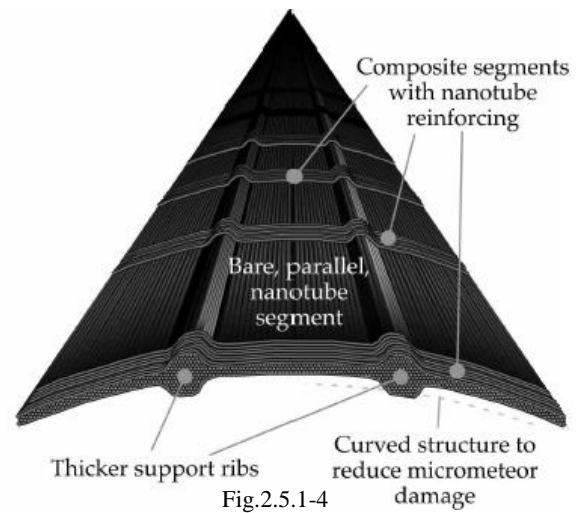


Fig.2.5.1-4

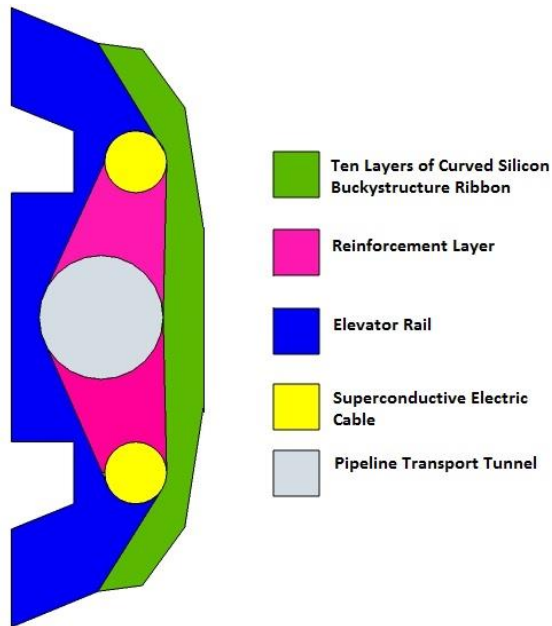


Fig.2.5.1-5

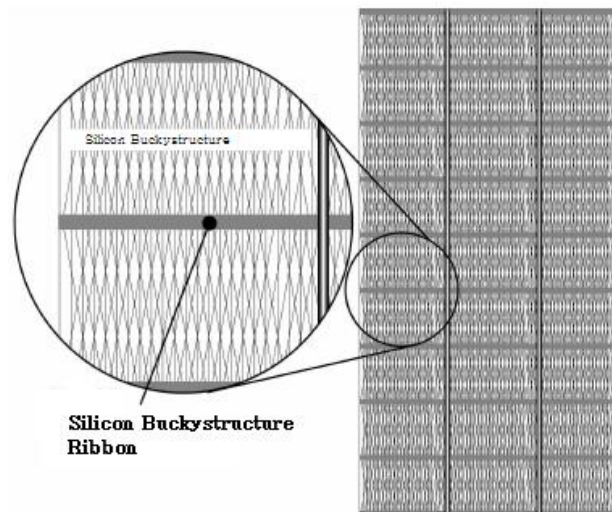


Fig.2.5.1-6

## 2.5.2 Attachment Interface

The attachment interface is consisted of several parts: The Cable terminus, Airlock, Dust Cleaning Repair Zone and Transport Waiting Zone. The whole parts are without gravity.

- When the cab arrives, the airlock gate will open and the cab will get into the Dust Cleaning Repair Zone.
- Airlock gate will close and dusk cleaning robot will clean up the cab and repairing robot will come and repair. The cab will be load and unload.

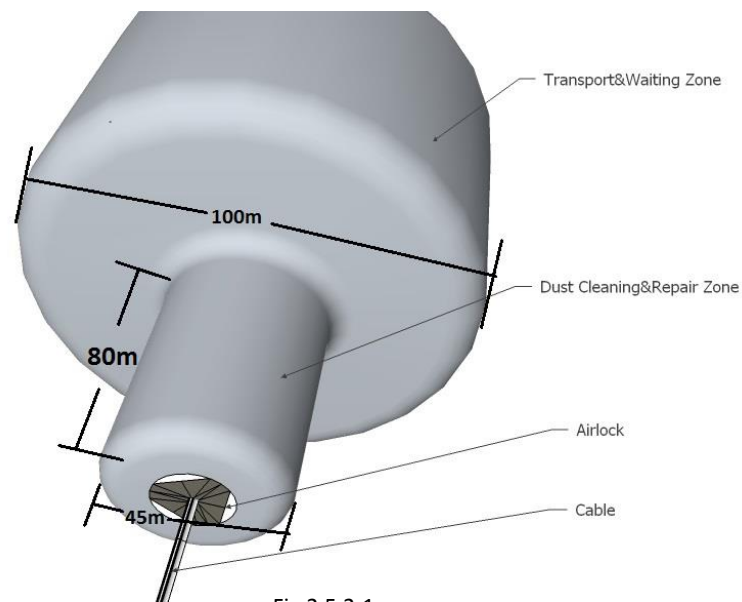


Fig.2.5.2-1

## 3.0 Operation and infrastructure

### 3.1 Basic Operations

#### 3.1.1 Materials

##### 3.1.1.1 External materials

Table 3.1.1-1

Materials	Usage	Amount	Source
Carbon nanotube	The whole frame	2500000kg	Moon
CFRP	Hinges and shell	2300000kg	Earth
Silicon (glass and Silicone plastics)	Axis and some small components; Solar panels and protecting shells; semiconductor materials	670000kg	Earth, moon and asteroids
Rubber	Cushions	50000kg	Earth
Plastic*	Pumps and some small components	100000kg	Moon and earth
Metal (Al, Fe etc.)	Axis and other struts	2500000kg	Earth
Others	Special components		Earth

\*Plastic consists of PC, PA, PVC, LFT, ABS, PBT and others.

##### 3.1.1.2. Internal materials

Table 3.1.1-2

Materials	Usage	Amount	Source
Plastic	*Roads and pumps	250000kg	Moon and earth
Metal	Railways and rebar	450000kg	Moon and asteroids
Glass	Windows	650000kg	Earth and asteroids
Wood	Buildings and furniture	35000kg	Earth
Paint	Buildings	4000kg	Earth
Stone	Buildings	2500kg	Moon and asteroids
Concrete	Buildings and railways	780000kg	Moon and asteroids

\*The plastic that is used to pave roads is recycled plastic. It can also from the garbage station in the space station. So when the road is broken, it can be fixed quickly.

#### 3.1.2 Transportation and storage

All of the raw materials are well processed so it can be used at once. They are shipped to the space station in cargo containers. Cargo containers are marked with all of the information (materials inside, date and usage) and shipped in order (Carbon nanotube and silicon first, CFRP and others second, special materials are shipped according the need) to fit the progress of works.

Build a port first for storing all of the materials. The port is divided into some parts so that materials can be sorted and ordered. Ships can land in the port, then cargo containers are opened, and materials are taken out and put on the conveyor that links the containers with specified part.

After that, ships leave the store and fly back with empty cargo containers.

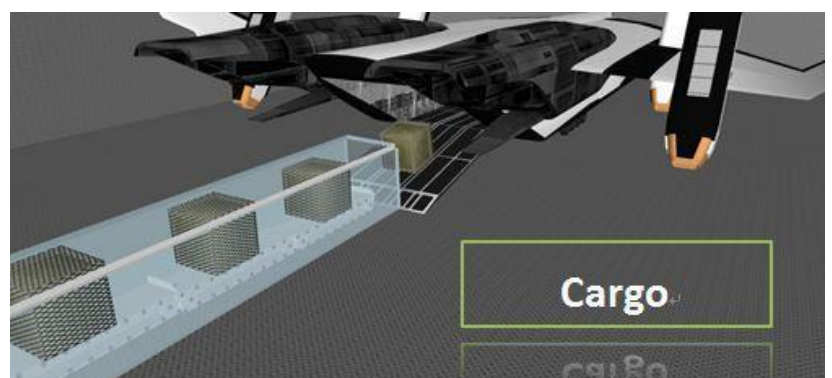


Fig.3.1.2-1

## 3.2 Basic infrastructure

### 3.2.1 Atmosphere

#### 3.2.1.1 Atmosphere composition

Table 3.2.1-1

Gas	Percentage	Source
Nitrogen	78%	The earth and some asteroids near the earth
Oxygen	21%	The moon
Carbon dioxide	0.04%	The earth and some asteroids near the earth, agricultural area
Noble gas (mostly He)	0.55%	The earth and the moon
Water vapor and others	0.41%	Agricultural area

The atmosphere is almost just the same as the earth's because this composition is the most comfortable one for residents. But water vapor may be a little more than it in the earth's atmosphere because more water vapor is needed to build some weather phenomena. Noble gas is also useful for some factories in industrial area.

#### 3.2.1.2 Pressure

Choosing a lower pressure (91kpa) of the atmosphere in the space station can not only be good for residents' health but also save a lot of source.

#### 3.2.1.3 Maintaining the atmosphere

The atmosphere is maintained mainly by agriculture and forestry; we have several ways to keep the balance between O<sub>2</sub> and CO<sub>2</sub>:

1). Build a factory to produce O<sub>2</sub>: there is a machine which can use ultraviolet ray from sunlight and some kinds of catalysts (such as TiO<sub>2</sub>) to break down water so that we can get both O<sub>2</sub> and H<sub>2</sub>. Hydrogen cells can use this part of H<sub>2</sub> to generate electricity.

2) The forest and farmland can keep the balance. We grow some trees and bamboos in the forest. The forest is around the residential area, and the farmland is in the residential area. These plants can be used to produce paper.

3) Build a factory where microorganism can grow, such as cyanobacteria, to produce oxygen.

4) Store some oxygen and other gas in cans to use in emergency.

5) Store some necessary chemical medicine, such as Na<sub>2</sub>O<sub>2</sub> or H<sub>2</sub>O<sub>2</sub>, to use in emergency.

#### 3.2.1.4 Air circulation and climate

The air can move constantly with the rotation of the station by a large air conditioning. This machine can pump air from residential area and industrial area to agricultural area. During this period, the air can also be cooled to the suitable heat.

The air-conditioning also control the climate to build seasons and weather. For example, it slow down the flow rate of the air so that some water vapor condenses to water drops, like the rain.

Table 3.2.1-2

Season	Temperature (°C)	Relative humidity
Spring	15~23	50%
Summer	20~28	60%
Autumn	14~22	50%
Winter	12~20	40%

### 3.2.2 Food Production

Table 3.2.2-1

	Grams person per day	Total Kilograms produced per year	Total kilograms per month for contingency
Grains and Crops	400	3,348,800	24,266
Vegetables	500	4,197,500	30,416
Meats	150	1,259,250	9,125
Fruits	300	2,518,500	18,250
TOTAL	1,350	11,324,050	82,057

Foreword: Food production will be divided into two sections. One is the agriculture; the other is husbandry.

### <1>Geoponics

Crops, grams and vegetables are growing in Agricultural Center (A.C.) in agricultural area. A.C. is set at 0.8G because it is good for plants' growing. The first step we take is to make them germinate by tissue culture. After that, A.C. would utilize Aeroponics to make the sprout grow. By suspending the plants' rhizomes, roots and stalks in the culture box, plants' rhizome will be sprayed with the nutrient in gaseous substance by machines. All the actions are automated during the whole process. The temperature and humidity sensor will show the value, which helps the computer system control the environment in the A.C.

In this way, we can decrease not only the area it takes but also water and soil resource which is used widely in original agriculture. Furthermore, the growth period will be cut down. What the extra advantage it has is that vegetables can get much stronger and healthier, which can offer people more nutrient.

### <2>Soil Cultivation

Aeroponics can't be suitable to all crops, fruits or vegetables. For the plants which cannot be cultivated by Aeroponics, we cultivate them in the traditional way (Soil cultivation).

The soil we provide is the special soil which abounds with nutrient. The soil contains N, P, K, Ca, Mg, and any other elements needed for plant growth, as well as some enzyme and microflora.

On account of that, we use could EM method (Effective Microorganism) to produce manure. In this way we could reduce the high outlay of chemical fertilizer.

#### 3.2.2.2 Growing of Husbandry

On Columbiat, husbandry will be substituted by test-tube meat in order to decrease the area husbandry takes. We will bring many sorts of muscle cells, such as beef's, pork's, mutton's, fish's, chicken's to the Columbiat and let them proliferate rapidly in plenty of culture dishes. Apparently, we could get plentiful meat continuously.

#### 3.2.2.3 Harvest

Good harvests are in February, June and October. At that time, robots (shown in 5.0) will do the reaping thing. There will be many types of robots which can reap different kind of crops.

#### 3.2.2.4 Storage

After harvesting, crops and grams would be sent directly to the restaurant or the special storage from the agricultural district by transport machine (an underground conveyor which is shown in 5.0).

With great transportation, the food still keeps fresh when it reaches the destination. First, the food would still be set parted in 8 sectors in case of the concatenate blight. Then every sector will be separated into 3 parts ----- one for meat, one for vegetables and one for grain. The storage will be kept at -4-5 Celsius degree(vegetables at 5°C, meat at -4°C and grain at 2°C) with low illumination and less oxygen.

#### 3.2.2.5 Packaging

When the food stored in the storage is going to be used, it would be sealed in PTEF (polytetrafluoroethylene) wrap in vacuum condition. PTEF could offer a "safeguard" through its stability to prevent food from being contaminated. And after that, food will be put in container with an electromagnet on each one. (The function will be shown in 3.2.2.1. E)

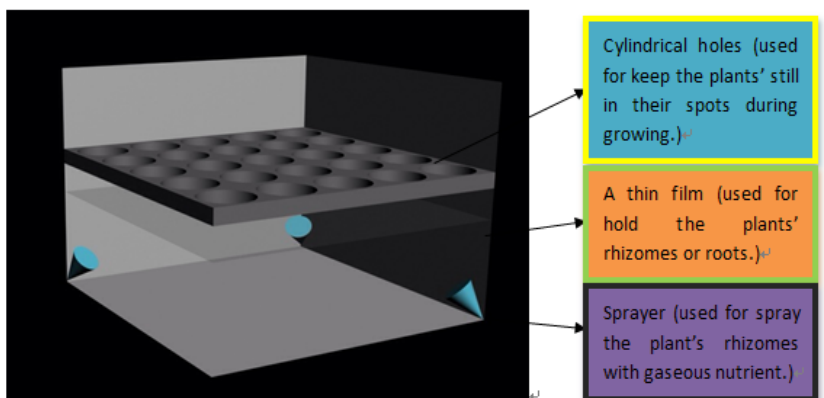
#### 3.2.2.6 Delivering and selling

Packaged food will be delivered to markets, houses people live in, restaurants via transport machine (an underground conveyor shown in 5.0). In this way, food can be delivered much faster.

Food would be sold through markets or Web-ordering System. People can buy food whenever they want. The price will be a little

Table 3.2.2-2

	Temperature/°C	Humidity/%RH	Illumination/Lux
<b>Grams</b>	17	55	1700
<b>Vegetables</b>	22	60	2000
<b>Fruits</b>	20	70	2200



(This is a model for Aeroponics culture box. The real box is 100×100 whereas the model is 5×5.)  
Fig.3.2.2-1

bit higher than it on earth because of the high-tech.

### 3.2.2.7 Waste Disposal

The waste will be sent to waste disposal center. To dispose the waste produced during agricultural production, the first step is classification. All the waste can be divided into three classes: one with high cellulose content, one with high protein content, and one with high mineral content.

- 1) Waste that included plenty of cellulose: will be picked out for the second time with the impurity content except cellulose as the criterion. The waste with little impurity will be sent to the industrial sector as a kind of agricultural product for papermaking.
- 2) Waste that included a great deal of protein: will be processed into fodder.
- 3) Waste that included abundant mineral: will be processed into fertilizer, which is used for soil cultivation.

## 3.2.3 Energy

### 3.2.3.1 Generation, distribution and allocation

Table 3.2.3-1

Types of energy	Percentage	Power(kW)	Allocation
Nuclear (fission and fusion)	35%	$5.25 \times 10^3$	For the main power system and industry
PEMFC (use hydrogen as fuel)	25%	$3.75 \times 10^3$	For residential electricity consumption ;transportation system; other small appliances
Solar panel	35%	$5.25 \times 10^3$	For the cycling of the environment(including water, atmosphere) and agriculture
MFC(use waste water)	5%	$0.75 \times 10^3$	For lighting and monitoring system

The nuclear power plant is near to the industrial area and as long as the technology of nuclear fusion power plant is available, use He-3 from the moon as fuel to generate electricity.

PEMFC can be used in cars, houses, and other appliances since this kind of cell can be made in different shapes. Use hydrogen so that there are no pollution problems because it can generate nothing but water. And meanwhile, water can be reused: catalyst (such as ultraviolet light and  $\text{TiO}_2$ ) is used to break down water to  $\text{H}_2$ .

Solar panel is still one of the main parts of energy composition. It is installed on the outside of the station. Those solar panels can also prevent the station from solar radiation. All the solar panels are centralized in one electric transmission line that is linked with the super capacitor.

MFC is installed in sewage treatment plant. During the treatment of sewage water, it can also help to clean water through electrolysis and sedimentation. But the power of MFC is still a little low; the way to increase its power is increasing the area of sewage water treatment tank.

### 3.2.3.2 Power transmission

In the station a power network is mainly used to link industrial area, agricultural area and power system with power plants and the super capacitor. Every district has an power plant (mainly use PEMFCs); WPT (Wireless power transmission) is used in residential area, which can transmit electricity from power plant to every family.

### 3.2.3.3 Electricity storage (especially in emergency)

Because the PEMFC is very convenient to use, every district has an emergency electricity generation system that consists of PEMFCs, fuels (mainly  $\text{H}_2$ ) and storage battery for residential electricity consumption. There is a supercapacitor to store electricity generated from nuclear power plant and solar panel.

## 3.2.4 Water Management

### 3.2.4.1 Water Production

We get water from the reaction between hydrogen and oxygen. In this way we can also gain energy. To obtain  $\text{H}_2$ , there is plenty of protium in the whole universe so we could get  $\text{H}_2$  easily. To obtain  $\text{O}_2$ , we acquire them from moon. We can also utilize the purified waste water.

### 3.2.4.2 Water Circulation & Required Water Quantity



Table 3.2.4-1

	Required Water Quantity ( Litres Per Day)
Residential Area	112000
Agricultural Area	30000
Industrial Area	45000
Total	187000

### 3.2.4.3 Storage Facility

Water is stored in 8 different tanks, which is shown in the picture; we have to prevent “chain-reaction” when something wrong happen to the water. After producing the water, the water goes to the upper 4 tanks. However, we get water from the other 4 tanks so that we could make hydroelectric generation during the process the water goes down from the upper 4 to the other 4.

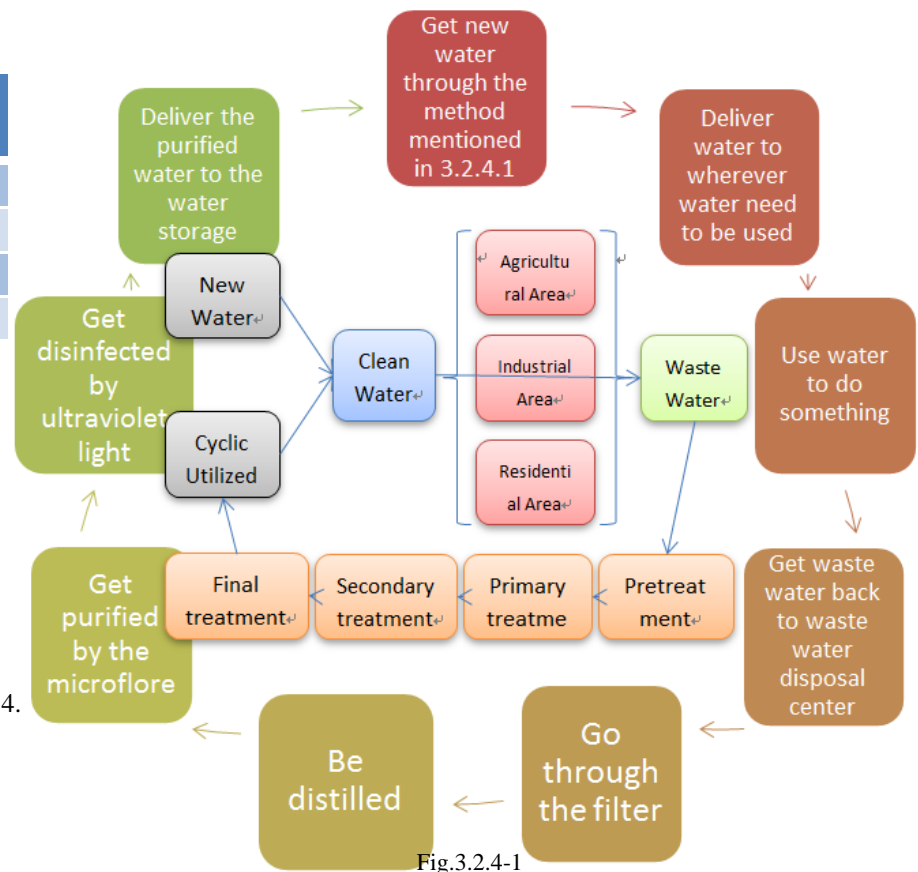


Fig.3.2.4-1

## 3.2.5 Household and Industrial Solid Waste Management

### 3.2.5.1 Waste Collection

Table 3.2.5-1

	Method
<b>Household Solid Waste</b>	People who live in the residential are obliged to throw his/her waste in the waste container located nearby where they live. The waste container is connected with the waste disposal center via tunnels. And it will deliver the waste to the waste disposal center per hour.
<b>Industrial Solid Waste</b>	The industrial solid waste will be collect by “waste-collector”. After one-day’s work, “Waste-collector” will go out to clean the industrial center --- collect the waste. It has a finder which can recognize the waste and mechanical arms which can grasp and collect the waste. The industrial waste will also be sent to waste disposal center via tunnels where it mixes up with the household waste.

### 3.2.5.2 Waste Classification and Disposal

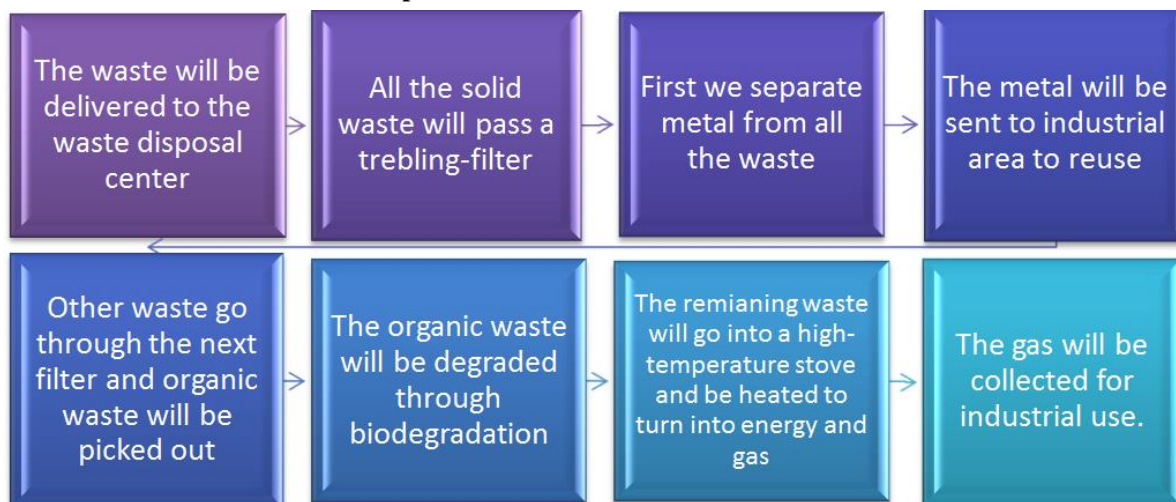


Fig.3.2.5-1

## 3.2.6 Communication system

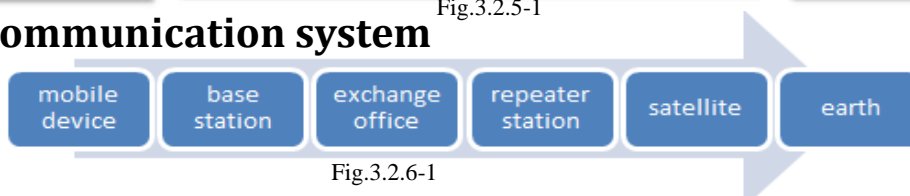


Fig.3.2.6-1

Table 3.2.5-2		
Features	Wavelength	Bandwidth
Laser	1500nm	5 tbps

### 3.2.6.1 External communication system

External is equipped with two duplex aerial on the multiple receivers and multiple

transmitter (receiver and transmitter are set in the space station and the aerial is set outside) Columbiat rents commercial satellite for information transfer. Columbiat rents satellite transponder with bandwidth of 1.5 MHz (\$350000 / year)

Table 3.2.5-3		Advantages			
Satellite communication	laser	Great Communication capacity	Great Confidentiality	Long distance transmission	Set work simplification
DTN		The ability of Information storage			

### 3.2.6.2 External communication device

Satellite laser communication: Laser, Light modulator, Optical emission antenna, optical receiving antenna, optical filter, optical detector.

### 3.2.6.3 Internal communication system

The internal communication in Columbiat is based on cell mobile communication systems.

The cell mobile communication system is made up by the mobile unit, base station and communication exchange office. There is only one exchange office which is in the middle of the Columbiat. A base station covers 30 square kilometer.

It's proper to keep 50 channels in each base station. There are 15 distributed base stations according to the acreage. Every base station and exchange office is connected with each other through optical fiber cable. There is also network service in Columbiat.

## 3.2.7 Transportation system

The transportation system consists of two main parts: resident transportation and freight transportation.

### 3.2.7.1 Resident transportation

Modern road traffic is built in the station. Every family can have a hydrogen-fuel-cell car to go wherever they want. There are two kinds of roads: ring-shaped road and Straight Street. Ring-shaped road has a radius of 600m, and it is on the periphery of one district and wider than Straight Street so that more cars can go on this road and traffic jams in the center of the district can be decreased.

There are ring-shaped railways that can link almost every corner in every

district, and the bigger one's radius is 600m while the smaller one's radius is 300m. Railway station is built every 1.2km. The railway can change its direction to another district so that it also can link districts.

### 3.2.7.2 Freight transportation

All the freights from the spaceships are stored in port first, and then they are delivered to different areas by elevators. Every area (like agriculture area, living area and industry area) has a storage center to store freights that this area needs, and then use trucks and carrying robots to deliver freights to different places. For example, in agriculture area there are stores used to store foods, and trucks are used to deliver them to the store in every district in living area first, finally it is robots that send foods to every family.

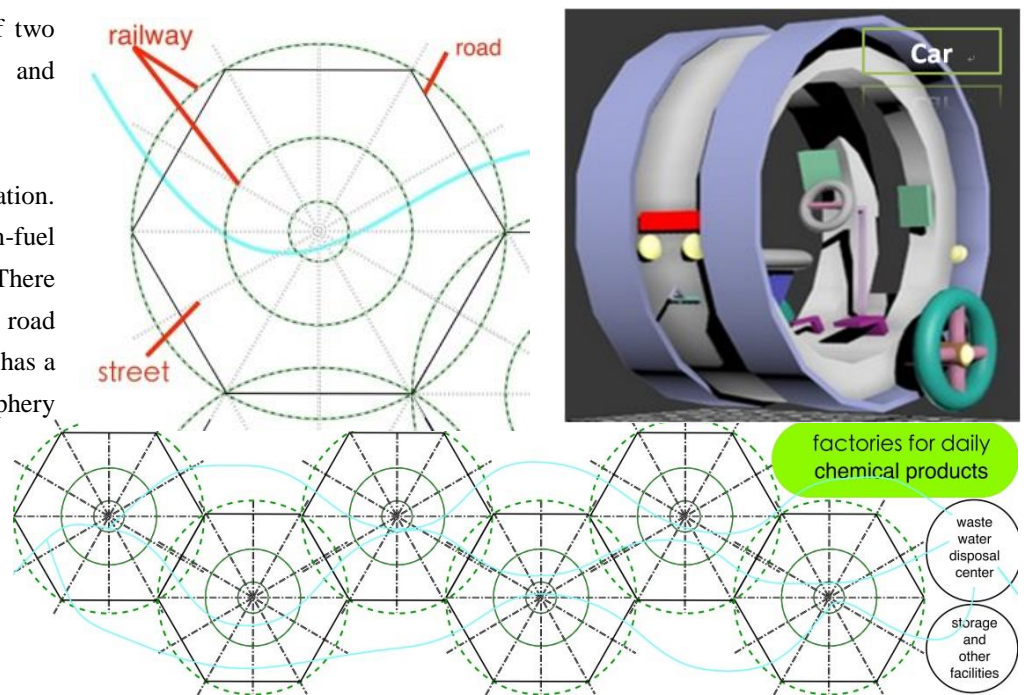


Fig.3.2.7-1

## 3.2.8 Day/ Night Cycle Provisions

### 3.2.8.1 Foreword

The illumination system on Columbiat will emulate it on Earth in order to make the Columbiaters (which means people on the Columbiat) feel natural.

### 3.2.8.2 Illuminant

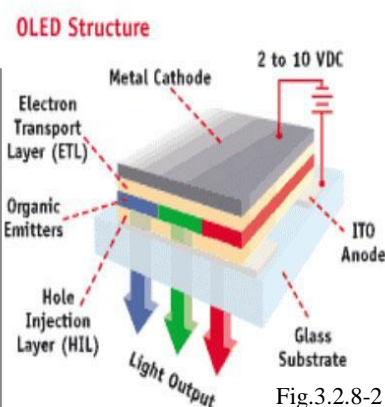
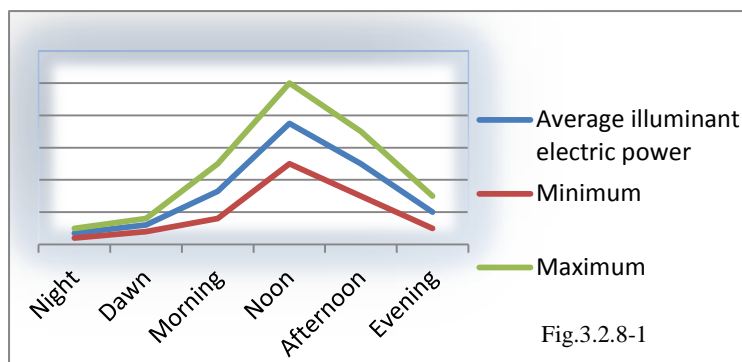
What we use as illuminant is a special TOLEDs which are extremely thin. This kind of TOLEDs has a wide variety of wavelengths. A full spectrum of authentic colors can be produced by TOLEDs, which makes it possible to simulate sunlight. Over the illuminant, there is a thin membrane whose refractive index is similar with the aerosphere's refractive index above it so that the illumination effect will be much better.

### 3.2.8.3 Illumination

The area inside Columbiat will have a 14-hour daytime and 10-hour nighttime, which is appropriate for human to live in. The central area will follow the GMT.

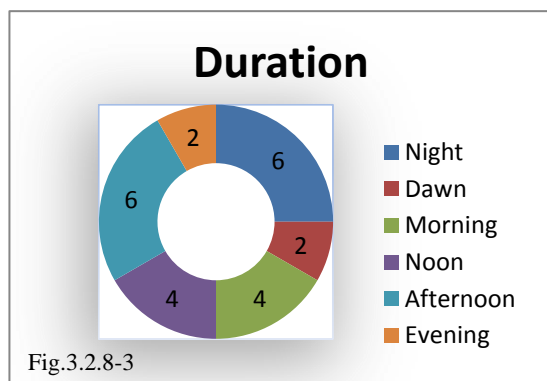
#### 1) Normal Area

The main illuminant is located at the torus over the prime-axis of the space settlement. It is fixed on a torus with magnetic suspension function over the prime-axis, which is

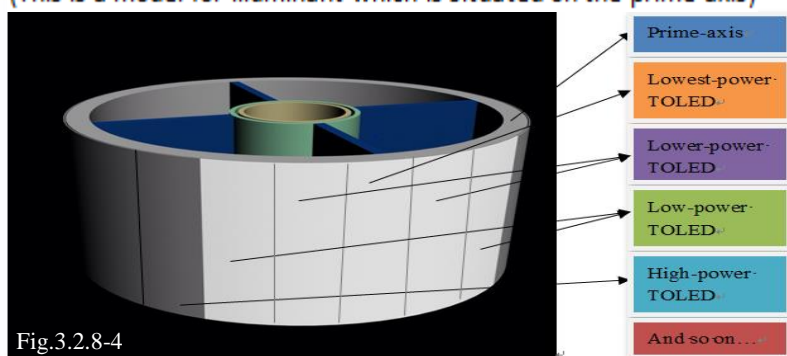


used to reduce the abrasion between the illuminant and prime-axis. The illuminant is arranged according to gradually changed electric power, which is used to furnish part of the space settlement with illumination but to keep the other area of the space in darkness. (We will use the TOLEDs with different electric power in order to not only create a time-lag on the space settlement but also save electric energy.)

#### 2) Specific Area



(This is a model for illuminant which is situated on the prime-axis)



The areas which are in the shadow region will be lightened by the light emitted from the TOLEDs under other four areas. For instance, the specific area will be lightened just as it will be if those 4 areas do not exist. The only difference is that the specific area get lightened by the illuminant under those 4 areas rather than the main illuminant.

(The electric power indicates the electric power of the illuminant. The slope of the broken line indicates the light intensity variation among each part of time.)

## 3.2.9 Industrial area

There are so many useful material made by agriculture and waste, an industrial area is built in the station. It is divided into two parts: 0g industry and 1g industry.

**3.2.9.1 0g industry:** There are some smelting factories to deal with different metals. Metals can be from wastes or ores.

Some components assembly plants are built in 0g industrial area so that more energy can be saved.

Some chemical factories that deal with harmful materials are built in 0g place in order to isolate them with residents.



There are also some science labs in 0g area.

**3.2.9.2 1g industry:** This area is mapped in maps in 3.2.7. Most daily chemical products (including paper, clothes, and soaps) are produced in factories in this area. They use materials from agricultural area or the earth, which can make no pollution and be safe for residents.

## 3.3 Construction machinery

**3.3.1 Conveyer belts** are used widely during the progress of building, including external and internal building. They are mostly used to transport regular components and some robots can do some processing during transporting.

**3.3.2 Transporting truck:** Some irregular or heavy or other special materials and components need to be transported by trucks.

**3.3.3 Robots** build almost all the construction. They can be assembled different arms or other components to do different works.

### 3.3.4 Processing truck

Some materials like concrete need to be mixed before using. A processing truck is used to finish this work.

**3.3.5 Cutter:** Some materials like glass, wood and stone need to be cut before using. Cutters can cut them by different ways. There are several kinds of cutting machine: water jet cutting, arc cutting, laser cutting, etc.

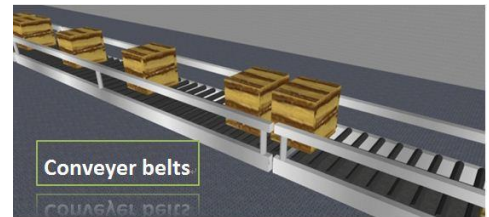


Fig.3.3.1-1

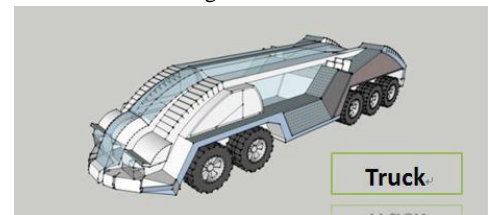


Fig.3.3.2-1

## 3.4 Propulsion

In order to establish and maintain rotation of artificial gravity volumes, also to keep the station remain stationary, we need a huge thrust and power must be ongoing.

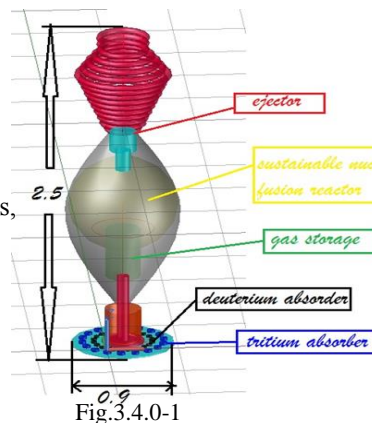


Table 3.4.0-1

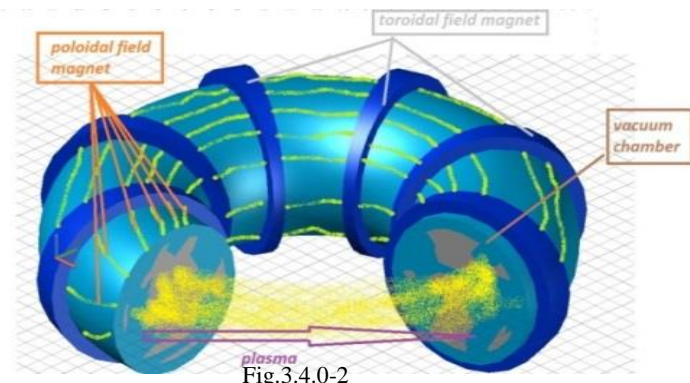


Fig.3.4.0-2

type	sustainable nuclear fusion reaction thruster
<b>Fuel</b>	The propulsion needs amount of fuel, therefore we chose sustainable nuclear fusion reaction thruster. The fuel of it is deuterium and tritium which is abundant in space, so it can absorb gas inexhaustibly as fuel.
<b>Setting mode</b>	Connector between space station and the propulsion is a magnet which has very huge attraction that it's impossible to be separated.
<b>Setting place</b>	The propulsion use energy that release from nuclear fusion reaction, it's really efficient and can provide huge thrust. In station, different zone need different thrust to produce centrifugal force to simulate gravity and keep all above mentioned zones a certain angular momentum, the propulsion will be fixed on the outer sphere of each zone that is mentioned, and the quantity of thruster in diverse zones is different.

Table 3.4.0-2

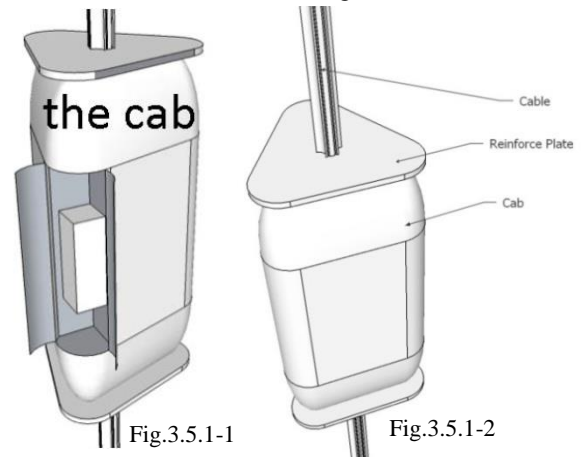
	Previous period	Sustain period
The mass of each propulsion device per day	500g	50g
The amount of power on	992	20
The method of energy supply	Nuclear reactor on the rails	Solar panel
Sustain time	5 years	Forever

## 3.5 Space Elevator

The space elevator will go up and down the cable at max velocity of 200km/h with acceleration of no more than 1 g.

### 3.5.1 The Outer View of the Cab

The cab is made of Reinforce Plate and cab section body. The Reinforce Plate, which is made of carbon nanotube, is in case of bumping into space trash. The cab section body has a height of 30m, meeting the requirement of three cargo containers (15 feet square by 45 feet long) and 100 passengers.



### 3.5.2 The Inter View of the Cab

The Cab is separated into several parts: the Electromagnetic Launch Systems, the Cargo Containers Zone, the Passenger Zone, and the Control & Communication Zone.

1. Control & Communication Zone act as the brain of the cab, which can man drive or automatic drive. Signals between the cab and the space settlement or the moon base will be sending and received here.
2. Electromagnetic Launch Systems is where the cab will grab onto the cable, with the ability to push the cab ascending or descending the cable at the acceleration under 1g and the velocity no more than 200km/h.
3. The Cargo Containers Zone is where the standard cargo containers stay in the cab. There will be three sections to store the cargo, each with a gate.
4. The Passenger Zone is where the passengers stay and live. (Refer to 4.5)

### 3.5.3 The Attachment to Ribbon

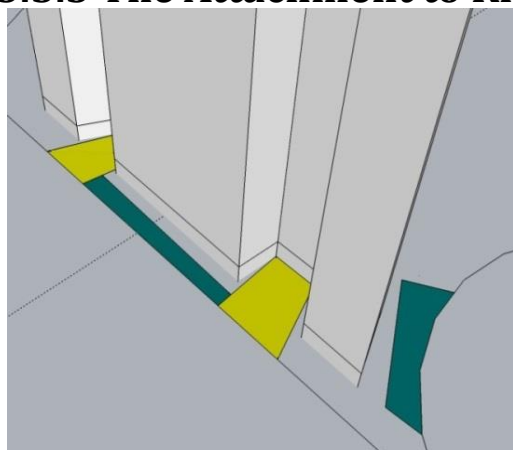


Fig. 3.5.3-1

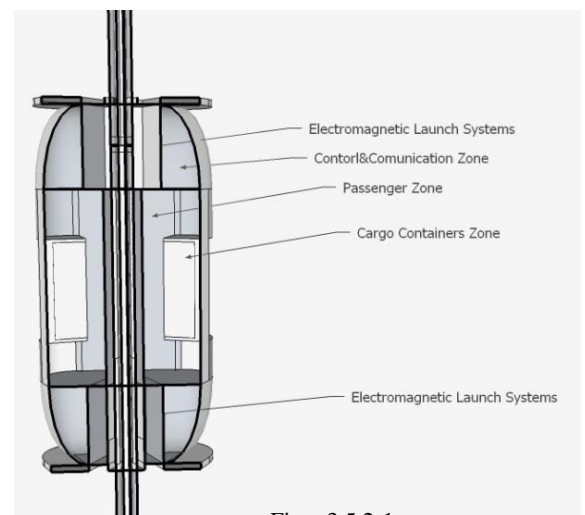


Fig. 3.5.2-1

### 3.5.4 The Method of Ascending / Descending Ribbon

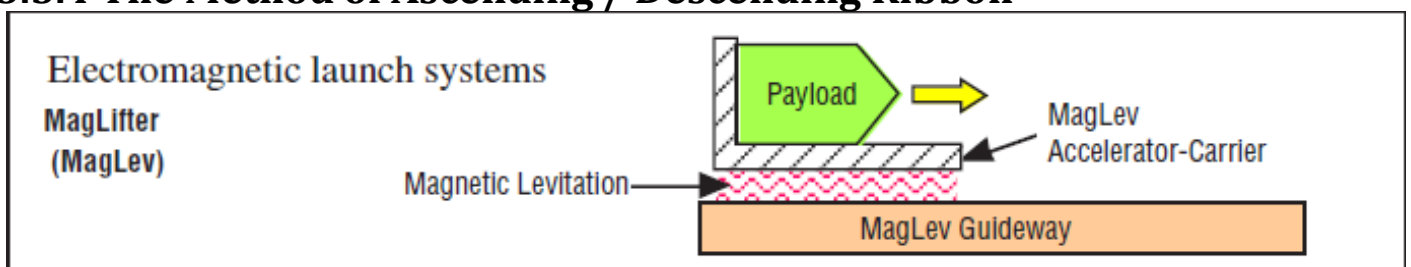


Fig.3.5.4-1



## 4.0 Human factor

### 4.1 Community and consumables

#### 4.1.1 Community design

##### 4.1.1.1 Public area (open space)

###### 4.1.1.1.1 Overview

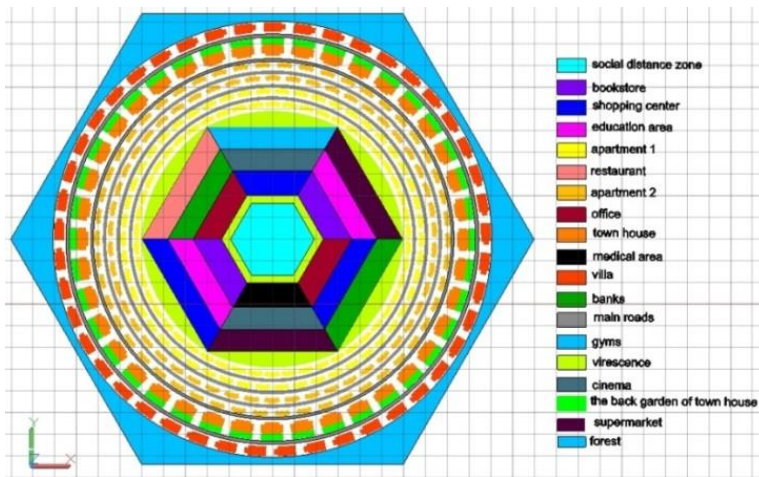


Fig.4.1.1-1

hold the meetings regularly. On the first floor there is a transportation ring, connecting two opposite residential areas so that it makes the inner transport much quicker. On the second floor there is a sightseeing deck, where people can catch a better view of the whole district.

##### 4.1.1.2 Psychological factors

###### 4.1.1.2.1 Varieties of choices

In order to face every lifestyle, lots of supplies need to have great quantities of sorts. More choices make residents get the feeling of freedom which fit everyone the most.

###### 4.1.1.2.2 Convenience in touch

As Columbiat is a business center for elites, all residents would care for efficiency much more. Compared to the design on the earth, we pay more attention to the convenience of residents. Smart watches play an important role here: it could help people book many deeds without complicated identity-confirmation, which save plenty of time. In addition, auto-cars also accelerate the speed people move from one place to another. In one word, Columbiat will have lots of details to perfect residents' daily life.

##### 4.1.1.3 Long-term consideration

###### 4.1.1.3.1 Relationships between environment and human

Forest would be in the living area to construct an environment like nature, made let-out gas like carbon dioxide absorbed as soon as possible. Meanwhile, industrial areas are divided from living area to avoid any gas which is harmful to people's health. Moreover, the auto-cars use electricity as energy so the auto-cars do not let out any carbon dioxide. As a result, we do not need to worry the harm to nature brought by human beings like greenhouse effect.

###### 4.1.1.3.2 Relationships between human and human

As the residents in the space settlement come from different nations, hold the different faith of religions, the environment have to establish a harmony interpersonal relation.

There are nine districts in the community. One district can be divided into three parts, the residential area, and the center square. The center square lies in the central part of the hexagon with radius of 48m; on the outer side is the commercial area, with the radius of 300m while the outer is the residential area with the radius of 600m. The rest part is the forest.

###### 4.1.1.1.2 Center square

We design a center square in every district. It has three floors. On the ground people can gather and



Fig.4.1.1-2

## 4.1.2 Amenities

### 4.1.2.1 Education

In order to make a robust education system, Columbiat will have town schools and they are in competitive situation. Students study in one school and take exams in the other school.

### 4.1.2.2 Food

A food safety system including general check and sterilization will set up to ensure people's health. Robots and underground conveyor belts are able to help people cooking at home and delivering the cooking materials.

### 4.1.2.3 Housing

Basing on the functions of sensors, every house will have a completely Internet of Things control by security center. People can control everything in the house simply even it they are not at home.

### 4.1.2.4 Entertainment and Recreation

Columbiat will provide 4D cinema and 89002.665m<sup>2</sup> of field for ball games. There will be a park for sightseeing and exercise and a central gym for all kinds of sports.

### 4.1.2.5 Medical

The medical system consists of one general hospital and other individual clinics serve as different functions.

## 4.1.3 Consumables

### 4.1.3.1 Major categories of consumables

#### 4.1.3.1.1 Housing

Furniture list <span>Table 4.1.3-1</span>	
Terms	Supplement per year in total
Tables/desks	19600
Chairs	40000
Wardrobes	12000
Cupboards	19200
Beds	14700
Dressers	7500

Style list <span>Table 4.1.3-2</span>	
Name of the style	Percentage
European	13%
Mediterranean	10%
American	12%
Central Asian	5%
Chinese	10%
Universal	50%

We offer the pleasant life style to the full-time residents

just like the earth environment. But we prepare varieties of furniture of different material and styles so that people in different ages or regions can adapt in the new environment. We list the styles of furniture and decorations here.

Cooking tools <span>Table 4.1.3-3</span>	
Terms	Supplement per year in total
Container	243000
Refrigerator	12000
Disinfection cabinet	12000
Juicer	12500
Microwave oven	12000
Cooker(all kinds)	244000
Induction cooker	12000
Pot	18000
Ventilator	12000

Toiletries list <span>Table 4.1.3-4</span>		
Terms	Supplement per year in total	Quantities per person per year
Toothbrushes	98000	4 nos'
Toothpastes	29400kg	1.2kg
Tissues	36750kg	1.5kg
Soaps/shampoos	36750000mL	1500mL
Cosmetics	15925000mL	650mL
Towels	98000	4 nos'
Shaving brushes	49000	2 nos'
Sanitizers	24500000mL	1000mL

#### 4.1.3.1.2 Food

Although food providing can be much more efficient practical in Columbiat, residents will still prefer to enjoy cooking with their own hands at home. We list the cooking tools and varieties of food material here for both restaurants and families.

Food material		Table 4.1.3-5				
Varieties		Supplement per year in total	Quantities per married adults per year	Quantities per single men per year	Quantities per single women per year	Quantities per children per year
Grains	wheat	1385495kg	53.4 kg	54 kg	52.1 kg	32 kg
	rice	294105 kg	11.2 kg	12.8 kg	10.8	5.4 kg
	corn	144840 kg	5.6 kg	6.1 kg	5.1 kg	2.7 kg
	soyabean	104352.5 kg	4.1 kg	4.3 kg	3.5 kg	1.8 kg
	sorghum	122647.5 kg	4.8 kg	5 kg	4.2 kg	2.3 kg
	barley	106410 kg	4.1 kg	4.2 kg	3.9 kg	2.6 kg
Vegetables and fruits	apple	323317.5 kg	12.5 kg	12.4 kg	12.6 kg	6.3 kg
	lemon	18877.5 kg	0.8 kg	0.3 kg	0.9 kg	0.2 kg
	banana	318682.5 kg	12.2 kg	12.6 kg	12.3 kg	7.1 kg
	strawberry	98293 kg	3.76 kg	3.8 kg	3.79 kg	2.5 kg
	carrot	111279 kg	4.3 kg	4.2 kg	4.23 kg	2.7 kg
	tomato	215765 kg	8.36 kg	8.12 kg	8.45 kg	4.3 kg
	potato	479650 kg	18.6 kg	19.7 kg	18.1 kg	6.3 kg
	cabbage	162590 kg	6.2 kg	6.54 kg	6.02 kg	4.34 kg
	onion	103310 kg	4.02 kg	4.2 kg	3.86 kg	1.4 kg
Meat	pork	629065 kg	24.7 kg	25.9 kg	21.4 kg	10.3 kg
	fish	457950 kg	17.6 kg	18.6 kg	16.8 kg	10.2 kg
	beef	240415 kg	9.4 kg	10.3 kg	7.6 kg	4.9 kg
	poultry	378502.3 kg	14.6 kg	16.4 kg	13.1 kg	6.79 kg
Dairy products	oil	240538 kg	9.125 kg	10.3 kg	9.1 kg	4.67 kg
	milk	6320000mL	250mL	200mL	200mL	300mL
	cheese	147702.8 kg	5.6 kg	5.4 kg	5.4 kg	6.21 kg
	egg	479205 kg	18.25 kg	17.3 kg	17.4 kg	20 kg

#### 4.1.3.1.3 Education

With the help of electric equipment like electric books, electric paper, we can save lots of paper but there are still quantities of people, especially children, preferring hand writing with paper.

Table 4.1.3-6

Terms	Supplement per year in total	Quantities per person per year
Pencils/pens	612500 nos'	25 nos'
Paper	367500kg	15kg
Books	147000kg	6kg
Printing ink	9800000mL	400mL
Modifications	490000 nos'	20 nos'
Printers	4900 sets	

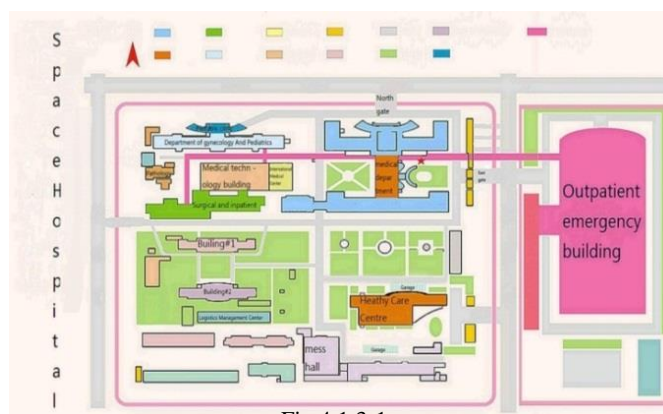


Fig.4.1.3-1

#### 4.1.3.1.4 Medical

There will be a hospital in each district. It covers an area of about a thousand square meters. The gross area is about twenty thousand meters. As soon as the staff finds a man's body situation isn't good, he will be sent to this local hospital. There are existing staff 350 people, including senior professional title 50 people. The hospital has 8 clinical and medico technical departments and 157 prepared beds now. The daily average number of the treatments is

Table 4.1.3-6

Terms	Quantities	Size
Football field	9	105m*68m
Basketball Court	18	28m*15m
Badminton court	90	13.4m*6.1m
Billiards	90	2.74m*1.525m
Natorium	9	50m*21m,1.8mdepth
Bar	9	13m*13m
Karaoke	9	13m*13m
Café	18	13m*13m

1000 person.

#### 4.1.3.1.5 Recreation

We set plenty of equipment of recreation, which lie in the commercial area of every district. We list the sites here.

### 4.1.3.2 Annual replenishment

#### 4.1.3.2.1 Paper

Use wood produced by forestry. Make paper in the factory and use additives as little as possible. Send paper to every people by robots.

Table 4.1.3-7

Kinds of paper	Amount (one people per year)	Total(all the people per year/kg)
A4(for documents)	1200 pieces	115200
Toilet paper	4kg	96000
Others	5kg	120000

#### 4.1.3.2.2 Clothing

Table 4.1.3-8

Terms	Supplement year in total	per	Quantities per married adults per year	Quantities single men per year	per	Quantities per single women per year	Quantities per children per year
Shirts	547125		20 sets	25 sets		18 sets	24 sets
Sweaters	96075		4 sets	2 sets		3 sets	5 sets
Dresses	117925		5 sets	0		7 sets	3 sets
Skirts	71575		3 sets	0		4 sets	3 sets
Shorts	120300		4 pairs	8 pairs		3 pairs	6 pairs
Trousers	256900		10 pairs	12 pairs		7 pairs	6 pairs
Jackets	84875		3 sets	5 sets		2 sets	4 sets
Socks	403050		15	12		18	20
Hats/caps	82050		3 sets	4 sets		3 sets	2 sets
Jeans	79225		3 pairs	2 pairs		4 pairs	3 pairs
Footwear	109275		4 pairs	3 pairs		6 pairs	4 pairs

### 4.1.3.3 Sources

All the heating, vehicles and lighting depend on the electric energy, which comes from PEMFC and methane. It is well explained in 3.2.3.

### 4.1.3.4 Means of distributing consumables

There is one community of sightseeing for tourism, while the others for normal residents. So there's a little distinction in distributing consumables between these two types.

#### 4.1.3.4.1 Housing

The principle of distributing houses is the family. A family of different numbers of people can live in different types of houses. In the sightseeing district, we may make the relatives or the people of the same race or religion to live in one district, providing a races-mixed area for those visitors to feel different cultures. In the normal districts, people in all kinds of religions live together, constituting the living surrounding a real land of multiculture.

#### 4.1.3.4.2 Food

All kinds of food are well prepared in every district. Since residents can buy the food by both web-ordering system and marketing, the warehouses in every district must be able to guarantee plenty of food and the robots have to transport them in time, ensuring residents to always get fresh food material.

#### 4.1.3.4.3 Education

There is hardly distinction in distributing of sources or amenities in education. All kids should be treated equally when getting educated. Although electronic equipment will take over the blackboard but paper will still be the main consumable in the classroom.

#### 4.1.3.4.4 Medical

The most advanced medical technology will be used in the space settlement, even the district hospitals. There is no distinction of medical between those districts and every family is asked to prepare the basic medicine in case someone's illness. Still, we will build the healthy net in each community so that the medical workers can take charge of it easily.

#### 4.1.3.4.5 Recreation

We also distribute the recreational equipment by the region in the sightseeing district as well. Besides basic ones, like ball games or watching the film, every kind of traditional entertainment should not be ignored, so we try to preserve varieties of games for those residents. But all sorts of preparation will be made in the normal ones, like chess rooms, gymnastics for judo etc.

## 4.2 Houses

### 4.2.1 Neighborhood

The locations and distributions of houses are showed in 4.1.1.1.1.

### 4.2.2 Designs of houses

#### 4.2.2.1 For singles (apartment 1)

The area of this type of apartment is about 70 Sq.m. Including a living room, a kitchen and a bedroom with study and bathroom.

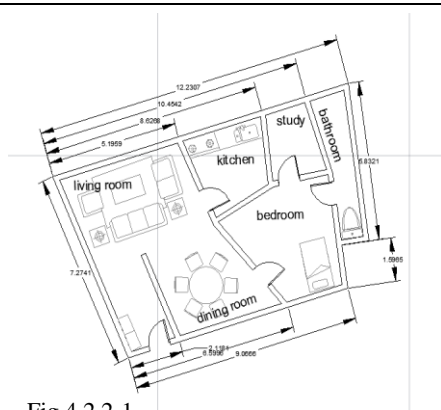


Fig.4.2.2-1

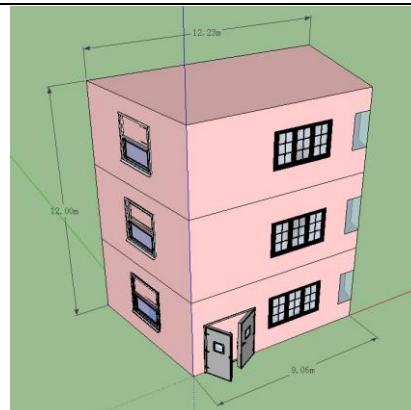


Fig.4.2.2-2

#### 4.2.2.2 For families with child (apartment 2)

The area of this type of apartment is about 140 Sq.m. It has a kitchen, a master bedroom, a store room and a bedroom. Every bedroom has a bathroom and a study.

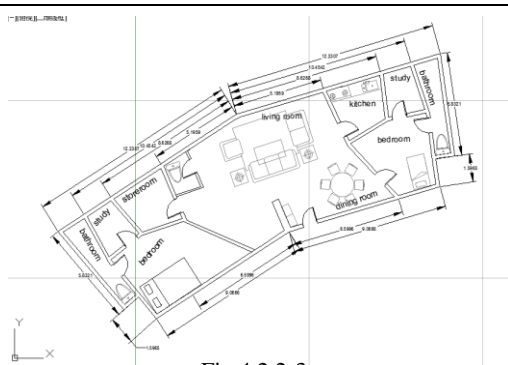


Fig.4.2.2-3

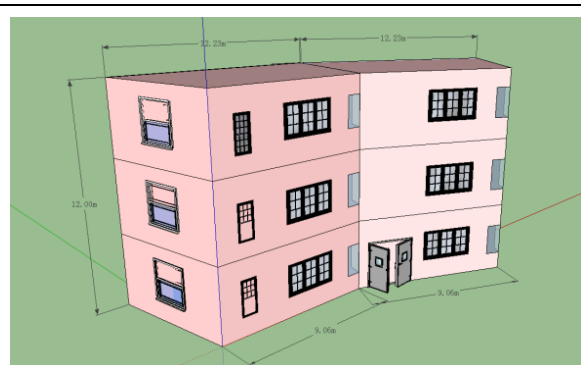


Fig.4.2.2-4

#### 4.2.2.3 For dink families or families with a child (town house)

This type of house consists of two floors. The area of the house is about 250Sq.m. Including a big garden and a ornamental horticulture inside.

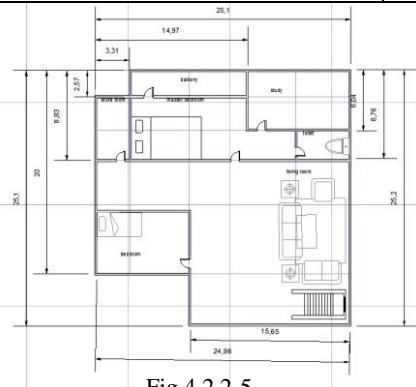


Fig.4.2.2-5

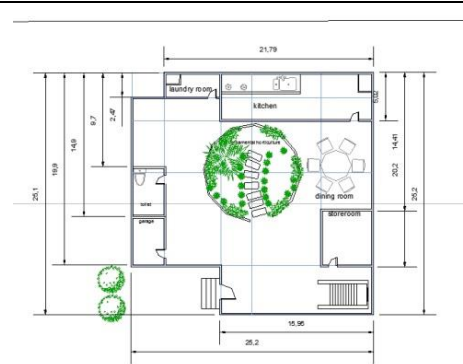


Fig.4.2.2-6



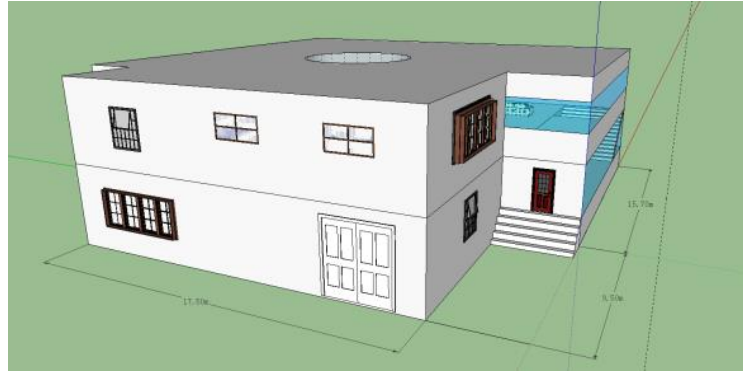


Fig.4.2.2-7

#### 4.2.2.4 For families one or two children (villa)

The villa consists of two floors and the area of this house is about 200 Sq.m. Behind the villa is forest.

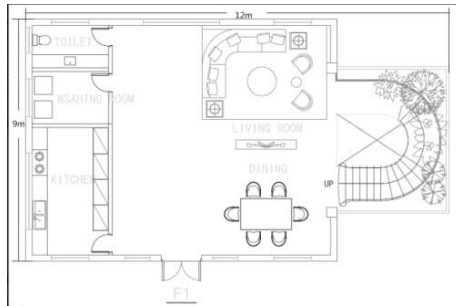


Fig.4.2.2-8

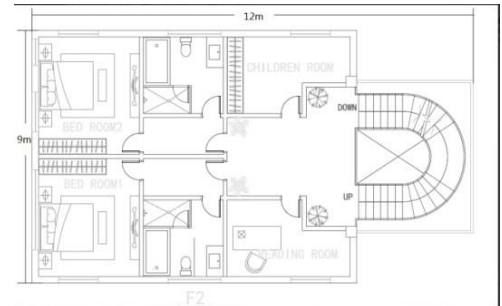


Fig.4.2.2-9

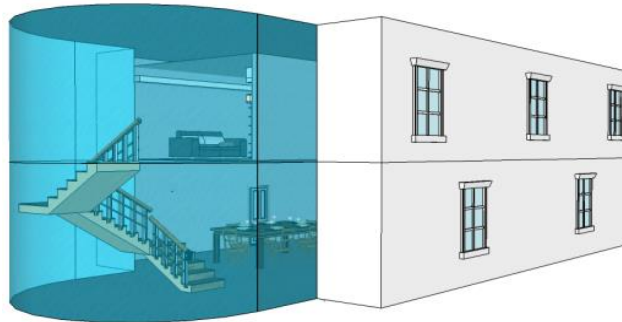


Fig.4.2.2-10

### 4.2.3 Quantities

Table4.2.3-1

Type of house	Quantity	Area(m <sup>2</sup> )
Apartment 1	8100	567000
Apartment 2	6075	850500
Town house	910	227500
Villa	450	90000
<b>Total</b>	<b>17560</b>	<b>1735000</b>



Table4.2.3-1

Term	Quantity per period	Period long(year)
Tables\desks	37575	1
chairs	60120	1
wardrobes	22970	2
cupboards	18120	2
beds	23341	1

## 4.3 Safe system

### 4.3.1 Devices and systems



#### 4.3.1.1 Device

Device	Details	View
Handrail	Handrails are used to support people while they are moving in the zero gravity area of the settlement and will be located on the surface of settlement. The shapes of handrails are broken lines that will help astronauts work every direction conveniently. (Material: Aluminum & Magnesium)	 Fig.4.3.1-1
Tether	The nanomaterial tethers will also be located on the surface of settlement to make a combined function with handrails, which design for bonding human while they are floating. The tether will store in the toolboxes of space suit as a back up.	 Fig.4.3.1-2
Cage	Cages are used for moving outside of settlement to carry people and cargos.	
Track chip	For tracking moving machines (vehicle, robots, etc.) in Columbiat.	

#### 4.3.1.2 System

Systems	Purpose
Pressure check system	To ensure humans are in a safe atmosphere and examine the leak.
Tracking system	It is used to find the location of humans and other space object to confirm it safety.
Emergency system	Design to call SOS for humans in danger.

### 4.3.2 Vehicles

Vehicle	Purpose	Detail	View
<b>Athena</b>	To transport people from Columbiat to other plants or settlements. Also, This spacecraft is used to carry people in an emergency situation.	Payload: 500 passenger	 Fig.4.3.2-1
<b>Orion</b>	Atlantis is mainly use to transport cargos. In addition, Alfa provides 50 seats for people in emergency.	Payload: 200 tones	 Fig.4.3.2-2

### 4.3.3 Spacesuit

#### 4.3.3.1 Layers

Anti-friction layer (Nylon spandex polymer/ Kevlar)

The points abrade more will be thicker (e.g. knees and foot)

Restraint layer (Neoprene-coated nylon)

Base on Mechanical Counter Pressure technique

Cooling layer (glass fiber)

Cooling and thermal protective

Radiation protect layer (nano-paint)

Protect people from cosmic radiation and radiation from device in spacesuit

Memory alloy fiber

Memorize everyone's body shape and make people flexible

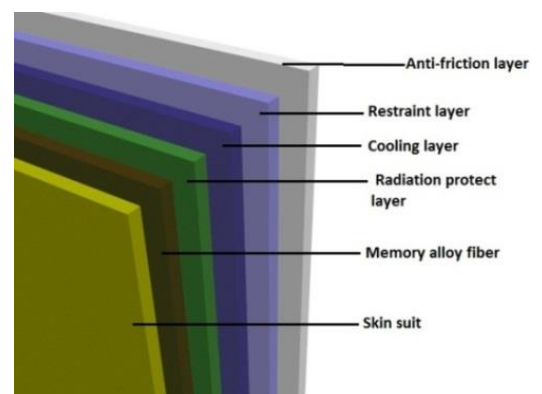


Fig.4.3.3-1

Skin suit (lycra & viscose)

Make people comfortable and soothe body problems in Zero-G

#### 4.3.3.2 Facemask

A. Main material: Silicon buckystructure

Showing information about things people's eye see (camera will help to make sure this function work). The material of face mask is transparent from inside and color in white outside, filters direct sunlight in daytime but provides visibility at night.

B. Camera

Take picture, record data, scan

C. Voice control and communication

Augmented reality function (such as Google Glass)

This function is able to help workers to show sketch on the silicon panel and enrich people's view. In addition, this function will help astronaut who will do special job (such as repairing and building, etc.) on the surface of Columbiat to model the future situation they will face.

#### 4.3.3.4 Systems

Central control system

Have control button of all devices in the spacesuit and including light

B. Voice system

Record notes, communicate with control center, and control the device

C. Life Support system

Provide electricity and have air cycling system inside (have tubes inside the suit)

D. Emergency system

Self-healing layer, wireless device in control system and propulsion system

E. Propulsion system

Help people who need move a long distance and this device is optional

Protective system

Resistant and anti-radiation material

#### 4.3.3.5 Donning and Doffing procedures

Before donning procedures, people should be exam their healthy condition to check whether they are able to finish the trip or not.

When people enter Entry Room, they need to say the size of space suit they need. Then the voice control system will recognize the demand and send out a space suit shelf from the window. After that, people need to don the space suit, which order is helmet, life supply bag, gloves and shoes. Besides, people are asked to put the shelf into Locker. Then a leak check and communication system check will begin. After the exams have finished, people can enter the Pressure Reducing Room. When the room is vacuum, people will be sent to preparing room automatically. If people are well prepared, they can press RED BUTTON on the floor to go out.

When people coming back to the airlock, they will first enter Detoxification Room, which will clean the space suit such as remove the dust, etc. After cleaning process, the pressure will slowly increase and when it gets to the normal pressure, the space suit is removed automatically and then people are able to go to the Exit Room to store the suits.

#### 4.3.3.5 Stowage

For the stowage process, people just need to put space suits in the shelf and resend the shelf from the window in the Exit Room. The Space Suit Stowage Room will take care of the space suit very careful.

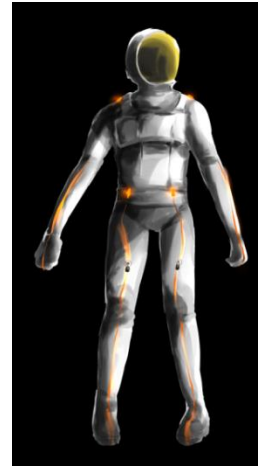


Fig.4.3.3-2

## 4.3.4 Airlock

### 4.3.4.1 Outer airlock

The airlock is made up of several parts: Dressing room, Waiting & Cleaning room, Decompression Chamber and four gates.

The main part of a single air lock cabin in addition to the

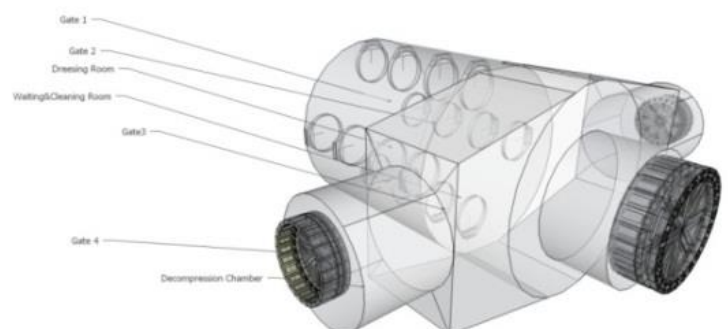


Fig.4.3.2-1

cabin are two air lock gates, one being inner lock gate

connecting with a sealed cabinet, and the other being outer air lock gate to the space; Their opening and closing are controlled by electric device, and pressure measurement can be performed at the same time to ensure the running safety. In addition, the air lock cabin is also equipped with cabin-carrying support equipment such as re-pressure discharge controlling equipment and extraction security console, re-pressing cylinders, communication and lighting facilities as well as the spacesuit for astronauts to descend, living facilities such as personal living goods, sanitary installation.

#### 4.3.4.2 Rotating airlock

Airlock express carry passengers through gate way and enter the rotary air lock. After the airlock express has entered the air lock, the lock gate will close. Gas tightness checked, air pump begin to work and increase the pressure until pressure and constituent reach the similarity of earth atmosphere and the main volumes' of Columbiat. The air lock begins to rotate until the rotary speed reached that of main volumes, with energy provided by engine that located at the outer shell.

As the rotary airlock's pressure and rotary speed (which determines the gravity condition) are identical with space settlement's main volume, the airlock is connected to the rotating axis (rotary at the same velocity), and meet the demand of completely same with main volumes. Airlock express enters the space settlement for shuttling passengers. When the express goes back, the gate that connects the station and rotary air lock will open. After the express has totally passed through, all gates are closed. That time will be gas tightness, and rotary air lock will be separated, the pressure will be lowered, the rotary speed will be slowed, ending up zero.

## 4.4 Arrival/departure area

### 4.4.1 Floor plans

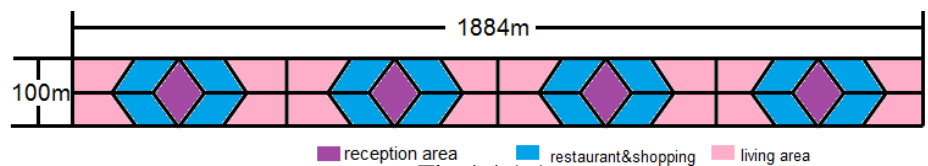


Fig.4.4.1-1

According to the design of 2.0, there will be two arrival/departure areas and the area of one is about 188400 square meters. We design this area a mini community. It can hold the population of 2500.

#### 4.4.1.1 Accommodations

All those visitors arriving at Columbiat are arranged to live in this type of room. It is designed for the family of three members but it is also suitable for those businessmen. To keep the room clean, the cleaning robots do their duty every day. There are also bigger room for larger families with a kitchen, two bathrooms and three bedrooms in it. All the rooms are connected to the control center in case there are any urgent situations.

#### 4.4.1.2 Other areas

The security area is the most important one. When people enter the Columbiat, they will be sent to the security area where they will get a fully body examine firstly. If passed, they will get their temporary identity in the smart watch. Afterwards, they are allowed to enter other areas.

The arrival/departure area is designed like a mini community; there is also commercial area, including restaurants and shopping malls in it, making it more convenient for visitors.

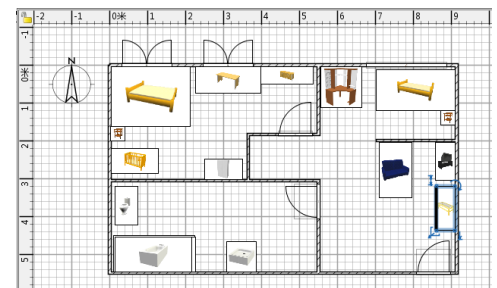


Fig.4.4.1-2

### 4.4.2 Facilities

Columbiat will have a sightseeing elevator for passengers from outside to the passenger center. Both visitors from space elevator and ship need to enter the sightseeing elevator first. During the journey in the elevator, visitors are able to view the amazing space and Columbiat, which definitely will show them impressive picture.

#### 4.4.2.1 Security measures

In order to set a completely security system, Columbiat will have a security station in the passenger center, including a supervision system and a self-check system.



#### 4.4.2.2 Supervision system

On the premise of personal privacy, a 360-degree rotating-lens camera system without any blind angle will set up for security. This system is able to record all behavior in public area in the passenger center. The cameras are high definition array infrared cameras that are able to scan a larger area of surveillance and work without visible light. Infrared cameras operate in wavelengths as long as 14,000 nm (14  $\mu\text{m}$ ), however, the visible light camera only ranges from 450–750 nanometer, which means infrared cameras promise a better security system.

#### 4.4.2.3 Self-check system

After arrival in Columbiat, every visitor will be sent to the security check station. Everyone must give his entire information such as sex, age, visiting purpose, duration of stay, etc. In addition, they need to have a facial and fingerprint scanning. When all the procedures are done, staffs will give them a smart watch that can sense their body temperature to make sure visitors are safe. The smart watch also have the function of GPS, which help passenger center to locate everyone.

## 4.5 space elevator

### 4.5.1 Seating and accommodations

#### 4.5.1.1 Fixed seats

Since there is no gravity in the space elevator, we design a special seat to fix passengers on the interior surface of elevator. It has the height of 1.29m and the length of 1.35m.

To ensure passengers' safety, they have to tie themselves tightly on belly and leg with safe belt. There will be a control panel on the right side of handrails.

#### 4.5.1.2 Gloves

We use a special gloves to help people moving in the cab, which is a special gloves using a kind of technique imitating gecko's claw. There is a kind of fur of nanometer level. People can grab onto everywhere with these gloves, with the advantage to help people moving more convenient.

#### 4.5.1.3 Rest and sleeping area

This area consists of the sleeping bag and a shelf holding the consumables. With no gravity, some people can hardly fall asleep. To solve this problem, we prepare these methods. First, moving to the sleeping bag with the gloves, people need to help themselves surrounded by the sleeping bag. Second, people have to wear the ear cover and eye mask to prevent the light and noisy. Among these two people living in one room, one has to keep contact with the master station, even in sleep. What's more, there will be the equipment detecting the concentration of  $\text{CO}_2$ . If the concentration is too high, the machine translating  $\text{CO}_2$  into  $\text{O}_2$  will be turned on automatically, making sure people's safety.

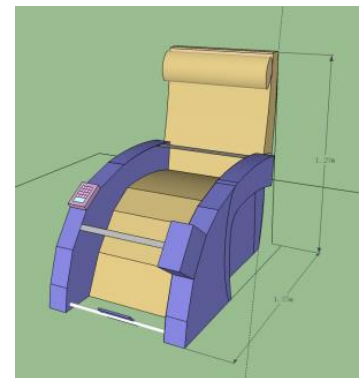


Fig.4.5.1-1



Fig.4.5.1-2

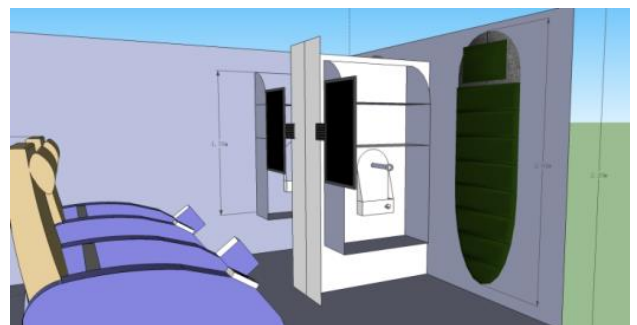


Fig.4.5.1-3

### 4.5.2 Entertainment

In the daytime, people can move to the chair, which has a large computer in front of it. People can watch films, listen to the music or play games with the control panel on the chair.

## 5.0 Automation

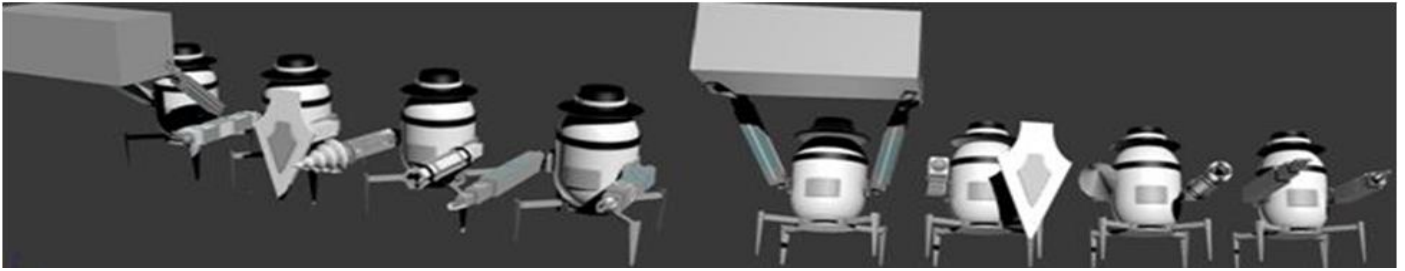


Fig. 5.0-1

The automation system in the future is made up of a well-automated system whose core is called Prometheus. This unmanned system can work by itself even under the influence of outside environment.

### 5.0.1 System” Prometheus”

**5.0.1.1** The substance of Prometheus is a group of supercomputers that have the same thinking model and have large quantity of database. It can find the question by dealing with different kind of information and can order the terminal of the system to carry out.

**5.0.1.2 Location:** Prometheus takes charge of shuffling different groups of computers that are responsible for different parts and database. So Prometheus is located under the ground of every settlement and is linked through high-bandwidth optical cables.

**5.0.1.3 Hardware facilities:** Using the most advanced supercomputer in the world and install video, sound and infrared probes all over the settlement to collect information.

**5.0.1.4 Security:** The places where Prometheus located are not allowed people to go into and are protected by automated security system. The whole system is half-closed, and in it are some fixing robots that are not connected to the outside, which take charge of fixing the system. Prometheus forbids any manmade information to get into the Internet in it, except a small quantity of useful information. All of the information that Prometheus has collected or processed will be marked (the information in database will be marked in another form). Only a few people who have the permission can monitor Prometheus and send order from the earth to it directly. People in the earth can switch off Prometheus mandatory.

### 5.0.1.5 Thinking ability

#### 5.0.1.5.1 Thinking patterns

Through a central processor, the system filters and matches the Superior Memory and then matches Lower Memory, and makes actions after the program memory. Finally, the results of operations and declarative memory are stored in the memory area of the processor.

#### 5.0.1.5.2 Processing of external stimuli

When receiving and processing external stimuli, the information received from the outside are allocated to various types of processor senses and processed by the central processor mentioned above. That information for operations obtained is transferred back to each processor. The key to this system is that the processor senses independently and respectively of the type of information processing.

#### 5.0.1.5.3 Attention

Prometheus need to filters for on the information received. The ones that are relevant parts of the work and in line with Superior memory will be filtered out, tagged and sorted as the third level. (The first level and second level are legal ethics and risk aversion) . In some cases, the level of attention would be changed. In emergency, the commands of the most advanced network would be issued directly as the most priority.

### 5.0.1.6 Learning ability

The memory of Prometheus includes short-term memory, long term memory, and program memory. Short-term memory would be used when dealing simple problems, but only as a special case of individual areas, and would be erased after the storage period. The methods used to solve the problems are in long-term memory which is the subject of robot learning.

Those useful memory summary and reflection would be obtained as long-term memory storage in the Superior Memory while short-term memory is stored in Lower memory. This is a the typical learning process of Prometheus. Most of the program memories were already stored in when the robot were built, but some of which cannot yet be upgraded or changed.

**5.0.1.7 Internet system:** every situation of every robot is connected with monitor system in Prometheus through Internet. Prometheus will analyze all the tasks and send to different Internet channels of different systems, and then robots will get tasks to

finish by them. Robot can do the more necessary task that it finds and cancel the task that it has gotten (each robot only can do one task at the same time) . Other automated elements are connected with the related parts in database while automated terminal are connected with civil Internet at the same time.

**5.0.1.8 Characteristics:** The modules that maintain the basic operation of the space settlement can work by themselves without orders from Prometheus, so supercomputers in these parts take charge of monitoring their operation and send out orders when something have to change. This makes sure that the settlement can be safe in a short time even if Prometheus is broken. And even it is broken, only the operating speed will be influenced and there will be copies in database since Prometheus is shuffled and located in different places with different functions.

## 5.1 Automated construction and assembly devices

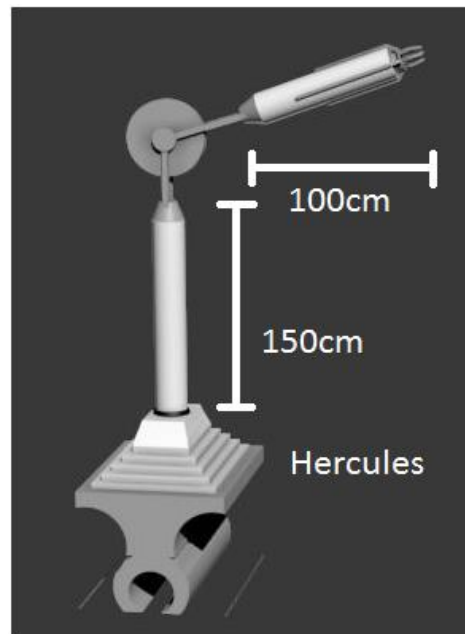


Fig. 5.1-1

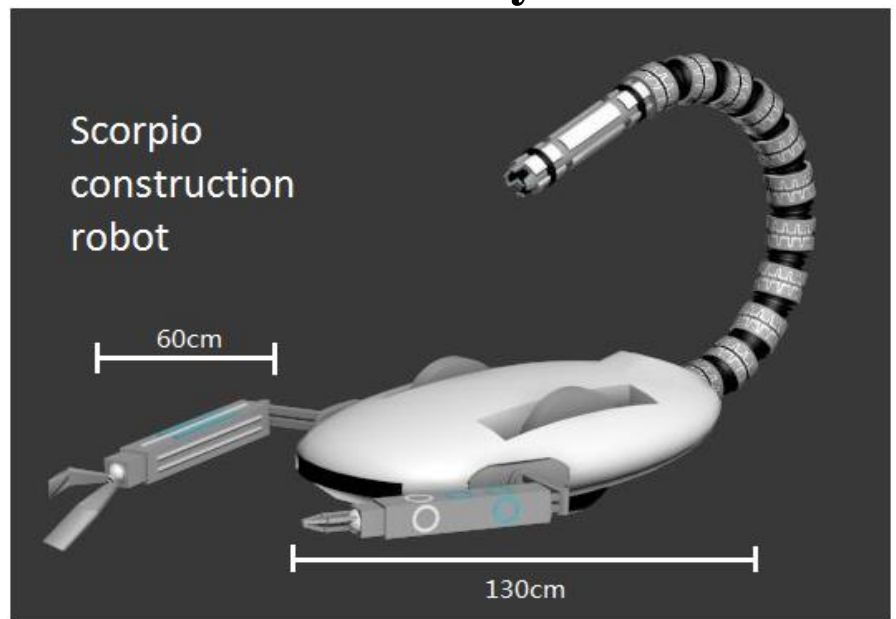


Fig. 5.1-2

In view of the length of the space elevator, we will build some rails like the scaffold at first to transport the robots. They will build and maintain the exterior structure termly. The robots will be sent to the base with the settlement’s parts. And after the building of solar panel, they will build the rails with the Prometheus system’s instruction. Then, the principal part of the settlement will be built. The robots that exterior construction needs are there-in-after.

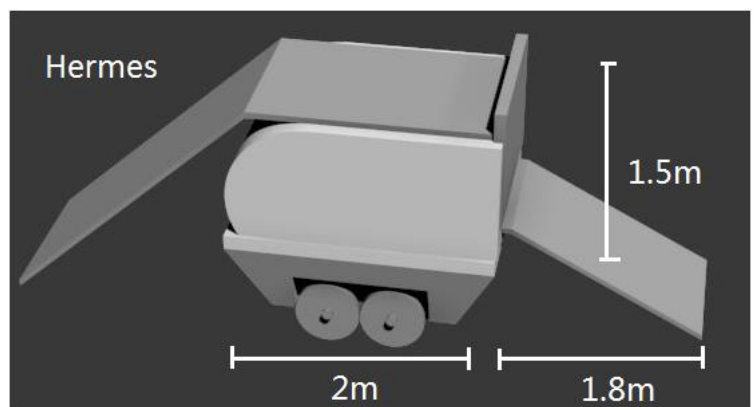


Fig. 5.1-3

Table 5.1-1

Railway transport module	Carry other robots and move on the rail.	Transport the construction robots on the rail.
Hercules	Transported by the railway transport module. Powerful, stable and flexible.	Carry and construct the large part of the settlement.
Scorpio	Use flexible electronics absorption technology, it can move on the surface of the settlement.	Construct and fasten the small part of the settlement.
Hermes	Transported by the railway transport module. Can store objects in or on it.	Transport the parts.

Scorpio Hermes and Hercules will responsible for the maintenance of the settlement and the space elevator. The robots that interior construction needs are there- in-after.

Table 5.1-2

Wheel transport module	Carry other robot and move by its wheels	Transport the construction robots in the settlement
Hercules	Transported by the wheel transport module.	In charge of the building of large project.
Scorpio	Can move in the narrow area and can move on the wall and the top of the settlement.	In charge of the building of small project. Construct and maintain the narrow area and the top of the settlement.
Hermes	Transported by the wheel transport module	Transport the parts.
Omnipotent	See details in 5.3	In charge of the rest part of construction; maintain.

## 5.2 Automation in maintenance

### 5.2.1 Precautions for potential hazard

Table 5.2.1-1

Contingency	Device	Precaution procedure
Conflagration	Heat sensor <sup>⓪</sup>	Monitor will report all the data collected to maintenance server for server to make quick response. <sup>⓪</sup>
Explode	Normal force sensor <sup>⓪</sup>	Monitor will report all the data collected to maintenance server for server to make quick response. <sup>⓪</sup>
Hull failure	Integrity sensor <sup>⓪</sup>	Detect hull failure at first time. <sup>⓪</sup>
Human criminal	Security app on Catdroid smart device <sup>⓪</sup>	Real time location service and forced report toward security server. <sup>⓪</sup>
Virus break-out	Health app on Catdroid smart device <sup>⓪</sup>	Health states and unfamiliar symptoms reported via health app on Catdroid, which connect general doctors and potential patients directly. <sup>⓪</sup>
Routine system failure	Scattered monitor <sup>⓪</sup>	Monitor will report all the data collected to maintenance server for server to make quick response. <sup>⓪</sup>

### 5.2.2 Response procedure

Table 5.2.2-1

Contingency	Response delay	Response procedure
Conflagration	1m <sup>⓪</sup>	First call for and make sure evacuation. Block out affected zones and then emit condensed CO <sup>2</sup> in the area. <sup>⓪</sup>
Explode	5s <sup>⓪</sup>	Immediately activate any isolation facility. And then emit condensed CO <sup>2</sup> in exploded area. <sup>⓪</sup>
Hull failure	10s <sup>⓪</sup>	Distribute oxygen mask. Then evacuate and activate lock down and repair work commenced. <sup>⓪</sup>
Human criminal	30s <sup>⓪</sup>	Assign Police robot. Isolate each functional volume for preventing potential desert. <sup>⓪</sup>
Virus break-out	1h <sup>⓪</sup>	Activate maximum isolation and ask for pathology support on earth via radio. <sup>⓪</sup>
Routine system failure	3s <sup>⓪</sup>	Switch to backup system. <sup>⓪</sup>

### 5.2.3 Robots

The robots will do the maintenance termly and they will also help people and the space settlement during the emergency. And every robot work outside of the settlement is able to work without the effect from the solar wind.

Here are the robots used in termly maintenance.



Table 5.2.3-1

<b>Hercules</b>	Transported by railway transport module.	Maintains the exterior of space elevator.
	Transported by the wheel transport module	For the maintenance of the large project inside the settlement.
<b>Scorpio</b>		For the maintenance of the surface of the settlement both the exterior side and the interior side. Also, the narrow part is included.
<b>Op what</b>	Type Re	For the maintenance of the small parts and details inside the settlement, can order by people and help them to maintenance their house or to fix their car.

Here are the robots can help during the emergency.

Table 5.2.3-2

<b>Omnipotent</b>	Type Re	They can do some basic maintenance.
	Type Nu	They can help the people who are injured or whose disease breaks out.
	Type Tr	They can transport the cargo and the disable people away from the disaster.
	Type Po	They can help the police to keep the order.

Table 5.2.4-1

Data type	Procedure
Critical data of settlement	Facial and iris scan
Department data	Facial and iris scan
Work group data	Password and fingerprint
Home and workplace data	Password or fingerprint

## 5.2.4 Authorization procedure

personnel will be asked for authorization When accessing critical data.

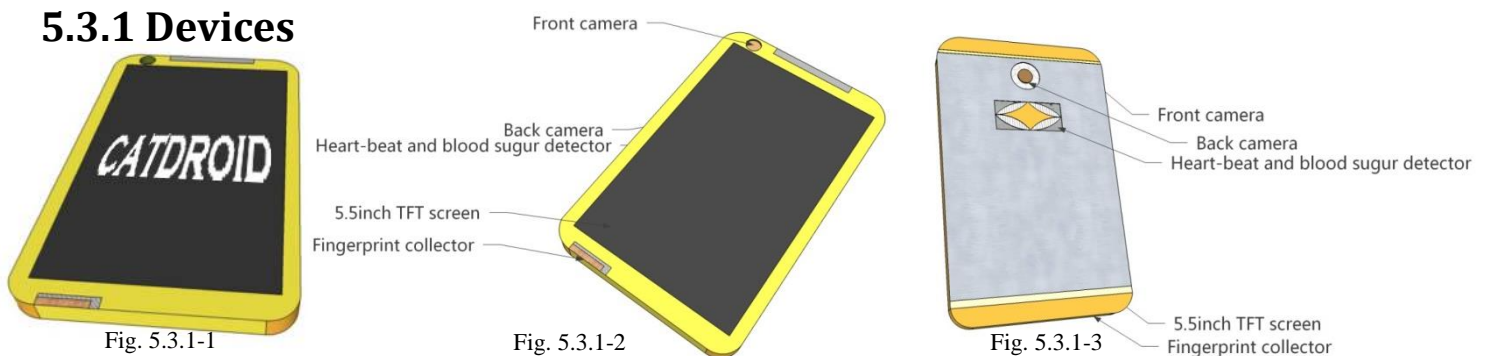
Divided by several ways to ensure data security, authorization procedures are achieved with fingerprint examination, facial and iris scan and password check.

In consideration of work and living convenience, residents would only be arraigned to swap their hands through the fingerprint collector on their phones to activate the fingerprint authorization process. However, stationary fingerprint collector is provided in case of absence of Catdroid smart device.

The facial and iris scan are for higher security demand.

## 5.3 Automation system for daily life

### 5.3.1 Devices



Between an area and another, there are some tracks for transportation. The transportations for people are convenient and like subways that they could go to wherever they want. As for cargo handling, we have conveyer belts, robots and trucks that are specifically designed. The details are mentioned in 3.2.7 and 3.3

#### 5.3.1.1 Catdroid

Shown as above, Catdroid is a mobile device that fulfills the task of communication, monitoring health state, ensuring community and owner's safety. Brand new device will be preinstalled of several system app-----Smart Columbiat: Clat Health, Clat safe, Clat thread, Clat map.

Introduction of Smart Columbiat apps preinstalled: Clat Health: Four major function: Measure heart-beat, measure blood sugar, measure blood pressure and present health suggestion based on parameters measured. Health suggestion provided include running to lose weight and relief blood overpressure, sporting to improve heart function, and eating or injecting insulin to maintain a stable

blood sugar level.

Clat safe: Quick way to call police for help, to provide information about criminal and to call for medical assistance. Also will alert owner the information about upcoming potential disaster based on position service and information offered by security server.

Clat thread: Discussing in workshop or in home place. Clat thread can deliver text, sound and video with no delay. And it also support group Face to face chat and real-time group voice chat.

Clat map: Offer convenience information based on position service. Places like workplace, shopping mall, convenient shop, hospital, gym, and even toilet.

### 5.3.1.2 Smart watch

Everyone who landed on Columbiat will be allotted a Smart watch for the purpose of immigration control, safety inspection facility, and also provide great convenience to resident's daily life.

As for the function of immigration control, Smart watch use position service based on wireless network to collect position data of everyone on the space settlement. In case of criminal and emergency event the position data will be used as great help to work.

Health function of smart watch conclude body temperature measurement, blood-sugar measurement, blood pressure measurement and heart beat measurement.

Smart watch can offer a real-time health report and state inspection of its owner.

Something when faced with parameter abnormal such as a low blood-sugar or amnesia, notification will popped up on screen to alert the owner about. Also when the owner faces with harsh failure in heart of violent bleeding, Smart watch will super quickly inform the security center on space settlement to send medical service ahead.

To provide convenience function, Smart watch is equipped with camera microphone and speaker, through which real-time voice and video chat are achieved. Smart watch is a handy tool for setting reminder for coming events and be carried all the time with its owner.

Also see 5.2.4 for the feature in authorization procedure.

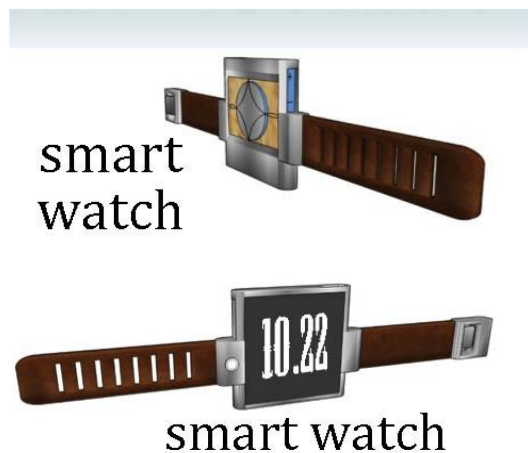


Fig. 5.3.1-4

## 5.3.2 Robots

Table 5.3.2-1

Omnipotent kinds	Using
Omnipotent-Co (Cooking) ◦	Provide food◦
Omnipotent-Tr (transportation) ◦	Transport goods◦
Omnipotent-Re (repair) ◦	Daily maintain and urgency reparation of the space station◦
Omnipotent-Po (police) ◦	Routine patrol and assistant of the police◦
Omnipotent-Ma (manager) ◦	Management clean and reparation of private family◦
Omnipotent-Se (secretary) ◦	Help personnel work, and they are resident in the office◦
Omnipotent-Ag (agriculture) ◦	Agricultural work◦
Omnipotent-Cl (cleaning) ◦	Cleaning work of the station◦
Omnipotent-Nu (nurse) ◦	Care, first aid and medical assistance work◦

### 5.3.2.1 Omnipotent robot (Multifunctional System)

ORs are modular structure robots. Specialized machinery and memory were packaged in separate memory modules and connected to the database of Prometheus, with some of the interfaces connected to the outside which are responsible for the exchange of information and energy supply. In the sensory module, sensory systems and sensory processor is packaged in a sensory module as an entity, to process outside information. Expand this module structure; we can see the foundation of our Multifunctional System.

The robot uses professional and specialized knowledge of Superior Memory as working memory, along with the knowledge base, the program memory using special tools, special senses, senses processor and the main central processor which are all packaged as a separate module. This enables a high-level thinking, work experience and knowledge to control the robot's judgment and actions. The judgments made by the robot brain are superior to those made by the body.

Different brain storage is associated with different expertise, such as cleaning, handling or maintenance. (If a brain contains garbage discerning knowledge, the a body mounted with the brain would become a cleaning robot) Depending on the "brains", the combinations basically are: cleaning robots, handling robots, service robots, assembly (construction) robots, fire-fighting robot, agriculture robots, robot inspections and nursing robots. The types are shown on their electronic screen in the front of the robot. When the robot comes back to the control center, its type can be changed by replacing their "brain" in accordance with mission requirements

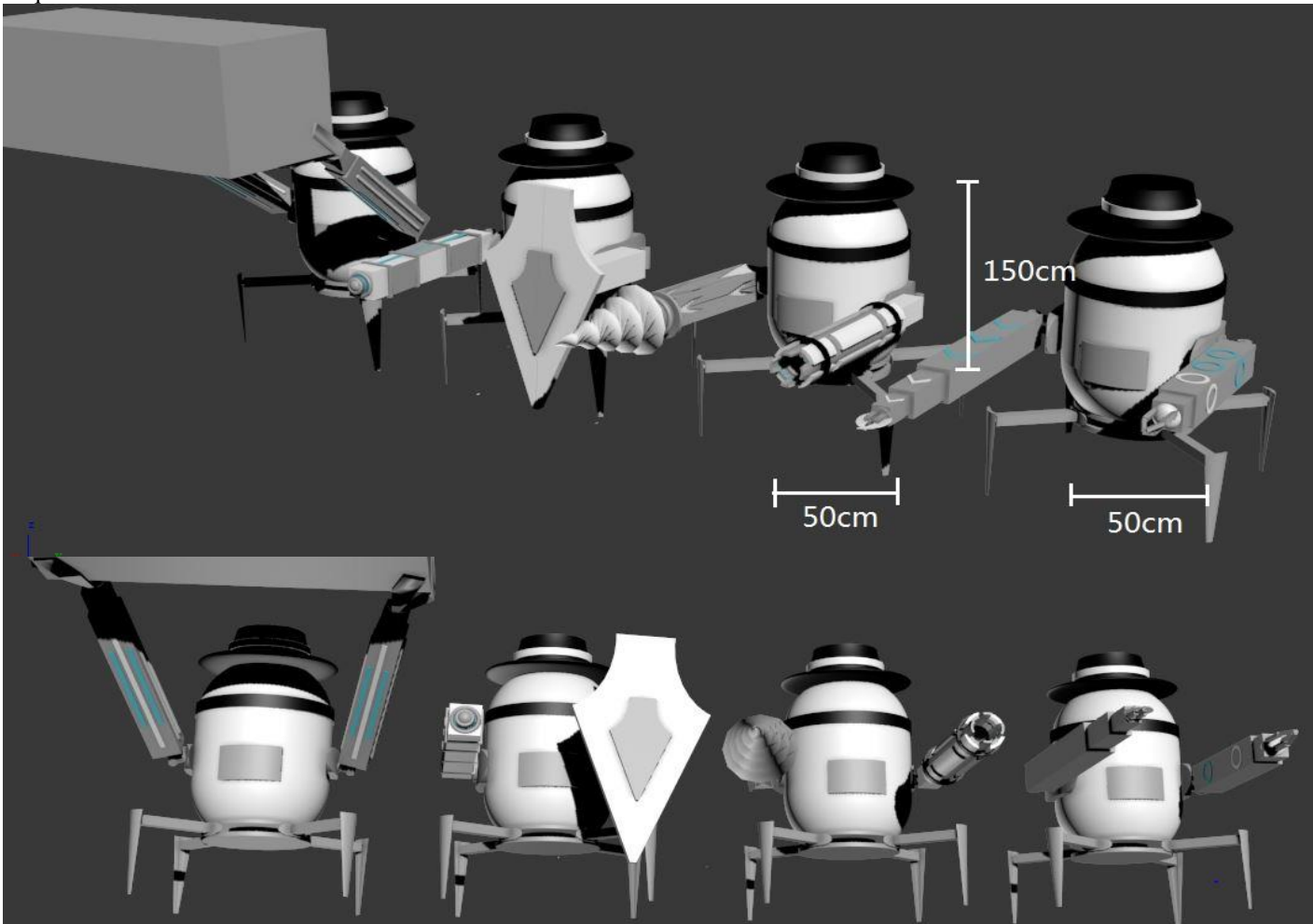


Fig. 5.3.2-1

### 5.3.2.2 Bandwidth management

Table 5.3.2-1

Computer	Bandwidth	CPU speed		Storage
Home	1Gb/s <sup>o</sup>	5GHz×8Cores <sup>o</sup>	15Tb~50Tb* <sup>o</sup>	16000 <sup>o</sup>
Office	1Gb/s <sup>o</sup>	3.5GHz×16Cores <sup>o</sup>	50Tb~175Tb* <sup>o</sup>	20000 <sup>o</sup>
Public	0.5Gb/s <sup>o</sup>	3.5GHz×8Cores <sup>o</sup>	50Tb <sup>o</sup>	10000 <sup>o</sup>
Central	1800Gb/s <sup>o</sup>	3.5GHz×16Cores×32CPU <sup>o</sup>	2500Tb <sup>o</sup>	5 <sup>o</sup>

## 5.4 Cargo ship management

Given that Columbiat is the largest business spot and transportation spot in space, Columbiat have the most powerful system of cargo ship parking and cargo management. The Cargo ship management system contains the park site, accommodate part and freight transport part. The system contains cargo transport facilities and storage facilities.

### 5.4.1 Cargo areas

Since the transport areas are zero gravity zones, cargo storage areas are distributed in 3-d dimensions all over transport volumes in the top of main volumes.

## 5.4.2 Cargo transport facilities



Fig 5.4.2-1



Fig 5.4.2-2

Cargo will go through conveyor belt from cargo ships to space settlement's storage. After a cargo ship enter parking sites, expandable mechanic arm reach the transport areas of the cargo ship. The conveyor belts go into the cargo ship automatically and convey the cargos into space settlement.

The conveyor belts are specially designed for insulated transit, because the cargo ship maybe contaminated by outside atmosphere of space environment.

The conveyor belts use magnetic field force to pull the cargos on them. The entire cargo container is specially designed for zero gravity transport. Electric conductors which were affected by electric field force are anchored on the bottom of containers. Containers move with the movement of conveyor belt to their defined destination. When they arrive at the destination, the magnetic field disappeared, they will be dropped down.

## 5.5 Repair facility



Fig 5.5.1-1

For cleaning away the dust, there will be a cleaning room inside the port. If a spaceship or a robot is going to enter the space settlement, they will be sent into the cleaning room first. After cleaning, they will be allowed to enter the settlement, and stop in the storage inside.

### 5.5.1 Cleaning

The cleaning room contains a strong electricity field starter. When the object comes into cleaning room, it will be locked on the orbit in the tube which placed the starter in it. While the object moved to cleaning part, the object stops, and the starter switches on, the electricity field will absorb the dust to the counter electrodes. And the object will continue to move.

### 5.5.2 Maintenance

After cleaning, the spaceship or the robot will be transported into the settlement which has gravity and atmosphere. After the passengers get off of the spaceship, the spaceship will be sent to the storage for maintenance by the maintenance robot there. And the robot will be repaired by other robots before they back to work either.

### 5.5.3 Dealing with the dust

We will change the counter electrodes every 3 months. The waste counter electrodes will be discarded with other rubbish.



# 6.1 Schedule

Table 6.1-1

Phase	Time taking from 20- to 20-															Completion Date
	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	
<b>Preparation</b>																
Hiring workers																49/Jul.
Transport material																52/Apr.
External structure																56/Feb.
<b>Internal structure</b>																
Residential area																63/Aug.
Day/night system																63/Aug.
Agricultural area																63/Aug.
Forestry area																58/Oct.
Transportation																56/Aug.
Atmosphere																52/Jul.
Adjusting																63/Aug.
<b>Automation</b>																
robots system																50/Jun.
Omnipotent																51/Aug.
Making of factory																55/Jan.
Space elevator																60/Aug.

Details:

## 1. Residential area

Table 6.1-2

Year	Schedule
2048	Prepare to start & Start to lay the foundations
2050	Basically finish road building and start to work on tubes
2052	Completely finish road building and tube works start building residential buildings, entertain facilities and hospital
2053	Building sports facilities, café and bars& Finish building hospital and start to plan for rivers
2055	Finish residential building and laying riverbed, clean the architectural trash, start to store materials
2058	Start community test runs, check problems, transport human needs
2062	Finish test runs, employees move to settlement, check for living
2063	Totally done, residents move to settlement

## 2. Automation

Table 6.1-3

Date	Schedule
May.15/2049	Begin the research and development of Omnipotent and its optional parts
Oct.15/2050	Start the adaptation of proposed convenience facilities to space environment
Dec.20/2051	Finish designing work and start manufacture of Omnipotent
Nov.1/2055	Manufacture work of both facilities and Omnipotent has finished

## 3. Space Elevator

Table 6.1-4

Date	Schedule
2058/Mar. – 2058/Sep.	Produce the need unit materials
2058/Oct. – 2059/Mar.	Assemble all the materials and build the main shaft of space elevator
2059/Apr. – 2059/Jun.	Produce the cabin and the electromagnetic accelerated device
2059/Jun. – 2060/May.	Assemble the cabin and adjust the whole magnetic levitation to test its security
2060/Jun. – 2060Aug.	Final check and test run

## 6.2 Cost

Table.6.2-1

Cost			
Steps	Amount	Cost(\$)/Unit	Total Cost
Material			
Carbon nanotube	2,500t	\$4,000,000	\$10,000,000,000
Silicon (glass and Silicone plastics)	670t	\$80,000	\$53,600,000
Rubber	50t	\$10,000	\$500,000
CFRP	2,300t	\$400,000	\$920,000,000
Plastic	350t	\$20,000	\$7,000,000
Metal	3,000t	\$10,000	\$30,000,000
Wood	35t	\$300	\$10,500
Paint	4t	\$2,000,000	\$8,000,000
Stone	2.5t	\$20,000	\$50,000
Glass	650t	\$160,000	\$104,000,000
Concrete	780t	\$1,000	\$780,000
TOTAL			\$11,123,940,500
Construction of Hull Components			
Construction of Principal Axis	1	\$20,000,000,000	\$20,000,000,000
Construction of Connection Cabin	6	\$50,000,000	\$300,000,000
Construction of Ports for Cargo Transport	4	\$3,000,000,000	\$12,000,000,000
Construction of Ports for People	1	\$8,000,000,000	\$8,000,000,000
Construction of Body Area	1	\$60,000,000,000	\$60,000,000,000
Construction of Space Elevator	1	\$40,000,000,000	\$40,000,000,000
Installation of Solar Panels	-	-	\$1,600,000,000
Construction of Propulsion Cabin	108	\$100,000,000	\$10,800,000,000
TOTAL			\$152,700,000,000
Phase 1 Costing			
Steps	Quantity	Cost(\$)/Unit	Total Cost
Internal Construction			
Transportation System	-	\$9,000,000,000	\$9,000,000,000
Production of Robots and Devices	-	\$7,000,000,000	\$7,000,000,000
Construction of Zones	9	\$5,000,000,000	\$45,000,000,000
Construction of Energy Supply System	-	\$8,000,000,000	\$8,000,000,000
Construction of other facilities	-	\$40,000,000,000	\$40,000,000,000
TOTAL			\$109,000,000,000
Other Costs			
Initial Designing	-	\$50,000,000	\$50,000,000
Final Testing	-	\$25,000,000	\$25,000,000
TOTAL			\$75,000,000
TOTAL COST		\$272,898,940,500	

# 7.0 business development

Our design in this part is perfect to show the functions and duty of Columbiat, a business and banking center in space, and a step to expand the space business.

## 7.1.1 Transportation Node and Port

Between an area and another, there are some tracks for transportation. The transportations for people are convenient and like subways that they could go to wherever they want. As for cargo handling, we have conveyer belts, robots and trucks that are specifically designed.

The details are mentioned in 3.2.7 and 3.3

## 7.1.2 Terminal facilities

We have enough landing areas to hold different types of spacecraft, convenient passageways which are prepared for the “VIP” and emergency situations. People could have a short rest during the journey in the area. Information and travelling advices are on the “Information Board”, advertising area is also set up in order to take some advertising fee. Moreover, shops and hotels are constructed surround the terminal station, which will surely bring a enormous business value. Walking down the green arrow and there will be other areas.

## 7.1.3 Activities for visitors and crews

### 7.1.3.1 Visit the moon

Taking one of the most incredible things in the world, the space elevator to the lunar surface, visitors are able to see the natural view of the outer space during the journey. We plan a special exhibition for visitors showing what kinds of mineral resources we gain form the moon and what types of automations and technologies we use throughout the whole course. Visitors will also get a chance to go for a stroll on the lunar surface. Our tour guides will keep you away from hazardous things and go after you all the time and give explanations which may help you make out all the things.

### 7.1.3.2 Sports in low or zero gravity conditions and its commercial value

Doing series of amazing actions that couldn't in the normal gravity condition makes the sports in space more attractive. Participants could keep fit during the interesting process of playing these sports.

Here are some of the sports we plan to have:

Table7.1.3-1

Name and value of gravity	Differences between these sports on earth	Where participants play	Special equipments
Low gravity basketball(0.5g)	People could jump higher and do more unusual actions	The basketball court in the low gravity gym	Specifically designed shoes that can offer a big friction.
Golf(0 gravity)	Shot balls to the boundless outer space, the route will be calculated.	Somewhere in the port.	The space suit we designed in 4.3.
Free sparring (0.2g)	Defeat opponent, use incredible actions.	The boxing court in the low gravity gym.	Nothing.
Yoga(0 gravity)	Complete actions in the air.	Anywhere safe in 0 gravity condition	Nothing.

Besides, we plan to hold “The Space Olympic Games”. There's no denying that it will really attract the public attention on the space settlement business, and will surely bring a booming future to the space business. It's a good chance for the Foundation Society to expand its scale.

### 7.1.3.3 Experience recreational facilities

People from earth can have a chance to experience recreational facilities in the space. Such as the “0 gravity stroll machine”, “0 gravity roller coaster” and other special facilities. On the other hand, there are many parks for them to have a rest.

### 7.1.3.4 The amusement parks, restaurants, shopping malls and movie theaters

Visitors could easily go to those places in the commerce center to have a rest, far away from the confine of the ships and enjoy

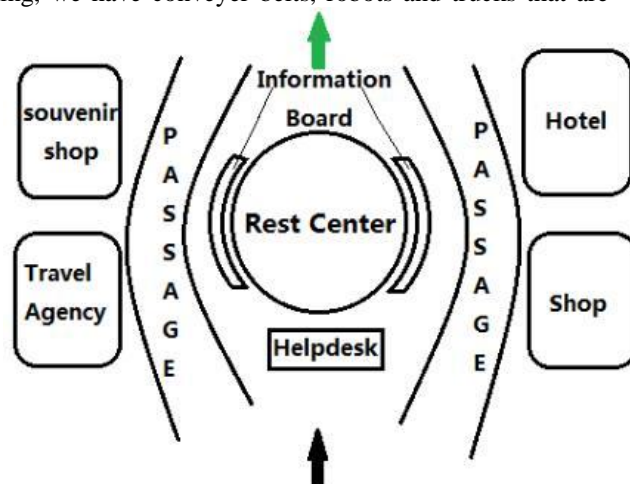


Fig.7.1.2-1

themselves.

#### 7.1.4 The function of transit

When the Foundation Society initiates operations of settlements near and on Mars, numbers of visitors in transit may temporarily reach 5000. We have a strong power to hold such a great number of visitors and offer them a interesting and comfortable life in space. They can eat every restaurant they want to and live in each hotel they prefer to. Besides, the activities we prepare are available to them.

##### 7.2.1 Office facilities

Since interest has been expressed by many companies, and it has a increasing trend of need, the list of companies which meet the requirement must be strictly controlled, because it is a good opportunity not only to balance the paying and income, but to have something prepared for the future. We would hold a bidding meeting in order to check all the companies' reputation and the state of operation. Choose some of the companies which have a large scale currently or have the potential to be succeed, offer them offices for free or in a low price, in order to enter into long-term strategic cooperation with them, and may even make acquisitions at last. These companies would provide important technologies or data for the Foundation Society's development and constructing facilities in the nearly future. As for the rest of the offices, we would sell them by auction for the purpose of cost reducing and profit taking.

##### 7.2.2 Banks

There are three banks to provide financial services for space-based companies, space settlement residents, and ships' crews; all of them must obey the reasonable rules laid down by the Foundation Society.

###### 7.2.2.1The space-based companies' banks

These banks are mainly located near the companies' offices in the commerce center. They mainly help companies solve the capital problems during the process of operation. Because the amount of money involved are always in large sums , so they use accounts and cards to pay or receive, it really needs a secure network environment, and the computing center do help that a lot.

###### 7.2.2.2The banks for residents

These banks are very similar to banks on earth. People use them to save money, manage money and do various of services just like what they do on earth.

###### 7.2.2.3The banks for the ships' crews

The ship's crews could exchange and withdraw money from those banks, if they take no use of the money they carry with themselves, they could choose the short-term financial products, which will help them earn some interest.

##### 7.2.3 Facilities For headquarters

Offices are constructed to be in different sizes, a big report hall is also equipped that could hold 400 people at the same time. Besides, we will set up a control center which has many computing and supervisory facilities to help staffs to monitor and manage the Columbiat and get information about the settlement and the others that belong to the Foundation Society. Also, it could help them analyze problems by calculating. In addition, we will have several meeting rooms to provide services to the members and guests. Cleaners will do the cleaning work regularly and the cooks will cook delicious meal for them so that they could focus on their works.

##### 7.2.4 Internal Communications

We set up a computing center to secure the internal communications between companies. It could also provide several kinds of services to the Foundation Society and bank if they have requirements. It checks the internet regularly and find out the leaks and repair them.

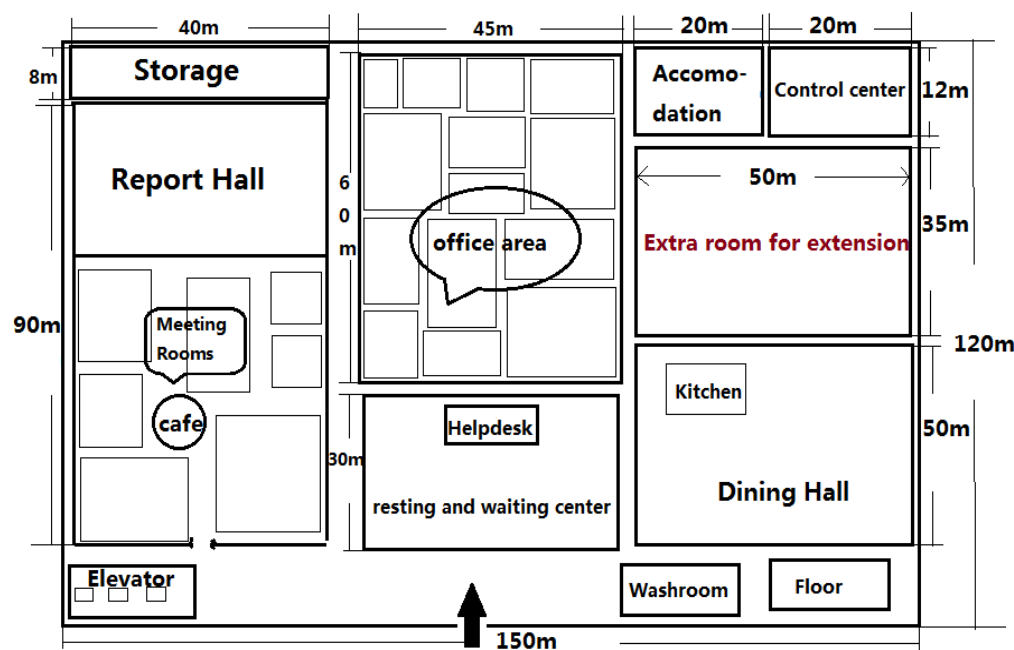


Fig.7.2.3-1



# 8.0 Appendices

## A. Operational Scenario

Mr. Black is a worldwide scientist who has made a great contribution in cosmic aerodynamics. He was invited to live in the space station.

Before the ship took off, Mr. Black stood outside of the space ship, raising his head and look up to the brightest “star” in the sky----Columbiat .

On the way to the Columbiat, Mr. Black intently gazed at it coming closer and closer, he thought the space station would be magnificent, but things is not his imagination. The Columbiat is tubby and many escape compartment surround the “bucket”. Mr. Black didn’t understand until he entered into the station.

When he got off the space ship, he was amazed at what he saw. Inside of the Columbiat is complex, and the partition of it is really clear. A huge axis connects with various zone, such as industry zone, agriculture zone, residence zone and so on. Mr. Block couldn’t believe his eyes, he got in the auto-car and car sent him to the registry office. There, he got an identity, a smart watch and a catdroid. Then, the smart watch led him to his new house. Mr. Block arrived the space elevator, the elevator moved fast, a few moments later, he reached residence zone. An automatic car waited for him in front of the elevator, and it stretched out a flat board. Mr. Black put his hand which worn the smart watch on the board. Later a green light turned on, the car opened the door and Mr. Black get into it and soon ,he got his new house. His house is a beautiful villa with forest behind it. He opened the door by using his smart watch. In the house, some robots were cleaning the floor. Mr. Black was really hungry , at this time, he was taken aback by a voice “What can I do for you, sir?” Mr. Black answered:”I’m hungry, I want something to eat.”Before the sound of his voice had died away, a robot grasped a sandwich and put it into Mr. Black’s hand. After he finished eating, he decided to accustom ambient things. He visit every zone, exclaim in great surprise for its high-tech all without exception. He found that Columbia is a compositive and comprehensive station, everything of it is absolutely necessary. After the sun went down, Mr. Black came back to his house with his completely exhausted body and go to his sweet dream.

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## C. Compliance Matrix

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3.1 Identifying material and construction process, and the transportation of the equipment and material.	11
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## D. Chart

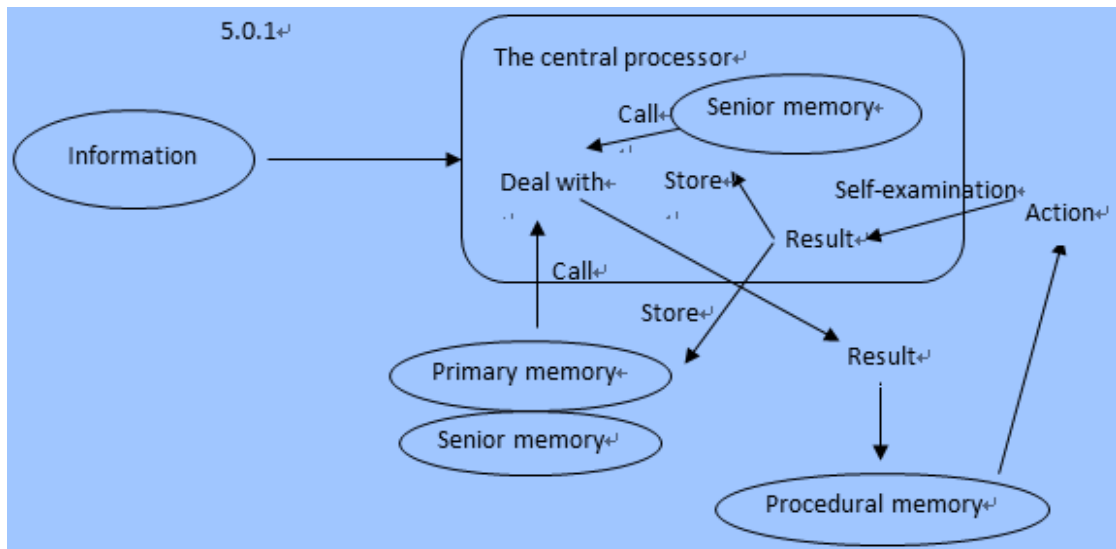


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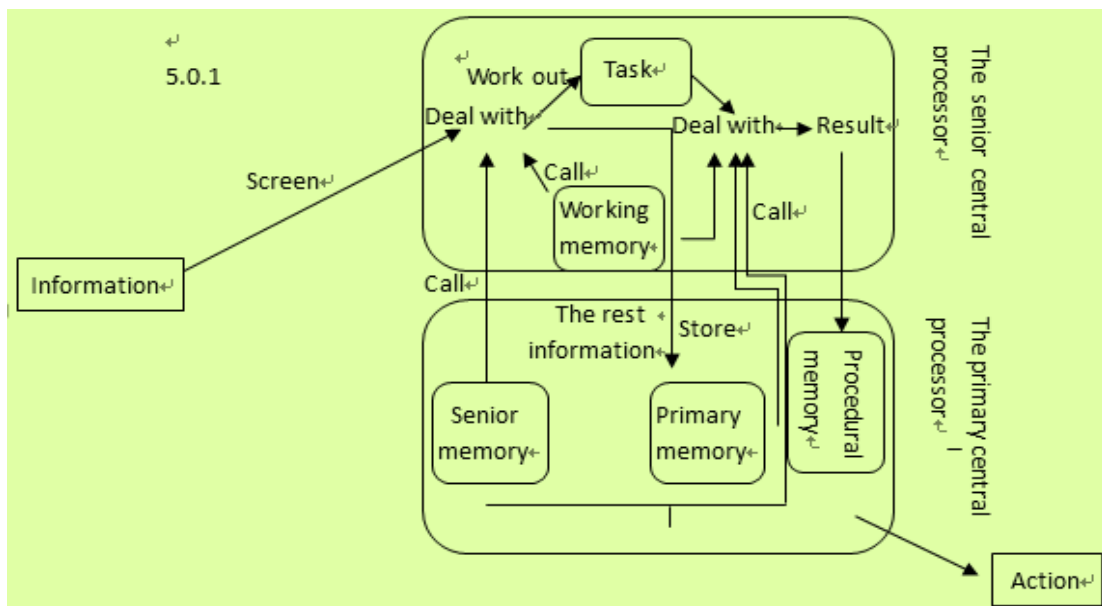


Fig.5.0.1-2

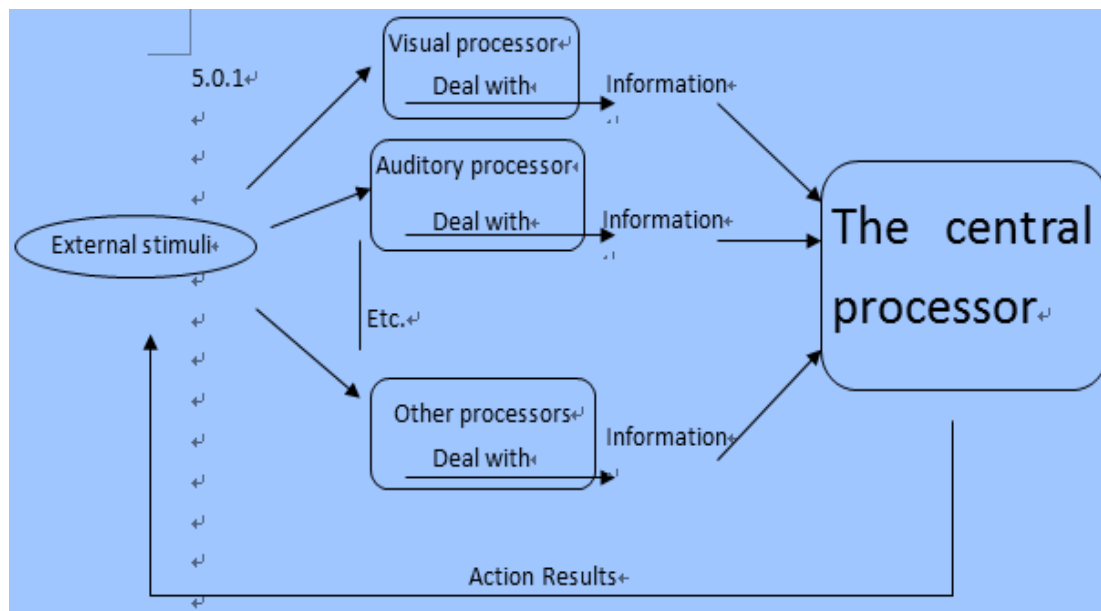


Fig.5.0.1-3

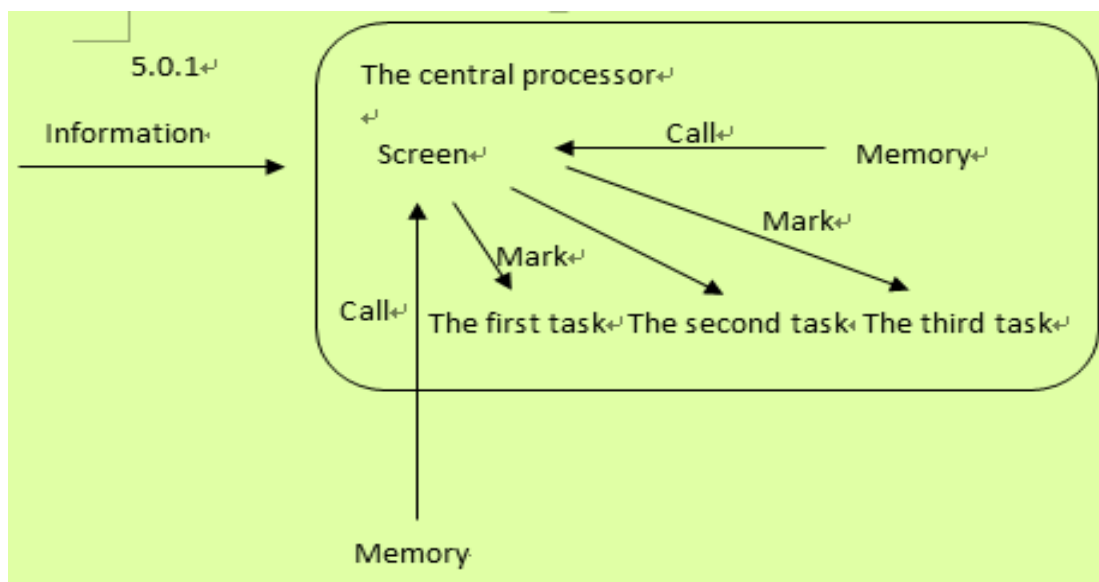


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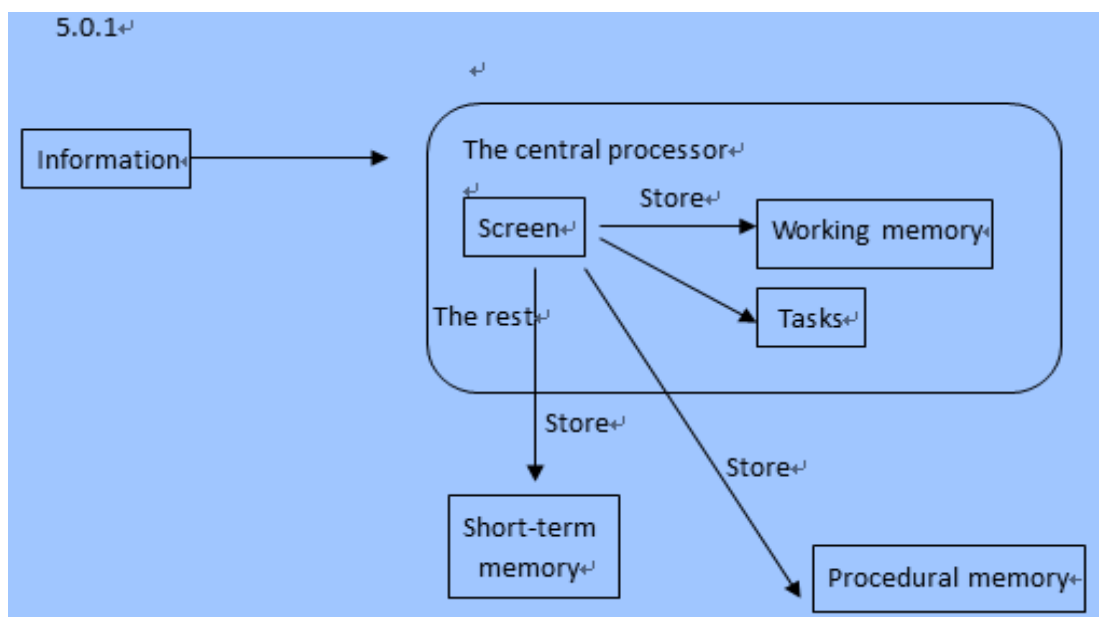


Fig.5.0.1-5