Sophons:
Haochuan Wang, Yichen Wang, Jiaying Zhou, Bingan Chen, Runxin Yan, Yifei Li, Chuqiao Chen, Ziqian Zhao, Jiarui Wu, Chi Sun, Qiyao Wang, Boyan Zhang

1.0 Executive Summary

It is honorable for our company to present the proposal of “LX-2” Space Settlement, a well-organized, detailed, clear, and practical space settlement design, to the Foundation Society. We have converted the very details of the request into a clear illustration of the variety of techniques we utilized.

The design proposal will be divided into four parts in order to be more comprehensive: Structure and Material, Operation and Infrastructure, Human Factor, Cost and Schedule.

The top priority of our Structural Design is to provide a stable and safe settlement for thousands of human beings living in a long term, and “LX-2” space settlement will be the pioneer in the field of space ore extraction. Details in our design accomplish this goal. For instances: the emergency Aigis-shelled-refuges are scattered all around the settlement; plenty of airlocks is installed to minimize the loss at an accident; special lights installed around the ports to make sure that cargo ships can operate normally in condition that lacks light. Moreover, the industrial area in the settlement is separated from others, to maximum the security leverage, and the industrial area will support the construction needs for “LX-2”, furthermore it will constantly extract various minerals from asteroids near the orbital. The modular robot “Cube” and the several sub-robots will work in a large range in the settlement from internal transformation to external construction.

Our Operation and Infrastructure design has satisfied the basic and comfortable surrounding for machines to work efficiently and people to work and live comfortably in the settlement. The detailed daily sources supply and wastes will be managed in order to maintain the lives of residents. The materials used to construct the settlement will be able to prevent the strong solar radiation. The settlement will maintain at a sun-facing orbit in L4 position, allowing us to design a system which can utilize solar radiation as the main source of energy for humans’ daily needs. In addition, our high speed and large scales of a network will provide safety for every resident's personal data.

In Human Factor part, our company has designed a modern living environment for dwellers in “LX-2”, maximizing the comfort staying inside. Sufficient supplements of food and materials are provided with a variety of choices, while most of which are advanced and economical. Roads and streets are designed for the best appreciation, in addition to several glorious spectacular sightseeing areas. Houses with different sizes are considered to be practical and convenient for all dwellers. There are types of service and emergence robots which will improve the living quality, boost the working efficiency, and protect dwellers’ personal security in emergency situation.

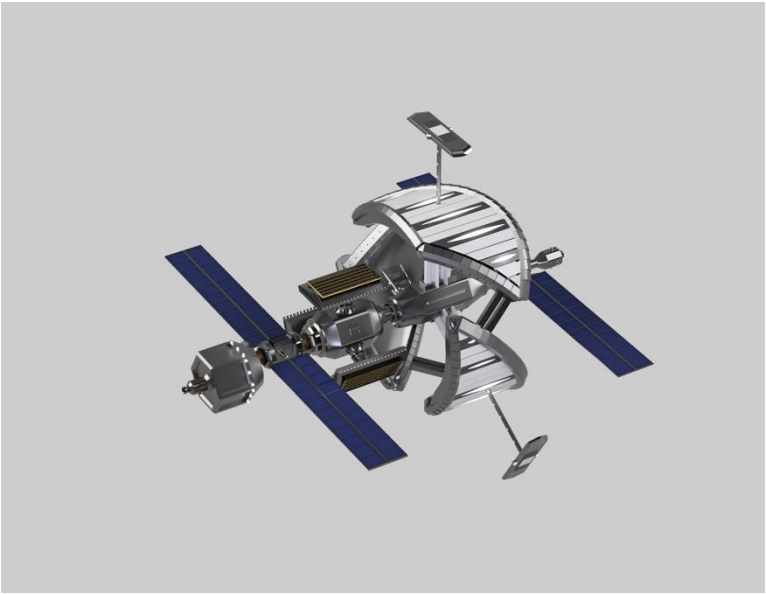
Schedule and Cost part has included the chronological schedule of the construction process of “LX-2”and the cost of construction and operation. We will present the clear construction timing and operation timing for the elementary steps before the occupation of inhabitants. We will also give a detailed, easily-recognized table for the cost of the entire project.

Our company is confident to handle this project, the first large residential usage space settlement on Mercury orbit. We deeply appreciate Foundation Society to give us the chance to present our proposal. Please have a nice tour in this piece of work.

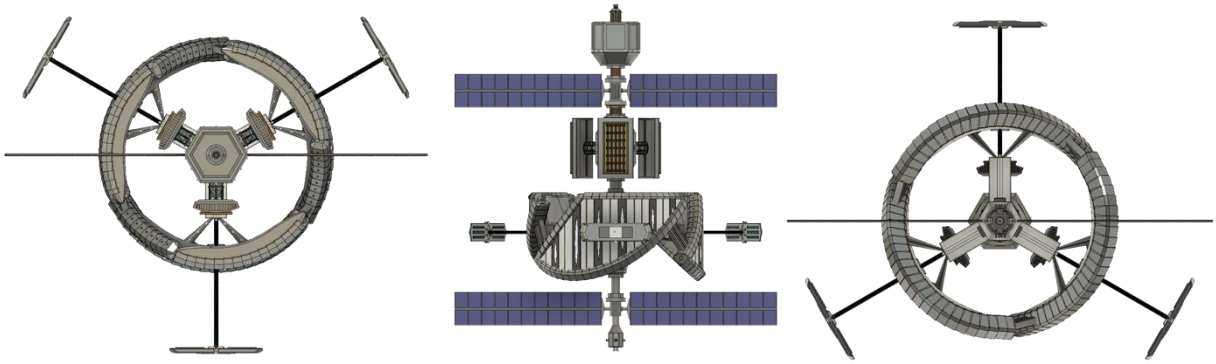

STRUCTURAL
DESIGN

2.1 Exterior Design

2.1.1Structural design



pic.2.1.1-Top right perspective view of LX-2

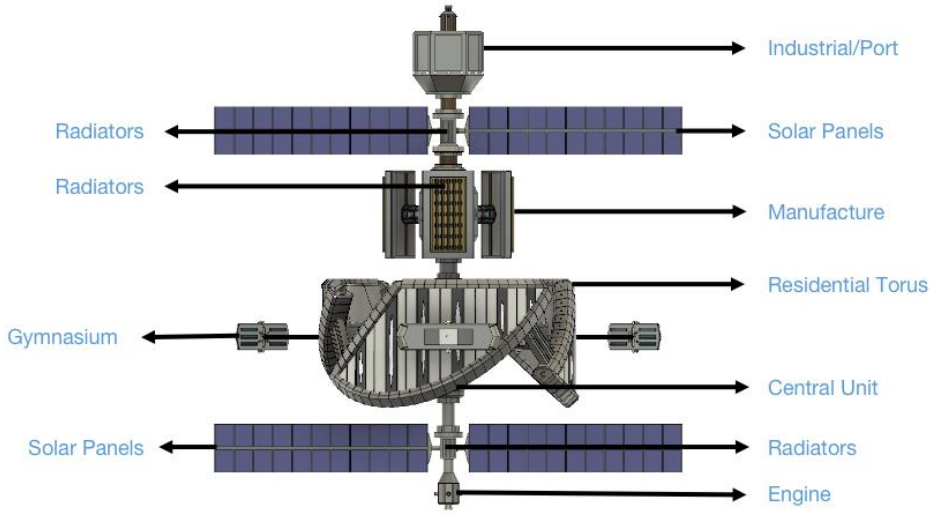


pic.2.1.2-Top, side, and bottom views of LX-2

a. Section division

LX-2 has five main units in total. One is the **residential torus**, which has three sub-units attached to the center unit. The rest four of them are on the central axle: engine unit, manufactural unit, port/industrial unit, and the center unit. In the **engine unit**, the plasma main engine locates at the end; the reactor, battery, and fuel tank locate inside the unit. The **industrial/port unit** is attached near the solar panels which directly provide it electric power, while it contains the heavy industries including ore

smeltery and semi-conductor industries. machineries, and assembly lines for robots and large components. In addition, the port is constructed on the six sides of this unit, allowing space crafts with cargos porting LX-2. Inside it also provides sufficient place for storage. The **manufactural unit** is constructed on the other end of the solar panels, which possesses three sub-units, each containing metal and non-metal manufacturing machines, storage, and maintenance zone for repairing robots. At last, the **central unit** contains the crucial equipment—the electromagnet stabilizer—which maintains the rotating part and the non-rotating part separate with a strong magnetic force (will be explained later). It also functions as a transportation hub between the axle units and the residential circle units. For the rest of the main axle, we use the space efficiently for warehousing.



pic.2.1.3-Section division of LX-2

Attached to the central unit is the **residential torus.** There are three sub-units in this unit, each occupies 1/3 of the torus' total volume. They provide a comfortable living area for Aynah's inhabitants and a farm that allows agriculture and aquaculture.

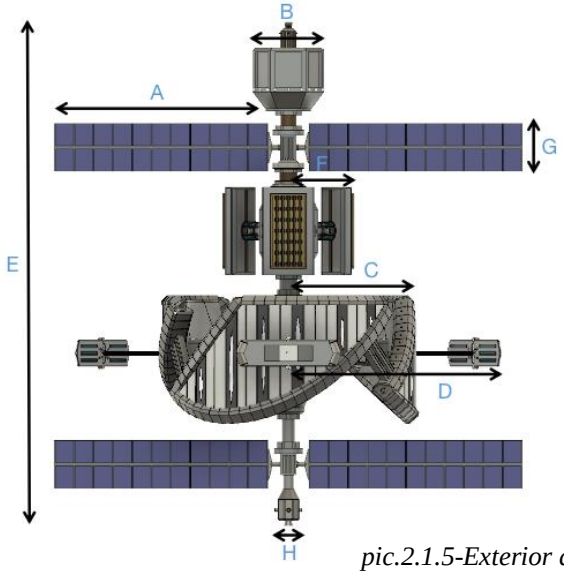
In addition to the main torus, we provide three separate **gymnasium units** attached to each of the main residence, providing 1g gravity for children living and people to exercise. For all of the human inhabited structure, a layer of 20 cm Aigis is appended on the exterior to prevent solar wind radiation and shields are installed to prevent over-radiation from the sun. This part will be further elaborated in 2.2 and Human Factors part.

b. Dimensions

Occupation of main observable volumes:

Unit name	Volume occupied/m^3
Engine unit	2.25x10^4
Industrial/Port unit	9.06x10^4
Manufactural unit	8.04x10^4
Central unit	7.53x10^4
Residential unit(three)	3.81x10^5
Gymnasium	3.00x10^4

pic.2.1.4-Occupation of main observable volumes



A	200m
B	60m
C	115m
D	230m
E	474m
F	38m
G	45m
H	20m

pic.2.1.5-Exterior dimensions

2.1.2 Artificial Gravity

a. Rationale

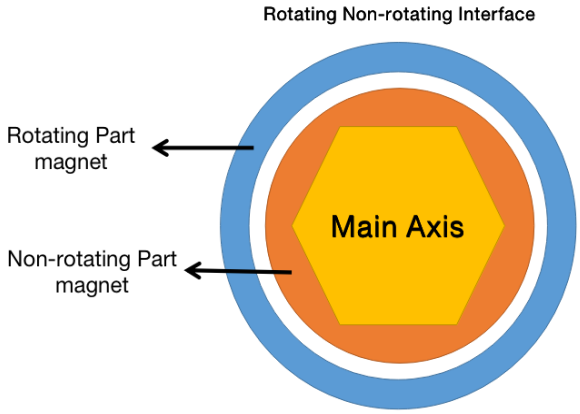
To create 0.5 g of pseudo gravity in the residential torus, 1g of pseudo gravity in the gymnasiums, and 1/6g of pseudo gravity in manufacture unit, LX-2's residential circle will rotate at frequency f. It can be calculated by:

$$f1 = \frac{w}{2\pi} = \frac{\sqrt{\frac{g}{R}}}{2\pi} = \frac{\sqrt{\frac{4.9m/s^2}{115m}}}{2\pi} = \frac{0.206/s^2}{2\pi} = \frac{0.033rev}{sec} = 1.97rpm$$

This frequency is biologically adaptable to the humans living inside LX-2.

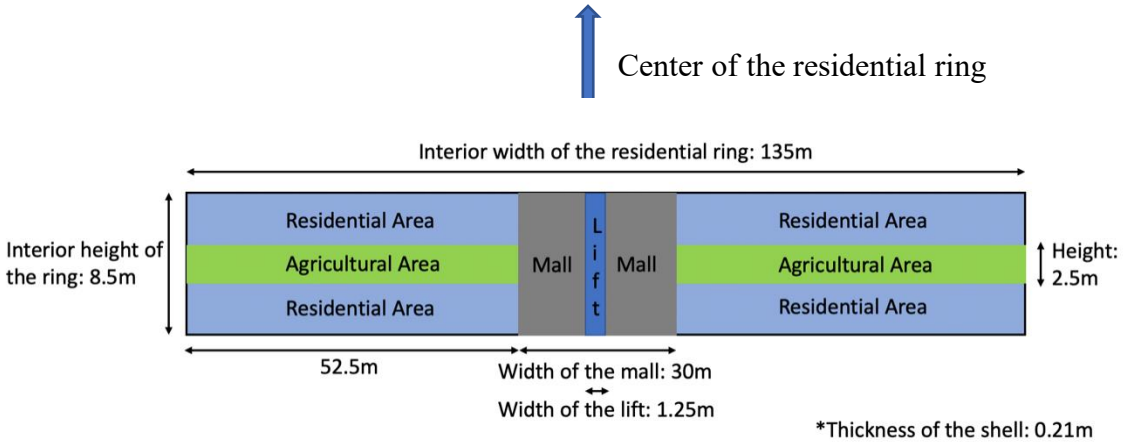
b. Rotating and non-rotating sections

LX-2 can be divided into two main parts: rotating parts (RP) and non-rotating parts (NRP). RP includes the residential torus, the industrial unit, gymnasium, and the central unit. At the interfacing space between RP and NRP, a magnetic stabilizer will maintain the relative position static between RP and NRP within magnetic force. In addition, a large mass will be at the center of mass of RP, keeping the system angular momentum at constant.



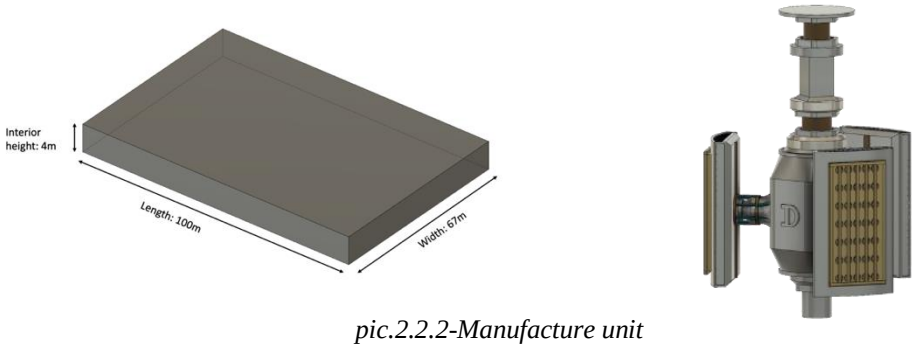
pic.2.1.6-Rotating non-rotating interface mechanism

2.2 Interior Space Distribution Designs



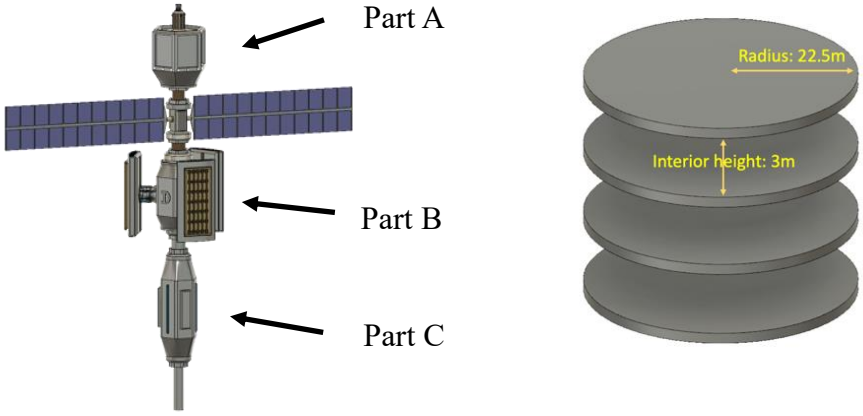
pic.2.2.1-Cross-sectional interior design of residential ring

This is the cross-sectional interior design of the residential ring. There are three main levels in the residential part. The mall divides each part into two main areas. For each area has two residential sectors. Between the two sectors, there is an agricultural area since it promotes air exchange efficiently.



pic.2.2.2-Manufacture unit

There are 3 unit of in-situ material processing as the upper right diagram shows. By rotating, it will provide 1/6 g of artificial gravity. In the upper left diagram, it shows the inner space of one unit for in-situ material processing. Each unit's width is 67m, length is 100m, and height is 4m, which creates 20,100 square meter of space and 80,400 cubic meter of volume in total.

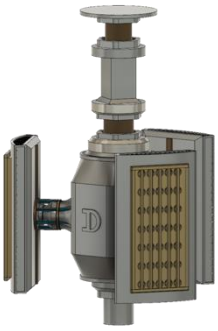


pic.2.2.3-Industrial unit interior design

Graphs above shows the design of area for metal smelting and semiconductor crystal production. There are nineteen levels in total which distributed in three sectors of the main axis (labeled with arrows in the graph, part A has 6 levels, part B has 10 levels, part C has three levels). Inner space of each level is a cylinder with radius of 22.5m and height of 3m. In total, the space is 30,203 square meters, and the volume is 90,609 cubic meters.

2.3 Construction Sequence

1. At the beginning, the industrial part which includes all the material processing parts and ten levels of metal smelting and semiconductor crystal production areas will be constructed on Earth and assembled in L4. In the industrial area, there will be permanent residential area which with the providing of air, food, water, human and bio waste and disposal, solar radiation protection and air filtration.

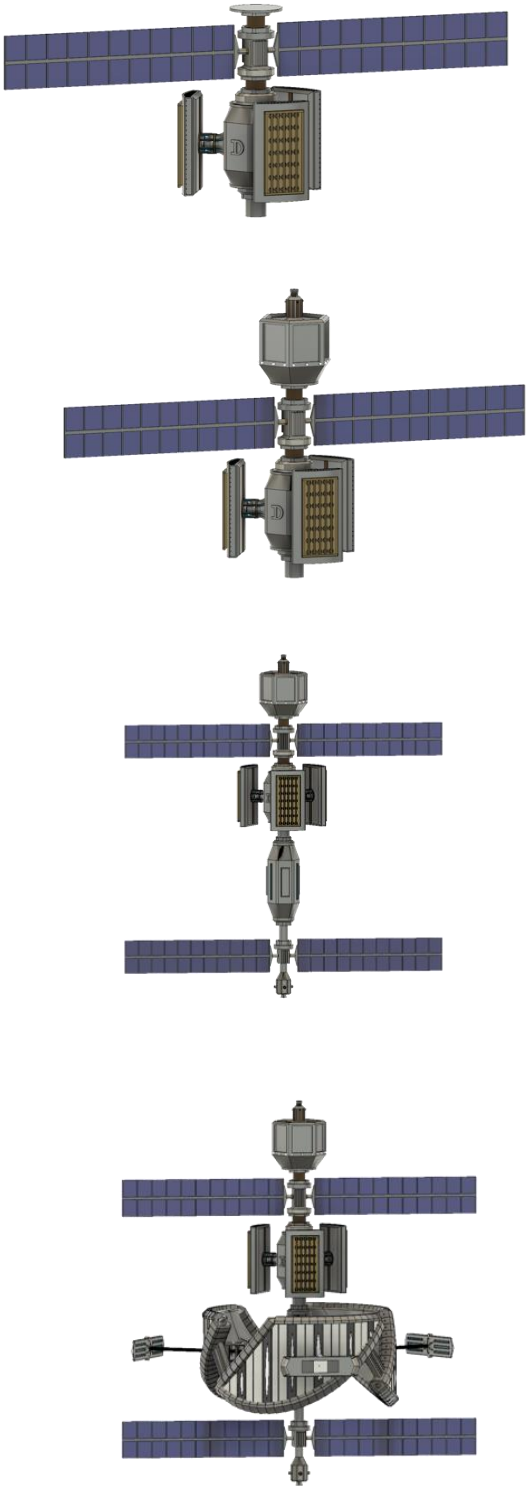


2. After that, solar panels will be constructed by industrial area and assembled to the settlement. By doing so, the settlement gains stable power from the solar panels.

3. Then ports for more convenient transportation and another six levels of metal smelting and semiconductor crystal production areas will be constructed. Also, an engine and thrusters will be built if the position of the settlement need to be fixed.

4. Next, the main rotating axis which connected to the residential ring will be built, include the rest three levels of metal smelting and semiconductor crystal production areas. Then, another pair of solar panels will be constructed in the settlement and assembled on to it. Also, another engine will be built to adjust settlement's position. Up to now, the industrial and power mechanism are already done, it is capable to build the residential ring.

5. At last, three main supporting posts will be connected to the main axis, and residential area will be finished. At the same time, gymnasium will be constructed. The whole settlement is ready to operate.



pic.2.3.1-Construction sequence

2.4 Construction Materials and Equipment

2.4.1 The material needs for the construction of the settlement and other facilities

Section Name	Material Name	Single Shell Area (m^2)	Single Shell Volume (m^3)	Material Density (ton/m^3)	Single Shell Mass (ton)	Number	Total Shell Mass (ton)
Residential	Al-Mg	34662	103.986	1.8	187.1748	3	561.5244
Manufactural	Al-Mg	14736	44.208	1.8	79.5744	3	238.7232
Industrial	Al-Mg	17600	52.8	1.8	95.04	1	95.04
Gymnasium	Al-Mg	16400	49.2	1.8	88.56	1	88.56
Engine	Ti-Al	3178	9.534	4.54	43.28436	1	43.28436
Central Axle	Al-Mg	16930	50.79	1.8	91.422	1	91.422
Support Frames	Ti-Al	5894	17.682	4.54	80.27628	3	240.82884
Solar Panels	Si	9000	27	2.3	62.1	4	248.4

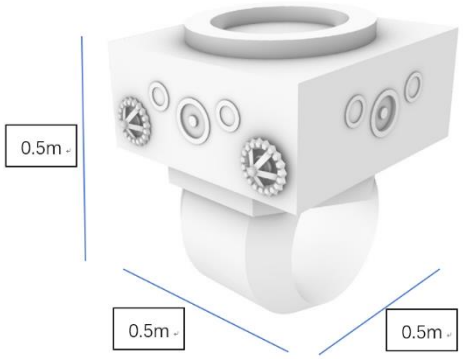
pic.2.4.1-Exterior construction material matrix

The total exterior construction material needed of LX-2:
Aluminum-Magnesium Alloy: 1074.2 tons
Titanium-Aluminum Alloy: 284.1 tons
Silicon: 248.4 tons

2.4.2 Automation equipment for the construction

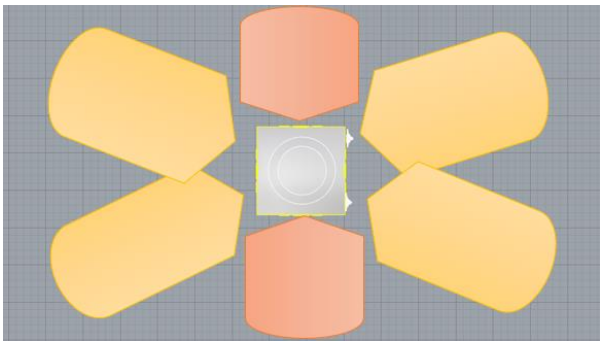
Automation plays an important role in the settlement. The construction of the entire settlement will be fully complete by robot and other automated constructional equipment. The construction equipment will be separated into to two major categories. The first category will be modular designed multi-functional-robots. Most of the robots will be manufactured on the fundamental block.

2.4.2.1 The fundamental block---Cube



pic.2.4.2-Cube

The outline design of the fundamental block--Cube is originally inspired by the construction block of Lego. This block will serve as the base for other multi-tasks robots. The top of the Cube is available to connect with multiple robotic arm. Each single block has a height-width-length all 0.5 meters size. The weight of Cube is 60kg. And the material for the Cube's outside structure is Aluminum-alloy The size of the cube makes it easier to move around in shallow space.



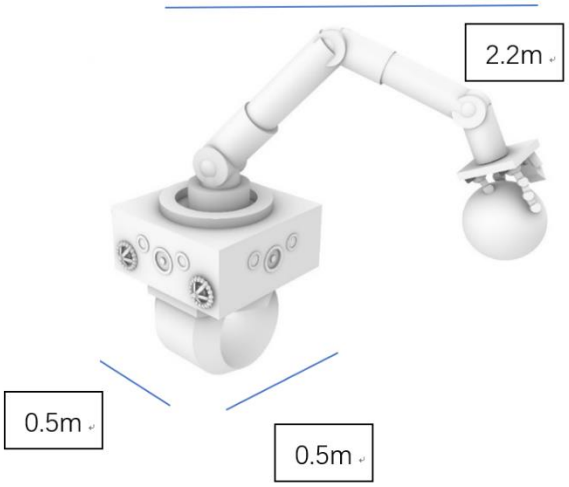
pic.2.4.3-Sensors

Rear, side and forward-facing cameras provide 360-degree field of view. Forward-facing radar provides a 200meter view of distant objects. It has 6 ultrasonic sensors which detect nearby objects, prevents potential collisions and assists with parking.

The power of the robot come from the battery box inside of the robot. The maximum battery storage is 40kwh, which supports Cube to travel in a maximum range of 100km. Such high capacity of the battery prolonged working hours to 72hours on a single charge.

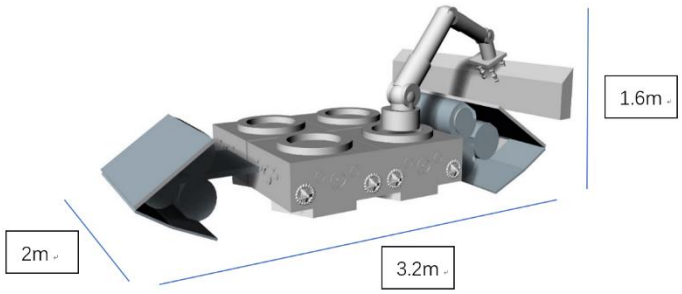
The receiver will support the function of receiving orders from people or control station to perform in correlation tasks.

2.4.2.2 construction robot



pic.2.4.4-CubeX1

The internal construction robot CubeX1 serves assembling, constructing, daily maintaining and repairing job in the settlement. The robotic arm for the CubeX1 has a length of 2.2m and a weight of 10kg. During the time picking up objects or holing heavy things, the Cube's wheel will be fixed and the robot will arrange its weight to keep the Cube balance all the time.

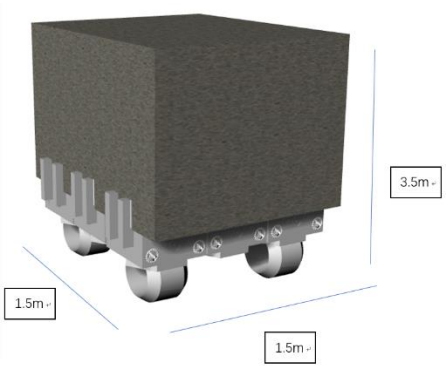


pic.2.4.5-CubeS1

The external construction robot CubeS1 will assist the robotic arm to fulfill the mission of phase1 outside construction of the settlement, and serves as the guide orbiting around the settlement, transporting asteroids, serving the emergency repairing the outside structure of the settlement. The size of the Cube S1 is flexible, the fundamental size is contributed by 4 Cubes and 6 Electronic Thrusters. 6 small size of Thrusters will totally provide 1000KW

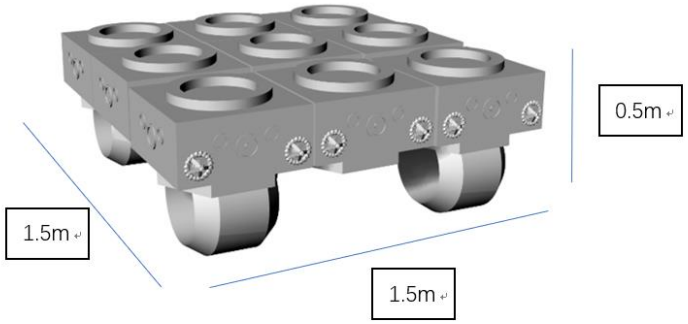
2.4.2.3 multi cube robot

The most outstanding feature of the Cube is that the Cube can be controlled and assembled to multi-amount and shape to fulfill various



pic.2.4.6-Multi cube robot

missions in all conditions. The control center in the Settlement can give orders to the Cube and let them assemble automatically in the assemble room. The automation system will be illustrated in operation section.



pic.2.4.7-Multi cube robot

Platform(3x3) as one of the most common multi-cubes robot serves the transportation system in the inner structure construction phase, and it will take the responsibility to transport cargos (raw minerals or metal materials) to meet daily needs.

2.4.Management of robots in settlement construction

First, we only sent 4 CubeX1 and 566 circuits control boards of Cube to L4 point. The first construction phase is to let 4 robots to expand the settlement and manufact other Cubes. During the second construction phase, 20 cubes will serve as free blocks to transport materials; 4 CubeS1 will transport building material assist 120 CubesX1 to construct the exterior of the settlement. During the third phase Cubes will serve their role to build the entire settlement in the maximum speed. After finish the construction of the settlement, the remain cubes will play the role in daily cargo delivery for dwellers, and other transportation service for industrial area.

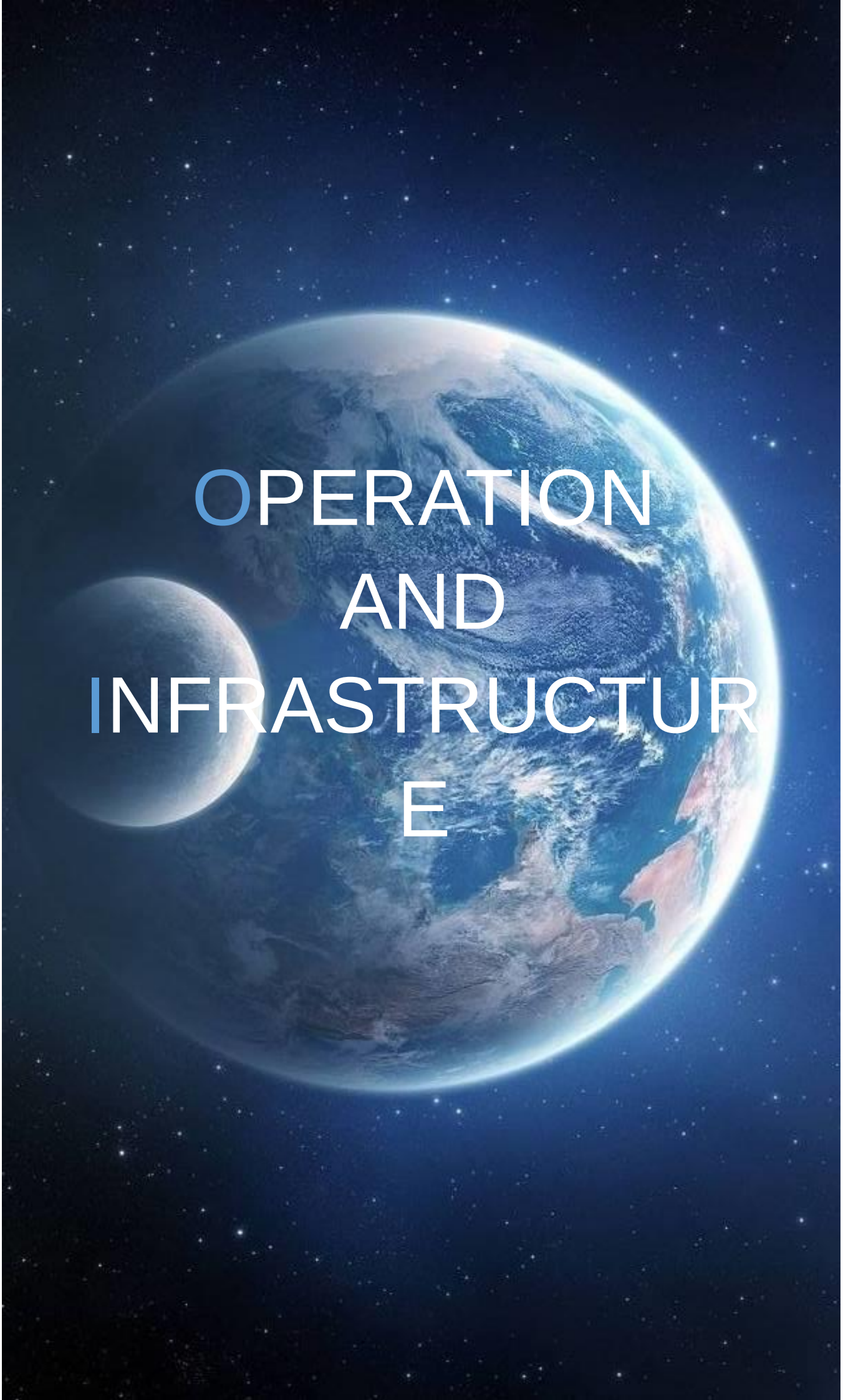
Name	Size(m)	Material	Quantity
Construction Phase 1			
CubeX1	0.5m×0.5m×0.5m 60kg (Robot arm:10kg 2m)	Aluminum-Iron Alloy	4
Cube	0.5m×0.5m×0.5m 60kg	Aluminum-Iron Alloy	20
Construction Phase 2			
CubeX1	0.5m×0.5m×0.5m 60kg (Robot arm:10kg 2m)	Aluminum-Iron Alloy	120
CubeS1	2m×3.2m×1.6m 300kg	Aluminum-Iron Alloy	4
Construction Phase 3			
Cube	0.5m×0.5m×0.5m 60kg	Aluminum-Iron Alloy	40

CubeX1	0.5m×0.5m×0.5m 60kg (Robot arm:10kg 2m)	Aluminum-Iron Alloy	270
CubeS1	2m×3.2m×1.6m 300kg	Aluminum-Iron Alloy	20
Platform	1.5m×1.5m×0.5m	Aluminum-Iron Alloy	20

pic.2.4.8-Robot management matrix

(every cubes' circuit costs 100,000RMB)

Notice: Since most of the robots will be full-automatically constructed by other robots using the material from the space, the total cost of all the robots will be the initial design fee, four robots' construction fee and transportation fee and 570 hundred circuits.


OPERATION
AND
INFRASTRUCTUR
E

3.1 Atmosphere

atmosphere	ratio	volume	density	mass/kg
N2	0.55atm	209,642.4m³	1.25kg/m³	262,053
O2	0.23atm	876,68.64m³	1.331kg/m³	11,686.96
water vapor	0.01atm	3,811.68m³	0.6kg/m³	2,287.01
total		381,168m³		276026.968

pic.3.1.1-Atomosphere composition

The air pressure among the settlement will be 0.8 atm. This kind of pressure is comfortable for human living. Considering the lower pressure than earth, we set the partial pressure on the settlement different with that of Earth. The partial pressure of N2 will be 0.55atm and O2 will be 0.23atm. To make the living area moister for human, there will be 0.01atm of H2O.

From the table, we can figure out that the mass in total will be 276,026.968kg. Nitrogen will be transport from the earth with the form of liquid to decrease the volume they need to take. The Oxygen will be obtained from electrolyzing of water. Total liquid volume will be 323.5m³.

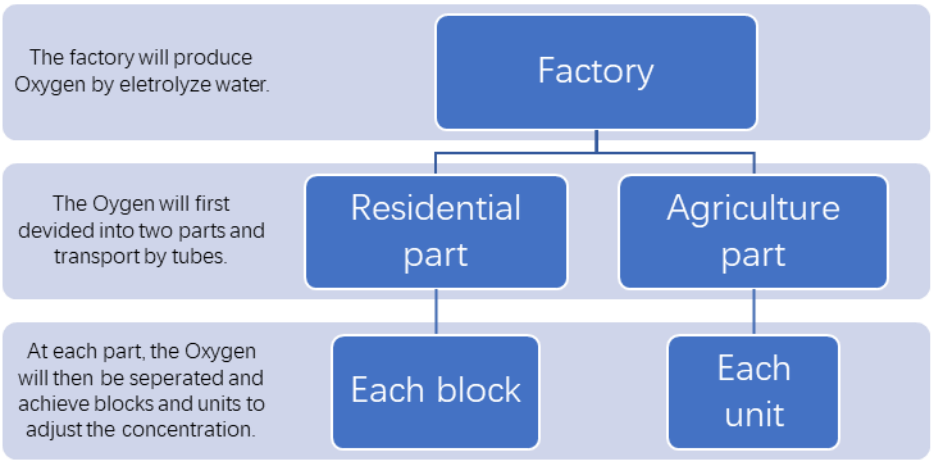
	Consumption		Generation
Human	1,650m3/day	Agriculture	1,500m3/day
Chicken	148.5m3/day	Green algae	350m3/day
Total	1798.5m3		1,850m3/day

pic.3.1.2-Atomosphere consumption and generation

After calculation, agricultural part may couldn't provide enough Oxygen for 3,300 people breathe. At the green zone in residential part, LX-2 will plant sufficient green algae to satisfy the consumption of Oxygen. The settlement will construction tubes to connect residential part and agricultural part to exchange Oxygen and carbon dioxide. At the interface between these two parts will set strainer to maintain air clean.

pic.3.1.3-Fan

The settlement will also set enough sensors on both residential and agriculture parts. They will monitor the concentration of Oxygen, and if the concentration is higher than 0.24 atm, the settlement will shorten the light time of plants and consume Oxygen. If the concentration is lower than 0.22 atm, the factory will produce Oxygen and transport to these two parts.



pic.3.1.4-Oxygen management

About the Oxygen supply in shelter for emergency condition, there will be tubes to transport air only to those shelter. After closing down, the shelter will have its own air loop that separate with the normal room. For preventing the uncork of tubes, at each shelter, there will be some liquid air to supply. And in the shelter, there will be Lithium perchlorate to transform carbon dioxide into Oxygen.

3.2 Electrical Power Management System

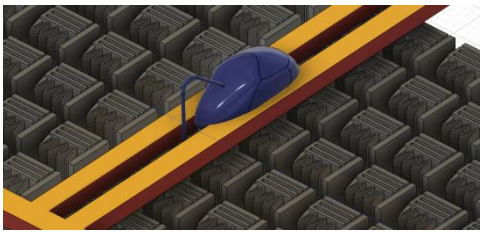
3.2.1 Electricity Generation

The generation of the electricity would be mainly solar pine and the solar panels. The solar pine is a special kind of nanometer material that can be painted on the surface of the space ship, and can transfer the solar energy into the electronic energy. It will not only save the out space of the space settlement, but it can also serve a function of protection on the surface. Also, we plan to build solar panels to help produce the electricity and serve a function of adjustment of the energy which partly made of memory alloy that can contract to decrease the spending space. And other living electricity could come from different areas in the LX-2, like a kind of glass can both used as a glass and a generator, and the flowing water or the heating garbage. The details of the kinds and the functions of the living generation system will be provided below.

The main solar penal will provide the most amount of the electricity of the LX-2 and it will change its generation area by monitoring the actual needed quantity of the electricity in the LX-2 automatically. However, the electricity for the propelling system, mainly ion engine, will be a small nuclear fission power station, which is put at the bottom of the LX-2, near the Ion Engine and provide electricity for it.

3.2.2 Electricity saving

All the electricity produced by the solar penal and the polar pine will be saved in

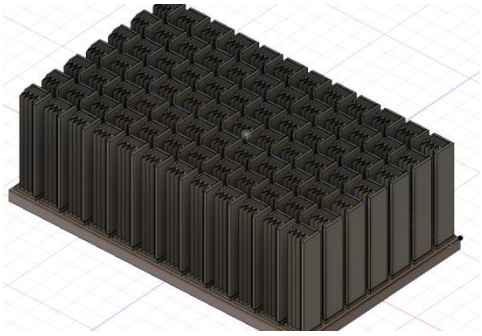


pic.3.2.1-A robot fixing MEAMS

three Main Electricity Automatically Management Systems (MEAMS), which are like three big batteries that keep the electricity and provide the electricity to industry portion, agriculture portion and the operation and lighting portion in different voltages. They will provide 3 weeks living necessary electricity for the LX-2 in the lowest living standard if the emergency happened. As the MEAMS is made of many small management units, one of the units broken will not affect other units' working. Its structure is quite simple and can be checked, cleaned and fixed be robots very easily.

Reserve energy and emergency management.

If the MEAMS is broken or the solar penal is out of order by emergency. The LX-2 will use the lowest living standard to save the energy. And the reserve energy will be used. Part of the engine energy will be moved to generate the electricity like operation and lighting. And the LX-2 will automatically deduce the total energy consumption in the settlement by deducing the light providing and entertainment electricity amount. And the most amount of the energy will be used to regain the energy generation first.



pic.3.2.2-Nuclear fission power station

If the nuclear fission power station has problems on normal running system, which has already checked and confirmed by robot and system, the order will be sand to the controlling room and then the controlling room will distribute some robot to fix the power station in order to get the normal electricity. However, if the robot and the auto-system find the radioactivity is higher than normal, which shows nuclear leak, the whole power station will be send to the outside space in a safety pathway.

The kinds of the generators and about the details about the electricity's productions：

Kinds of generator	Functions	Location	Control	Descriptions
Solar penal	Mainly electricity	Solar penal	Controlling room	Main electricity choice
Solar pine	Mainly electricity	Surface	Controlling room	A special electronic coating
Nuclear fission power station	Propelling system	Bottom of the LX-2, outside of the living area.	Controlling room	For the electric needed of the propelling system
Electronic glass	Lighting	Glass	Each room	A special electronic glass

Radiations	Heating and services	Surface	The heating company	The huge difference on temperature by unbalanced sunshine

Usage quantity of the electricity：

Sector	kW/day
Domestic	25300
Industrial	19358.4
Lighting	997.6
Operation	50
Agricultural	446.5
Transportations	190
Automatic control	4

3.3 Thermal Management

In space, especially the orbits and locations in the solar system, where the space station is located. The external heat from solar radiation and residual heat generated by the operation of the internal equipment are all issues to be considered. In this situation, what the space station should do is to dissipate heat effectively. The thermal management section is divided into two parts, passive heat control, and active heat control.

3.3.1 Passive Heat Control

Simply, passive heat control means heat insulation and prevent the heat from outside. Method of insulation on below.

Multi-Layer Insulation, short for MLI is covered on the main areas habited with personals, which is a layer of thin, radio reflective Mylar coating.

pic.3.3.2-MLI heat insulation material

The special propriety of this material is that the solar thermal radiation can't get through it. That means almost zero heat would escape or gain through the surroundings (including ceilings, floors and walls). Which prevents heat from being conducted between layers. The reason to eliminate the heat circulate is to increase the temperature of the radiator as much as possible. According to the radiative power equation, a slight increase of the temperature cause an immense grow on the radioactive power.

In addition to the layer, below the layer pavement, there are sticks made of multi-layer metals, which can bend in the heat environment. The detailed information of adjusting the layer's direction in 3.3.3.

3.3.2 Active Heat Control

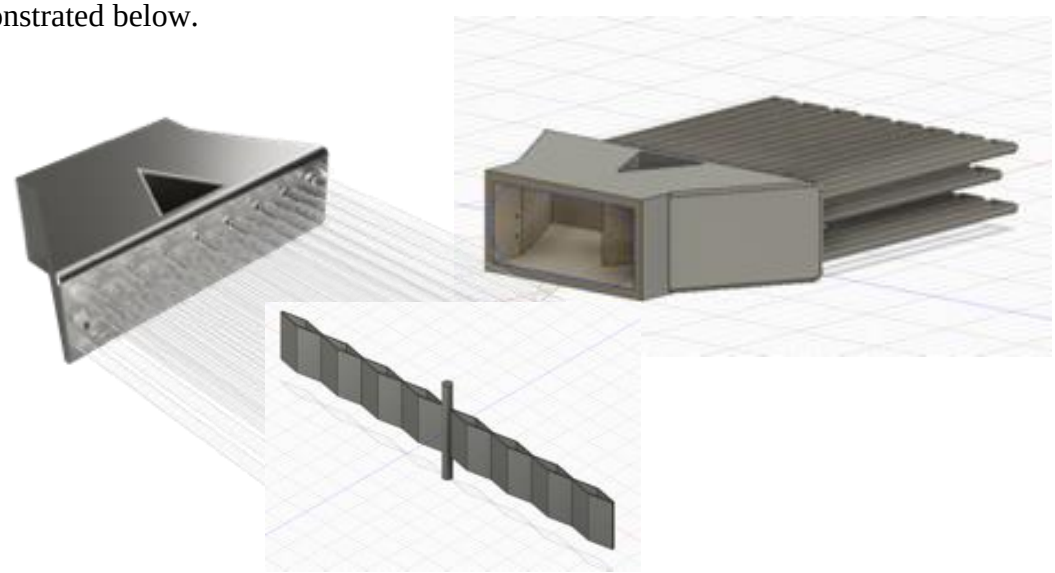
Since there are no air or other substances to perform heat convection, and the only way for heat to get in and out of the settlement is by inward and outward heat radiation. The heat that needs to be discharged from the living area mainly comes from the air conditioning system (including factors such as human body heat rejection). Besides, there is massive heat generated by the industrial section devices and equipment. The central air conditioning system inside the settlement will

concentrate all the heat in one place through the pipelines. The heat transportation system outside and for the industrial part is similar. But the liquids running in the pipes are different, in the interior of the settlement, the coolant is water, which has a relatively large specific heat capacity. When comeing to the outside, the liquid ammonia is used as the main coolant. The ammonia water is vaporized by heat, and then the ammonia gas enters the liquefaction tube to cool down, liquefy and release heat.

	Melting Point	Boiling Point	Specific Heat Capacity
Water	0 °C	100 °C	4200 J/(kg • K)
Ammonia 25%	−57.5 °C	37.7 °C	1600 J/(kg • K)

pic.3.3.1-Thermal properties of water and ammonia

The exterior radiator devices (liquefaction) and properties of coolant are are demonstrated below.



3.3.3 Schedule and Management

Using methods stated above, utilizing insulation material in the area that can receive direct sunlight and expand the radiator at the section in night side. How to arrange this thermal management equipment is a primary consideration. First, as the space station rotates, when the side that facing the sun and get exposure to the sunlight. The multi-layer metal plate is bent by heat, and it will extend and prop up the MLI to reflect the solar heat. At the meanwhile, the radiator in this side will relieve itself. Vice versa on the other side. In this case, the settlement could dissipate the heat Effectively while reducing sun exposure time and intensity.

3.4 Water management

3.4.1 water source

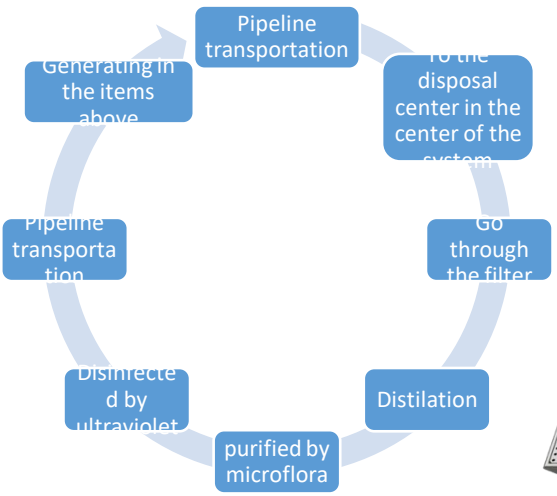
There are two main sources of water for us. The first is that a certain amount of water needs to be transported from the Earth to start the space station project at the beginning of its operation. When the entire space station is stable, there is no need to transport liquid water from the Earth. Instead, we will collect solid water from the freezing line in the nearby asteroid belt into the space station. The liquid water in the freezing line will be collected directly by robots.

3.4.2 Water distribution

Items	Total
Settlement/m3	99,000/day
Industry/m3	19,000/day
Agricultural/m3	12,000/day
Thermal/m3	6,000
Total/m3	130,000/day (6000 for extra consumption)

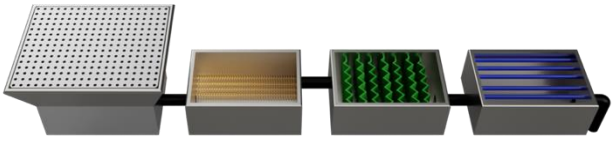
pic.3.4.1-Water usage distribution

3.4.3 Water Circulation System



pic.3.4.2-Water circulation

All of the home-use water and industrial water will be processed seperately in order to prevent cross-pollution. The water should be circulated after it operates stably. The used water will firstly pass a long pipeline transporting them to the disposal center where all the polluted water centralized. Then, for some physical pollute, the metal filter would



pic.3.4.3-Water purification device

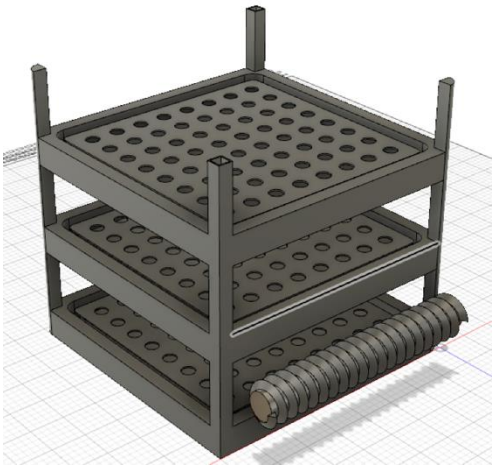
filter them and get some water without big solid. For the next step, the water simply be distillated in order to let all the tiny particles out of the liquid. After all the physical purifications, the microorganism contained in the half-purified water would pass through the microflora which can digest some organic pollution. The last process of purification is the ultraviolet processing, cleaning the left organic particles such as part of bacteria. Then the purified water will be transported through pipelines again so that they can form a circulation of water.

3.5 Agriculture Part

Agriculture		Yield/Month (kg)				
Volume	2*2*2(m3)			Every Month	kg	Units
				Meat	19,800	825
	wheat	9		Vegetable	59,400	1,850
	lettuce	40		Staple food	32,670	1,360
Type	chicken	24		total		4,035
	tomate	17.8		total volume		33,280m3
	potato	30.2				

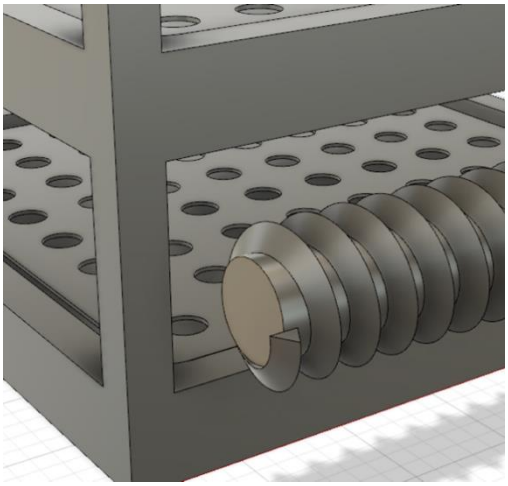
pic.3.5.1-Agriculture management

There will be five type of plants in the units. Wheat is mainly for making protein and staple food. Lettuce will provide vitamin and multiple layers of taste. Chicken is high protein livestock and high production. Tomato will provide vitamin and varies flavor. Potato will be staple food and mainly for energy. Every unit will be one specific kind of crop, easy to be harvest.



pic.3.5.2-Agriculture unit

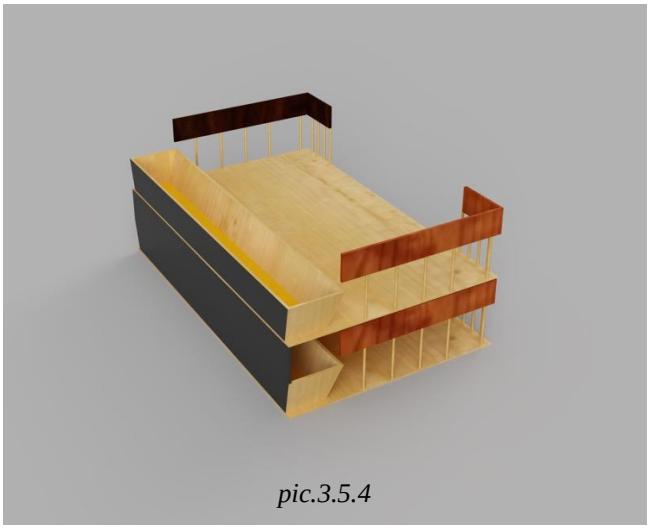
Each unit will contain three floors and isolated harvest equipment. The harvest equipment is a machine which could both harvest and sow seeds. This equipment will connect with a board which could fold and stretch. This equipment will response to all the three layers in one unit. After turning on the machine, it could move forward in one layer and carve the crops and collect them on the stretching board. While the



pic.3.5.3-Agriculture unit harvest equipment

machine moving backward, the crops will be collecting to the bottom with the board to the bottom of this unit. For the unit of livestock, all the chicken will be collected and dispose in a particle place.

At the bottom of each units, there will be three interfaces which connect to three tubes in each unit. These three tubes will be the tunnel to transport water, air, and food. Meanwhile, at the stanchion of each unit, there will be wire for the electricity using, including LED board, and harvesting equipment. By connecting these interfaces with other units, all the food, air, and nutrition water could be easy transport to or from the same place.



pic.3.5.4

By connecting units, food will collect and translate to other places. There will be LED board at each layers' roof to maintain the growing of crops. The temperature will also be controlled to the most productive temperature. For the livestock, different ages will have different humidity and temperature. A slope will be set at the bottom of these units. After the mature of chicken, they will be pushed onto the slope and transport to the disposing center.

After connecting all the units, three tubes will also be connected and collecting food, transport nutrition water and wire. Then the food will be separated into two parts. The first part will be storage in fridge for recently use. The other part will be storage after air-drying or making to cans. The good that going to use will be transported to a cooking center. After finishing cooking, the food will be divided into packages and transport to rooms.

Vegetable is going to take 1,850 units (lettuce and tomato). Staple food will take 1,360 units (potato and wheat). Meat will need 3,100 units. Totally, there will be 4,035 units for LX-2. 33,280 m3 will be needed for agriculture part.

3.6 Automation Systems

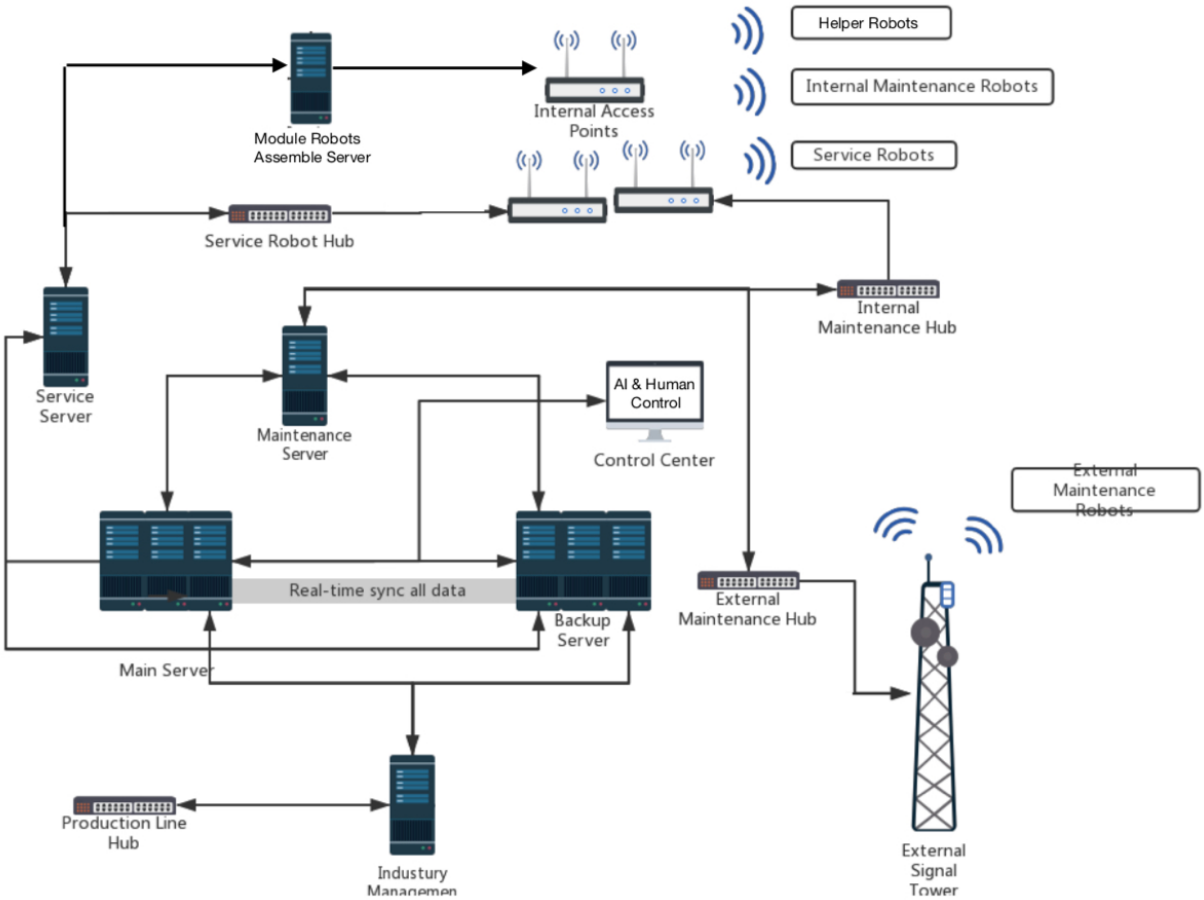
Autonomous operation by artificial intelligence would in charge under normal conditions, manual intervention by engineer in fault/abnormal/emergency situations.
One or two engineers are required to be at control center alternately
When main server is down, the backup server will take over its work, which is absolute synced with the main server.

Module Robot control pod is specially designed for module blocks assemble works, it can determine the shape and size the task need and construct a capable robot for it. Otherwise, it could combine the blocks according to the demands of the personals.

	Main Server	Backup Server	Service Server	Maintenance Server	Industry Management Server	Total
Quantity	12	12	4	4	4	36

	System	Displays	Human Controllers
Service Section	Assign tasks to service robots.	Monitor the status of robots and devices, connections, remaining batteries and current tasks.	Assign temporary, special tasks to service robots. Supreme authority to control service robots.
Maintenance Section	Run daily maintenance tasks and monitor the status of the space station, dispatching emergency repair robots when abnormal occurs.	Monitor the status of robots, remaining batteries and current Maintain tasks progress.	Manually operate the maintenance robot under special conditions or large-scale system failure.
Industry Section	Control manufacture and refining lines, including raw materials and products management.	Monitor robots' positions and working status, industries production line status and refine output.	Supreme authority to control robots and production line. Special production and emergency stop.

Network diagram:

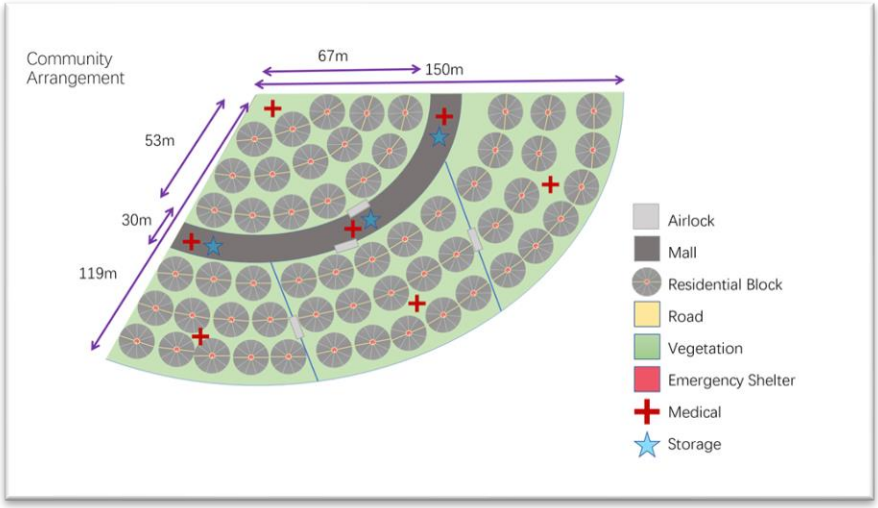


pic.3.6.1-Network diagram


HUMAN
FACTORS

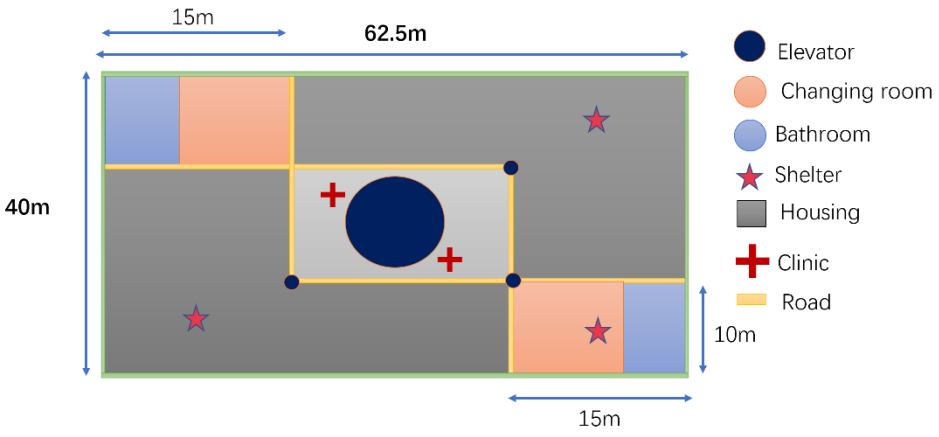
4.1 Community Design

The total area of the residential area, in 1/2g, is 112860m^2, which is equally divided into three leaf-shaped sectors *(refer to pic.2.1.3-Section division of LX-2 at p.5)* Each sector has two identical floors of 4 meters high and, thus, 550 residents settle per floor. The basic plane figure of one is shown above in pic.4.1.1. One community consists of basically two functional areas: the business & entertainment and the residential area.



pic.4.1.1-plane figure of one floor of residential area

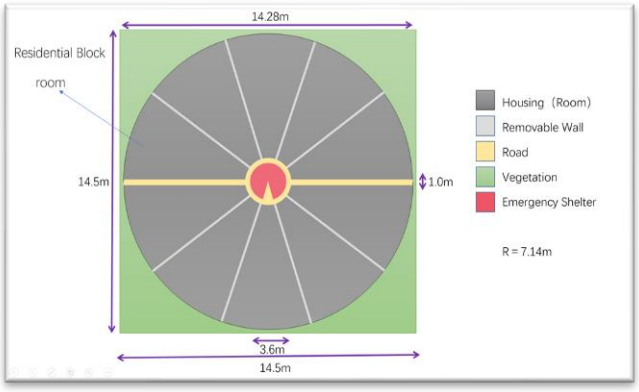
The grey ring (though not a closed 'ring'), as shown, represents a collective area for business and entertaining uses, which is called a **Mall**. It contains three major storages and medical areas for each floor. Residents are also able to do collective activities in the squares in the Mall. In the middle of each Mall, there is an elevator connecting to 1g gym, where children are able to have sufficient daily exercise. The graph of gym is shown below.



pic.4.1.2-plane figure of gym in 1g

In order to guarantee the safety, the residential area is divided into four districts, with

local hospitals for each, separated by firm and hermetic walls with an airlock embedded in the middle. Note that there are also airlocks in the walls between residential areas and the Mall. Instead of traditional cubic apartments, **Residential Blocks** are designed to best fit in the special arc of section. A more specific diagram of one residential block is shown with dimensions and labels below.



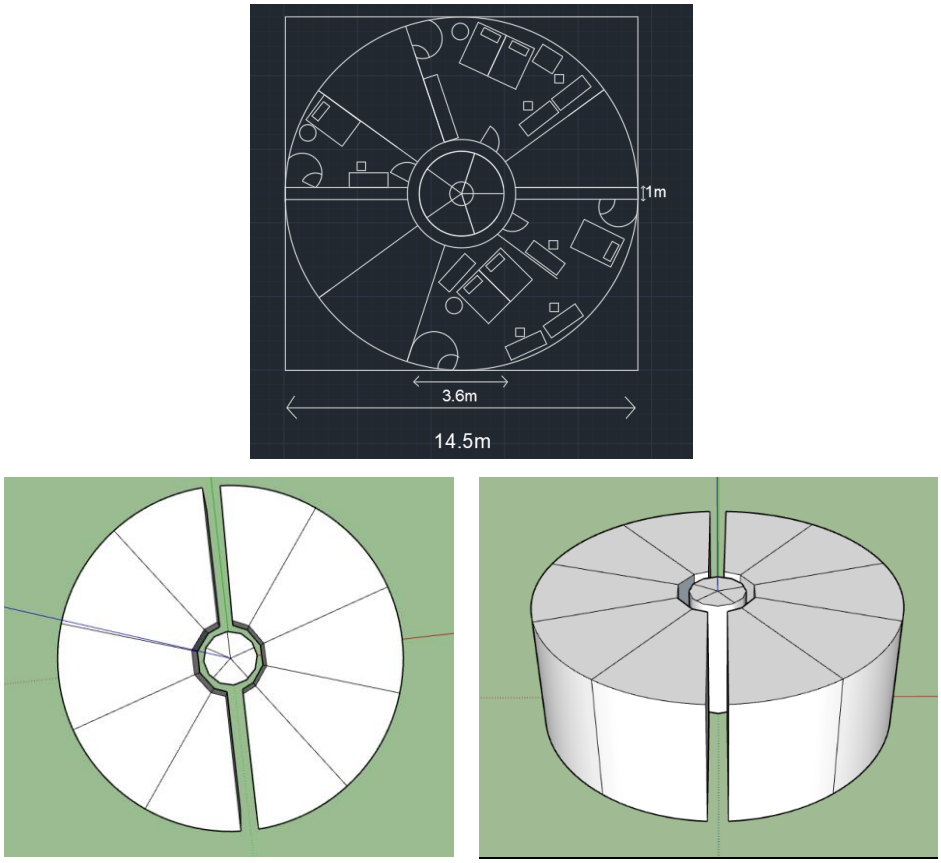
pic.4.1.2-plane figure of one block

As shown, within one block, there are 10 rooms (with removable walls able to convert flexibly in a spatial reconfiguration). To be more specific, once a person living in a house married with another settler, they can remove the wall between two rooms and arrange a space for a couple. When ever they have a baby, they can remove another wall to create a family room. The door for each room, is set along the road, which is represented in yellow in the figure above, providing convenience for people to get interact with the community, as well as the efficient reach to the **Shelter** in emergency.

The emergency shelter is a three-layered-cylinder with a notch…? for refugee to enter. Though it has a entering gap, the cylinder can be sealed to gain a distinct atmospheric environment to the outside, which is realized by the emergency gas pipeline inside the shelter. However, the cylinder is normally unsealed and the pipes will not be initiated until facing the special events. For the arrangement for different layers, the lowest is a storage for necessary food and water resources and basic tools and safety devices during the short period of emergency. The upper two layers are dormancy cabins for the ten residents in the Block. In emergency period, they can lie on the boards of cabins and have rests.

The rest of the areas are vegetation areas. Chosen grass are special plants that are tolerant to drought with low respiration, which ensures that they won't deprive excessive amount of oxygen at night.

4.2 Residential Space Design

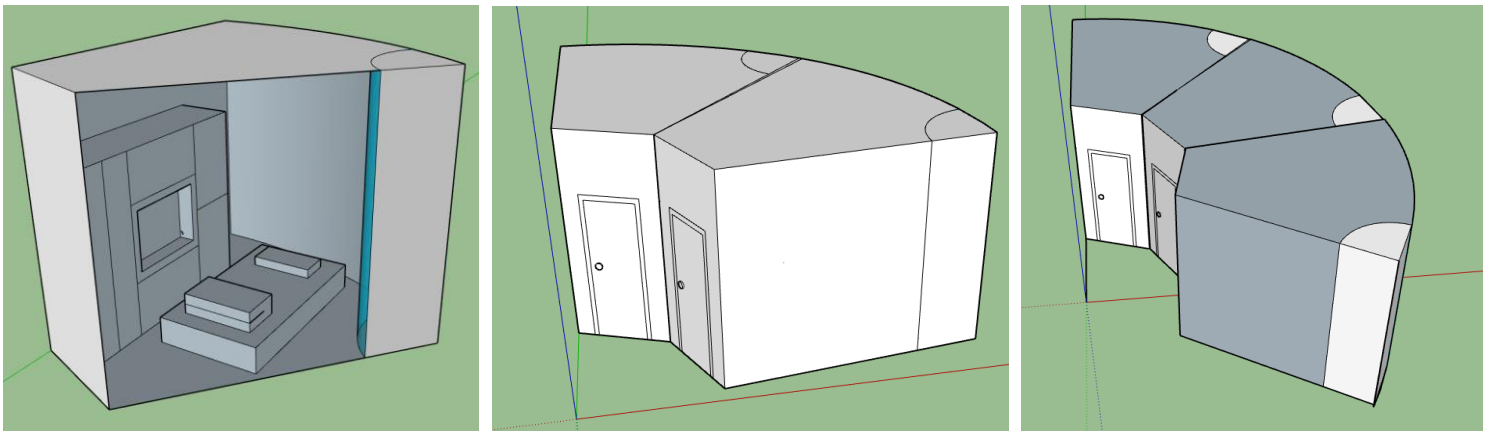


pic.4.2.1-figures of one block

The outer layer (grey) is divided into 10 rooms with removable walls. While the inner shelter has three layers, the upper two are dormancy areas, bottom as storage. Each layer of shelter has been divided into five dormant zones. The connecting doors are located on the inner wall of the outer living area, which can lead to the inner emergency area. The entrances to the innermost shelter are on the outer walls of the shelter, which correspond to the two outer housing doors. Residents can enter the enclosed shelter through two doors through the central circle (yellow) in case of emergency. On the outside walls of shelter, there are ladders built into the walls that allowed people to climb into the first, second, and third floors of the shelter. People are not allowed to open outside doors in an emergency. They can directly open hidden openings on the floor to access the bottom storage items.

There are 3 types of indoor design, for single, for couple and for family. The overall design is to place cylindrical "apartments" across a scalloped residential area. In fact, in the cylindrical design, the outer ring will be used for human habitation.

Each of cylindrical design will be cut into 3 layers, two for human residence and one layer designed for storage. Each layer is a circle, which is divided into five parts.



pic.4.2.2-Assemble of cabins in one block

As shown, each is a basic form, in other words a “unit”, of house for one citizen, consisting of a bed, a wardrobe, a window, a TV and two storage cabinets which are fixed on the wall. Each resident has a uniform indoor environment and identical furniture. Plus, all 300 visitors will be placed in single houses. As for couple, they share two times of one-tenth fan. We design each single house to be flexible so that the wall can be raised and reform it into a two-bedroom when couple moves in. The same principle utilizes in family house. We combine 3 pieces into one integral house for family.

The number of each types of rooms are counted below.

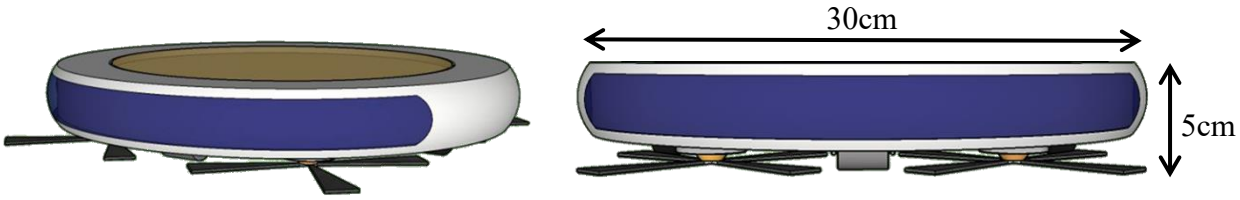
Distribution of Population (in term of types of rooms)		
	numbers of room cell	population
Single Room	2370	2370
single female	1050	1050
single male	1020	1020
traveller	300	300
Double Room	420	840
Triple Room	30	90
Total	2820	3300

4.3 Residential Automation Facilities

4.3.1 Cleaner robot

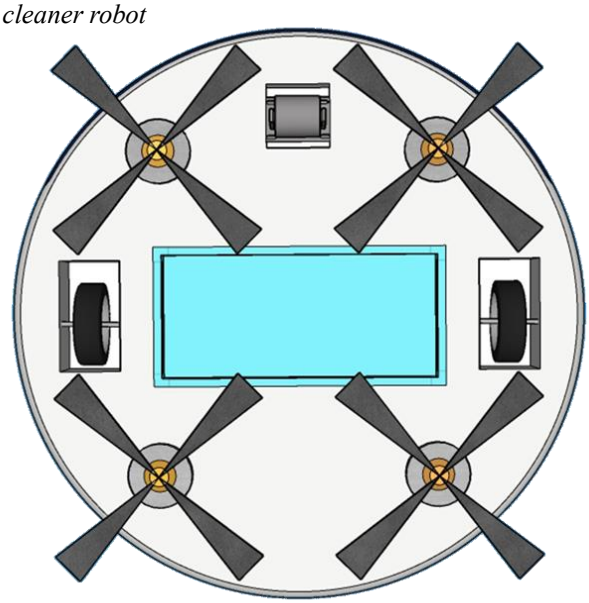
The robot is used to clean the floor of the house. It can sweep the floor and clean dust on the floor. If people want to control it, they just need to download an application in their personal electric devices.

Name	Quantity	Cost
Dust killer	1600	1,280,000RMB



Pic.4.3.1-front view of the cleaner robot

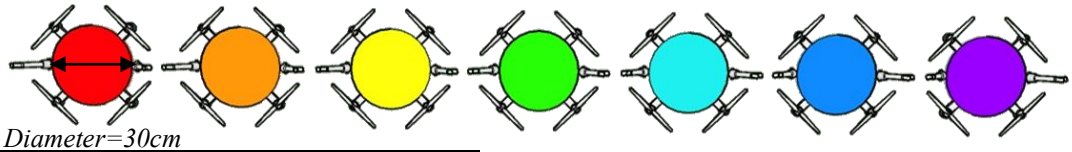
The picture on the right is the bottom of the cleaner robot. Four brushes which can spin freely are arranged regularly in the four corners. Their function is to sweep dust to the tiny vacuum cleaner in the center of the robot. Besides, there are two kinds of wheels at the bottom. The wheel in the front is omni-directional wheel, which has function of controlling moving direction; the wheel on two sides is fixed wheel, which has feature of providing motive power.



Pic.4.3.1-bottom view of the cleaner robot

The blue and translucent sensor can ensure robot to stop in front of obstacles. Also, the yellow liquid crystal screen on the top is the display screen of data and buttons. People can also get the data of the robot in their electric devices.

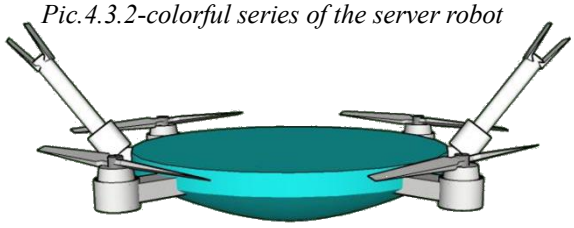
4.3.2 Server robot



Diameter=30cm

Pic.4.3.2-colorful series of the server robot

Name	Quantity	Cost
Rainbow	1600	960,000RMB



Pic.4.3.2- figure of the server robot

The robot has the function of carrying and delivering things. Citizens can ask them to transmit things like dish, bowl or tools through using their headphone

or the application on their phone. The robot is a series which includes seven different colors just like rainbow. This design can beautify the appearance of the robot and delight citizens especially kids. The robot has

Name	Quantity	Cost
Spirit	3300	825,000RMB

four screw propellers used to fly through rooms and has two robot arms used to pick and hold things from table.

Pic.4.3.3- figure of the headphone device

4.3.3 Headphone device

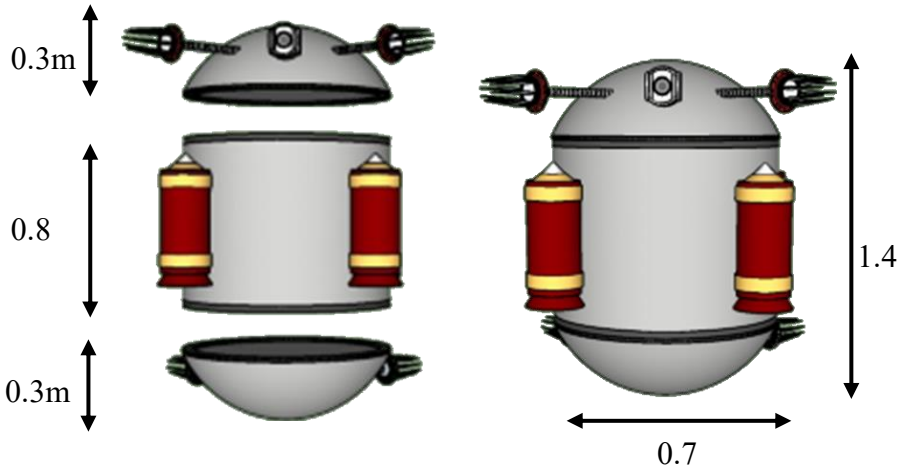
Spirit basically performs all the functions of headphone wires, such as answering the phone, adjusting the volume, pausing, stopping music, but it needn't wire anymore actually. The user can adjust the size of headphone to the proper easily. And there is a button below one side of the headphone, and it is used to control the start of receiving and answering verbal message. Because of this device, citizens can remotely communicate with others when they are working.

4.4 Emergency Plan

4.4.1 Urgent automation robot

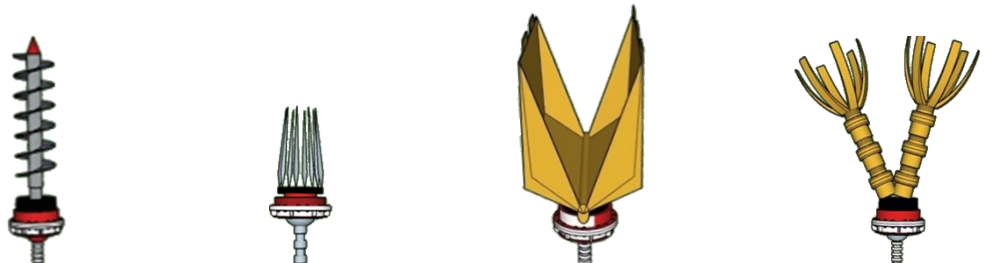
The settlement has thousand urgent robots. The robots can be divided into three components. The three parts are connected by strong magnet, and all of them can work as a single robot. The relatively small part has tiny volume which ensure arriving the area of the accident in time. It can check the pre-condition of the urgent environment of the accident. The relatively large part can

Name	Quantity	Cost
S bonding	450	21,573,000RMB



Pic.4.4.1.1- figure of the urgent maintenance robot

achieve the main tasks of maintenance. The tasks include cutting down the huge fire, doing the basic repair, etc. Besides that, the three parts can work as a huge robot.



Pic.4.4.1 - four sorts of robot arm

The robot has different sorts of the robot arm which contains the steel drill, the flexible and intelligent robot hand and so on. Also, the robots have very strong and efficient propeller that ensures the fast motion of all the robots, so that the robots can arrive the domain of the accident in very short time.

4.4.2 The Solar Proton Event detector

The advanced detector can find the omen of the solar proton event, so the early preventing is totally possible. The detector can check the strength and the time of the solar proton event, and relative workers can do some work to prevent the demagogue result of the event.

4.4.3 Plan

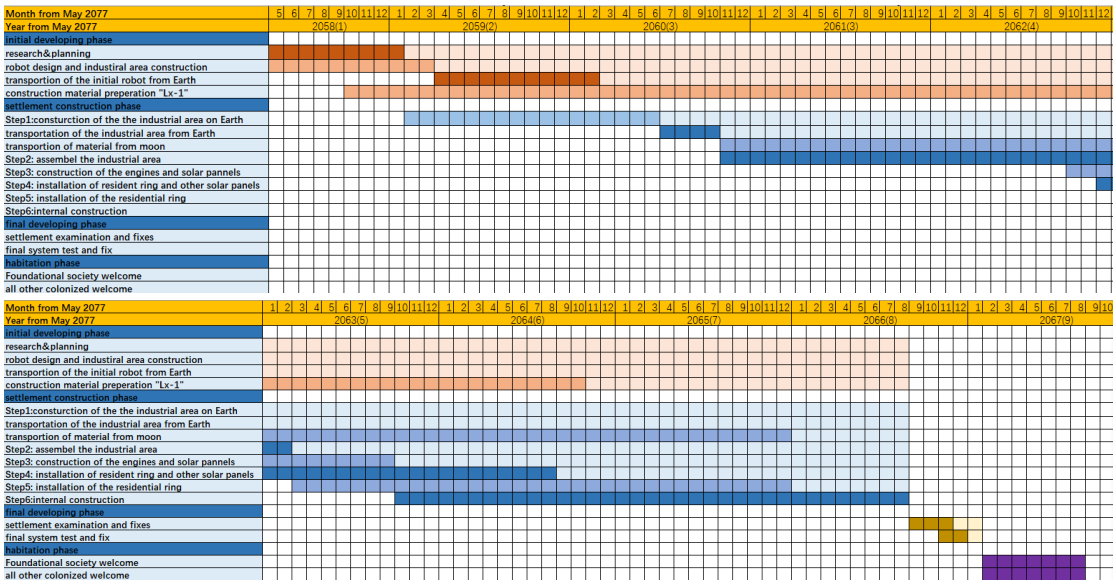
	5s	3min	1h
Space debris collision	The system automatically closes all the hatch doors which are near the accident cabins in 1 second. Alarm goes off to notice the citizens. Urgent maintenance robot and firefighting robot receives the notice and the basic situation of the accident.	The management layer uses broadcast to illustrate the situation to citizens if the accident causes large impact. Also, urgent maintenance robots begin checking the situation of the cabin and trying to repair it. If objects in the settlement go outside, in order to prevent the production of space junk, specific robot will capture them.	Detector and robots check the safety condition of relative area, and robots try to basically repair the broken devices. Relative technicians prepare and produce the components which are needed in the process of repairing. Besides, the management layer of the space settlement discuss the plan of preventing the future debris or reducing the related damage.
Solar particle event	Solar Proton Event detector can give the clear alarm about 10 minutes before the Solar Proton Event. So, before the happen of the event, citizens have already go into the shelter, and robots have already stopped working and have went into	Robot and human still keep inside the robot cabin and the shelter. The detector measures the intensity of the event.	Robots begin working and urgent maintenance robot checking the situation of devices. If the environmental condition is normal and the situation is safe, robots will report and then humans will come out of the shelter. After that, electric engineers and computer engineers repair the broken devices.

	the robot cabin.		

If the area of the accident is the greenbelt of human residence, then all the citizens need to go to the shelter. If the area of the accident is a single unit (10 rooms), then only the citizens in the unit need to go to the shelter of their unit.


SCHEDULE
AND
COST

5.1Schedule for Settlement Construction



The total construction time is 9 years and 2 months, including the initial planning time to colonizer welcoming.

5.2 Cost of the settlement

5.2.1 Cost of Structure Department settlement's Construction

Section Name	Total Shell Mass (ton)	Material Price (¥/ton)	Cost (¥)	Source
Residential	561.5244	2000000	1123048800	Moon
Manufactural	238.7232	2000000	477446400	Moon
Industrial	95.04	2000000	190080000	Moon
Gymnasium	88.56	2000000	177120000	Moon
Engine	43.28436	2000000	86568720	Moon
Central Axle	91.422	2000000	182844000	Moon
Support Frames	240.82884	2000000	481657680	Moon
Solar Panels	248.4	2000000	496800000	Moon
			3215565600	

Human Power	30	200000RMB/year	6000000RMB/year

Total Structure cost: 3,221,565,600RMB+6000000RMB/year * 9.16years =3,276,525,600RMB

5.2.2 Cost of all the robots

Devices	Quantity	Unit Cost	Total Cost
Cube	4	50,000+12,000 RMB	248,000 RMB

Circuit	570	6,000 RMB	3,420,000 RMB

Total robot cost:3,668,000RMB

5.2.3 Cost of the Operation Department

types	quantities/kg	unit cost	cost/¥
water	13,000	2,000	26,000,000
aluminum alloy	10,000	2,000	20,000,000
titanium	2,700	2,000	5,400,000
N2 (liquid)	4,000	4,800	19,200,000
ammonia	7,600	650	4,940,000
types	**unit**	**unit cost**	**cost**
MEAMS	252 units	720,000	180,000,000
System of robot pathway	3 unit	91,000	273,000
Fixing robots	3 unitys	224,000	672,000
Solar pine	56340 m^2	4,900	280,000,000
Nuclear fission power station (powering the main engine)	1	67,900,000	67,900,000
Operation cost of electricity control systems	/	/	8400/day
TOTAL		**/**	**604,385,000**

Total OP cost: 604385000RMB

5.2.4 Cost of the Human Factors Department

Devices	Quantity	Unit Cost	Total Cost
Shelter Protection Layer (Arsigs)	111,655,345 (cm^3)	2 RMB/cm^3	223,310,690 RMB
Staffs' salaries	20 (number of staff)	120,000 RMB/year	2,400,000 RMB/year
S bonding	450	47,940 RMB	21,573,000 RMB
Dust killer	1600	800 RMB	1,280,000 RMB
Rainbow	1600	600 RMB	960,000 RMB
Spirit	3300	250 RMB	825,000 RMB

Total HF cost: 246,241,690RMB+21,577,000RMB/year

5.2.5 Total Cost

Total Cost: 4,130,820,290RMB
Total Annual Spent: 21,577, 000RMB/year

5.2.6 Future Commercial Plan

Income	Spend/ Earn	Total amount
Asteroid Mineral	180,000,000RMB/year	300,000,000RMB/year

Extraction		
Visitor's Servicing Fee	120,000,000RMB/year	
Outcome		
Settlement Maintain Fee	2,400,000RMB/year	25577000RMB/year
HF Maintain Fee	21,577,000RMB/year	
Settlement Maintain Fee	1,600,000RMB/year	

Notice: 1:We assume LX-2 can capture 2,500tons' steroid mineral every month, with have iron aluminum and other rare space material. And the extracting percentage is 60% then Lx-2 can produce 18,000ton metallic material every year. And the income of asteroid mineral extraction is 180million RMB every year.
2: We assume one visitor's servicing fee one year is 500 thousand RMB, so 300 visitor's servicing fee after the cost price is about 120million RMB every year

The annual profit of the settlement is 274, 423,000RMB/year
The time needed to cover the cost of the settlement is 15.05 years

END OF PROPOSAL