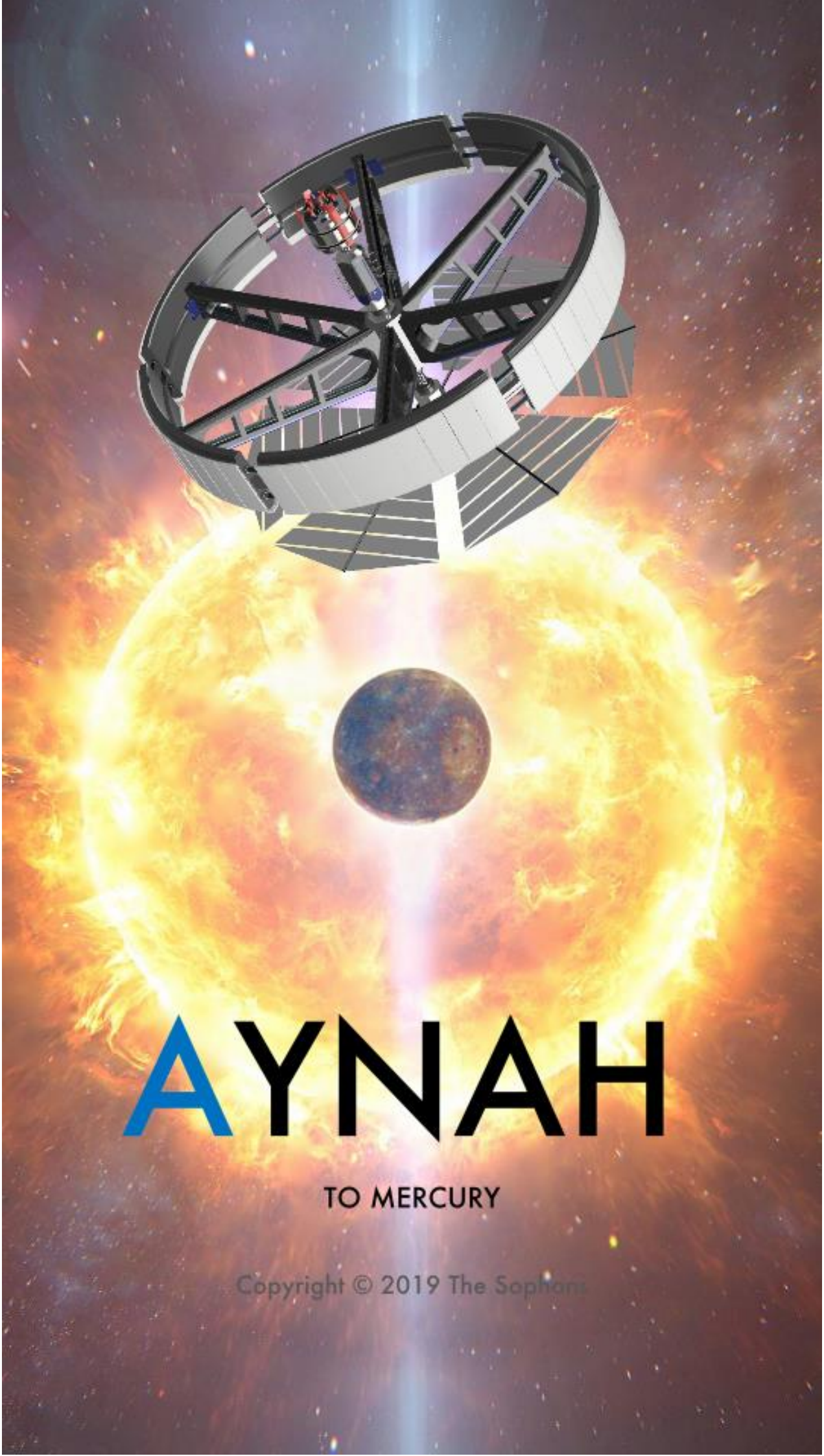

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1.0 Executive Summary

It is honorable for our company to present PROPOSAL AYNAH, a well-organized, detailed, clear, and reasonable 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 six parts in order to be more comprehensive: Structural Design, Operation and Infrastructure, Human Factor, Automation Design and Services, Schedule and Cost, and Business Development.

The top priority of our Structural Design is to provide a stable and safe settlement for human beings living in a long term. Details in our design accomplish this goal. For instances: 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, we not only ensure the stability and safety of the settlement, but also offer variety ways to amuse our residents. They will be explained to you by human factor department.

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 of Mercury, allowing us to design a system which can utilize solar radiation as the main source of energy.

In Human Factor part, our company has designed a modern living environment for the residents, 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 types of people. Residents can choose the entertaining approaches not only among the given 3 ways, but also discover recreations in the activity areas on their own, which fit the people from children to adults. Aynah provides residents fantastic experience both physically and mentally.

Automation Design and Services of Aynah has provided the highest quality of design and the most economical construction plan for the upfront building, including the mining and power production and take responsibility for construction and management of the Settlement Aynah. For the residents on Aynah, we will provide them with different kinds of robot boost their working efficiency. In addition, our high speed and large scales of a network will provide safety for every resident's personal data.

Schedule and Cost part has included the chronological schedule of the construction process of Aynah 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.

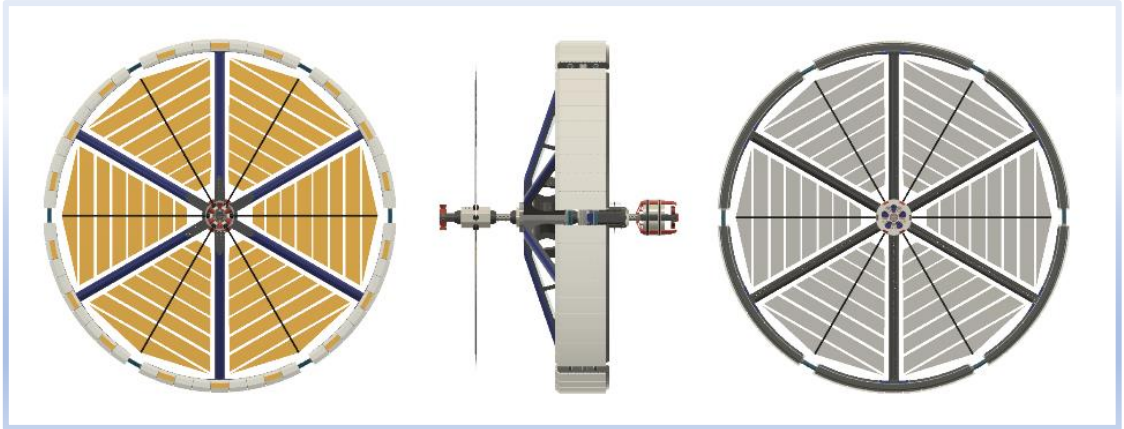
Business Development handles all the commercial parts of Aynah. In this section we will explain how we will use the funding budget to build the settlement and how we will earn a steady income by the settlement. We will present time points when we will recover the cost by the income.

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.

2.0 Structural Design

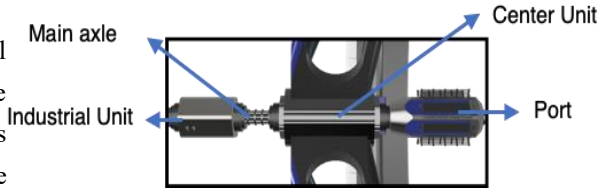
2.1 Exterior Design

2.1.1 Three-view drawing

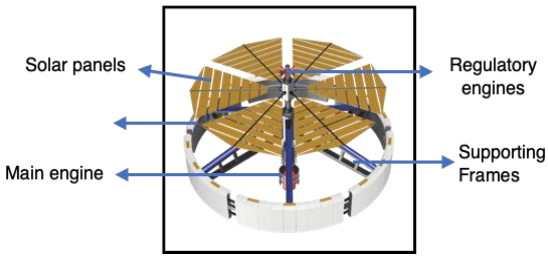


a. Section division

Aynah has five main units in total. Four of them is on the central axle: engine unit, industrial unit, port/warehouse 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 zone. The **industrial unit** is attached to the solar panels which directly provide it electric power, while it contains the heavy industries including ore smeltery, metal manufacturing machines, and assembly lines for robots and large components. In addition, there is maintenance zone for repairing robots. The **port/warehouse unit** allows spacecrafts with cargos porting Aynah, and provides a large space for storage. At last, the **central unit** contains the crucial equipment—the electromagnetic stabilizer—which maintains the rotating part and the non-rotating part separate with a strong magnetic force. It also functions as a transportation hub between the axle units and the residential circle units.



Graph 1.1.1



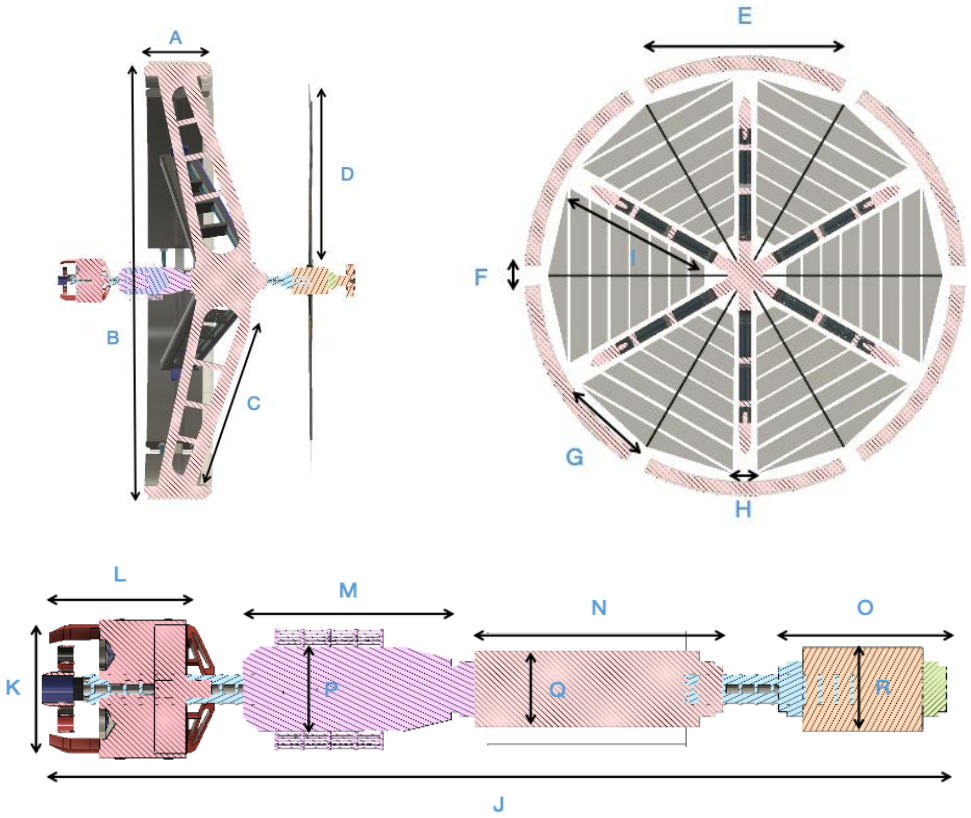
Graph 1.1.2

On the rotating ring locates the **residential unit.** There are six sub-units in this unit, each occupies 1/6 of the ring's total volume. They provide a comfortable living area for Aynah's inhabitants and a farm that allows agriculture and aquaculture. A layer of water is utilized to prevent solar wind radiation and a shield is installed to prevent over-radiation from the sun. This part will be further elaborated in 2.2 and Human Factor part.

Unit name	Volume occupied/m^3
Engine unit	3.064x10^5
Industrial unit	1.466x10^5
Port/Warehouse unit	4.206x10^5
Central unit	5.628x10^5
Residential unit(single)	2.465x10^6

Graph 1.1.3 Occupation of main observable volumes

b. Dimensions



Graph 1.1.4 Aynah dimensions

A	130m
B	2000m
C	825m
D	820m
E	902m
F	118m
G	400m
H	110m

I	554m
J	550m
K	85m
L	54m
M	130m
N	140m
O	74m
P	40m

Q	36m
R	50m

Graph 1.1.5 Aynah dimensions data

2.1.1 Artificial gravity

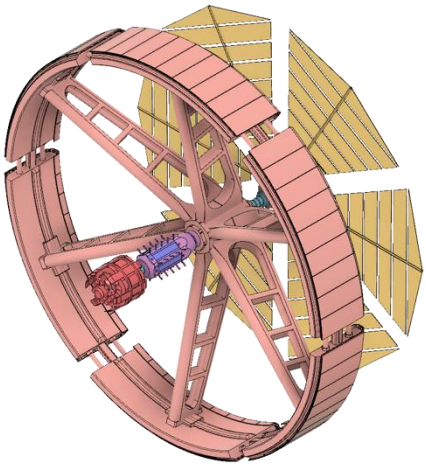
a. Rationale

To create one g of pseudo gravity in the residential circle, Aynah's residential circle will rotate at frequency f. It can be calculated by:

$$f = \frac{w}{2\pi} = \frac{\sqrt{\frac{g}{R}}}{2\pi} = \frac{\frac{9.8m/s^2}{1000m}}{2\pi} = \frac{0.98/s^2}{2\pi} = \frac{0.157rev}{sec} = 0.945rpm$$

This frequency is physically adaptable to the human living inside Aynah.

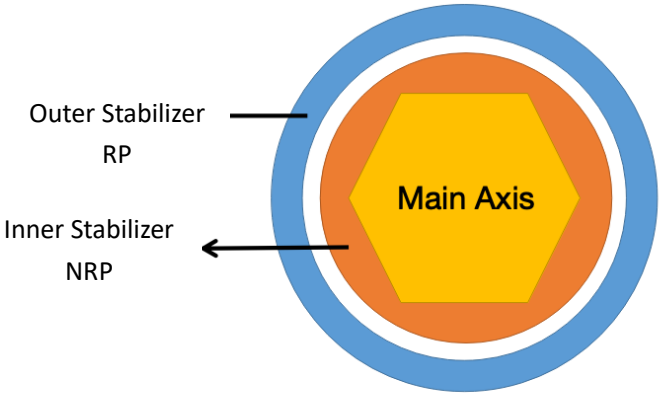
b. Rotating and non-rotating sections



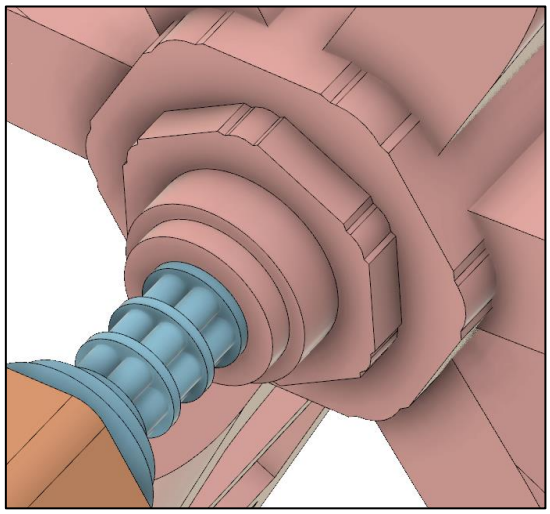
Graph 1.2.1

Aynah can be divided into two main parts: rotating part (RP) (pink) and non-rotating part (NRP) (other color). [Graph2.1]

RP includes the residential circle, the supporting frames, and the center unit. At the interfacing space between RP and NRP, an electromagnetic stabilizer will maintain the relative position between RP and NRP using magnetic force. In addition, a large mass will be at the center of mass of RP, keeping the system angular momentum at constant. [Graph2.2]



Graph 1.2.3



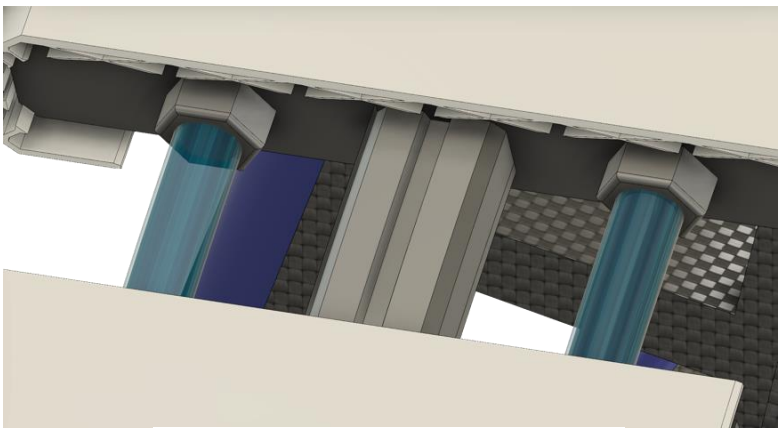
Graph 1.2.2

1. Pressurized and non-pressurized sections (depressurization response)

Graph 1.3.1 Pressurized sections(single)

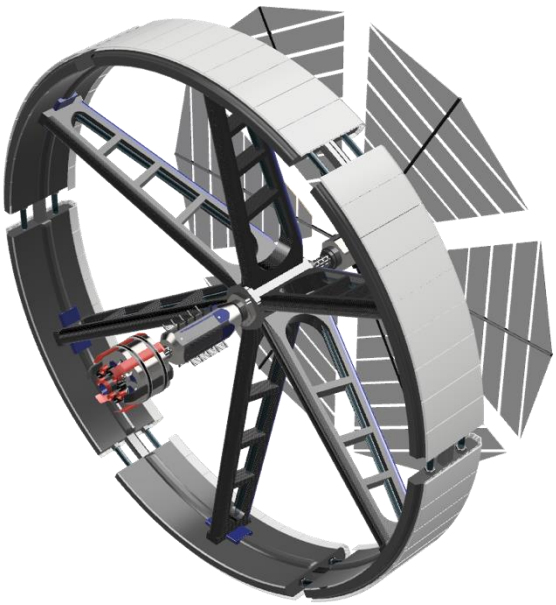
Graph 1.3.2 Pressurized sections(whole)

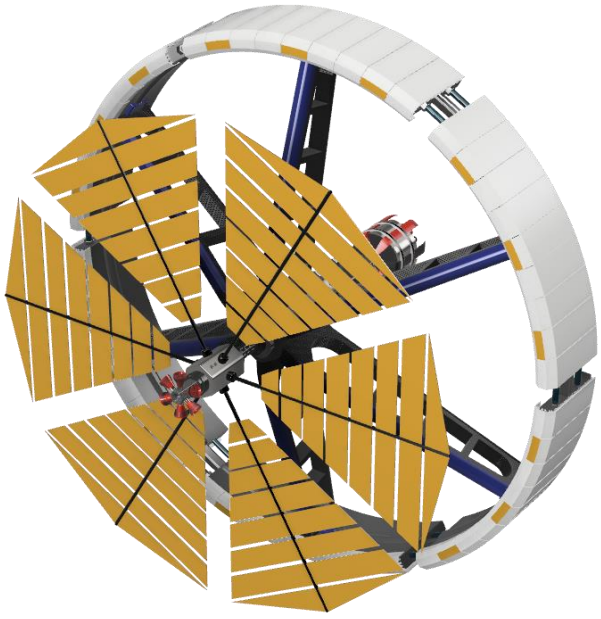
Aynah's residential units and the industrial unit are the only pressurized units. Between each residential unit there are three corridors, two for normal transportation of carts and people and another for emergency evacuation when depressurization occurred. People in the depressurized unit can immediately transfer to the safe units, then the depressurized unit will be isolated.



Graph 1.3.3 Transfer corridors

Overall Exterior Structure Model:



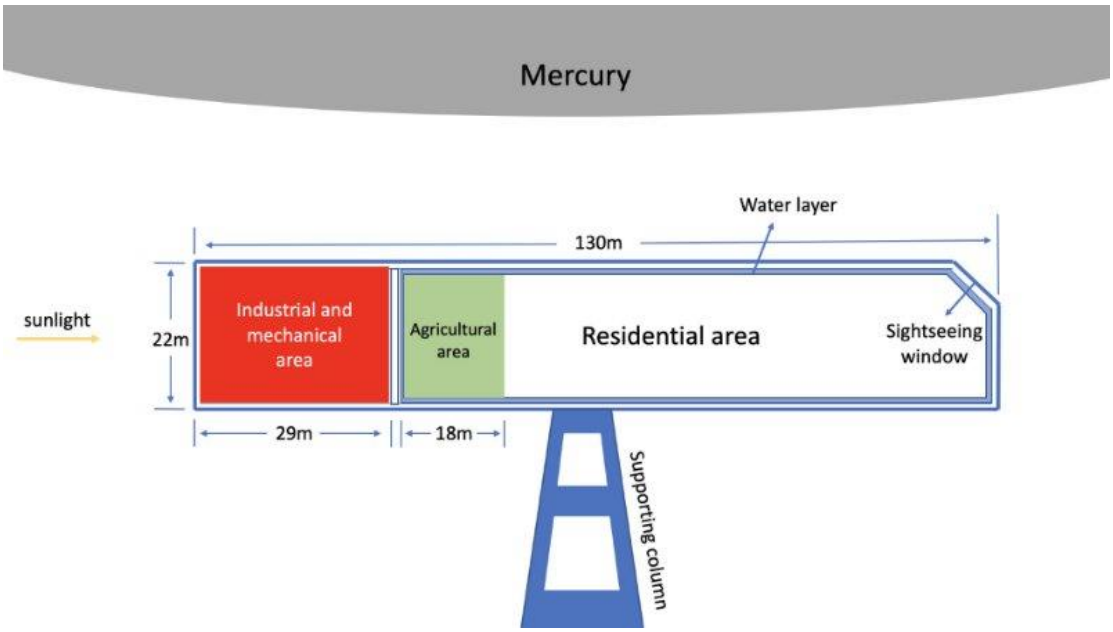


2.2 Interior Design

The interior design of Aynah includes the internal space allocation of the **residential units (in the rotating circle),** the **industrial unit(axle)**, the **central unit(axle)**, the **port/warehouse unit(axle)**, and the **engine unit(axle)**. The following will present graphs with textual explanations.

1. Residential units

The graph below shows a cross sectional look into the internal of a single residential unit, which is representative for the rest five. To be specified, the internal is divided into three main areas: Industrial-mechanical area, agricultural area, and residential area. The industrial-mechanical area serves for different functions, including but not limited to: Food production, food storage, daily necessities storage,

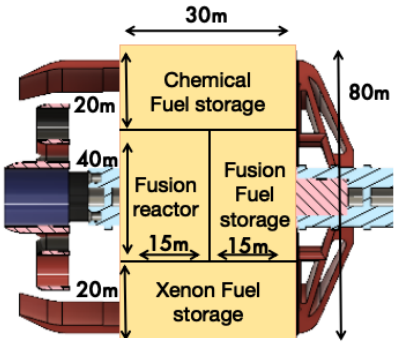


Graph 2.1.1 Transfer corridors

energy storage, water storage, robot maintenance, and robot storage. As named, the agricultural area provides space for agricultural usage, livestock farming, and aquaculture. At the opposite side to the sunlight direction locates the residential area, which provides a safe and comfortable place for human inhabitants to live in (detailed information please check *Human Factor* part). The residential and agricultural areas are surrounded by a layer (0.5meter) of water to prevent harmful cosmic and solar radiation.

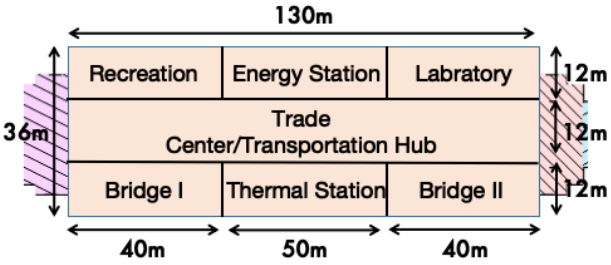
2. Axle

The axle is the non-rotating rod at the geometrically symmetric center of the entire structure. On the axle, according to the graph from left to right, there are **the engine unit, the port/warehouse unit, the central unit, and the industrial unit.**



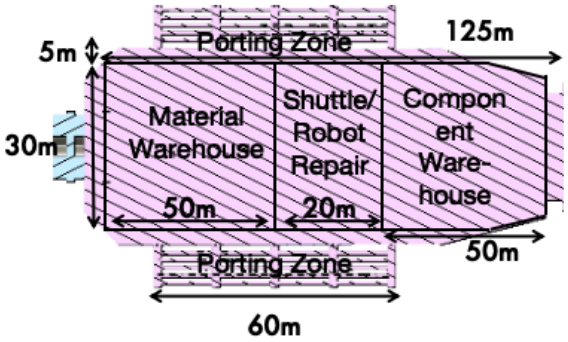
Graph 2.2.2 – Engine Unit

The engine unit has four internal parts and a external thruster frame with eight assisting chemical thruster and one main electric plasma thruster. The chemical fuel storage zone provides tanks to store liquid oxygen and hydrogen up to 3000m^3; the xenon fuel storage provides tanks to store liquid xenon for the electric plasma thruster to use. The fusion fuel storage stores helium-3 and deuterium for the fusion reactor, which provides the electricity for the electric plasma thruster.



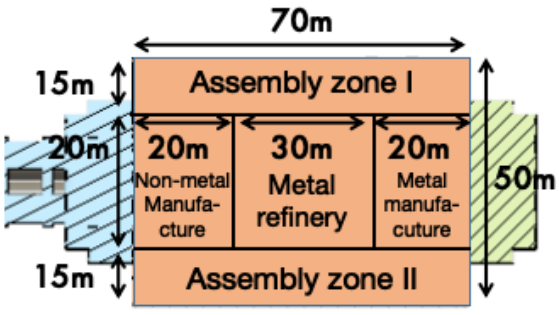
Graph 2.2.3 – Central Unit

The central unit is the largest axle unit with a length of 130m and diameter of 36m. It includes a recreation zone for entertainment, a laboratory for low-gravity research, an energy station for settlement electricity management, a thermal station for axle heat management, two bridges for settlement control, and a trade center/transportation hub at the middle for cargos, components, and personnel to transfer and trade.



Graph 2.2.4 –

The port/warehouse unit provides plenty space for material, robot, and component storage. In addition, it has an external shuttle/robot porting zone. Shuttles or robots can undergo repair or maintenance in the repair factory.

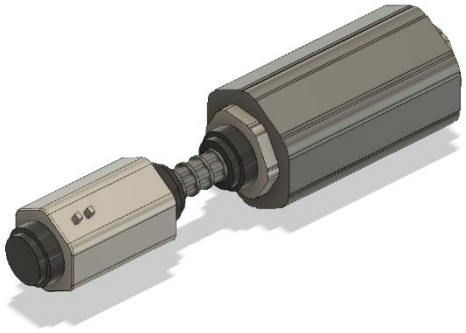


Graph 2.2.5 – Industrial Unit

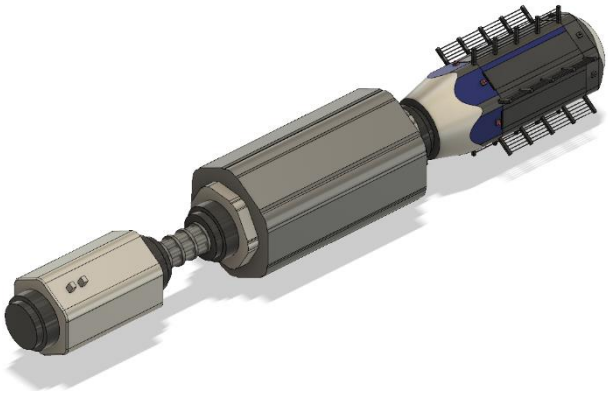
The industrial unit is the first unit to build in construction and the most important unit in the entire settlement. It attaches to six solar panels and receives energy sufficiently. In its center, there is a metal refinery which refines aluminum, steel, magnesium, and titanium, etc. Adjacent to the refinery are two manufacturing zone to manufacture metal and non-metal respectively. Also, there are two assembly zones to assemble components for construction, robots, and other products.

2.3 Construction Process

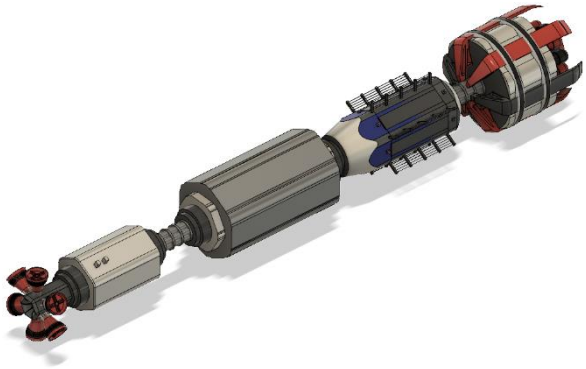
2.3.1 The construction process



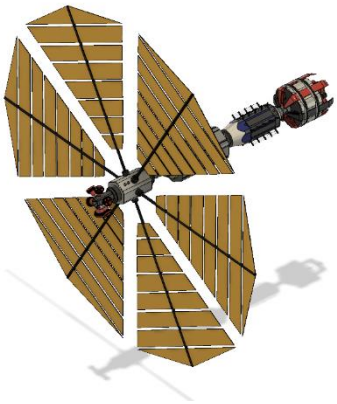
1. At the beginning, the industrial area will be constructed on Earth and assembled in the orbit around Mercury to prepare for further refining mines and building more components on the settlements which are required.



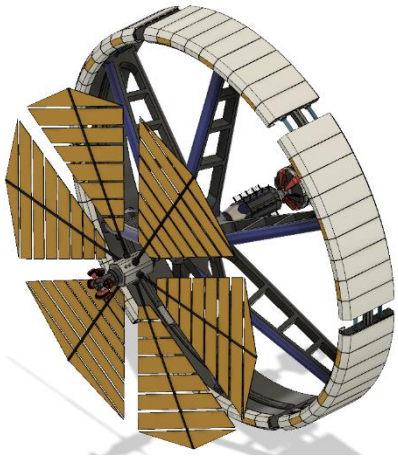
2. Secondly, the main cylinder will be built and stretch out from the industrial area, which including ports for cargo ships and cargo warehoused to store things.



3. After that, engines and thrusters to correct Aynah's position in the orbit will be done and applied to keep the settlement on the orbit.



4. Furthermore, solar panels will be installed on the main cylinder to provide plenty of electricity to operate the settlement.



5. At last, residential ring will be finished and connected to the rotating part on the main cylinder. The whole settlement starts to operate.

2.3.2 Pseudo-Gravity

Artificial gravity will be applied mainly in the human living ring to maintain residents' health and to proceed experiments which gravity is needed. There are 12 tiny thrusters on the residential ring to initiate rotation.

2.3.3 Emergency Response

There are six parts of residential area in the residential ring which are separated by six main airlocks. What's more, each block and public areas are also separated by airlocks. Before human residents arrive, all airlocks will be closed and the air pump will send enough air in the residential ring to create an atmosphere with 1 kpa air pressure.

3.0 Operation and Infrastructures

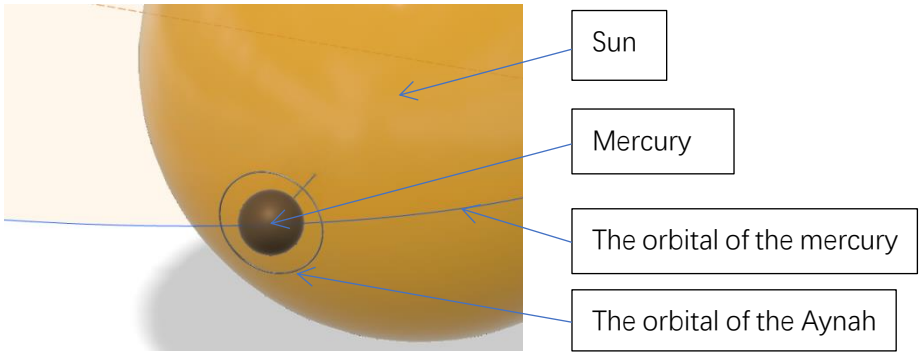
3.1 Location and Materials Sources

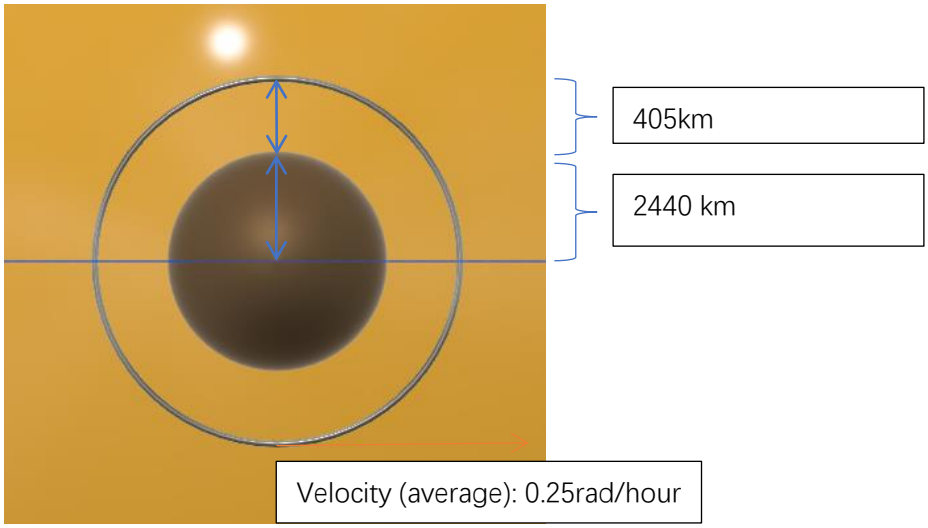
3.1.1 Orbital Altitude

The orbital is important for the space settlement because it's relevant to the basic operation of the Aynah. The details of the data and the reasons will be shown below.

Our orbital will be a perfect circle which around the Mercury and perpendicular to the orbital of the Mercury's orbital. The orbital altitude of the space settlement Aynah around the Mercury will be 405km. So, the regulation of the revolution will be 8 hours per one around. And the speed of the Aynah in average is 0.25rad/hour or0.000218rad/second.

And as this graph shown,





And the reason why we choose this orbital of these data is that

1. It's easier to get the source from the earth and from Mercury because the altitude is at middle of the higher orbital and the lower orbital, which can save the energy of the transportations because the spaceship will not cost too much energy to get rid of the gravitational force of the Mercury by this orbital. In other words, this orbital will make the settlement gains more ducking opportunities.
2. Save the space taken by the orbital because it's a perfect circle. And the circle is even smaller because the altitude is relative lower and this can be protected more by Mercury's gravitational field.
3. Facing to the sun all the time can make sure the enough solar energy income.

3.1.2 Materials

3.1.2.1 Materials usage

The construction of the space settlement will use as more materials on the Mercury as possible and a little will be carried from earth. In considering the rich of the advantages of the alloy, the element iron will mainly exist on the form of alloy. For the basic survival needed like water and oxygen, these will be gained on the Mercury and by chemical reactions, which will be explained by following proposals. The kinds of the materials as graph below;

Kinds of materials	Function	Details	Recourse
Ti alloy	Support the strength structure	Structural supporters	Mercury and Earth
Al-Si alloy		Main structure	Mercury
Mg alloy			Mercury
Si-Mg alloy (25%silicon& 1%magnesium)	Residential cycle	Residential circle outer shell	Mercury
Al-Si alloy			Mercury
Mg-Al alloy		Residential circle inner shell	Mercury
C-fiber-epoxy resin		Residential circle shell	Earth
Ceramic material	thermal insulation material		Mercury
Steel			Mercury& Earth
Stainless Steel	Inner space materials	Inner space	Mercury& Earth
Silicate		Inner space	Mercury
Silicon	Solar panels	Solar panels	Mercury
Ceramic		Solar shield	Mercury

3.1.3The sources

The source of these materials as the table shown below;

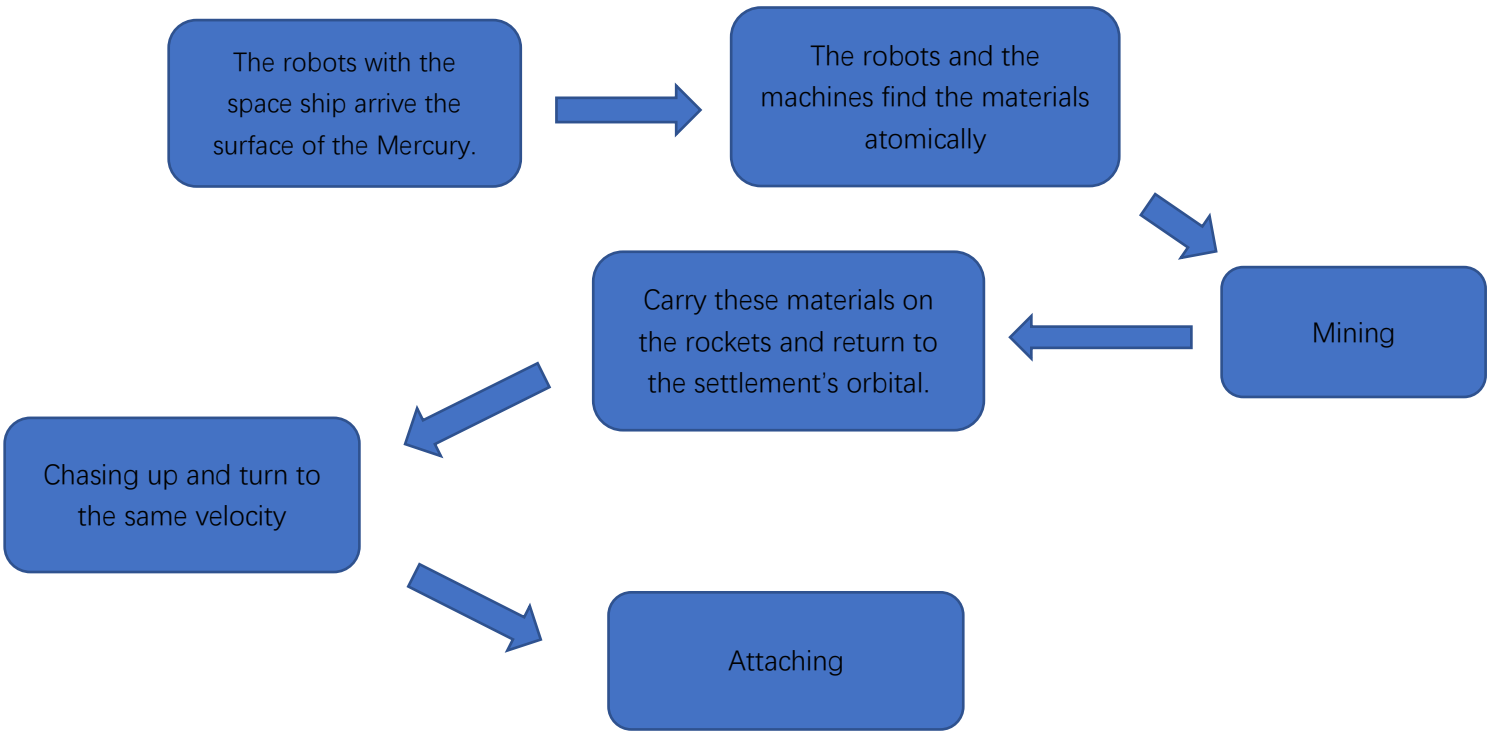
Kinds of materials	Quantity /%
Al	73
Si	9
Mg	3
Ti	5
Fe	4.1
Ni	0.3
C	3.5
Ceramic material	2
Cu	0.1

Actually, the iron was placed in the deep location of the Mercury and it might be difficult to get this kind of material. However, in some places of the Mercury, the earth crust of the Mercury and mantle was taken off. Scientists supposed it formed due to a huge crash of a meteorite happened many years ago or the erosion of the sun in many years. Anyway, it's possible to get iron and other needed materials from this special region so the requirement of the iron will be the highest one. 3.1.3 Transportations of the

materials

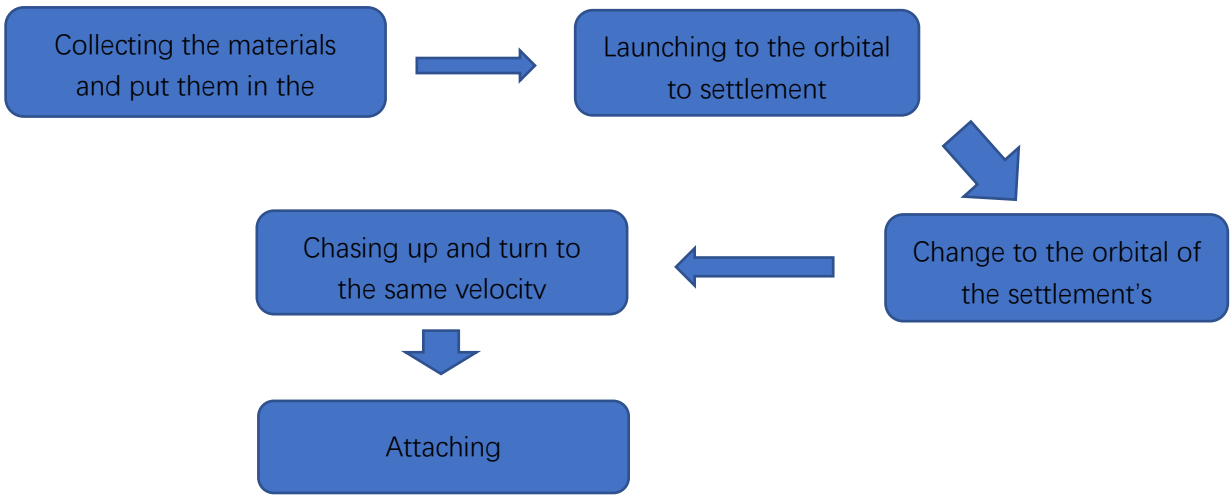
The all materials are come from Mercury and earth, so the transportation of these materials must rely on the staller rockets and the space transportation ship. The space rockets will carry CASSSC with materials from earth or Mercury to the space settlement. Specially, the equipment are needed to have the abilities to overcome the extremely temperature on Mercury.

For Mercury transportation system:



Material	Density / ton/m^3	Resource location	Usage Part	Volume / m^3	Mass / ton	Price
Al-Si Alloy	2.6	Mercury	Res-circle outer shell	403000+487000	2314000	
Al-Mg Alloy	2.75	Mercury	Res-circle inner shell	1000+2800	10450	
Silicon	2.3	Mercury	Solar panels	33912(glass)+4898(solar	89263	
Ceramic	2.7	Mercury	Solar shield	12282+64998	208656	
					total : 2622369	

For earth transportation system:



3.2 Community Infrastructure

3.2.1 Interior Environment Controlling

Component of Atmosphere	Percentage (%)	Pressure(kPa)
O_2	22	22.29
N_2	76.98	77.98
H_2O	1.0	1.01
CO_2	<0.2	<0.203
TOTAL	100	101.3

3.2.1.1 The atmosphere of residential area

The atmospheres in the residential area and industrial area is similar to the atmosphere in the Earth.

Use the pump to modify the pressure

The nitrogen come from the anaerobe which can be used to produce the available nitrogen for people, because of "anaerobe", this kind of bacteria can just be generated on the roots of the plants.

As for the generating of the oxygen, we may not pump oxygen produced by the plants in the agricultural area, because the oxygen should be provided to the fish in order to satisfy the demands of the fish under the water. (The fish are under the water which the plants are growing.)

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

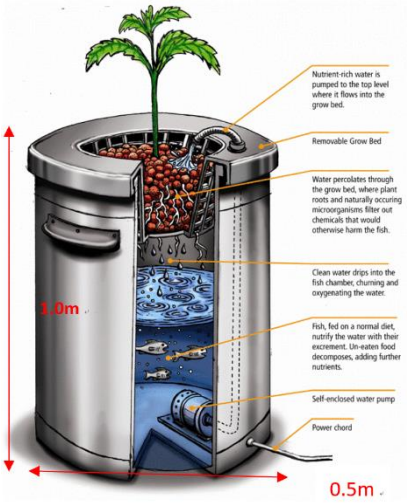
As for the season controlling system, we can use the LED which has been mentioned in 3.1 to provide the suitable light condition for different season. Also, we use the sir condition to maintain the temperature in the craft.

3.2.1.2 Climate and the weather controlling

A large air condition with the appliance of the electricity energy which can also pump the air from residential/ industrial area to agricultural area in order to establish a great circulation.

3.2.2 Agricultural operation

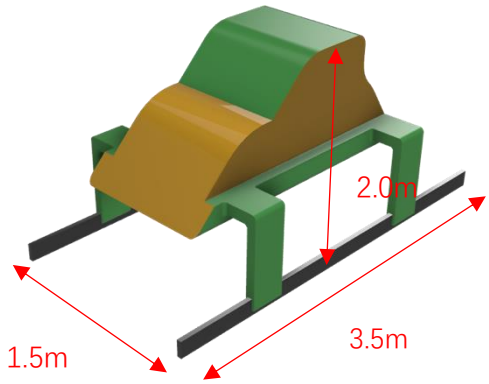
3.2.2.1 Food production



300,000m^2 agricultural area (about 6 floors, each floor is about 50,000m^2) including the growth of Purple cabbage、potato、broccoli、lettuce; also the fish in the nutrient solution. (there should be a model)The main technique is aquaponics, which is a combination of fish and plant production using aquaculture and hydroponics systems, this technology uses nutrient solutions to help to build a carbon-oxygen cycles to make fish and plants to coexist.

As for the generating of the oxygen, we may not pump oxygen produced by the plants in the agricultural area, because the oxygen should be provided to the fish in order to satisfy the demands of the fish under the water. (The fish are under the water which the plants are grown.)

3.2.2.2 Harvesting



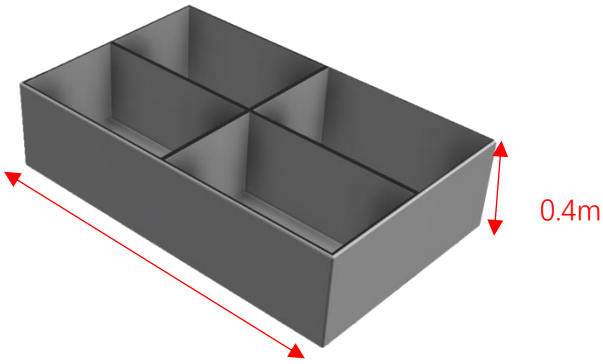
On the left is a harvesting machine. The machine is two meters high and includes the tracks below. Its length is 3.5 meters and its width is about 1.5 meters. Such a design can make it easy to turn when collecting grain. The box above is for storing grain collected by a mechanical arm at the bottom of the machine. The slides on both sides of the bottom have fixed directions and can power the machine. On average, about five such robots are used per hectare of land. In the boxes above this machine, in can automatically pack food in sterile environment and turn it into “food boxes” when it is produced. Selling these "boxes" directly.

Selling of the food:

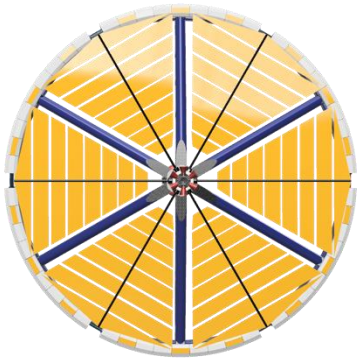
1. We can sell them directly to the consumers on the spacecraft
2. We can sell these foods to the people who come to visit – the short-term visitor.
3. We can just store the food from different condition and give these to whom do the experiment on the earth

3.2.2.3 Storing

Under each agricultural plot there is a large warehouse for storing grain. Because most of the grain is hydroponically cultivated, the lower temperature of water can be used to ensure that the food will not deteriorate or rot for a relative long time.



3.2.3 Electric Energy



3.2.3.1 Generation 2.0m c power

Mainly from th anels group which is (1.0m e spacecraft. As for the panels group which is gold in order to conversion more electricity, it includes 6 pieces of panels and the radius is about 1,000m.

3.2.3.2 Allocation of the electricity

Types	Residential	Industrial	Agricultural	Operation	Total
Electric energy/kWh	3266000	249900	57600	10000	3673500

3.2.4 Water

3.2.4.1 Water supply

We should have about 200L per person per day for the residents, as for 14000 residents, we should have almost 2,800,000 liters per day to supply the residential needs. (Without the visitors)

2,840,000L, as for the time period which there are some visitors on it.

(Only Drink)

Water circulation:

For the transferring of the water, we can just bring lots of water from the Mercury and distil them using the heat from the the electric energy.

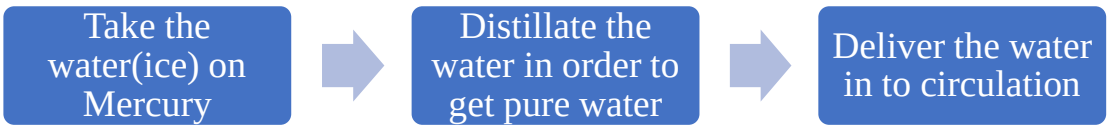
The E-energy used in distillation per day:

2800 t*2.26*10^6 kJ/t = 6.328*10^12 J = 1.76*10^6 kWh

2840 t*2.26*10^6 kJ/t = 6.42*10^12 J = 1.78*10^6 kWh

Initial water supply:

3.2.4.2 Water quantity



The water consumption in the whole industrial area is about 1600 tons. The water consumption in our whole area mainly includes residential water, industrial water and agricultural water.

	Residential	Agricultural	Industrial	Total
Quantity/ L/day	3,000,000	11,500 (circulation)	1,600	3,001,600

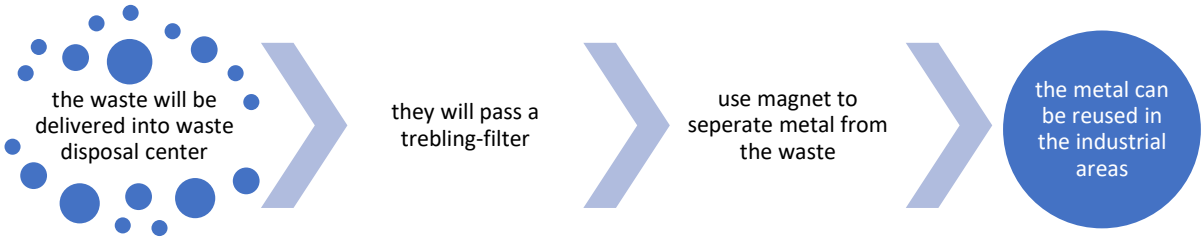
3.2.5 Solid waste management

3.2.5.1 Residential solid waste:

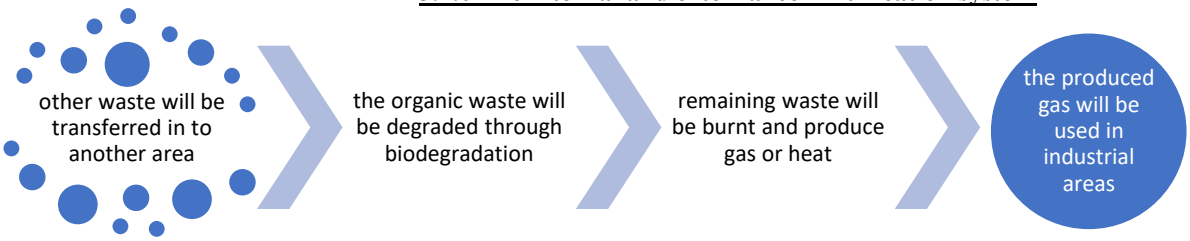
There is a large garbage transfer station near all the residences. Everyone can throw the garbage directly into these containers. The containers will be cleaned automatically periodically, and the garbage will be transferred to the treatment center for disposal.

3.2.5.2 Industrial solid waste:

There will be a lot of scrap discharged from industrial areas containing very high levels of metals. We will regularly clean up the waste disposal systems of these factories, classify them and prepare to deliver them to the waste disposal center.

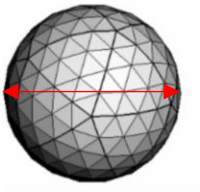


3.2.6 The internal and external communication system



The internal communication system of Aynah will take the measure of putting all the functions to a pair of glasses which allow you to communicate with others and given orders to the auto-system. It will also give the passenger privacy, which only send the message or location while you give it orders (except for some emergency situation).
For the emergency health problems, personal devices will also contain the equipment to detect heart rate, breathe…… to avoid some erupt diseases. By connecting personal devices to the central computer, Aynah could send medical professionals and medical devices to the position.

Talking about the external system, Aynah would use the satellite to communicate with the earth or other stations. For receiving the signal for others, Aynah will set 2 aerials which could get the message from either side. The aerials will be used a shape of polyhedral structure to receive more message from different sides. Aerials will be set on the central part of the settlement and send essential message to the earth or other settlements.
The diameter of aerials will be 10 meters.



There will be two aerials to receive message from satellites or planets.

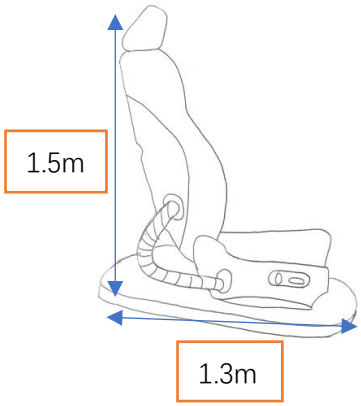
Internal transportation system

1.

There will be two kind of internal transportation systems. The first one is made for traveling through the ring. The second one is the way from the ring to the central part of the settlement.

About the vehicle using among the ring, considering there will be 14200 people live in the settlement,

there will be 2000 vehicles set in the ring. This system has connected with the internal communication system (the glasses), which allows resident to call the vehicles, and set the destinations. While the vehicles having a bad battery, they will be charging at the charging point, which exist among the ring. And there will be one repairing center for them.

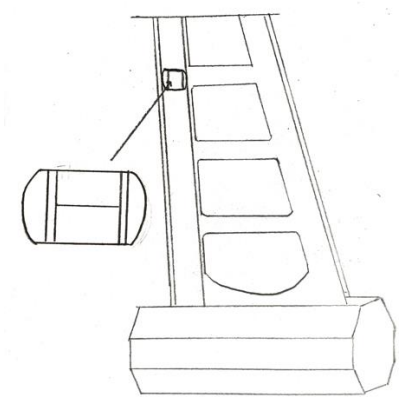


For special uses, there will be a board that could allow crews to lay down.

2.

Considering the rotation speed

There will be three transportation equipment connecting the ring and the central part, which will be set in the connecting part. The carriage will run in the tunnel among the connector.



As the carriage go down to the center, the gravity will getting smaller. In order to prevent the uncomfortable while the radius is too small, the carriage will have self-rotation. And there will be construction to regular the goods. The height of carriage is 20 meters and separate into two floors. It will take 5 minutes to finish a one-way journal.

3.2.7 Day/Night Cycle and Storage

The LED board will be set on the top of residential part. The older to make up an environment that is similar to the earth, the intensity of lights will change between different times in a day. For example, the intensity of lights will be weak in the morning and strong at the noon.

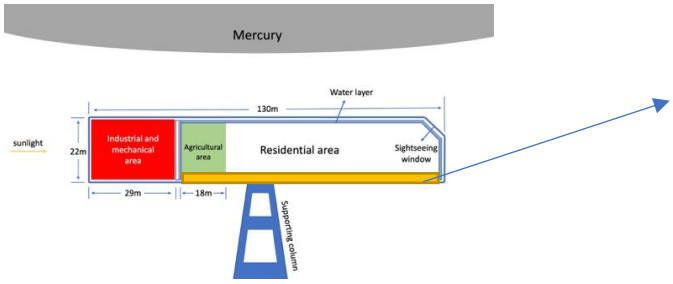
Specifically, the lighting time of agricultural part will be extended properly, in order to get larger output. The night time will not only be dark on the ceiling, actually, Aynah will imitate a view of starry sky, to prevent the feeling of oppression construct by low ceiling.

Daytime schedule

	Begin	End
Spring	7:00	18:30
Summer	6:30	19:00
Autumn	7:00	18:30
Winter	8:00	18:00

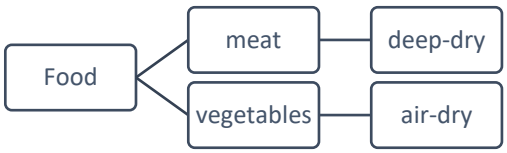
Illuminance schedule (Lux)

	Morning and afternoon	Noon	Average
Spring	800lux	3000lux	2000lux
Summer	1000lux	4000lux	2500lux
Autumn	800lux	3000lux	2000lux
Winter	6500lux	2500lux	1500lux



The yellow part will be set for lighting board, it can also be opened for the views of space.

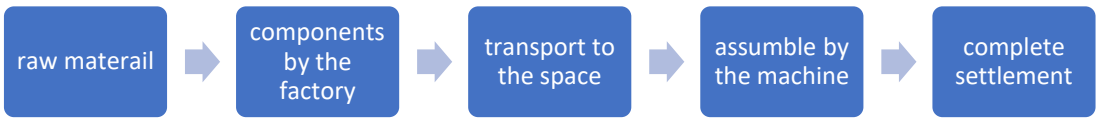
The storage part will be set in the ring, which has a low temperature and low density of oxygen. Some of the food will be make up to the cans for a long time storage which could be help while facing some emergency condition. And some of them will be stored as fresh vegetables, for daily consumptions. The fish can be done with deep-dry in order to stored longer. To be more specific, the temperature will be hold at 4° C to protect the food. Specially, some extra food that won't be used for a period will be cooked and packed into instant food to solve the emergency situation. The design of *Aynah's* has considered the situations that may cause interrupt plant growing for three months, thus, the storage part of *Aynah* could support lives of 14200 people for at least three months. More than that, the diet of *Aynah's* crew will be definitely healthy and support all the need of nutrition.



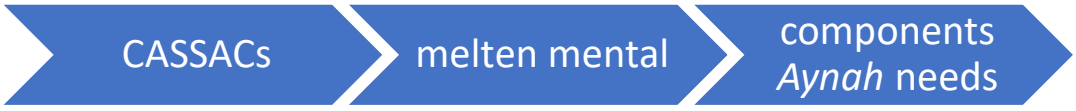
The storage will be renew as the new crops and meat create, to keep a high level of best-before date. After calculating, the storage part needs the volume of 6800m^3 to support people's needs for three months.

3.3 Construction Machinery —— The materials and component and the use of CASSACs

The materials and components will be made on the factory which exist on Mercury. As the factory finish it, they will be sent to the outer space and assemble in the space by machines. CASSACs will be used to transport the component to the space and after that, they will be melted to the raw material.



In order to solve the problem of transport and storage using, part of the CASSACs will be saved, instead of melt.



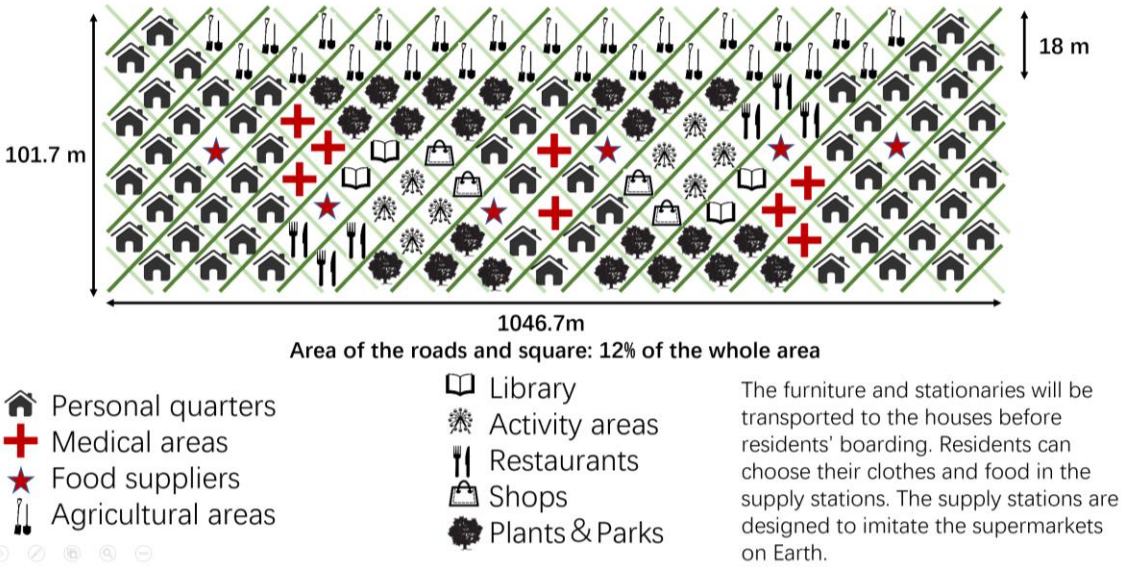
The details of the sorts and different functions of the machines and the equipment will be shown as automation's parts. And here is a table from automation about the types of all the equipment.

Name	function	number	Min-size (volume and weight)	material
Pioneer	Internal	Initial:1	15m^3	Aluminum alloy

	construction robot	After:16 surface	2 tons	
Pirate	External construction robot	Initial:1 After: 16space	$15m^3$ 2tons	Aluminum alloy
Digger	Mining robot	40	$15m^3$ 2tons	Magnesium alloy
Waggon	Transportation robot	80	$25m^3$ 1t	Magnesium alloy
Band	Communication and individual device	14,000	------	Robber
Dusk Killer	Domestic robot	13,500	$2.8*10^{-3}\ m^3$	Aluminum alloy

4.0 Human Factors and Safety

4.1 Community Design



The total area of the community is $638969m^2$(101.7m×6280m). The diamond shaped map of the community distribution is shown above. In order to guarantee the safety of the residential area, the community is divided into six same communities. Different communities are set on separate boards. Thus, the map shows the distribution of one single community.

The community is mainly divided into 7 parts: personal quarters (35.5%), medical areas (5%), access to good food(4%), agricultural areas (15.7%), entertaining areas (17.8%), plants and parks (10%), and streets (12%). In between, the streets are not shown in the map but are built along the green lines in the map. The entertaining area is divided into 4 parts: library, activity areas, restaurants and shops.

Specifically, the community is symmetry in general. There are three housing areas in one community, with a medical area for each. The entertaining areas are arranged between three housing areas. The agricultural area is a separate area for the better management and control.

To be remarkable, both the food suppliers and restaurants are the accesses to good food. But people can get free and merely fixed kinds of food from the food suppliers freely every day, whereas they can buy better food with more choices at restaurants with money.

Term	anticipated quantity/person/year	total anticipated quantity/year	description	source
food	820kg	11644000kg	grains, vegetables, meat, eggs, fruit	produced from the farm land
wash supplies	20kg	284000kg	tooth brushes, soup, combs, shampoo, etc.	earth and shops
office supplies	10kg	142000kg	pens, paper, glue, etc.	earth and shops
clothing	40kg	568000kg	outer space suits, inner space suits, shirts, trousers, sweaters, etc.	earth and shops
stationaries	300kg	4260000kg	furniture, experimental supplies, etc.	earth and shops

The costs of daily resources and their sources are shown above. The supplies are distributed to their places before human settle in. extra suppliers are stored in the basement of the food suppliers and the shops.

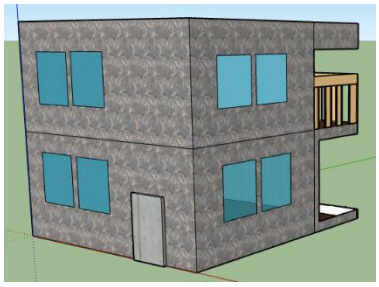
4.2 Residential Design

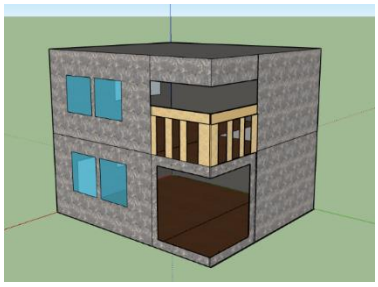
According to the requirements of RFP, we have designed four different models for single, families, couples and visitors. We plan that they have the same shape, but different lengths, heights and floor plans.

Each house has two-floor buildings connected by stairs and four windows on three sides of the house. One floor is separated from the other, even if they are in the same building. (which means, a building with two floor and hold two different families). To guarantee the security and privacy for each floors of residents, people living in the second floor are needed to climb the ladder out of the house to reach their floor.

Every house is assembled with containers (CASSSCs). Apart from families, for the other three groups, we adopt the way of joint rent, which can save space and meet the requirements of each room area.

Below are the illustrations of different angles of the house. (The specific sizes of the houses will be shown after several paragraphs)



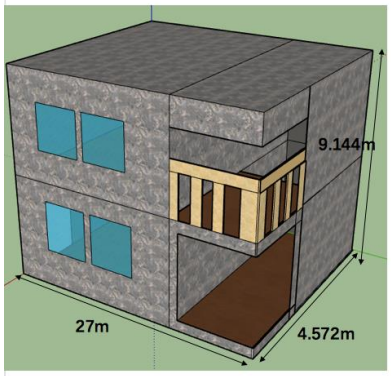


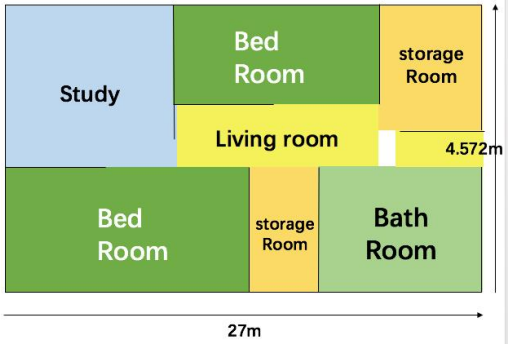
This is the specific data for each type of household.

Four types of houses (number of people on each floor)	Quantity of containers (CASSSC)	Number of households (per floor)
single (4)	3	1225
couple (2)	2.5	3500
family (3-4)	3	700
visitor (6)	4	33.3 (34)

The following is the floor plan of each type of apartment and the corresponding length, width and height as well as the area occupied.

4.2.1 Type 1: For Families (3-4 people living together)



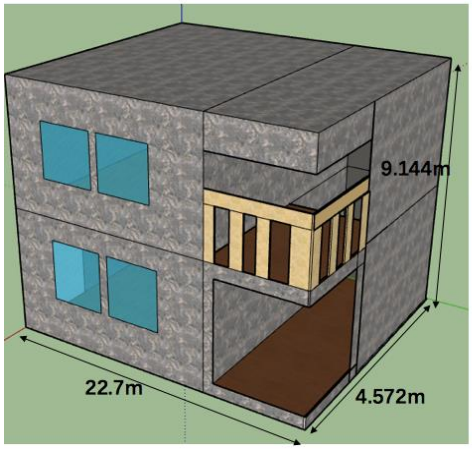


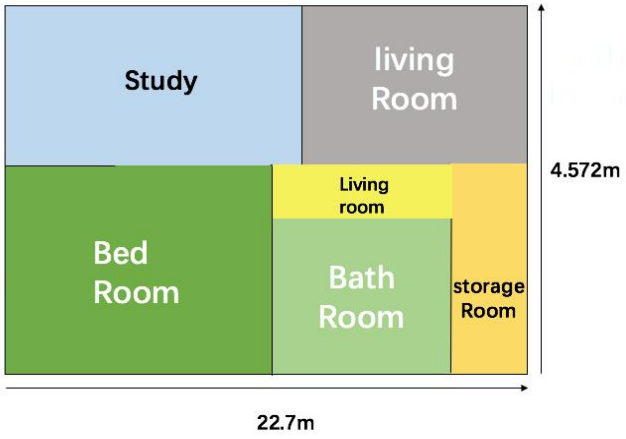
the number required of this design：350

For families

area：123.444 square meter

4.2.2 type 2: For Couples (2 people living together)



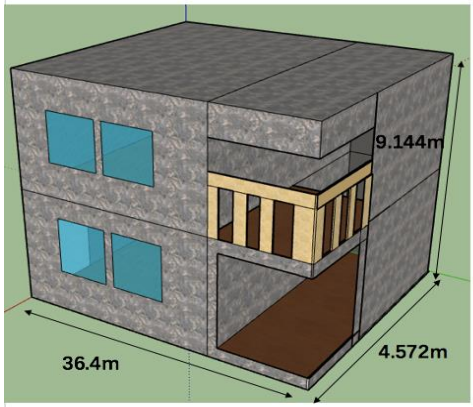


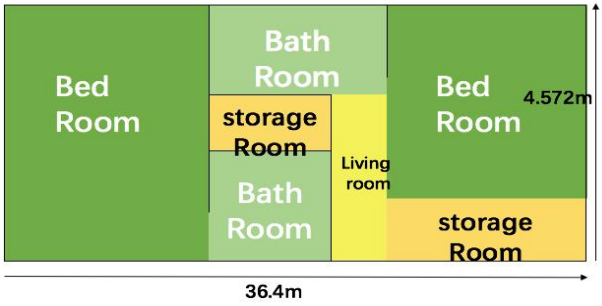
the number required of this design：1750

For couples

area： 103.78 square meter

4.2.3 type 3: For single men/women (4 single people living together)



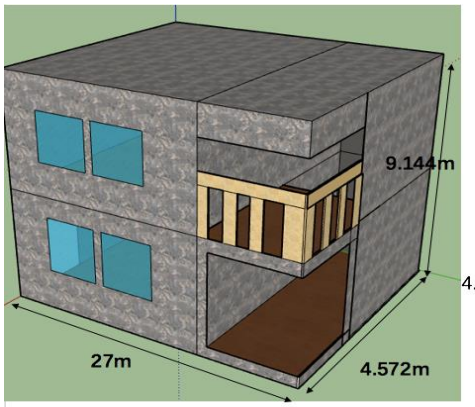


the number required of this design:17

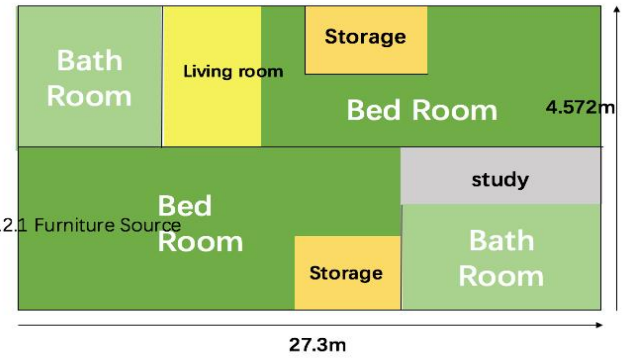
For visitors

area:166.421 square meter

4.2.4 type4: for visitors (6 visitors living together)



4.2.1 Furniture Source



the number required of this design：613

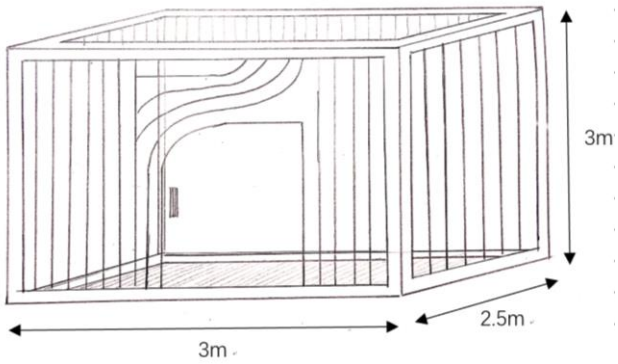
For single

area：124.8156 square meter

4.3 Safe Access

These designs below are something enabling safe human access to any location on or in low-g settlement areas.

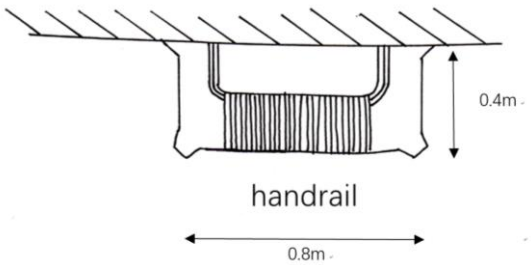
4.3.1 Cage



The cages will be installed on the back of the people to keep the safety of the astronauts. Inside the cages, are the necessities for the astronauts supplying for the normal life in emergency or out-space activities.

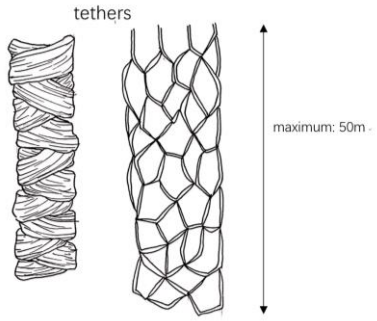
4.3.2 Handrail

Handrails will be installed on each floor and each room nearby doors and airlocks to guarantee human safety when emergencies happen. Human can use handrails as supporting tools to keep balance under the low-g condition.



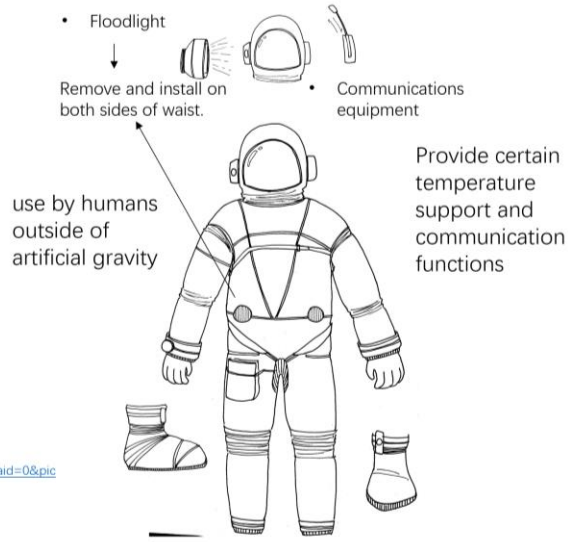
4.3.3 Tethers

Tethers can also link spacesuits human wear and room they stay. There are two types of tethers, one is heavier and has greater tension which means it can tolerate much more pressure, another is lighter and more convenient for storage and stretch. The heavier one is designed for emergency, Lighter one is for daily protection.



4.3.4 Spacesuits

Types of spacesuits	Quantities
Portable spacesuits for emergency conditions	14200



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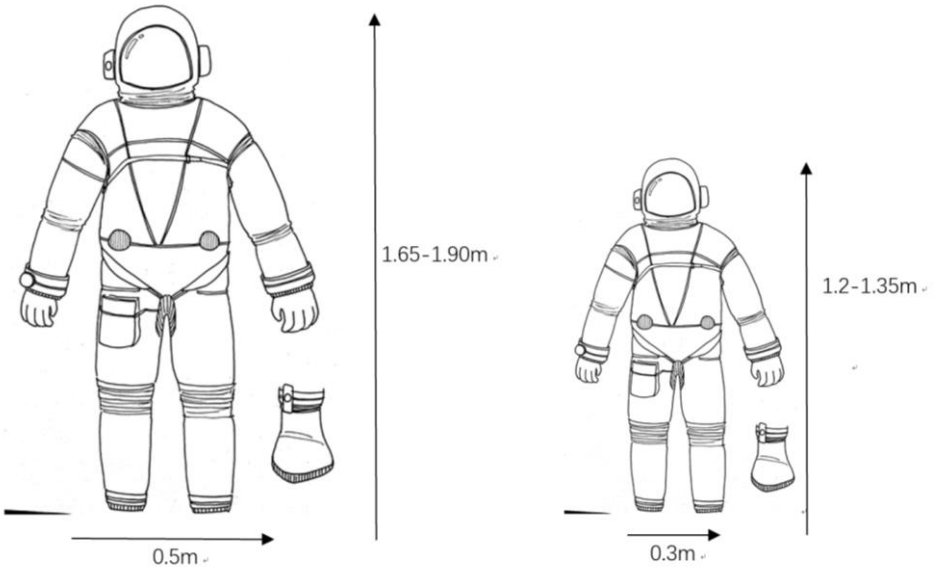
"Science popularization in China"

Those spacesuits are flexible which can be stretched from a proper range. And, these spacesuits are designed separately, consists of adult size (both visitors and citizens) and child size. The total amount of spacesuits will be 14200, which include 700 for children, the rest for adults.



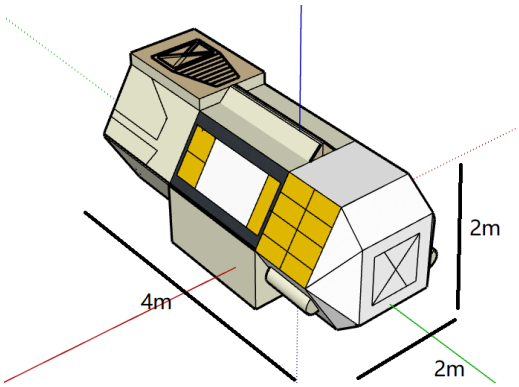
5.0 Automation Design and Services [computer and robot systems]

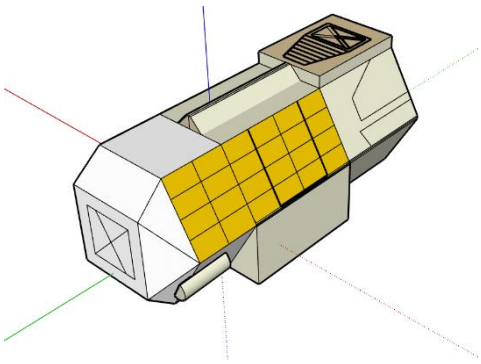
5.1 Automation of Construction Processes

5.1.1 Using of automation in construction

Brief introduction about construction robot

The using of automation equipment in construction is separating in to internal constructional robot and external constructional robot. The internal robot is design for assembling of the settlement, soldering smaller size of the medal building material. The external robot is design to help the building robot arm to assembling the main scale of the settlement, including the external armor and the solar panels. The constructional robot can be separated into 3 segments, the main body, robot arm and the motor equipment.





Introduction about the main body of the robots

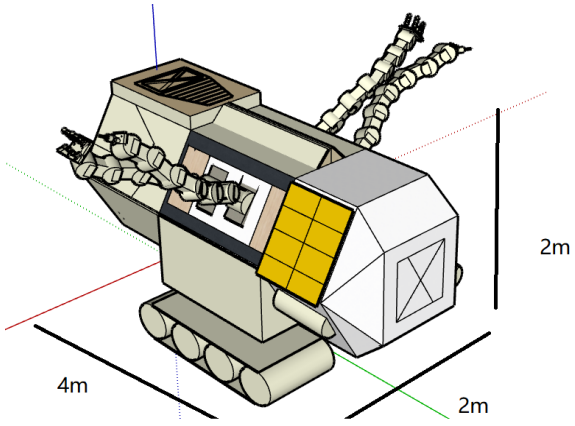
The main body part as the core of the robot is mainly made by aluminum alloy (material from the Earth) or magnesium alloy (from the Mercury). The main body of the robot can be viewed as three part. The head of the body serve the role of an individual center controller. The second part serve as the storage of robot arms, and robot can adjust arm length and chose the right type of robot hand catching, transporting, and soldering. The surface of the first and the second segment is partially covered by solar panel which mainly support the energy for the robot when it is assembling the material. The third part is combined with the energy storage and the cargo storage.

The initial rocket will carry two construction robot and fly from the earth to the orbit of the Mercury. This rocket will be sent one robot B1 to the surface of the Mercury. The robot B1 serve the job to produce more robot which all same the same function as B1 but made with Mercury material from the manufacturing facilities which already existed on Mercury. They are going to build the refining base, transport material, build the transportation system between the surface of Mercury to the settlement.

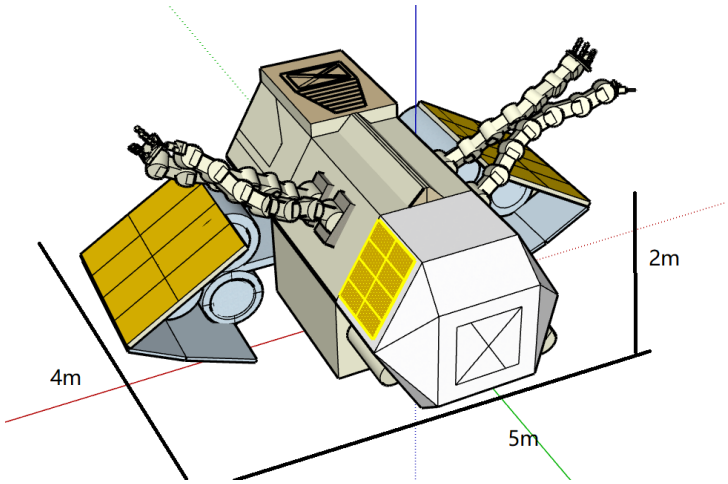
5.1.2 Constructional robots

5.1.2.1 Internal constructional robot -----Pioneer

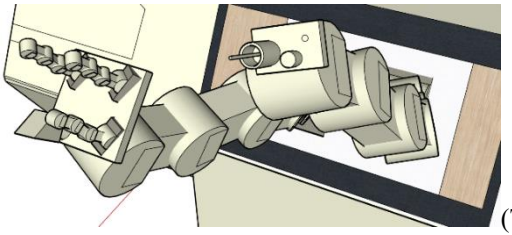
The internal constructional robot has the apron wheel for its' motor system, and the maximum number of the robot arm is 4, and the maximum length of it is 10m. The solar panel on the surface can be withdraw and offer rooms for robot arm to move.



5.1.2.2 Exterior constructional robot-----Pirate



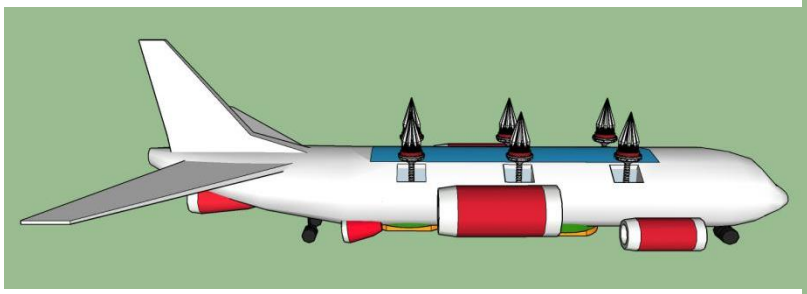
The external constructional robot has the similar main body (solar panels position has changed), but the motor system has changed from apron wheel to 6 ejectors (3ejectors each side) and there are extra panel on each side of the wing.

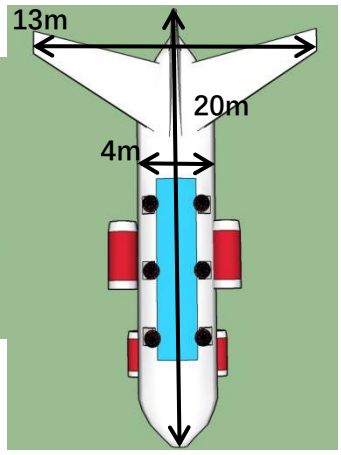

(The detail of the robot arm and hand)

5.1.3 Automation for transportation and delivery

In the task, automation equipment will be used to delivery building materials and robot components. The route is from the surface of Mercury to orbital near Mercury.

The following robot is delivery robot which is like a plane:

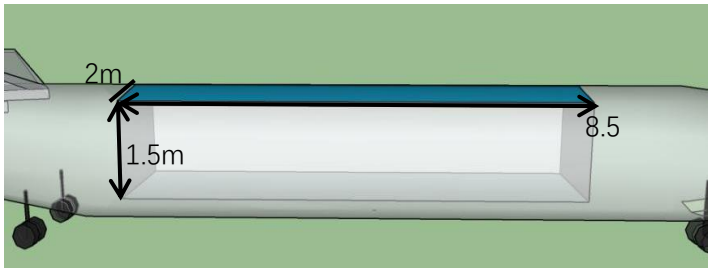




The robot has a huge body to satisfy the carry of high-quantity cargo. So it can carry lots of material in short time just by itself. The reason

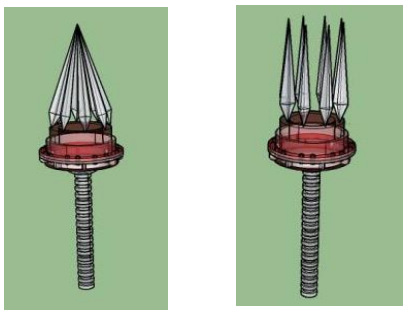
why delivery robot has a plane-like shape is the structure of plane tail can keep body stable. As a result, in the process of flying, robot needn't continually adapt the propellers for balance.

Energy of robot mainly supported by liquid hydrogen combustion (specific details introduced in5.3) and partial supported by solar power . Solar panels are installed on the tail of robot and they convert solar energy into electric energy to provide energy for drive of plasma engine and other essential functions. Plasma engine are basically set on the left and right side of robot to provide power. Thrusters on these two side can spin freely to adjust flying direction. Besides, there are two compound thrusters just at the bottom of robot, which do the work to rise delivery robot up without running on the track. Also, they reduce the press of wheels by acting force onto the ground at the moment of landing.

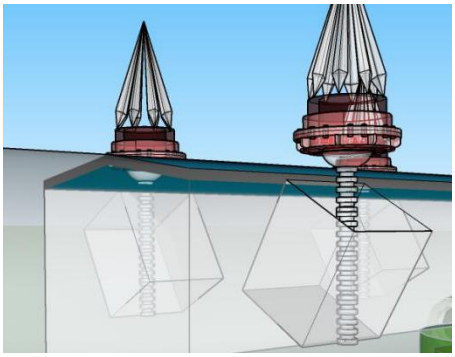


The robot uses a large cuboid container ($25.5m^3$) to store materials. When robot is carrying and flying, glass cover closes to seal up container; when robot isn't carrying or flying, glass cover opens automatically. At the same time, if there is cargo in the container, robot hands next to the container will take cargo out. This can rise the work efficiency and save a little time.

About the robot hand, it has flexible arm which could bend to any directions easily, as well as 8 strong and long paws that could hold big goods and move them efficiently. If the robot hands are not being used, they will be stored in a proper room, so they won't explore outside.



Robot hand



5.2 Facility Automation

5.2.0 Introduction of robot

Inner and exterior constructional robots separately transform into inner and exterior robots for maintenance. In other words, they have same body. And the only difference between them is various robot arm and extra protective material.

In order to work in extreme environment and violent solar activity, exterior robot for normal and urgent maintenance are protected by aluminized fabric, a kind of material with high-temperature stability (1000℃) and radiation-protection.

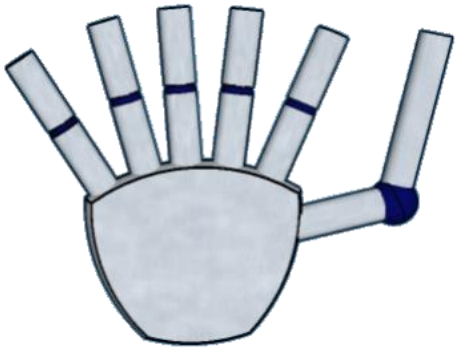
Aluminized fabric

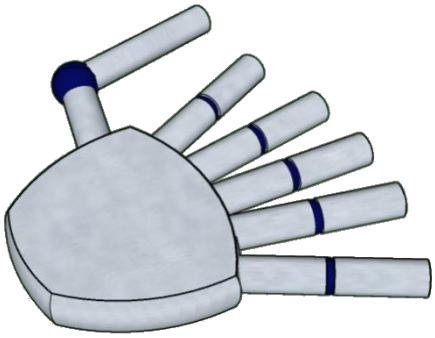
http://www.huishangbao.com

5.2.1 Robot for maintenance

This is the common hand for both interior and exterior maintenance robot. It has 6 fingers that is similar to panda's hand, and the design ensure robot to hold large goods firmly. Also, because it is made from aluminum, a rough metal which has friction factor of about 1.1, the hand could hold extremely huge things. The hand has two mainly function. Firstly, holding things, such as tools of repairing, components and broken goods. Secondly, installing or changing specific robot arm for itself. Each robot has 3 "panda hand" and other 5 hands can be installed to work as multiply tools. Robots just need to match the complementary structure of arm and hand, then the arm and hand will be fixed.

In the process of work, robots use their equipment of flaw detection to check if there is damage. After that, they use tools in their "panda hand" or hands of tool to solve the problem.





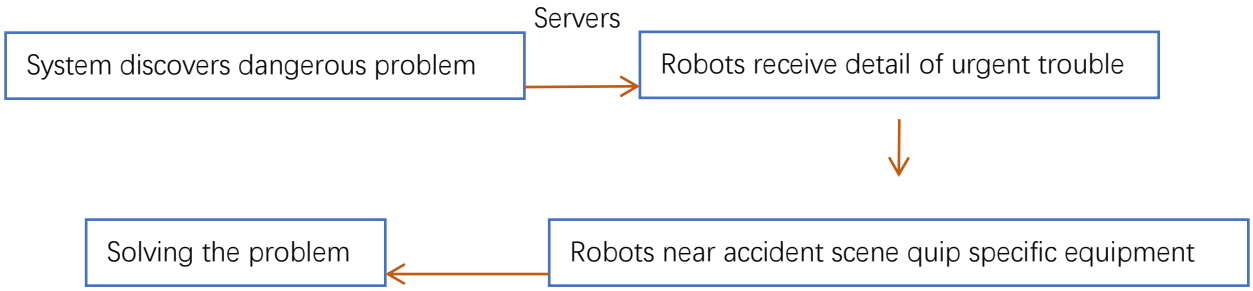
5.2.2 Robot for urgent repairing

Interior urgent robots as well as exterior urgent robots are transformed from exterior constructional robots. Because exterior constructional robots have ejectors to ensure fast moving. And they haven't "panda hand", all the 8 robot hands are used as tool.

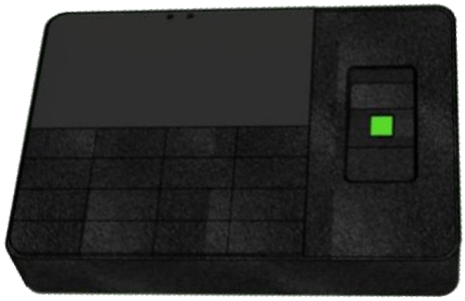
In addition, urgent robots don't work in normal time. They are stored in the warehouse. Therefore they'll

equip themselves quickly by using numerous equipment in the warehouse in urgent situation. Also, before executing task, robots will calculate a plan. So, in the process of urgent repairing, they needn't communicate with headquarters. This avoids electromagnetic suppression and shielding of solar flare to affect the communication.

The solution of urgent situation:



5.2.4 Accessing critical data



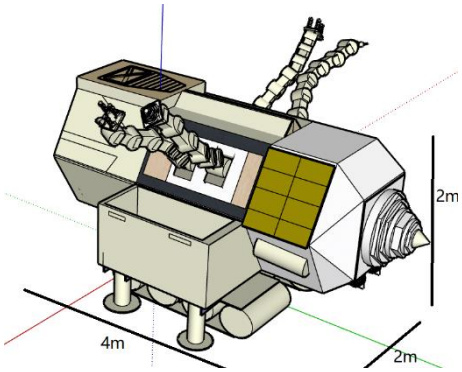
Identification machine

IM is connected with computer to offers identification of fingerprint, face and password. People can access critical data after finishing all the three identifications. If any one of the three fails, the person won't access successfully.

5.2.5 Backup system and plan

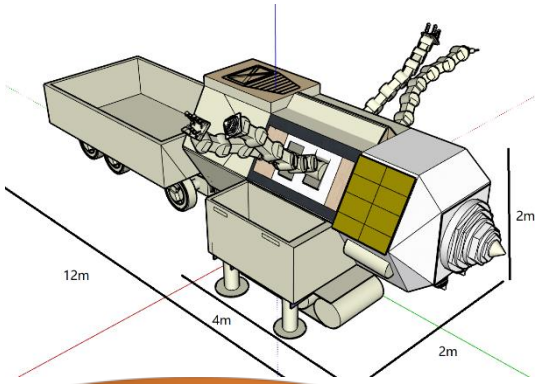
Electronic system	Main server has a same backup server, they are placed in two different place. This ensures server will still work if one of the main server is destroyed.
Water and Food	Water and food will be stored in normal days. So when some mistakes happen, food and water will be offered continuously.
Energy	Power station in the space station can offer the energy for at least 5 days, after energy stops producing because of some fault.
Broken room	Closing and insulating the broken room and using air in the air chamber to adapt air pressure to the normal.
Exploding & Burning	System closes relative rooms rapidly, then using carbon dioxide, water or other methods to put out a fire. Finally, adapt carbon dioxide ratio in irrelative rooms.

5.3 Habitability and Community Automation



5.3.1 Mining robot----Digger

The mining robot serve the role to exploit the ores, whether on the surface of Mercury or in the pits of Mercury. It can shatter bigger row ore into small chunk then collect them into their portable storage on the side of the main body. Robots hand have the function picking up ore chunks, shattering, collecting ore powder. The maximum storage ability is 2 m^3 .



5.3.2 Transportation robot -----Waggon

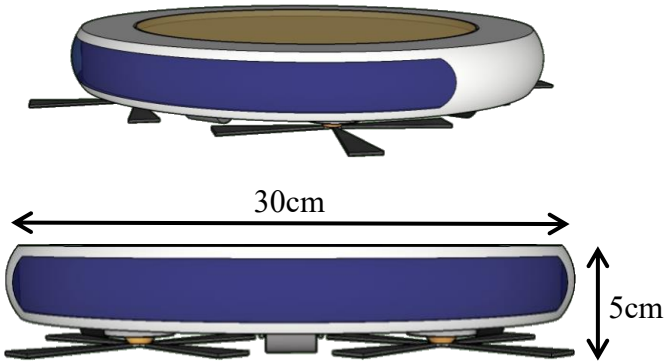
The transportation robot have no individual power system, so it need to work with other robot like Digger or Pioneer. It serve as the transportation only on the surface of the Mercury, the maximum storage volume is 25m^3(inner length:8m; inner height: 1.6m; inner weight: 2m)

5.3.3 personal information processor VOR watch

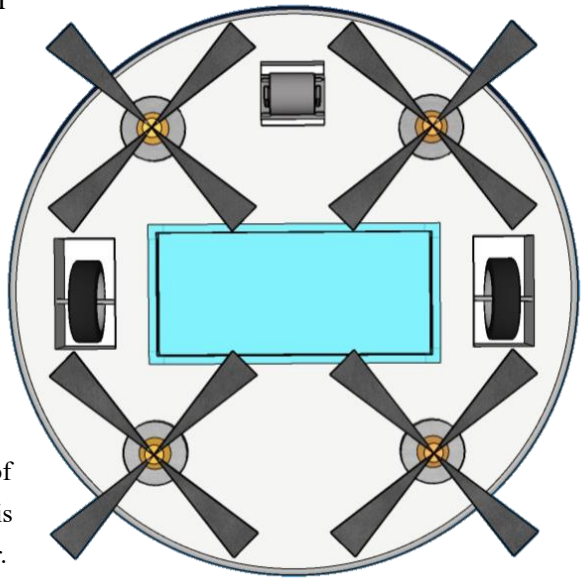
Everyone in the space station has a VOR watch. The watch looks like a bracelet, it's convenient. Although it seems too simple to do lots of things, it can do all the things that a phone can do. Small light point on the watch is a liquid crystal screen, and it shadows phone page on user's finesse. Users just need to touch the screen on the finesse to control the watch. Besides, people with spacesuit can also control the watch by touching the screen on the suit. Therefore, people can use their "phone" anywhere and anytime without using hand to hold the "phone". The watch can be powered by using polar energy or charging.

(wearable.ofweek.com)

5.3.4 Household robot ---Dusk Killer



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.



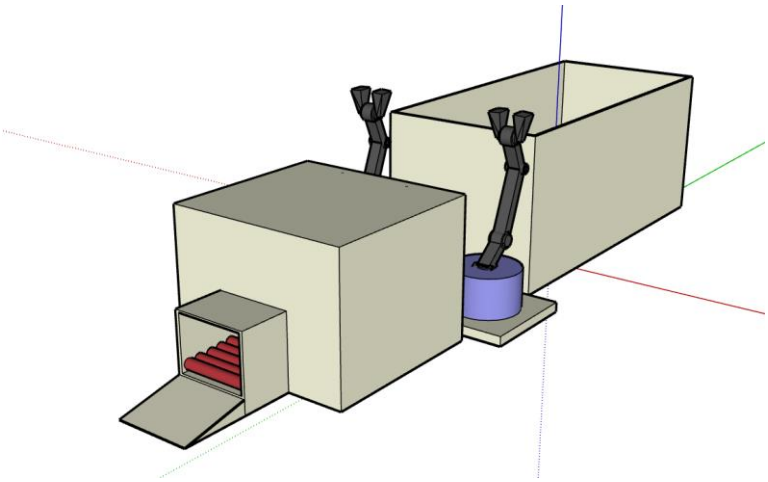
The picture on the right is the bottom of the cleaner robot. Four brushes which can spin freely are arranged regularly in the four corners. Their function is to sweep dust to the tiny vacuum cleaner in the center of the robot. Besides, there are two kinds of wheels at the bottom. The wheel in the front

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.

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.

Name	function	number	Min-size (volume and weight)	material
Pioneer	Internal construction robot	Initial:1 After:128 surface	$15m^3$ 2 tons	Aluminum alloy
Pirate	External construction robot	Initial:1 After: 128space	$15m^3$ 2tons	Aluminum alloy
Digger	Mining robot	80	$15m^3$ 2tons	Magnesium alloy
Waggon	Transportation robot	80	$25m^3$ 1t	Magnesium alloy
Band	Communication and individual device	14,000	------	Robber
Dusk Killer	Domestic robot	13,500	$2.8*10^{-3}$ m^3	Aluminum alloy

5.3.5 The refinement of the mineral and the power resource

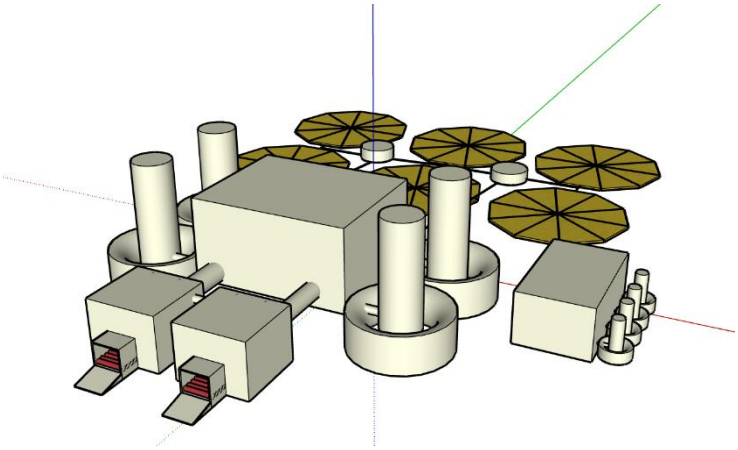


The refining factory

The refining factory is constituted by ten of the refinement unit (show in the graph)

The refining factory mainly produce Silicon-Aluminum Alloy. The running energy of heating raw ores are provided by liquid hydrogen combustion from the Power factory. The whole refining factory yield

The power factory



The power factory produces the liquid hydrogen and oxygen for the power system liquid hydrogen combustion.

The power factory has two basic working steps. The first step was use the electricity collected by 6 (200m^2) large fan shape solar panels to melt the water and use the brine electrolysis to separate oxygen gas and hydrogen gas. Second step is to condense two gases in to liquid form and reserve them in bottles or straightly transform them to the robot.

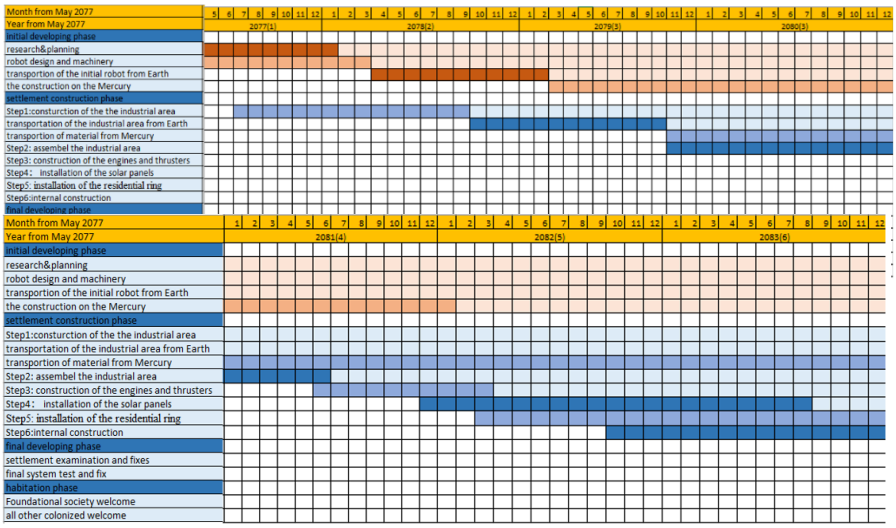
The strategy adopted by Auto is to use solar energy to electrolyze ice for fuel, so that the robot can reproduce itself, so most of STR's construction materials can be obtained from rocks and metallic minerals on mercury and transported to mercury orbit using the chemical energy of ice, so there is almost no Cost. The cost in the table here mainly takes into account some necessary materials/equipment that can never be obtained or processed from mercury, such as metal processing machines, assembly lines, cables (rubber), organic materials, precision electronic chips, computer control equipment, etc. They make up most of the cost. Because they need to be transported from earth. Transportation cost: 2000$/kg according to our research.

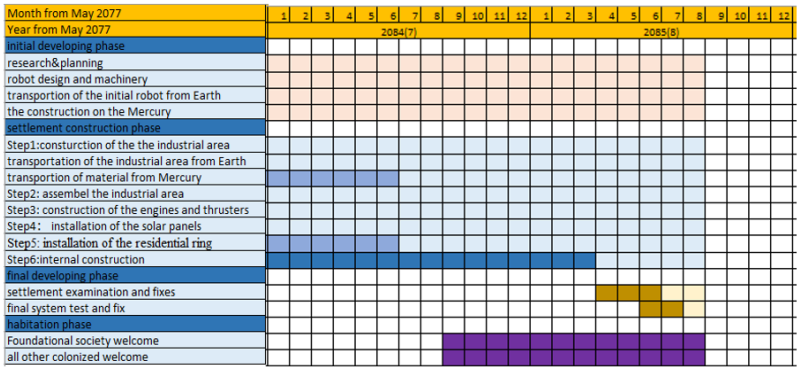
The transport spacecraft adopts chemical + electric hybrid propulsion, and the whole route is divided into two parts: earth surface -oribi, orbit- mercury orbit. The first part is chemical propulsion, and the second part is electric propulsion, powered by solar energy.

6.0 Schedule and Cost

6.1Schedule

The whole construction from the beginning research to the end required 8 years and 1 month.





6.2 Cost

The total cost of **structure**: 9.2B

Structure cost	
	Cost
Phase1: Construction Frame Establishment	500M
Phase2: Construction of Industrial Unit	1B
Phase3: Construction of Engine and Thrusters	500M
Phase4: Installation of Solar Panels	100M
Phase5: Construction of Port/Warehouse	500M
Phase6: Construction of Central Unit	5B
Phase7: Construction of Supporting Columns	100M
Phase8: Construction of Residential RIng	1B
Phase9: Internal Construction	1B
Total Cost	**9.2B**

The total cost of **operation**: 16.64B

	Quantity	Unit cost	Total cost
communication system	2	120,000,000	240,000,000
Lighting board	628,000m2	1,000	628,000,000
Transportation system 1	2,000	12,000	24,000,000
Transportation system 2	3	65,000,000	195,000,000
Converting system	1	550,000,000	550,000,000
Agricultural	3,000,000kg	0	0
Materials	8,000,000t	1,500	12,000,000,000
Environment controling system	1	1	3,000,000,000
Total	/	/	16,637,000,000

The total cost of **human factor**: 17.45B

	quantity	unit cost	total cost
food	14200	0.01 million	142 million

Devices	Quantity	Unit cost	Total cost
interior space suit	14200	10000	142000000
exterior space suit	2840	5000000	14200000000
aluminum for furniture	923000kg	0.225$/kg	207675
display screen in house	14200	2000	28400000
gamma acquirer	237	1000000	237000000
pressurized facilities	284	10000000	2840000000
experimental needs			17447607680$

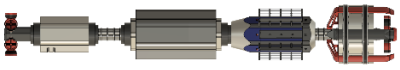
The total cost of **automation** :4.42B

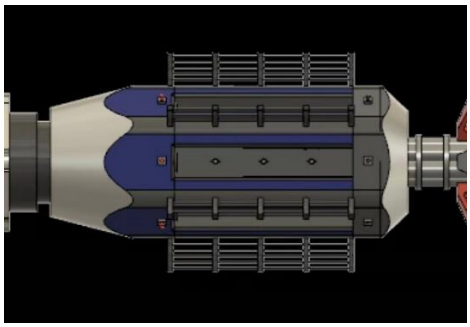
Automation Total cost : 4.42B

Name	function	number	Min-size (volume and weight)	material	Cost $(usd)
Pioneer	Internal construction robot	Initial:1 After:128 surface	15m³ 2 tons	Aluminum alloy	complete0.4B circuit 1.2B
Pirate	External construction robot	Initial:1 After:128 space	15m³ 2tons	Aluminum alloy	complete0.4B Circuit:1.2B
Digger	Mining robot	40	15m³ 2tons	Magnesium alloy	0
Waggon	Transportation robot	80	25m³ 1t	Magnesium alloy	0
Band	Communication and individual device	14,000	------	Robber	2,000,000
Dusk Killer	Domestic robot	13,500	$2.8*10^{-3}$ m³	Aluminum alloy	

The total cost:47.71B

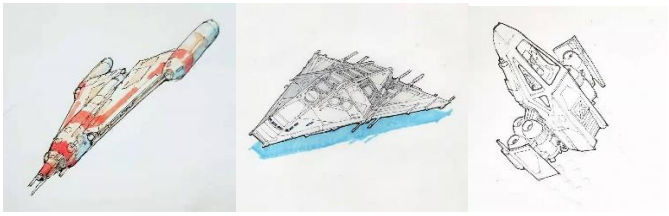
7.0 Business Development





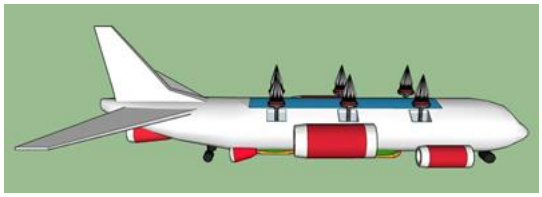
The main cylinder will be built and stretch out from the industrial area, which including ports for cargo ships and cargo warehoused to store things.

A) Three types of the interplanetary space shuttles which could help transporting personnel and cargo to the settlement.

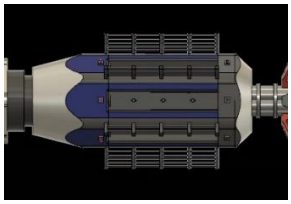


(www.artstation.com)

B) This is the shuttle that we use to transport cargo from the surface to Aynah.



C) This part of the porting area has 6 individual port which could port 24 space shuttles in the same time. It provides a waiting hall for all customers.



D) Since we don't have a vehicle system to operate, we will use the connector between the ship and the part above to transport the customers to the waiting hall. Once the ship arrives near the part, the connectors on the part will connect the door on the ship to enable the pressurize environment for the customers to go through.