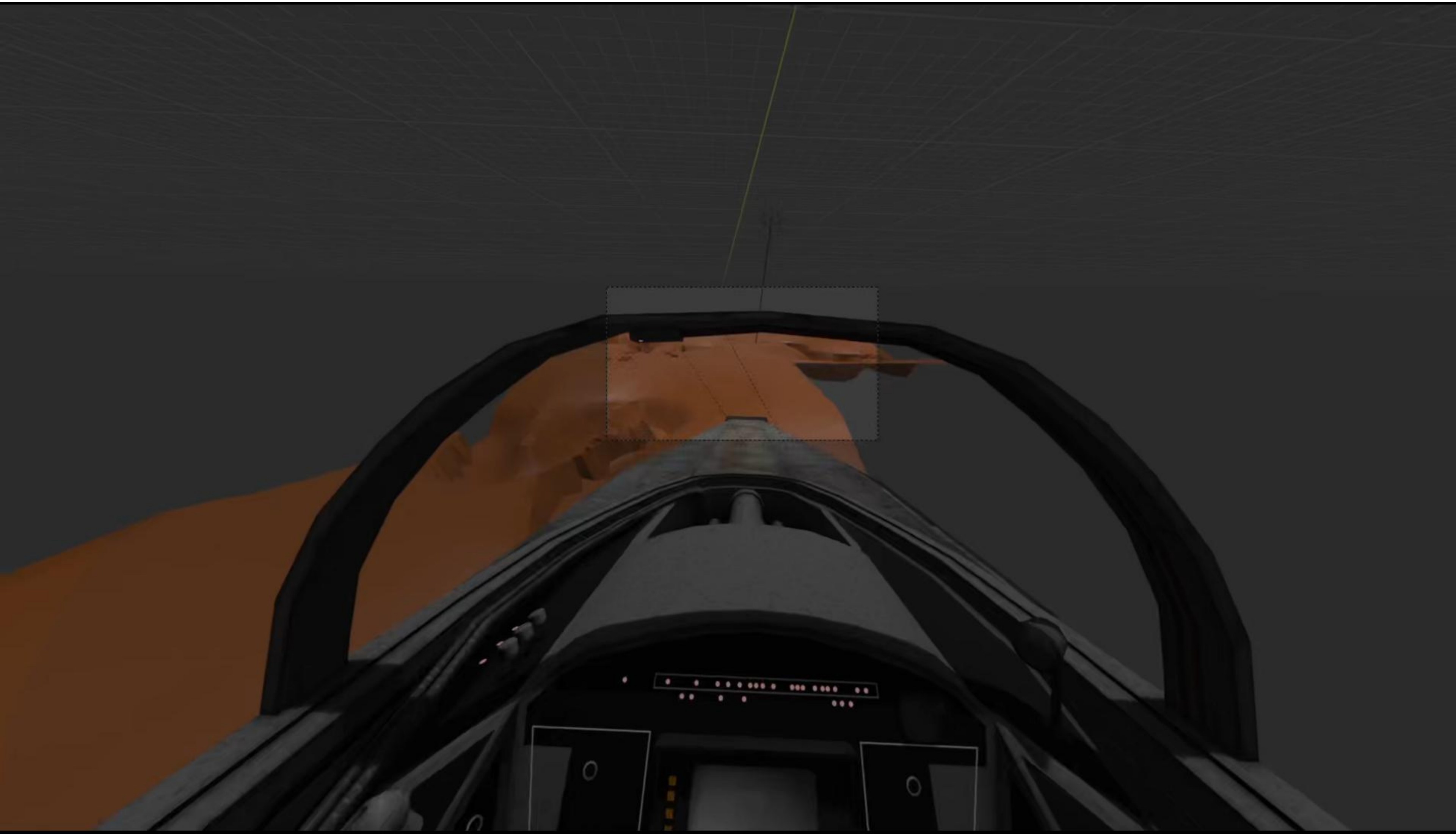


2.1.1 Components and Dimensions

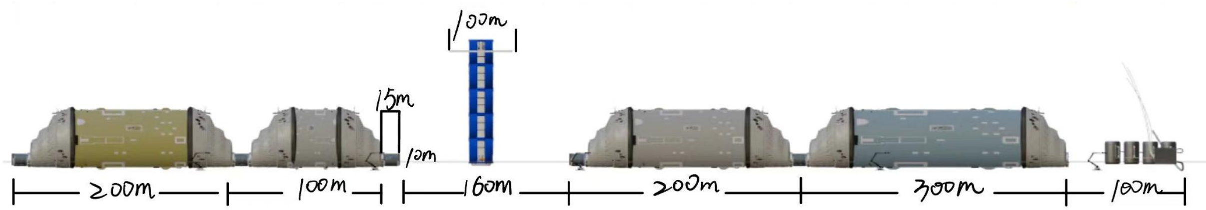
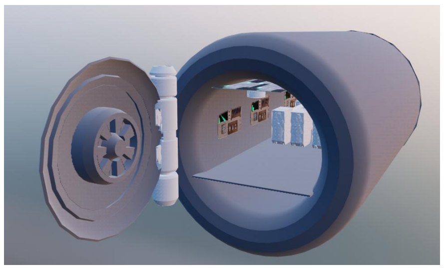
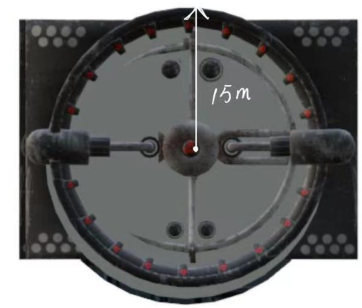
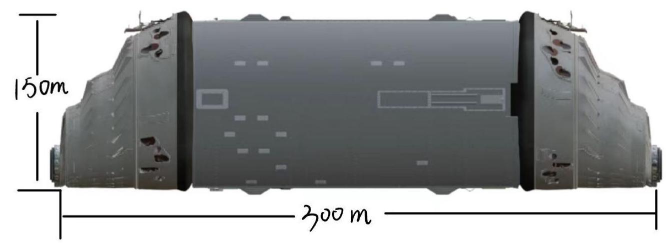


Fig 2-1-1 *General dimension [Wanxuhang, Blender]*



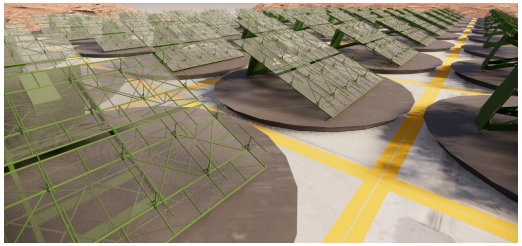
*From left to right: **Fig 2-1-2** dimension of a typical module [Wanxuhang, Blender]; **Fig 2-1-3** cross-section of a typical module(inside a lava tube) [Wanxuhang, Blender] ; **Fig 2-1-4** dimension of a tri-gate air-lock[Wanxuhang, Blender]; **Fig 2-1-5** cross-section of a typical tri-gate air-lock(inside a lava tube) [Wanxuhang, Blender] ; **Fig 2-1-5** cross-section of a typical tri-gate air-lock(inside a lava tube) [Wanyutong, Blender]*

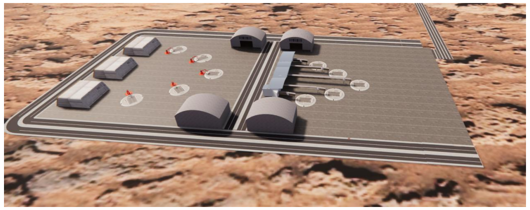


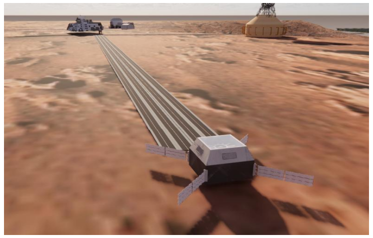


The underground section of the base is composed of several modules, with all parts between modules being fully interchangeable. The only differences lie in the dimensions and internal layouts to achieve modularity, facilitating manufacturing and logistical maintenance. Each module is connected by a three-channel airlock chamber, which regulates the movement of personnel and vehicles both into and between modules. The airlock chamber is also equipped with a Mars dust removal system (see Section 4.3 for details). The underground transportation network is located on one side of the interconnected chambers. Vehicles traveling to and from the Martian surface pass through this transportation corridor.

2.1.1 Components and Dimensions







From left to right: ***Fig 2-1-2*** *External communication station[Huzhiyuan, SketchUp];* ***Fig 2-1-3*** *Nuclear fusion reactor [Chenjunrui, SketchUp];* ***Fig 2-1-4*** *External research lab & vehicle garage [Huzhiyuan, SketchUp];* ***Fig 2-1-5*** *External recreation park[Huzhiyuan, SketchUp];* ***Fig 2-1-6 Port****[Chenjunrui, SketchUp];* ***Fig 2-1-7*** *Microwave receiver[Chenjunrui, SketchUp]*

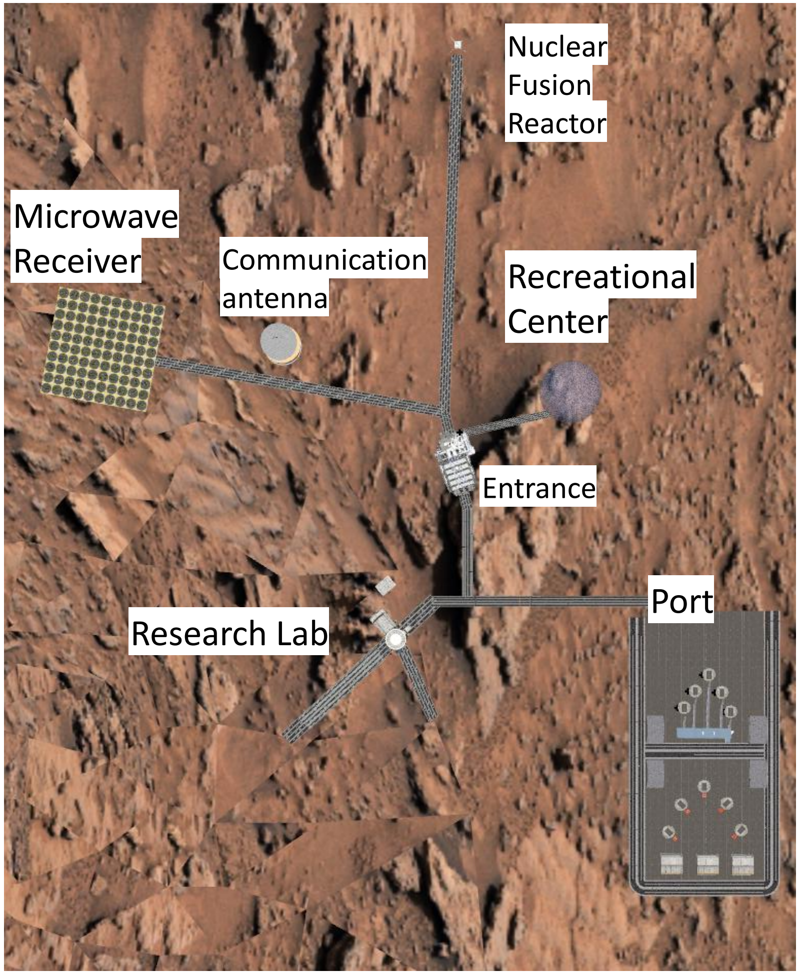


Fig 2-1-1 *General dimension [Huzhiyuan, SketchUp]*

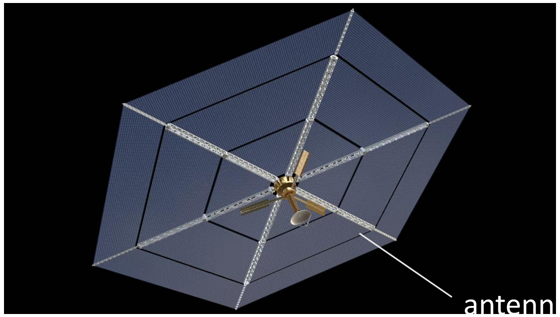
The surface facilities are connected to the underground base's exit (elevator location) via a road network. Given the rugged terrain of the Martian surface, constructing roads can significantly improve the lifespan and operational efficiency of both manned and unmanned Mars rovers, thereby reducing costs. The surface research base is located between two craters in Utopia Planitia, facilitating collection operations. The nuclear reactor and microwave receiving devices, both of which pose certain risks, are positioned 4 kilometers away from the base to ensure safety.

2.1.2. function among different parts

Fig 2-1-1 Functions among different modules [Chenjunrui, Powerpoint]

	Length (m)	Width (m)	Height (m)
Residential Area(down)	200	150	50
Agricultural Zones(down)	200	150	150
Water Treatment Facilities(down)	105	30.25	22.7
Research Lab(down)	400	100	30
Transport Road(down)	2000	50	0
Air Lock(down)	109	26	50
Restore layer(down)	2000	200	10

2.2.3 orbital solar panels system



- Round receiving station

ground receiving station in a concentrated manner, and a large-area rectifier antenna (the ground rectifier antenna covers a range of 1-5 kilometers and is designed as a grid-like structure that efficiently absorbs microwaves) is installed on the ground to receive the microwave energy. Rectifier antennas convert microwaves into direct current for use or storage by ground equipment.

The shape of the solar satellite is a regular hexagon with 300m of the edge. The are of the solar panel Is about 233,826.86 m^2 can support 42MW (by the System of satellite without consider wastage of transmission).

- Comparing to set solar Pannel to surface

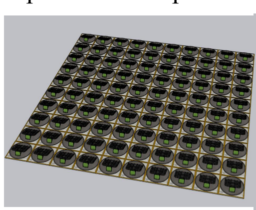
	Surface	**Space**
Energy supply fluctuated	huge	stable
Efficiency (W/m^2)	25~100	180
Equipment wear	by dust storm	almost to none
Energy transmission range	wire length	almost whole planet

- Energy Efficiency

Influencing-factor	efficiency
Microwave device conversion	90%
Atmospheric depletion	85%
Rectenna efficiency	95%
Total	72.7%
Total power	30.5MW

- D.A&F.C advantage

D.A has built 100-megawatt prototype SPS that Provided power for SEAC. We have enough experience of create satellite. Engineers from two companies developed an efficient microwave energy transmission system.



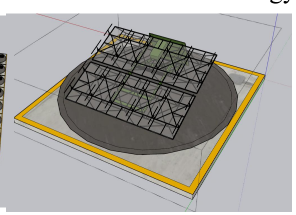


Fig 2-2-1 Microwave receiver array[Chenjunrui, Sketch Up];
Fig 2-2-2 Microwave receiver[Chenjunrui, Sketch Up];

- The antenna array of the satellite(with a transmitting surface of up to several hundred meters)generates one or more highly directional microwave beams to transmit microwave energy to the ground receiving station.

We decide to create a solar energy satellite in the space orbit of Mars. Transfer the energy by microwave to surface of ground.

Parameters	Mars Orbit	Mars Surface
solar irradiance (W/m²)	590	400–450 (clear day), 100 (dust storm)
solar panel efficiency	30–40%	30%
power density (W/m²)	177–236	120–135 (clear day), 30 (dust storm)
transmission and energy storage efficiency	~48–72%	~85–90%
available power(W/m²)	~85–170	~100 (clear day), ~25 (dust strom)

2.2.4 Nuclear Fusion Reactor

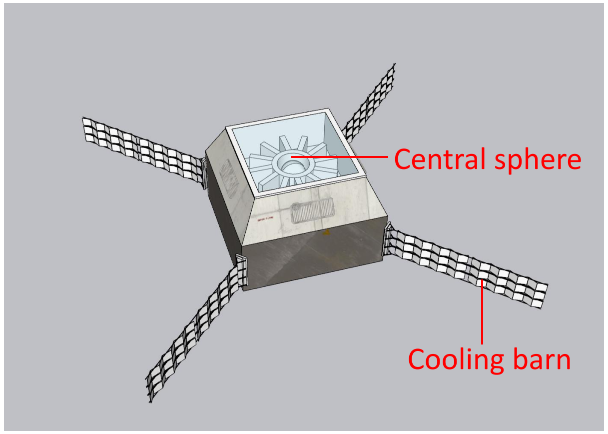


Fig 2-2-1 *Top view of the port[Chenjunrui, Sketch up]*

Fusion power plant

This equipment is from subcontractor **Fusion Founders**.

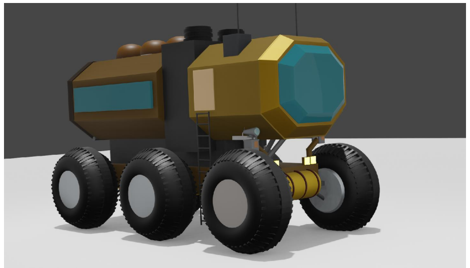
The fusion reactor supplied by this vendor is only 17 inches in size. Even with external cooling and other auxiliary facilities, it is still relatively compact. The vendor requires an 80-foot-long cooling arm for the fusion reactor. To ensure safety and enhance cooling efficiency, we equipped it with four radiators, each over 20 meters long, which is a significant achievement.

This system can provide 10MW energy. We decide to build two energy system for higher ability of Bear contingency risk. （with both solar power and nuclear Fusion power)

The reactor and the base are connected by a road network and an underground facility, maintaining a safe distance of four kilometers. This setup ensures convenient access for base personnel to perform maintenance on the reactor.

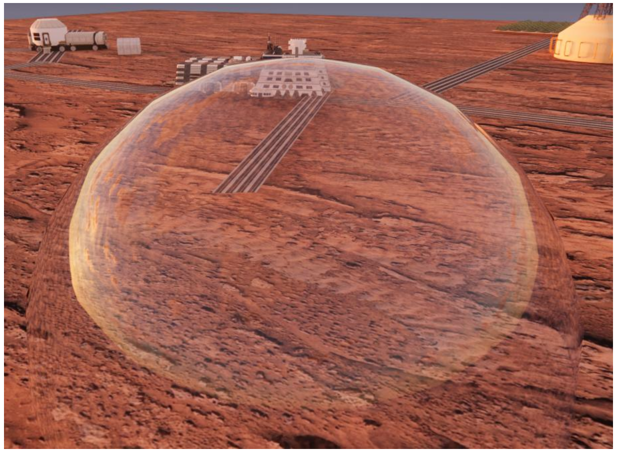
2.2.5 Dimension of external research lab & vehicle garage

The small laboratory located on the Martian surface provides a base for adventurous scientists conducting operations directly on the surface. The main structure is divided into two sections: the laboratory/living quarters and the garage. The laboratory/living quarters offer facilities for basic sample processing and analysis, along with living amenities to allow scientists to rest. The garage houses 20 manned/unmanned multipurpose Mars rovers and drones. These robots can be controlled either by scientists in the underground base or by those working on the Martian surface.



From left to right: Fig 2-2-1 Manned/Unmanned Mars rover[Liwenyu, Blender]; Fig 2-2-2 Cargo drone[Zhouhongen, Blender]; Fig 2-2-3 dimension of external research lab & vehicle garage[Huzhiyuan, Sketch up];

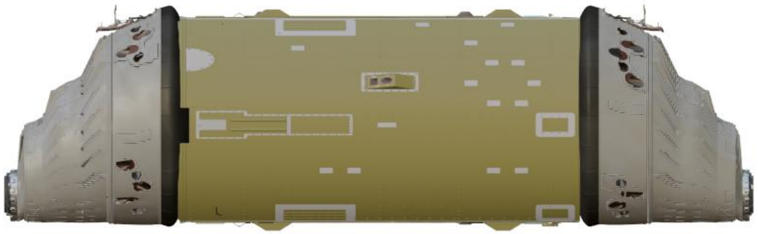
2.2.6 Recreation park



The recreational facilities are divided into two zones: one on the ground and the other within the residential area. The recreational park serves the dual purpose of entertaining residents and maintaining their physical health to help them adapt to life back on Earth. Detailed in 4.4.

Fig 2-2-4 dimension of external recreation park [Huzhiyuan, Sketch up];

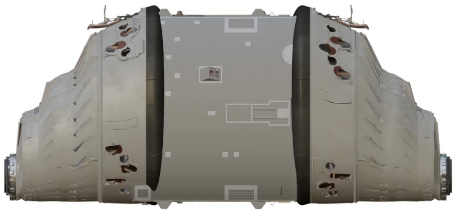
2.2.7 residential area

The residential area includes residential buildings, commercial zones, and supporting infrastructure. To save space and provide a high quality of residential life, the entire residential area is designed with two levels.

From left to right: Fig 2-2-1 Dimension of residential module[Wanxuhang, Blender]; Fig 2-2-2 Cross section of residential module[Wanxuhang, Blender];

2.2.8 Core Module

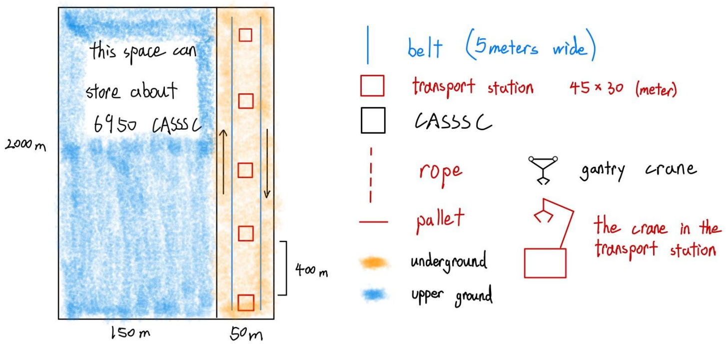


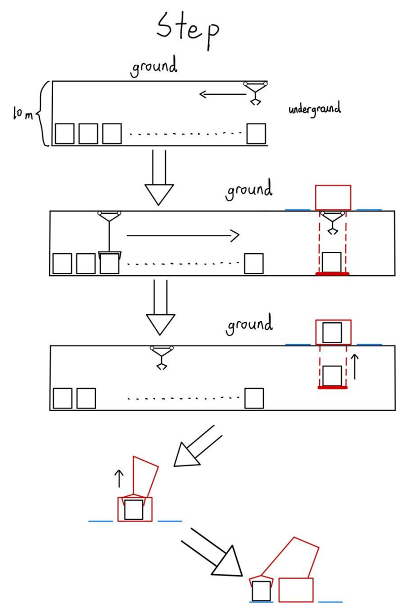

The core module is transported from Earth and includes 3D printing robots to assist in construction while maintaining communication functions. All other structures are built starting from the core module and then expanded to other regions.

From left to right: Fig 2-2-3 Dimension of core module[Wanxuhang, Blender]; Fig 2-2-4 Cross section of core module[Wanxuhang, Blender];

2.2.9 storage

The storage area is located beneath the entire structure. It is divided into several sections: energy storage, cargo storage, experimental materials storage, and others. The storage system consists of an underground CASSSC storage area and an above-ground conveyor transfer system. Containers are moved by gantry cranes, lifted via transfer stations, transported on conveyor belts, and delivered by vehicles. Used containers are returned to storage following the reverse process.

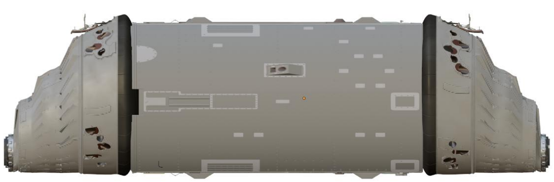




From left to right: Fig 2-2-1 Flowchart for Loading and Unloading Goods Using the Storage Area [Linyujing, Blender]; Fig 2-2-2 Cross section the tube with storage colored[Liuyunjing, Powerpoint];

2.2.10 agricultural module

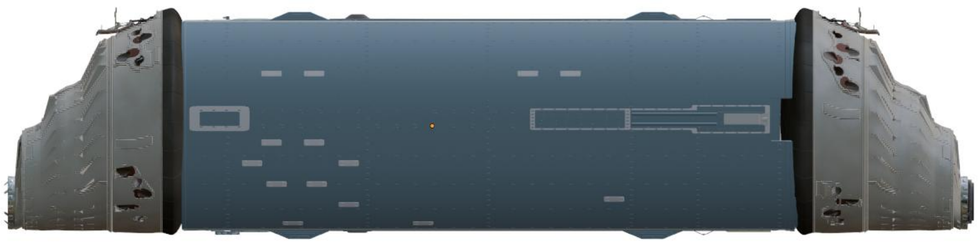
We plan to grow our own food to sustain the residents' lives. The agricultural area is divided into zones for different types of crops and pastoral areas, which provide diverse energy sources.



From left to right: Fig 2-2-3 Dimension of agricultural module[Wanxuhang, Blender]; Fig 2-2-4 Cross section of agricultural module[Wanxuhang, Blender];

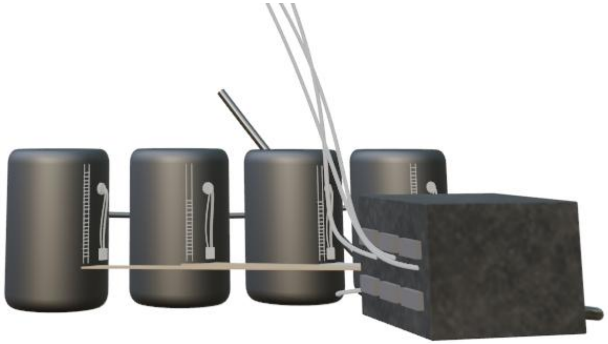
2.2.11 research lab

We have two research zones: one is underground for routine research activities, and the other is above ground for ground-detection experiments. The total area of the research parks is substantial, allowing scientists to carry out various tasks within a single park.



2.2.12 Water Management and Storage

The water distribution and storage system is located above the entire structure for easy distribution to each area. Additionally, a water processing facility is set up in the lava tube to recycle wastewater into clean, usable water.



2.3.1 Construction Steps

1. Launch satellites into Mars orbit to explore landing sites and map lava tubes. Deploy energy satellites (solar panels) and unmanned probes for preliminary surface exploration.

2. A pioneering team of approximately 20 people will land on the Martian surface to establish a temporary settlement, utilizing housing technology from Blown Away Company.

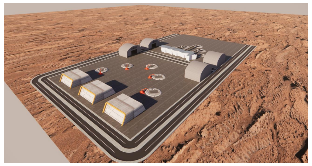
3. Complete the construction of an airport to improve cargo transportation efficiency.

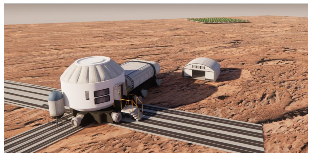
4. Build surface laboratories and nearby simple factories, while simultaneously constructing the fusion reactor and ground microwave array.

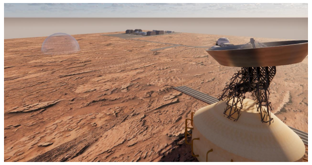
5. Finish the construction above the ground by complete the building of communication center.

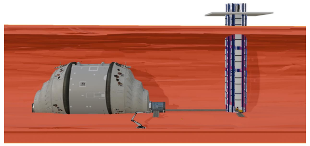
6. Begin underground base construction using processed resources collected on Mars, starting with the core module and then expanding by combining airlocks and modules to complete the research lab, agricultural module, and wastewater treatment system.

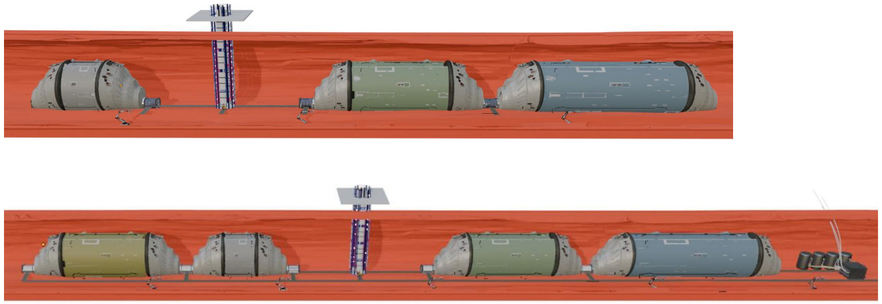
7. Complete the assembly of the residential module, and complete the construction of the entrance above the ground.











From top to bottom: ***Fig 2-3-1*** *construction of port[Chenjunrui, Sketch Up];* ***Fig 2-3-2*** *construction of lab above ground[Chenjunrui, Sketch Up];* ***Fig 2-3-3*** *construction of elevator and core module[Wanxuhang, Blender];* ***Fig 2-3-4*** *construction of working area[Wanxuhang, Blender];* ***Fig 2-3-5*** *construction of living area[Wanxuhang, Blender]*

2.4 Exit and entrance

The underground section is equipped with a total of three exits: one main exit in the center and two auxiliary/emergency exits on either side. The exits are located within the underground base (lava tube), with the central position being relatively convenient for transportation. The exits on the left, near the living facilities, and on the right, near the work facilities, are not too far apart. This allows residents, researchers, and workers to feel at ease and easily locate the exit regardless of whether they are heading out or returning. The two auxiliary exits in the lava tube are reserved for emergencies and can be opened during urgent situations or when there is a need to transport large amounts of cargo.

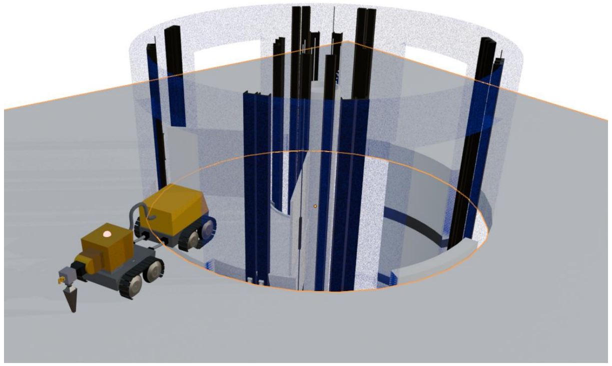
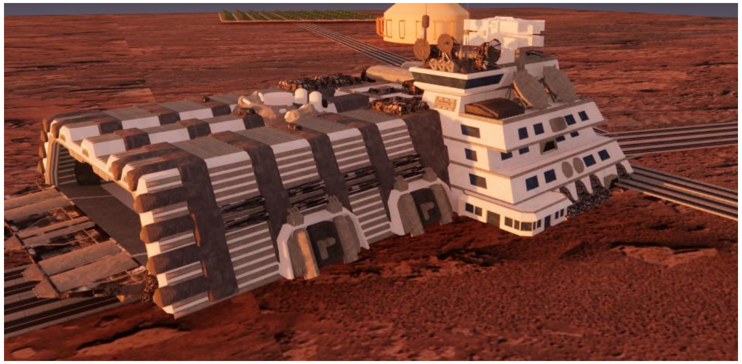
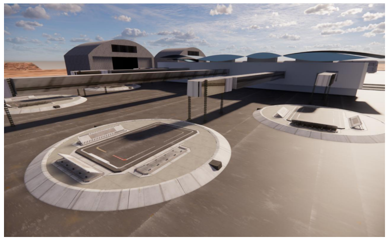


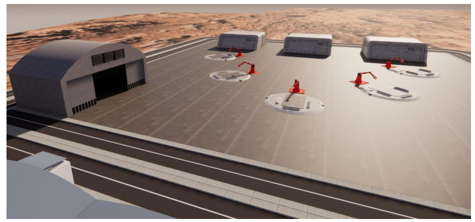
***Fig 2-4-1** the position of exit and entrence [Wanxuhang, Blender] Fig 2-4-2 elevator at exit and entrance[Wanxuhang,Blender] Fig 2-4-3 exit above the ground[Chenjunrui, Sketch Up]*

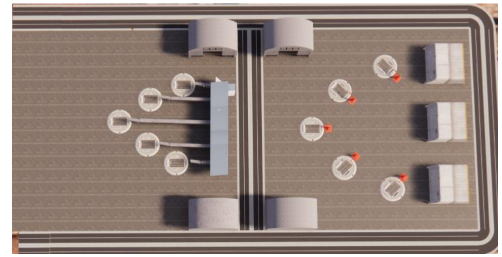


2.2.1 Port

The port is designated for loading and unloading cargo and personnel arriving from Earth and other parts of the universe. It is divided into a cargo area and a personnel area, utilizing robotic arms and jet bridges for loading and unloading cargo (CASSSC) and personnel, respectively. After unloading, the cargo is transported via conveyor belts through airlock chambers to a temporary storage warehouse. From there, unmanned vehicles use the road network to deliver the cargo to the entrance of the lava tube.



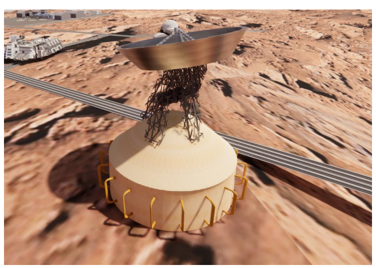


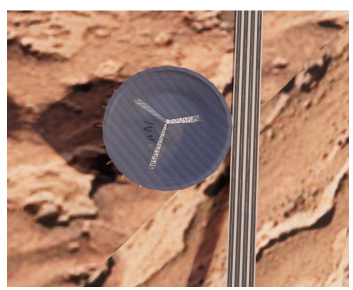


*From left to right: **Fig 2-2-1** Top view of the port[Chenjunrui, Sketch up]; **Fig 2-2-2** oblique view of the port[Chenjunrui, Sketch up]*

2.2.2 External Communication Station

The communication base station is used to receive information transmitted from other locations in the universe, utilizing X-rays as the communication frequency band. The station includes a parabolic antenna and its supporting facilities to ensure its capability to receive information. Additionally, the station also serves as a deep-space telemetry and control hub, tracking missions and other deep-space objects in Martian orbit.





*From left to right: **Fig 2-2-3** Top view of the external communication station[Huzhiyuan, Sketch up]; **Fig 2-2-4** Oblique view of the external communication station[Huzhiyuan, Sketch up]*

External Construction Material

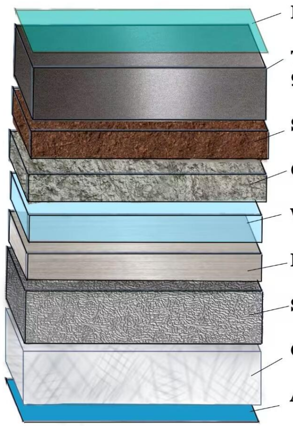


Fig 3-1-1 *Glass [Liuxin, Sketch Book]*

source	use	Layer	thickness(cm)
Luna	Dust mitigation	shield	1.21
Luna(processed at construction shacks before construction.	High tensile strength High stiffness Good low temperature Toughness	Chainmail	9.15
dirtbuilders	Low cost, Strength	Blocks	4.57
Earth (imported to Mars)	UV and gama radiation, protection	Plates	4.57
Earth/Mars (processed chemicals)	radiation sheilding	Liquid	4.57
Earth or synthesized on Mars	radiation shielding, heat storage	Mesh	4.57
Earth	electricity generation	Fabric	2.29
Manufactured on Mars	Thermal InsulationShock Absorption	Plates	6.86
Earth (advanced processing)	High strength Structural integrity	Mesh	7.21
Luna/Earth (refined)	Structural integrity	Plates	0.09

Table 3-1-1 *Explanantion [Ludongyan, Excel]*

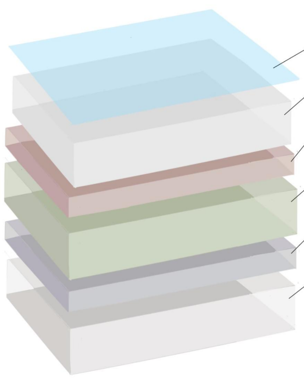


Fig 3-1-2 *Glass [Liuxin, Sketch Book]*

Source	Use	Layer	Thickness
ElectroProtect	Dust Prevention	Shield	
Mars Hard Roll	High Resilience of tension chemicals, and shielding of radition	Plates	
ElectroProtect	Light Absorption	Block	
BuckyBreakthroughs Carbon Creations Tubular Technologies	Radiation Shield	Plate	
BuckyBreakthroughs Carbon Creations Tubular Technologies	Radiation Shield	Liquid	
Mars Hard Roll	Thermal Protection	Plates	

Table 3-1-2 *Explanantion [Ludongyan, Excel]*

Operation Materials

Materials	Source	Use
Air	Stuff of Life (Subcontractor)	Life Sustain
Water	Stuff of Life (Subcontractor)	Life Sustain
CASSSCs	CCA	Transportation And Construction
Solar Panels	Dougledyne/Fletchtel	Electric Power Peneration
Circuits	ElectroProtect (Subcontractor)	Electrical System
Sewer Pipes	Waste Products (Subcontractor)	Sewage System
Paint	Seals-lt-All (Subcontractor)	Appearance Design
Silica	Mars	Glass Manufacturing
Aluminum	Mars	Construction of machinery
Cement	soil solutions(Subcontractor)	Streets construction
Concrete	soil solutions(Subcontractor)	Streets construction
Refined debris	Refinery	Streets construction
Magnesium Hydride	Mars	Energy Conservation

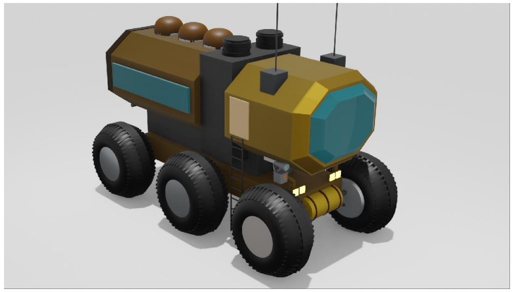
Table 3-1-3 *Operation Materials [Ludongyan, Excel]*

Transport of Materials

Material Sources	Transport Methods
Mars	If possible and necessary, sample directly on Mars and then use external delivery ship
Settlement	Using external delivery ship
Subcontractor	From Subcontractors or external delivery ship
Earth	Launch to the surface by individual spaceships or external

Table 3-1-4 Transport of Materials *[Ludongyan, Excel]*

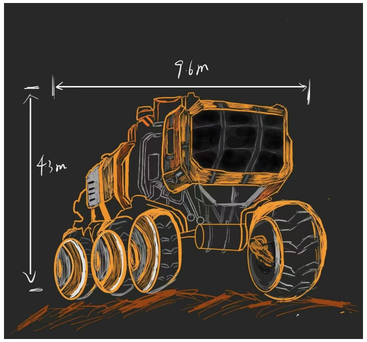
Fig 3-1-3 *External Delivery Ship [LiWenyu Yegengyuan, Blender]*



- transport large building materials and other equipment needed for the settlement
- useful wheels on the surface for both flying in the sky and running on the surface
- door front convenient for loading and unloading cargo and goods
- The size allows enough goods to reach

- Sustain 70-100 people
- Contain enough oxygen & energy for 12hrs
- Use recyclable and reusable energy
- Solar panels

Fig 3-4-1 *Drawing of Cargo-handling Vehicle [Liujiaming, Notein]*



- Vehicle: Hermes.
- Two grooves: charge for UAV.
- End:c ase for smaller robots.
- Rough tires to increase friction
- Maximum weight of 25 tons

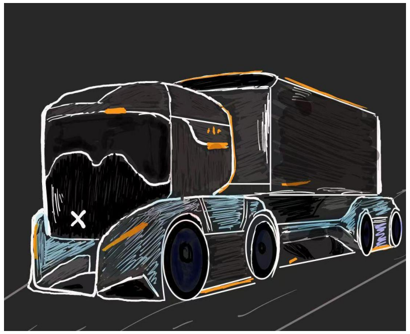


Fig 3-4-2 Drawing of Personnel-handling Vehicle [Liujiaming, Notein]

3.2.1 Food production

Table 3-2-1 Food production and consumption *[Geheming, Excel]*

food	A person's consumption per day/g	Total consumption in the first year/t	CASSCs in total in the first year	Food source
Meat	160	23.36	2	Imported from Garden-A-Go-Go
Eggs	24	3.5		
Milk	500	73		
Dry Plant Product	380	55.48		
Vegetables	550	80.3		
Fruit	200	29.2		
Total	1814	264.34		

Agricultural area

To sustain a city of 400 people on Mars, approximately 57328.33 m² (5.73 hectares)

Category	Total Annual Consumption (t)	Yield (kg/m²/year)	Required Area(m²)
Dry Plant Product	55.48	5	11,096
Vegetables	80.3	10	8,030
Fruit	29.2	8	3,650

Table 3-2-2 Area of Agriculture *[Geheming, Excel]*

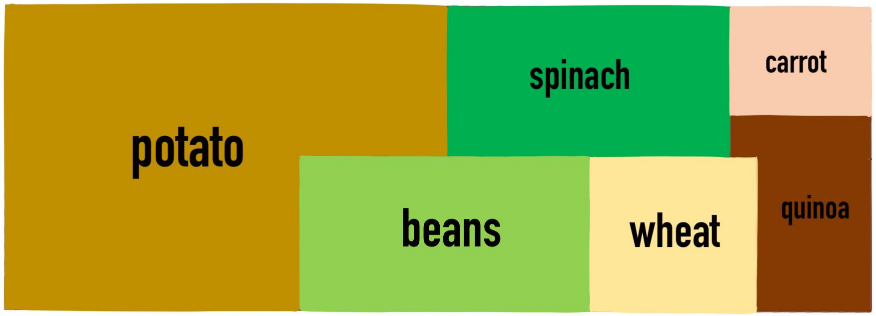


Fig 3-2-1 Food preservation control panel *[Liumohan, procreate]*

Agriculture

The whole are is devided into zones, with different crops grown in each section. Several areas were divided into different sizes in proportion to the number of crops required.

3.2.1 Food production

Food Production

The greenhouse is designed to grow crops and vegetables on Mars.

- LEDs provide the necessary spectrum of light
- Hydroponics systems utilizes sprinkler and drip irrigation systems to deliver water efficiently
- Mechanical Arm helps to sow the plants

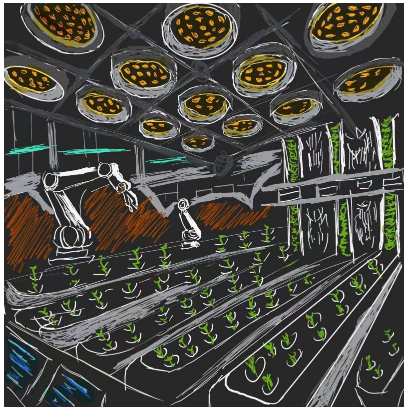


***Fig 3-2-2** Agricultural Producion Venue [Liujiaming, Notein]*

Food Distribution

The food distribution system integrates automated and sustainable practices to support 400 residents. This streamlined approach ensures a reliable, sustainable supply chain for long-term survival on Mars.

Food Preservation

This control panel ensures optimal preservation of food by maintaining key environmental parameters. The system integrates real-time sensor data and automated controls for energy efficiency, ensuring food quality and safety while adapting to Martian conditions.

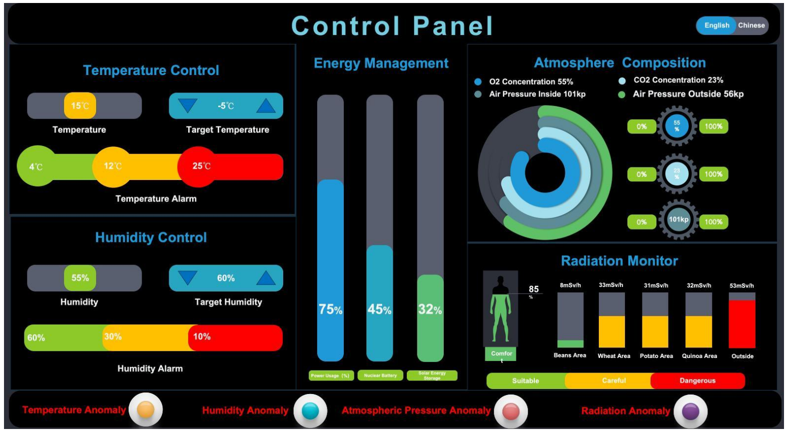


***Fig 3-2-3 Food preservation control panel** [Lijianyang, PPT]*

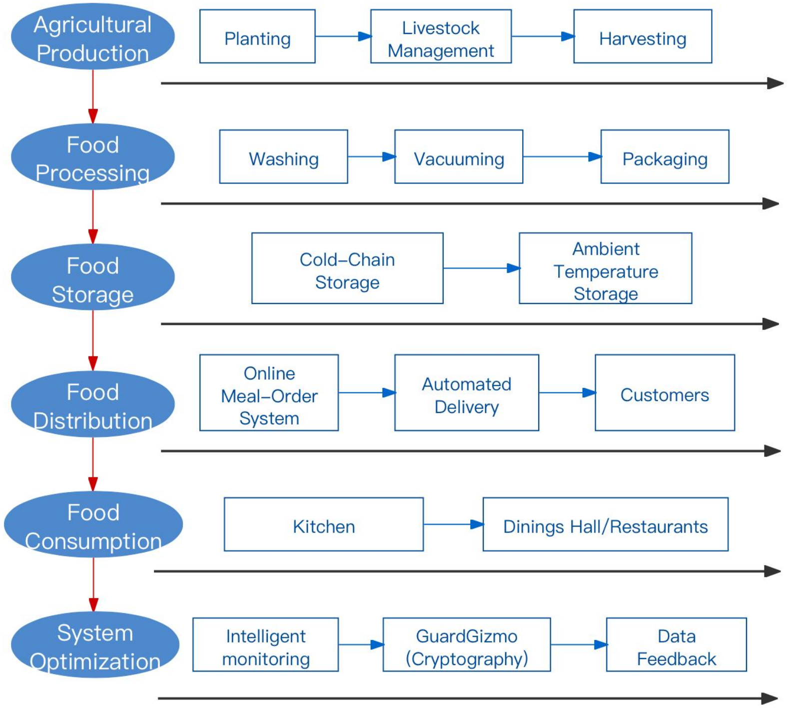


***Fig 3-2-4 Food distribution process** [Lijianyang, WPS]*

3.2.2 Electrical power generation

Solar Electricity Generation

Dougeldyne Astrosystems has already mastered the capability of low-g solar panel manufacturing. The two companies take advantage of good solar satellites by working together. Then through microwave transmission, the efficient conversion of solar energy to electricity is attained.

Zones	Energy Demand (kW)	Area(m²)
Residential	4500	52326
Agriculture	3000	34884
Laboratory	1000	11628
Entertainmen t	750	8721
Storage	750	8721
total	10000	116280

Table 3-2-5 *Electricity power generation [Geheming, Excel]*

Nuclear Electricity Generation

Since dust storms are common on the surface of Mars, which can interfere with solar energy transfer, a backup source of nuclear energy is important.
Fusion founders built a power plant that can power a community of 5,000 people with 10MW of energy.
Although the generators created by fusion founders have issues with cooling, by working with Coolwave Dynamics, these issues can be effectively solved and the generators can be put into operation.

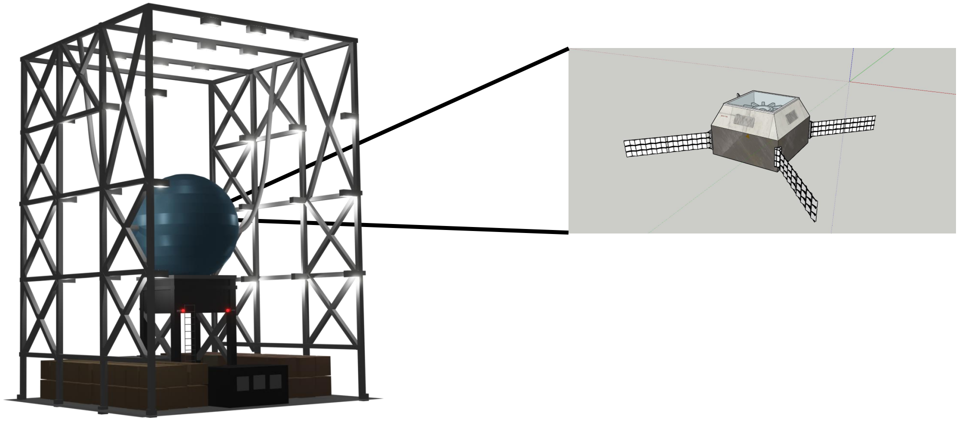


Fig 3-2-6 Nuclear Power Generation
[Liwenyu, Blender]

Electricity Storage

Compressed Air Energy Storage (CAES)	Details
Principle	CAES stores energy by compressing air into a sealed underground chamber, using surplus electricity. The compressed air is later released to drive turbines, generating electricity
Efficiency	Around 85%, with adiabatic CAES system can improve efficiency
Infrastructure Requirements	Requires large, sealed reinforced chambers for air storage, and gas turbines for air expansion
Advantages	- Low operational costs - Suitable for large-scale, long-term storage - Produces CO2 for agriculturul use
Environmental Impact	- If combined with gas turbines, can produce greenhouse gas that can be used for agriculture - Noise pollution during operation, requires
Location	Located in lava tube, next to agricultural area, keeping distances from residential areas in order to avoid drawbacks

Table 3-2-7 *Compressed Air Energy Storage [Lijianyang, Numbers]*

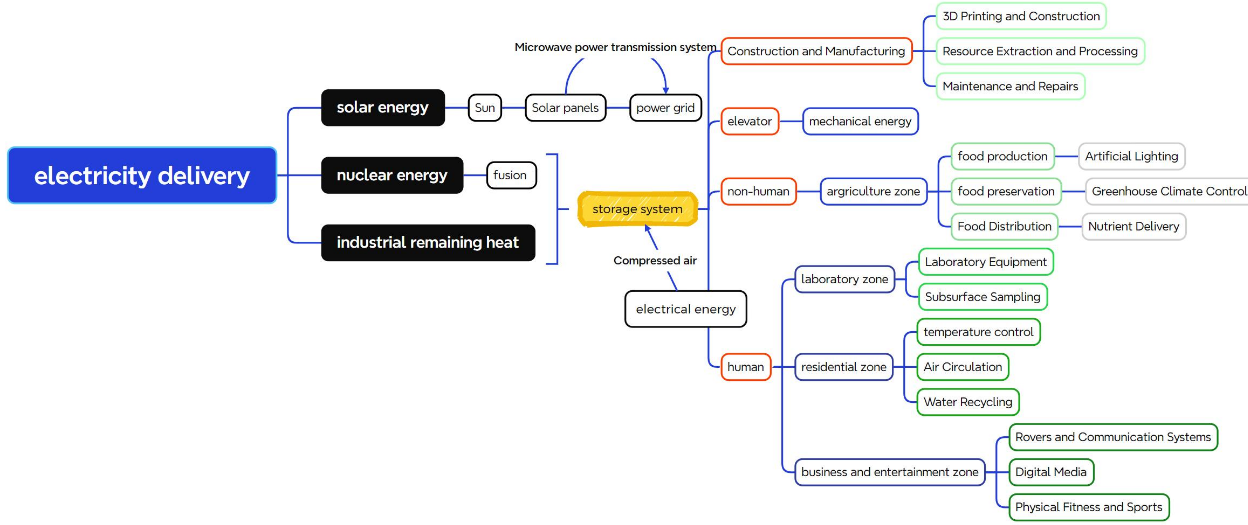


Fig 3-2-8 *Electricity Delivery [Yegengyuan, Geheming, XMind]*

The diagram outlines a comprehensive electricity delivery system designed to utilize various energy sources and ensure effective distribution across different zones.
The energy sources include solar energy (via solar panels and potentially a microwave power transmission system), nuclear energy (including fusion reactors), and industrial remaining heat, all of which are funneled into a central storage system. This system may utilize technologies such as compressed air or other forms of stored electrical energy.

3.2.3 Internal and external communication systems

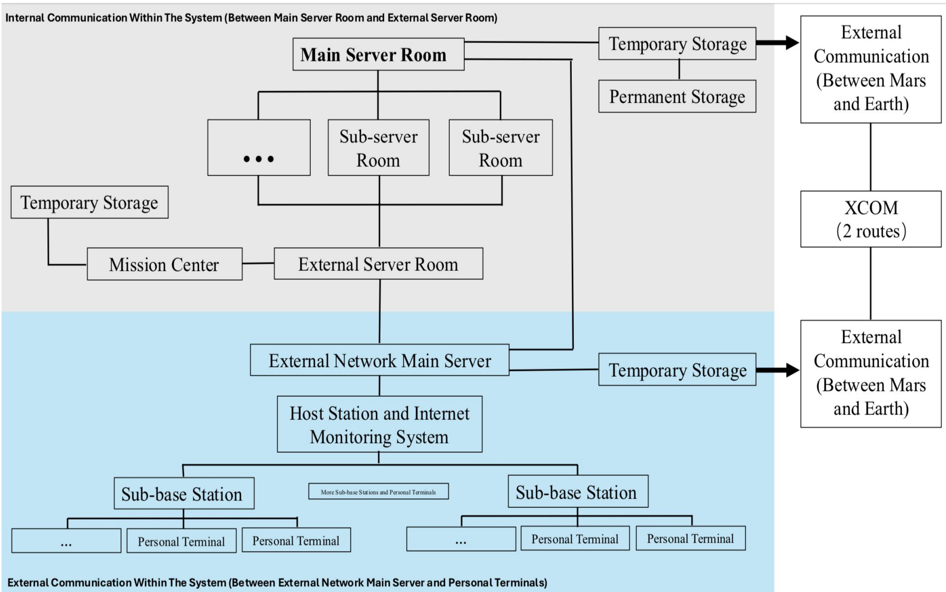


Fig 3-2-7 Overall Network Structure [Wang Junye, PowerPoint]

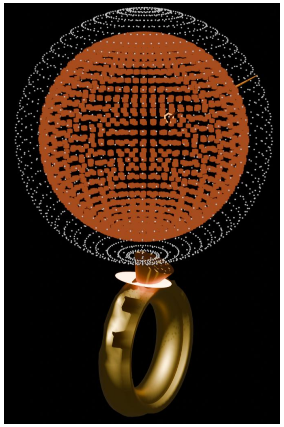


Fig 3-2-9 Communicational Ring [Dai Weiguo, Blender]

- Personal terminal
- Projection is used to operate the ring
- Functions of the ring:

1. communicating/sending information to the sub-base station/antenna
2. Locating position and navigation

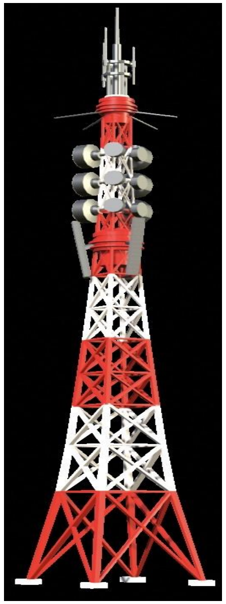


Fig 3-2-10 Signal Antenna [Wang Junye, Blender]

	Internal Communication Within the Settlement		External Communication Between Mars and Earth [X-ray Communication]	
Communication Technology	Optic Fibre Communication	Wireless Local Area Network (WLAN)	***XCOM*** | Direct Communication	***XCOM*** | Satellite Chain Communication
Design Description & Explanation	• Primary System: Optic Fiber Communication Systems • Between the Main Server Room and Sub-base Station+Between Storage stations. • Optic fibers installed for information transfer	• Used between Personal Terminals and Sub-base Station • The settlement is divided into several cells, and an antenna is constructed within each cell. • Information can be passed quickly from personal terminals to personal terminals, or from one cell to another, aided by antennas.	• X-ray communication is fairly efficient when communicating across long distances • X-rays are less affected by the medium due to its short wave length • Device-Miniaturized High-Speed Modulated X-Ray Source (MXS): adjusting x-ray intensity, emitting X-rays as binary data. • Device-X-ray detector: receiving and convert the binary data of the X-rays into readable information.	• Unusual periods (e.g., solar flares, cosmic radiation), severe medium interference between Mars and Earth • Direct X-ray communication is not suitable, so we employ Satellite Chain to maintain informative connection between Earth and Mars. • 1 satellite placed in an orbit around Mars; 1 satellite placed in an orbit around Earth; 2 satellites placed in Earth's Lagrange points L1 and L2

Table 3-2-8 Internal and Externa Communication Technologies [Wangjunye, Numbers]

3.2.4 Internal and Mars Surface Transportation System

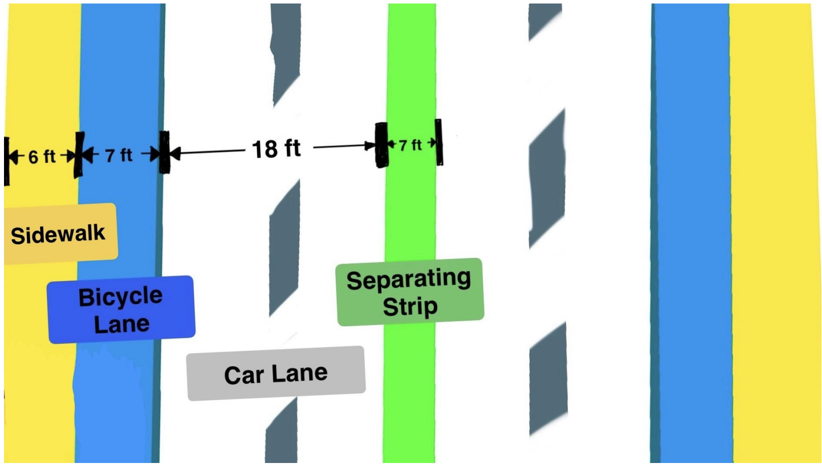


Fig 3-2-11 Transportation Lane [Wang Junye, Procreate]

Frame Materials	Titanium
Height	3.6 (ft)
Length	5.2 (ft)
Carrying Capacity	1 (person)

Fig 3-2-12 Bicycle Overview [Wang Junye, Numbers]

Fig 3-2-13 Bicycle Demonstration [He Ziruo, Krita]

Material	Aluminum Alloy, Glass, Rubber
Height	11.5 (ft)
Length	32 (ft)
Carrying Capacity	24 (passengers)

Fig 3-2-14 Public Transport Overview [Wang Junye, Numbers]

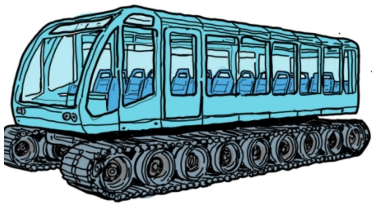


Fig 3-2-15 Public Vehicle Demonstration[He Ziruo, Krita]

1. Short-Distance Transportation:
Bicycles [Within the Settlement]

- Residents' transportation method
- Low-gravity surface, consuming less body energy
- Low maintenance costs+Emission free

2. Long-Distance Transportation:
Public Vehicle [Within the Settlement+Mars Surface]

- Longer distance travel
- Carries 24 people, higher carrying capacity
- Powered by electricity

3.2.5 Atmosphere Composition and Pressure

Gas Type	Overall	Area with Human Activity	Agriculture Area	Storage Area
Oxygen (%)	21%	21%	21%	21%
Nitrogen (%)	78%	78%	78%	78%
Carbon Dioxide (ppm)	≤1000	≤500	≈1000	≤1000
Temperature (°C)	15-26	18-26	15-20	23
Humitidy (%)	30%-50%	30%-50%	60%	50%
Pressure (KPa)	50-100	100	50	100
Amount (CASSSC/year)	3050	1050	1500	500

*Gas amount is calculated considering the approach "Stuff of Life", by utilizing "Lockless Airlocks", it makes sure all gases are well-preserved

Table 3-2-16 *Atmosphere control [Lijianyang, Numbers]*

3.2.6 Household and Industrial Solid Waste Management

To meet the environmentally-friendly theme, waste disposal systems are vital in Space City.

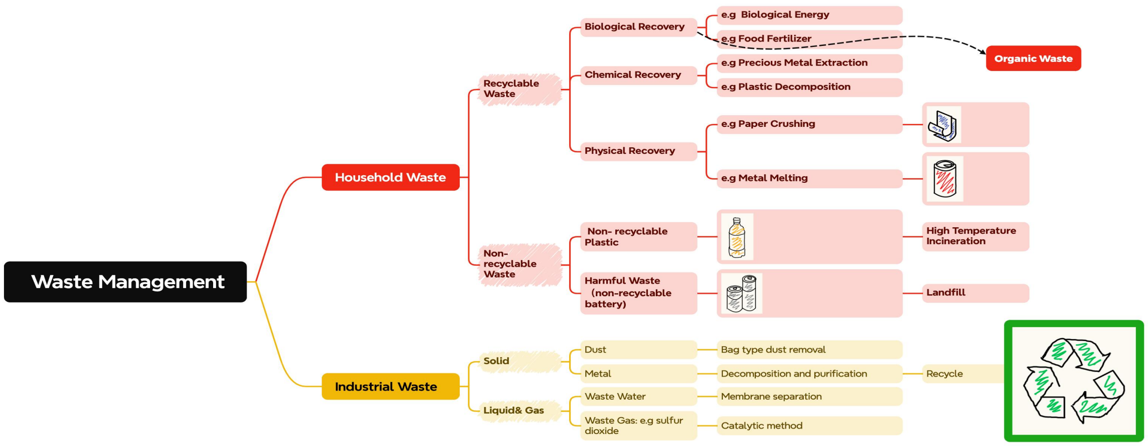
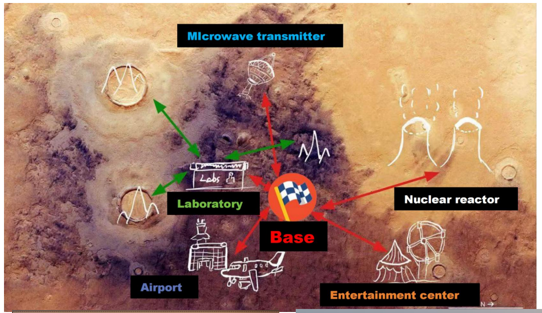


Fig 3-2-17 Waste Management [Liu Jiaming, X-mind]

3.3 Materials Harvesting Operation



Size: 191.14 m^3
Mass: 15876kg
Gravity: 0.38g
Pressure: 4.674*10^6N
Popularized metal:jarosite, 3.2*10^3kg/m^3

Fig 3-3-1 *Drawing of the exterior road network [Liujiaming, Notein]*
Fig 3-3-2 *Drawing of CASSSC [Yegenyuan, Blender]*

3.2.7 Water management

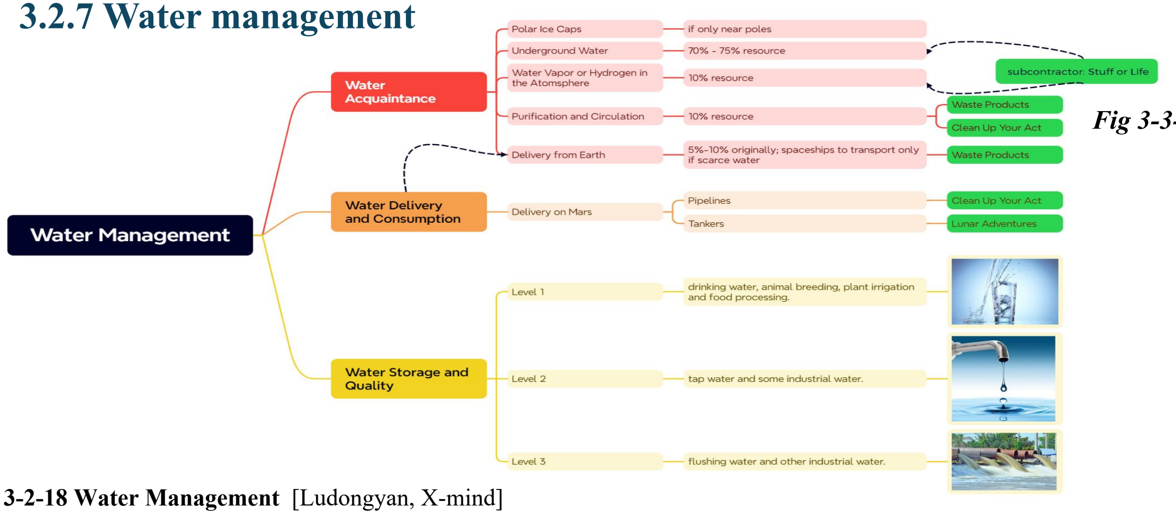


Fig 3-2-18 Water Management [Ludongyan, X-mind]

Fresh Water Source

- Water on Mars: ice near the North Pole
- Drill through the crust to acquire water.
- 1.15 water per person per day per cubic meters in 2023, National Bureau of Statics of China
- 13800 cubic meters of water from 75 CASSSCS transported from Earth
- Pipelines and tankers transport and deliver water to various places in & above the lava tube.
- 3 levels to use

4.1.1 Community Distribution

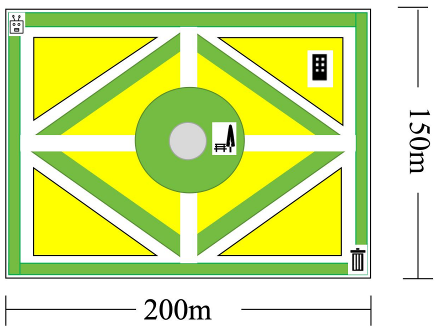


Fig 4-1-1 B1 Community Design
[WPS Office] by Chen Liuxuan

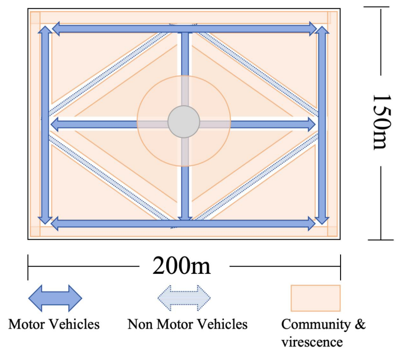


Fig 4-1-1 B1 Community Transport System Design
[WPS Office] by Chen Liuxuan

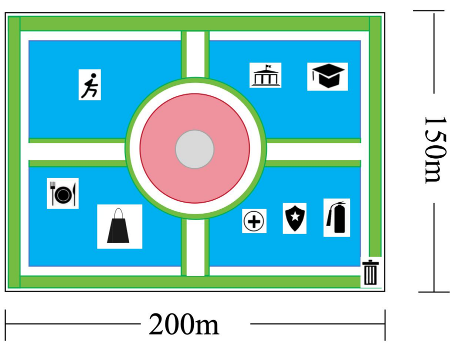


Fig 4-1-1 B2 Community Design
[WPS Office] by Chen Liuxuan

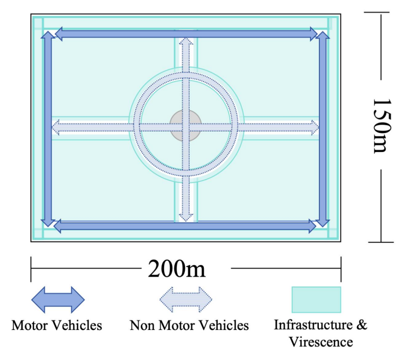


Fig 4-1-1 B2 Community Transport System Design
[WPS Office] by Chen Liuxuan

Region Function	Symbol
Residential Building	
Green Space	
Road	
Infrastructure	
Business Complex	
Elevator	
Park	
Hotel	
Storaging Area for Automation	

Waste Station	
Sport Center	
Restaurant	
Entertainment Center	
Government	
Study Center	
Hospital	
Police Office	
Fire Station	

Table 4-1-1 Symbols

4.1.2 Greening Distribution

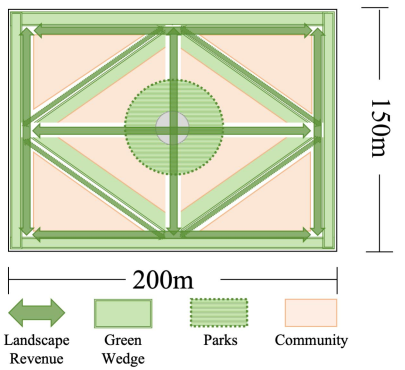


Fig 4-1-1 B1 Community Greening System Design [WPS Office] by Chen Liuxuan

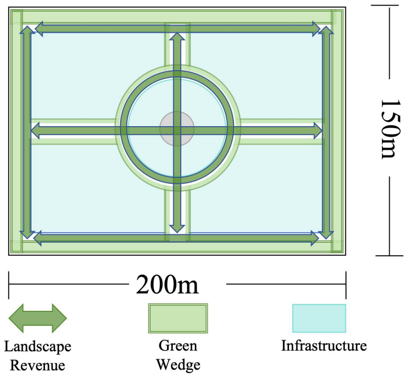


Fig 4-1-1 B2 Community Greening System Design [WPS Office] by Chen Liuxuan

	Place	Function	Type	Number
Lower layer	Roadside	Oxygen-producing	Snake plant	807
			Spider plant	
			Boston fern	
		Air-Purifying	Rubber plant	540
			Bamboo palm	
	Park	Ornamental	Pothos	449
			Peace lily	
			Aloe vera	
		Algae	Spirulina	225
Upper layer	Roadside	Oxygen-producing	Willow	1256
			Rubber fig	
			Wheatgrass	
		Air-Purifying	Rubber plant	1076
			Bamboo palm	
	Park	Ornamental	Petunias	1016
			Geraniums	
		Algae	Spirulina	405
		Soil Enrichment	Mosses	811
			lichens	

Table 4-1-2 Greening Trees

Material Category	Name of Material	Unit	Daily for Capital Demand	Monthly Demand	Annual Demand
Cleaning Supplies	laundry detergent	kg	0.01	120	1440
	dish soap	kg	0.005	60	720
	toilet cleaner	kg	0.02	240	2880
Personal Hygiene	toilet paper	volum	230	2800	33.6
	body wash	milliliter	50	600000	7200
	shampoo	milliliter	30	360000	4320
	toothpaste	kg	1	14.4	172.8
	toothbrush	month	1	4800	57.6
	mouthewash	milliliter	10	120000	1440
	skin care product	kg	5	600000	720
	femininie hyginine product	month	1	4800	57.6
Clothing Supplies	clothing	year	1	4800	57.6
	laundry detergent	kg	0.02	240	2880
Others	stationary	kg	0.005	60	720
	restorative	kg	0.002	240	2880
	cleaning tool	year	0.001	4.8	57.6

Table 4-1-3 Consumables Type and Quantity [Excel] by Fan Sizhe

Material Category	Name of Material	Unit	Daily for Capital Demand	Monthly Demand
Food	bread	kg	0.2	292
	potato	kg	0.2	292
	vegetable	kg	0.175	255.5
	fruit	kg	0.2	292
	milk and product	kg	0.375	547.5
	cheese	kg	0.03	43.8
	meat	kg	0.1	146
	meat product	kg	0.23	33.28
	low fat spread	kg	0.03	43.8
	butter	kg	0.015	21.9
Water	potable water	kg	3	438
	cooking water	/	3	438
	saitary water	/	15	4380
Breath	oxygen	/	0.84	122.4
Source of Energy	electricity	kliowatt-hour	6	730

4.1.3 Consumer Goods Supply Mechanism

Fig 4-1- Flow chart of consumables transport [Figma] by Yang Muyi

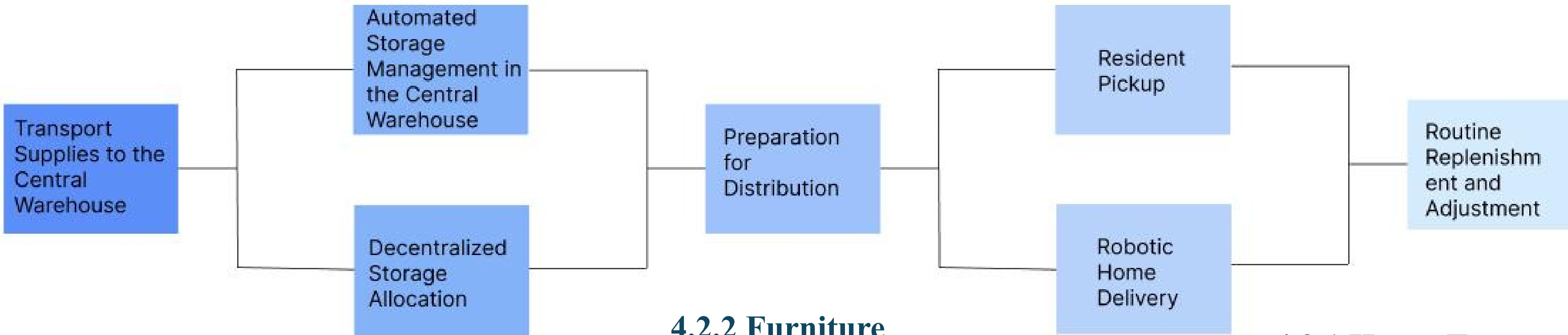


Table 4-3-2 Furniture Items and Quantity [Excel] by Fan Sizhe & Zhang Xinyue

Type	Amount	Source
chair	232	Blown Away
sofa	193	
coffee table	77	
dining table	154	
dining chair	540	
Wardrobe/Wardrobe	463	Bots4U
kitchen	77	Clean Up Your Act
cabinet	232	
icebox	39	Fusion Founders
cooking range	154	
range hood	77	
washing machine	232	Waste Products
washroom	116	
shower	77	

4.2.2 Furniture

toilet	116	Bottom Cleaners
carpet	77	Seals-It-All
sofa	77	
green plants/potted plants	232	Garden-A-Go-Go
bed	309	Blown Away
table lamp	116	Brain Wave AI
TV set	116	
pan	77	Nano Solutions
teakettle	39	
wash basin	232	Stuff of Life
table setting	116	
computer	116	Brain Wave AI
toilet	232	Bottom Cleaners
bathtub	77	
shower cubicle	39	Extreme Survival Technologies (EST)
Dust Bin	680	Toss It To Me

4.2.1 House Type

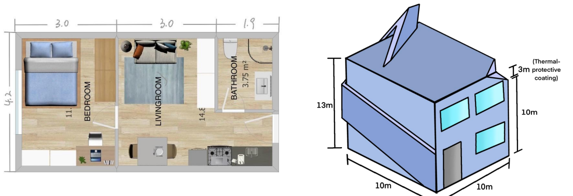


Fig 4-2-2 Interior & exterior design of the single department [Room Sketcher] by Ji Xiaodi&[CAD] by Li Xianye&[Procreate] by Chen Liuxuan

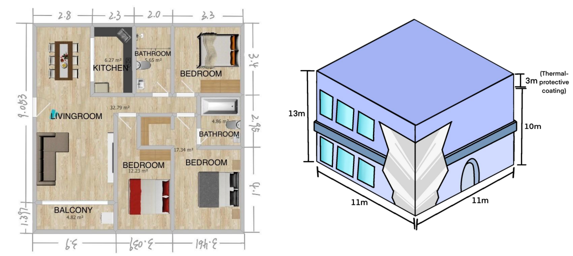


Fig 4-2-3 Interior & exterior design of an apartment for married people with children**[Room Sketcher] by Ji Xiaodi&[CAD] by Li Xianye&[Procreate] by Chen Liuxuan**

House Type	Resident Number	Area per Floor/m^2	Floor Number	Number Required
Single Apartment	1	33.18	2	120
Apartment for Couples	2	45.9	2	30
Apartment for Families	3-5	108.68	2	5
Hotel	8	31.08*4	5	5

Fig 4-2-4 Interior &exterior design of hotel twin room interior design
[Room Sketcher] by Ji Xiaodi&[CAD] by Li Xianye&[Procreate] by Chen Liuxuan

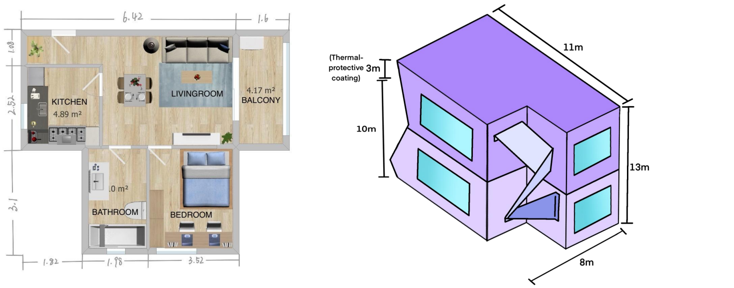


Fig 4-2-1 Interior & exterior design of couples apartment
[Room Sketcher] by Ji Xiaodi&[CAD] by Li Xianye&[Procreate] by Chen Liuxuan

4.3.1 Location of Research Lab

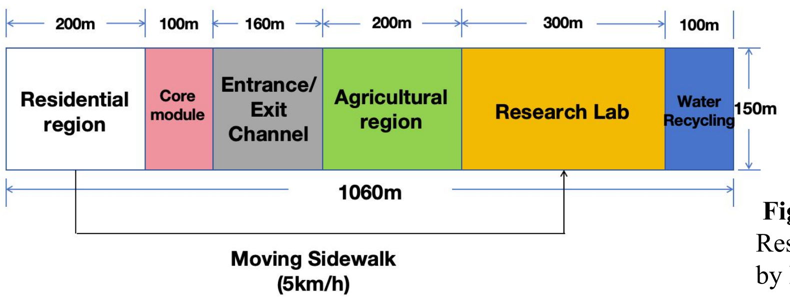
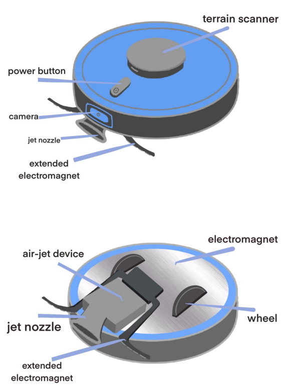
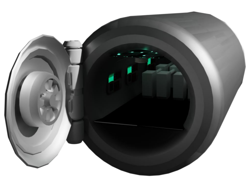


Fig 4-3-2 Location of Research Lab [Procreate] by Liu Mohan

4.3.2 Dustproof System





- **Dust Removal Chamber:**
- **Electromagnetic adsorption**——Martian dust has a high electrostatic charge.
- **Airtight**: only open one cabin door while operating——ensure Mars dust doesn't get into the living areas.

Research Lab Location Explanation

1. Core Module & Residential Area & Exit/Entrance Channel

- The core module is the first to be designed and serves as the base's central hub.
- The residential area must be next to the core module for convenient access.
-The core module must connect directly to the exit/entrance channel for efficient base operations.

2. Agricultural Area Placement

-The agricultural area supports research experiments and supplies the residential area.
- It is located between the exit/entrance channel and the research lab, ensuring proximity to both.

3. Transportation Network

-Residents can travel efficiently across the base using the highway system, following this route:
-Residential Area → Core Module → Exit/Entrance Channel → Agricultural Area → Research Lab

Fig 4-3-2 Dust removal robot [Procreate] by Ji Xiaodi
Fig 4-3-3 Dust removal chamber[Blender] by Wan Yutong

4.4.1 Exterior Recreational Activities

Fig 4-4-1 Red Dune Camping [Procreate] by Yang Muyi

- **Site**: Sand dunes on the surface of Mars with transparent protective cover as camping tent.
- **Safety**: Transparent tents with air filtration and temperature control ensure comfort, while backup oxygen and a central emergency shelter are available.
- **Experience**: The camping area is equipped with Martian style grilled food equipment (using compressed oxygen combustion technology), allowing visitors to enjoy delicious food while admiring the unique night sky on Mars.

Fig 4-4-2 Low-Gravity Jumping Arena Generated by ChatGPT

- **Site**: Located on the relatively flat surface of Mars.
- **Safety**: Flexible suits with motion stabilizers and impact-absorbing floors ensure safety. Nets surround the area to catch high jumps.
- **Experience**: Residents enjoy jumping several meters high and playing games like zero-gravity basketball, combining fitness and fun in a unique environment.

Fig 4-4-3 Mars Kite Surfing Generated by ChatGPT

- **Site**: Open plains with steady wind currents and smooth terrain near the city.
- **Safety**: Aerodynamic suits with dust-resistant visors and stable kiteboards ensure safety, while drones monitor for emergencies.
- **Experience**: Participants glide across dunes, using Martian winds for propulsion. Low gravity allows for spectacular high jumps, making it a thrilling and visually stunning activity.

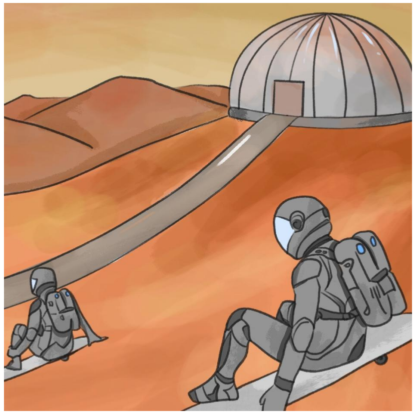
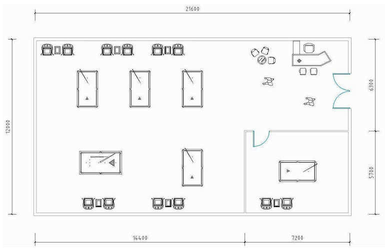
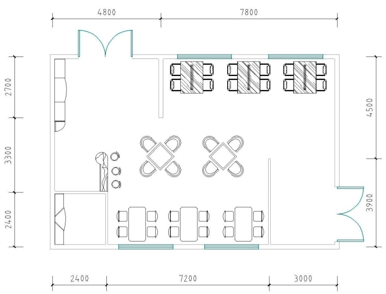


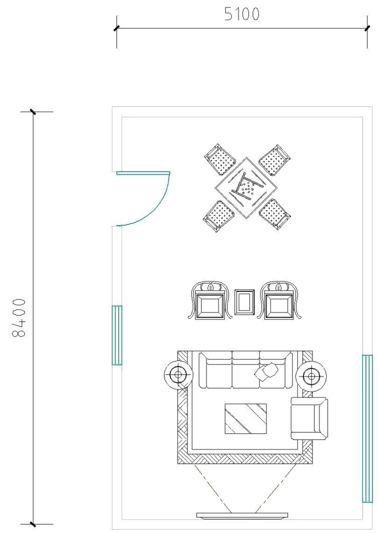
Fig 4-4-4 Volcano Boarding [Procreate] by Yang Muyi

- **Site**: Martian sand dunes and extinct volcano slopes provide a stable environment for sliding with a scenic backdrop.
- **Safety**: Lightweight suits with reinforced padding and helmets protect participants, while rescue drones monitor the activity. Emergency airbags in suits add extra safety.
- **Experience**: The low-gravity environment offers longer, smoother descents, making the ride thrilling yet safer.

4.4.2 Interior Recreational Activities

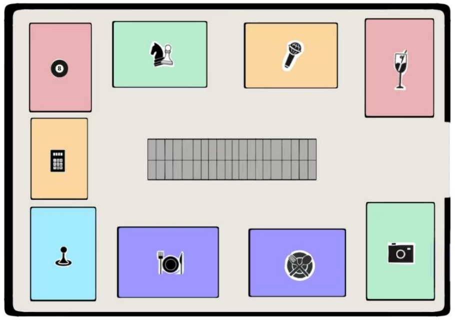


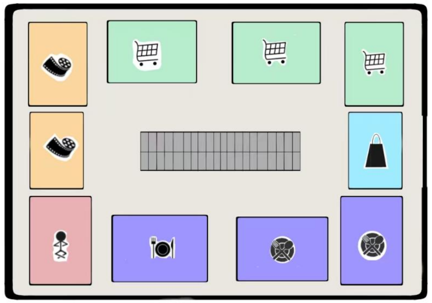




These indoor entertainment facilities are the key source of people's happiness. Our design included a huge variety of choices for citizens, like pool halls, cinemas, meditation rooms, game centers, and saloons. These facilities could efficiently reduce the pressure on workers. Also, having a higher average life expectancy than without entertainment.

Fig 4-4-5 Pool Hall [Photos] by Li Xianye
Fig 4-4-6 Chess and card room [Photos] by Li Xianye
Fig 4-4-7 Bar [Photos] by Li Xianye
Fig 4-4-8 Interior Recreational Facilities Distribution by LiuXin[Sketchbook]





4.4.3 Spacesuit Design

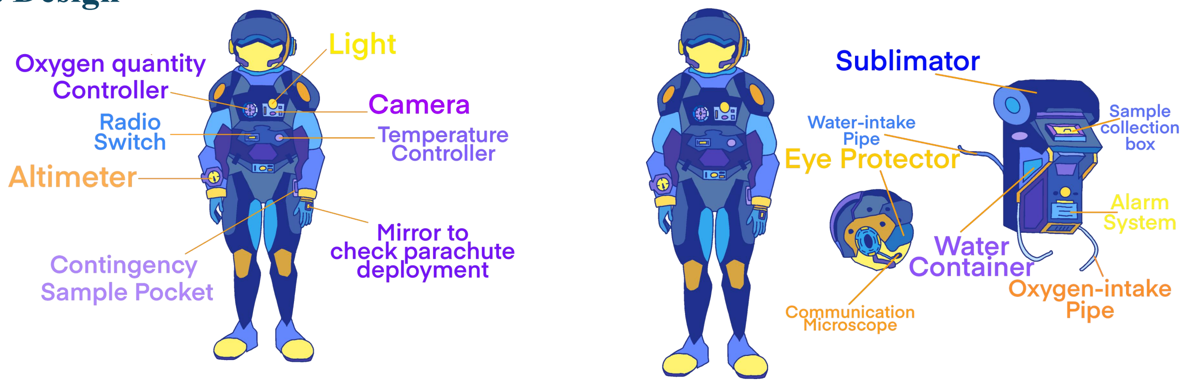


Fig 4-4-5 Spacesuit Design [Procreate] by Zhang Mofan

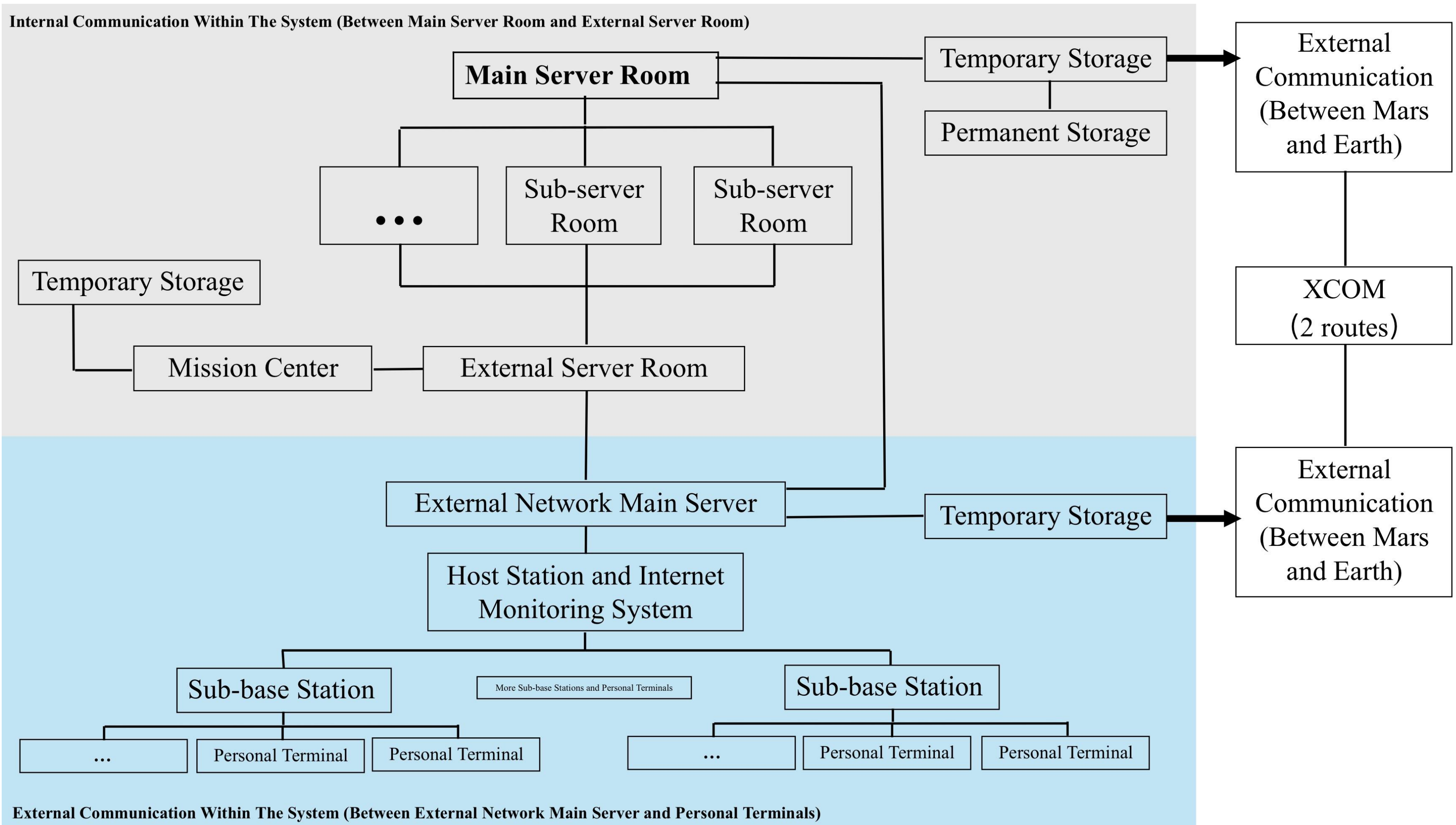


Fig 5-0-1 *Overall Network Structure[Junye Wang, PowerPoint]*

Function grading:
A and B

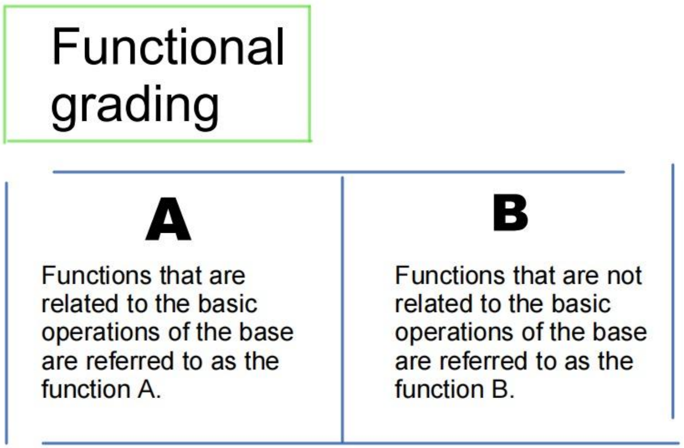
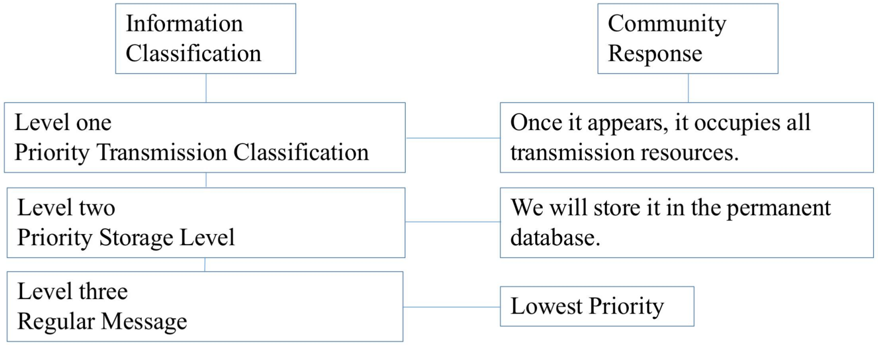


Fig 5-0-2 *Functional grading[Yutong Wan, PowerPoint]*

		The main machine room works properly	**The main machine room is broken**
Auxiliary machine room works properly		Main machine room：A+B Auxiliary machine room：B‘	Main machine room：x Auxiliary machine room：A’+B’
Auxiliary machine room is broken	Partial damage	Main machine room：A+B Auxiliary machine room：B’+B’（cloud)（external server room)	Main machine room：stop Auxiliary machine room：A’+A’（cloud)（external server room)
	All broken	Main machine room：A+B Auxiliary machine room：stop	Manual repair

Table 5-0-3 *emergency plans[Zhiru Wang, PowerPoint]*

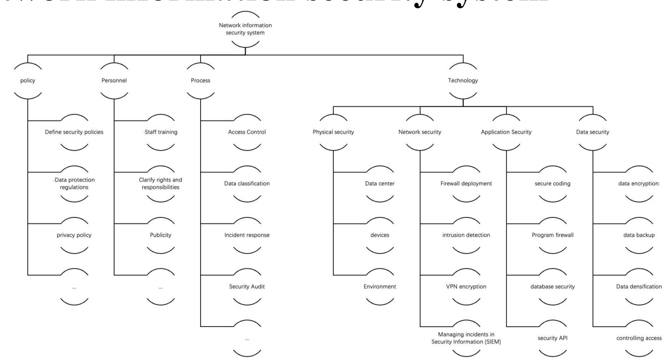


information three levels: L1, L2, and L3.
L1 is the priority transmission level, which, once it appears, occupies all transmission resources.
L2 is the priority storage level, and we will store it into the permanent database.
L3 is for regular messages and has the lowest priority.

Fig 5-0-4 Information Classification System[Wang Jingming, WPS office]

Regarding emergency plans: Corresponding to different damage scenarios in the main control room and sub-machine rooms.

Network information security system



Regarding considerations for user information security:
User messages are typically categorized at level 3.

Network information security system

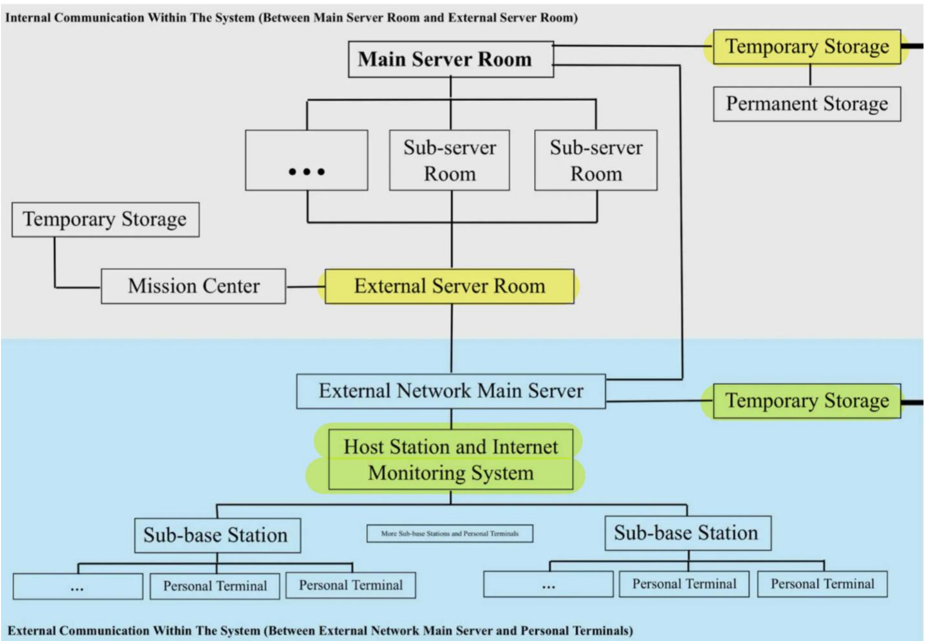


Fig 5-0-6 *Network information security system[Junyue Wang, PowerPoint]*

Regarding considerations for user information security:
User messages are typically categorized at level 3.

At this level, the data does not enter the main database but only passes through a temporary database. The temporary database clears data once a month, ensuring the security of user information.
In the process of communication, the emerging aggregation organizations are also a part of network security monitoring: They are used as institutions to block the spread of cyber attacks, among other purposes.

Encryption Level Classification

Security classification	Security verification	
A		
B		
C		
D		

department	security level of accessible personnel	Access path
Water maintenance	D	Online+Offline
Agricultural	D	Online+Offline
Residential	C	Online+Offline
lab	A	Offline
storage	B	Offline
industry	C	Online+Offline
Mining district	C	Online+Offline
core	A	Offline

Fig\Tab 5-0-7 *Encryption Level Classification(2)[Jiaqi Song, PowerPoint]*

Warehouse management and logistics system

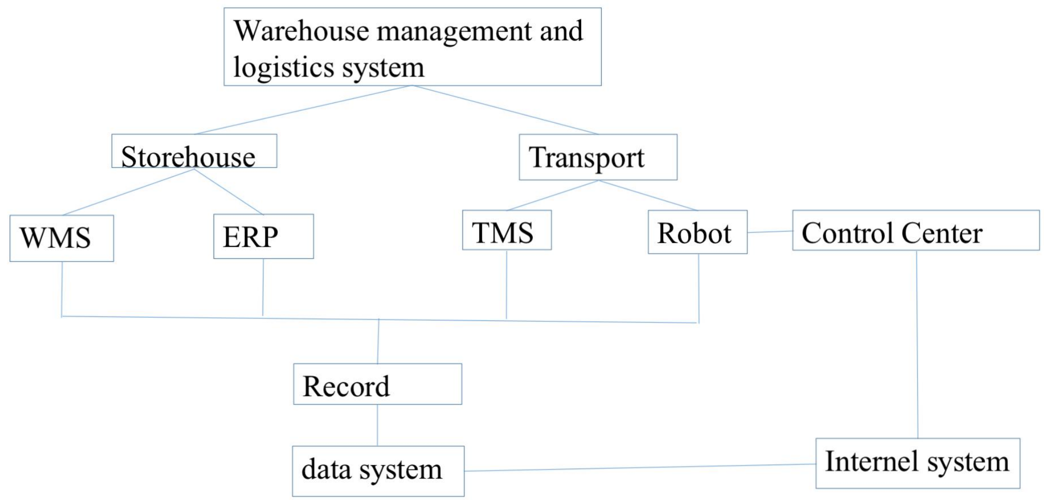


Fig 5-0-8 *Warehouse management and logistics system [Jingming Wang,WPS office]*

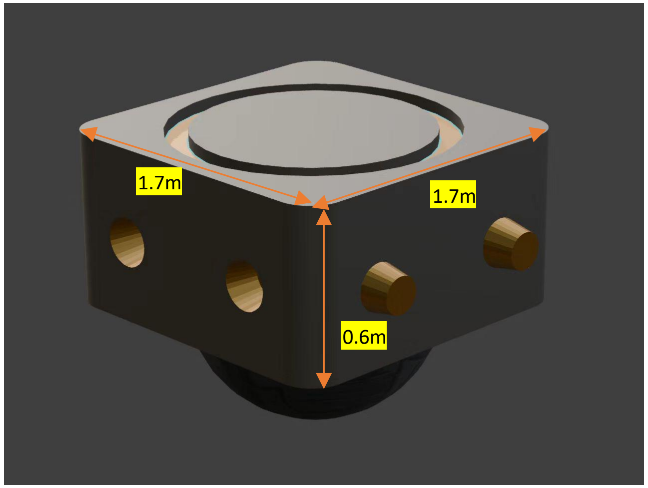


Fig 5-1-1 External Construction Robot[Xuhang Wan,Blender]

External Construction Robot

- The external construction robot builds the base crust before human arrival.
- Utilizes a modular system that is compact and combines efficiently for various construction tasks.
- Reduces Earth-to-Mars transportation costs and enhances convenience for building infrastructure.

Fig 5-1-2 External Construction Robot[Xuhang Wan,Blender]

Combined Deformation Form

- "A0001" is a cargo transport unit with a robust structure for secure movement and load-bearing.
- The spiked wheel aids construction robots in navigating rough terrain and stabilizing or breaking up surfaces.

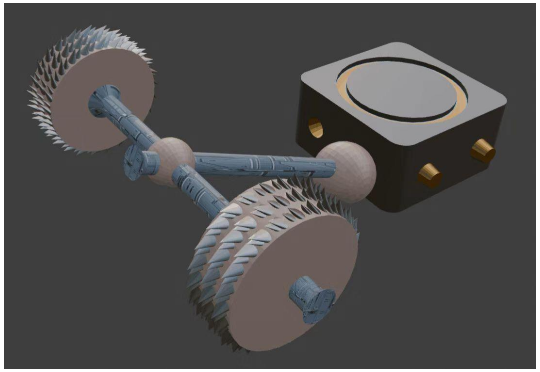


Fig 5-1-3 External Construction Robot[Xuhang Wan,Blender]

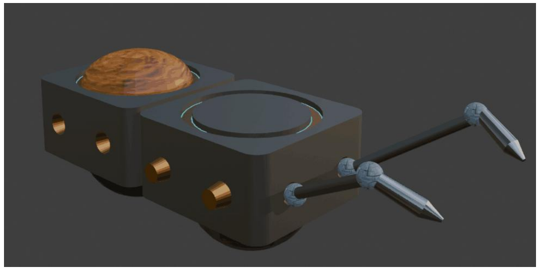


Fig 5-1-4 External Construction Robot[Xuhang Wan,Blender]

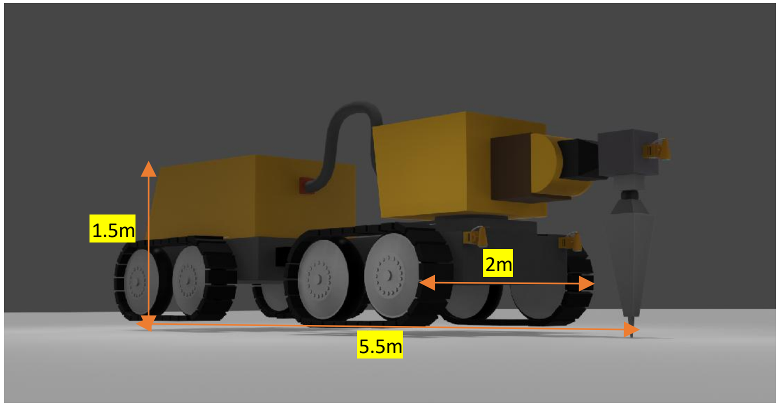


Fig 5-1-5 *External Maintenance Robot[Wenyu Li,Blender]*

External Maintenance Robot

- Repairs building surfaces with 3D-printed materials for precision.
- Uses magnetic tracks to navigate walls seamlessly.
- Operates continuously, minimizing downtime.

Fig 5-1-6 *Transport Drone [Hongwen Zhou,Blender]*

Transport Drone

- Designed specifically for Mars transport missions, adapting to challenging terrain.
- Equipped with dual propeller pairs for enhanced stability.
- Engineered for optimal performance in low-pressure Martian atmospheres.

Internal Maintenance Robot

- Designed for internal base construction and maintenance tasks.
- Features an elevatable platform for high-reach operations.
- Equipped with a storage box for accessible materials and flexible mechanical arms for versatile construction handling.

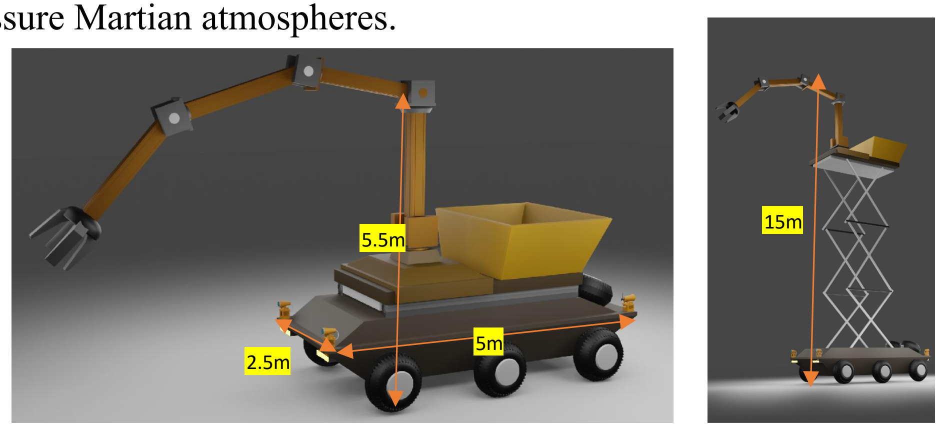


Fig 5-1-7 *External Maintenance Robot[Wenyu Li,Blender]*

Robot Vacuum Cleaners

- Equipped with a bristle roller to sweep debris into a collection box during operation.
- Features two robotic arms: one for rotational cleaning and another functioning as a vacuum for debris absorption.
- Includes six sensors for detecting obstacles and garbage in all directions, ensuring thorough and efficient cleaning.

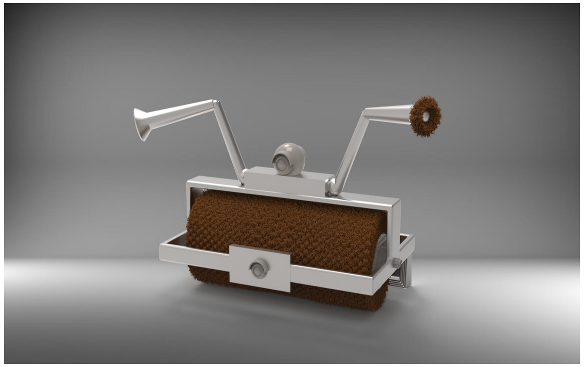


Fig 5-1-7 *Robot Vacuum Cleaners [Hongwen Zhou,Blender]*

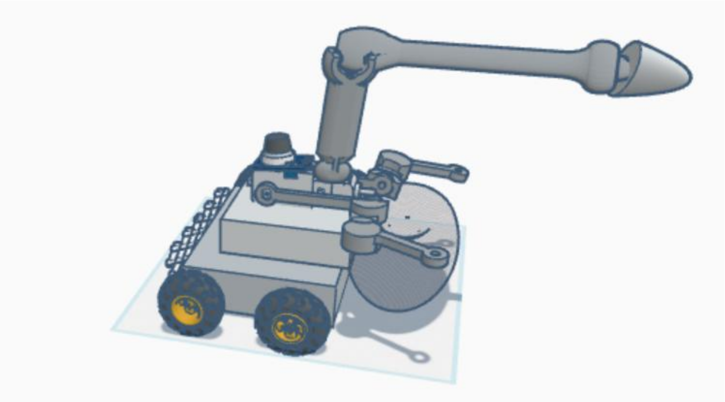


Fig 5-1-8 *Mars mining robot [Xujin Li,tinkercad]*

Mars mining robot

- Autonomous Mars mining robot for mineral collection.
- Flexible robotic arm with drill for ore extraction.
- Durable loading net for material transport.
- Advanced navigation for optimal route finding.

Transport Cart

- Multi-functional transport robot for people and materials robot for people and materials.
- Front section dedicated to passenger seating.
- Rear section for cargo, construction supplies, and emergency equipment.

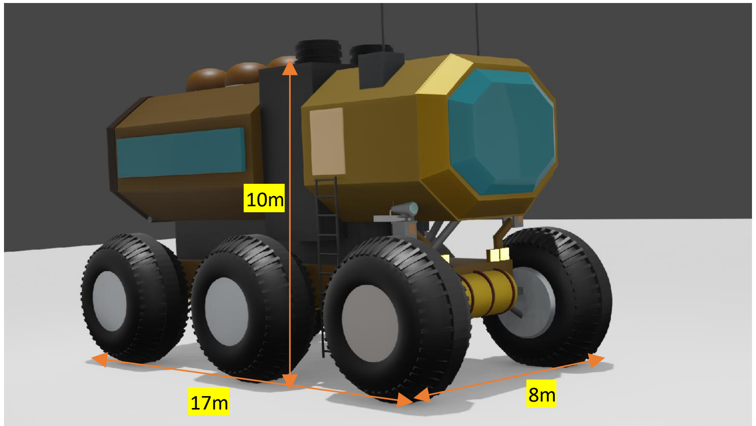


Fig 5-1-9 *Transport Cart [Wenyu Li,Blender]*

5.2.1 Robot Classification

	main task	Covered Modules	quantity	function description		location
Infrastructure Operation and Maintenance Robots	Energy Management Air circulation Waste Disposal Water resources maintenance	Core functions Water treatment	15	Responsible for the dynamic maintenance and detection of infrastructure, response to anomalies or failures.Rapid equipment repair and dynamic adjustment when energy, air and water systems are abnormal		core area water treatment station
Agricultural and Resource Management Robots	Agricultural planting and irrigation Resourcecollection and transportation	Agriculture Collection transportation	48	Dynamic sowing, harvesting and irrigation tasks ensure stable monitoring of the greenhouse environment.Mineral collection robots support underground excavation and resource classification, and transport equipment is used for material allocation at collection points and bases.		Agricultural area Collection point
Safety Emergency Response Robots	Security monitoring Emergency response and conflict management	Security With emergency module	40	Real-time patrol and monitoring to detect security threats, such as fire and gas leaks. In case of emergencies, quickly evacuate residents and cooperate with the monitoring system to provide solutions.		Site wide range Lava tube inlet outer area
Researchand Exploration Robots	Terrain and underground resource detection Data Acquisition	Detection and data management	20	Terrain scanning and 3D modeling, collecting subsurface samples and supporting preliminary data analysis. Collect environmental data in real time to monitor climate change and support research missions and construction evaluations. .		Lava tube inlet and outer area Laboratory module Control Center

Table 5-2-1 *Robot classification and description[Jiaqi Song,ppt]*

5.2.2 Repair and Maintenance

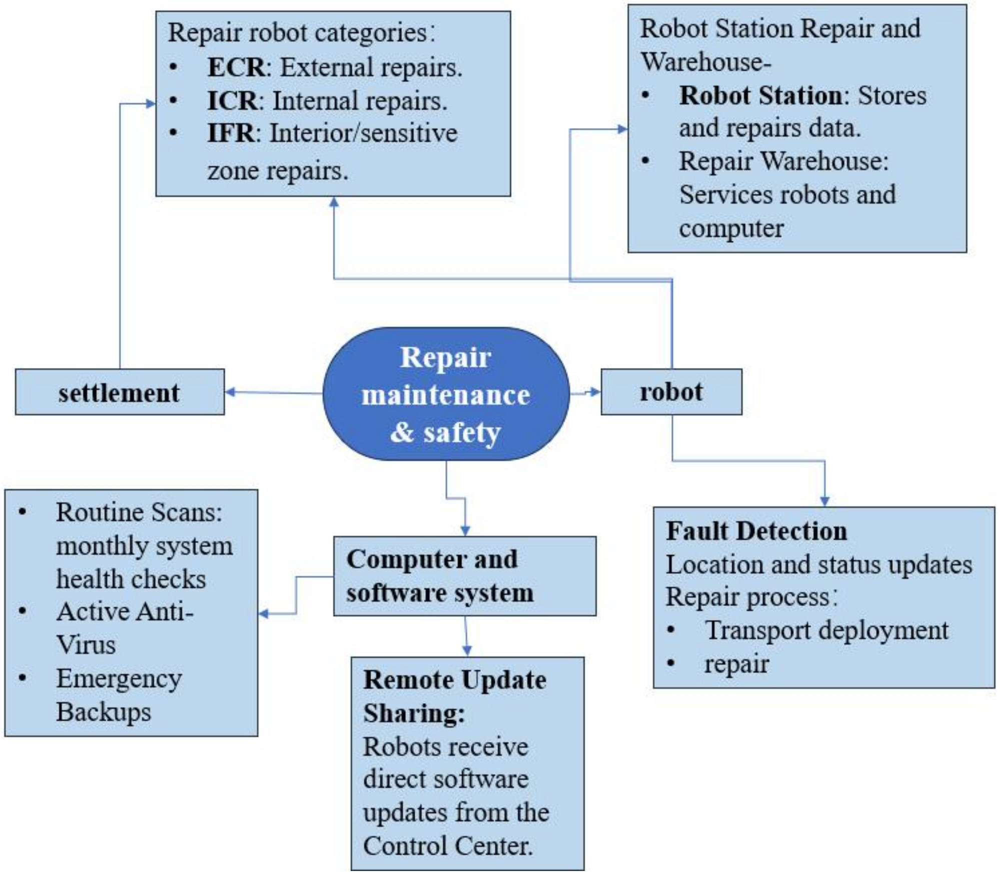


Fig 5-2-2 *Repair and Maintenance[Jiaqi Song,ppt]*

System	Amount of Intervention	Rationale
Residential Zone	Low	Monitoring life-support systems and ensuring basic utilities are functional.
Mining Zone	High	Overseeing resource extraction and handling equipment malfunctions.
Storage Area	Low	Managing inventory conditions like temperature and preventing spoilage.
Laboratory	High	Supervising experiments and ensuring safety protocols are followed.
Core Energy Zone	High	Monitoring critical power systems and manually overriding during emergencies.

Table 5-2-3 *Human Intervention Needed[Jiaqi Song,ppt]*

robot repair description:

Fault Detection:

- Robots perform self-diagnosis and send reports to the Control Center.
- Location and status updates every 5 minutes
- disconnection triggers recovery dispatch.

Repair Workflow:

- Control Center deploys transport vehicles to retrieve faulty robots.
- Repairs are conducted in Robot Stations (minor fixes)
- Repair Warehouses (major repairs).

5.2.3 Emergency and alarm systems

alert system

alert for different group of people:

- official:
  Provide detailed data and suggested actions to facilitate decision making
- individuals:
  action instructions that easy to understand

multichannel notification:

- PCD:Vibration, screen display, voice alarm.
- Sound alerts: sirens and announcements
- Light alerts:
  settlement light that have differentcolor to indicate the different type of emergencies

Fig 5-2-4 *A schematic diagram of an alarm.[Jiaqi Song. procreate]*

Contingency Table

Hazard	Detection	Action
Power failure	Power monitor	Backup power system
Fire	Smoke detector temp sensor	Self-extinguished, isolate the area that in fire
Water leakage	Water level sensor	Regional shut off, send repair robot
Depressurizatio n	air pressure sensor	Damaged section isolated, increase oxygen supply
Cyber breach	Network monitor Firewall	Active security protocol, reboot affected system
Hazmat	Gas sensor Chemical detector	Evacuate, protective device and isolate that area

Table 5-2-5 *Contingency Table[Jiaqi Song,ppt]*

Design Principle:

- redundancy
- isolation
- modualrity
- expanability
- safety priority

5.3.1 Livability and convenience

Robots	Functions	Quantities	Places
Maintenance Medical	• Provide medicine • Emergency medical aid	60	Habitats
Transport carts Cargo drone	• Transportation • Select cargo	25 20	Habitats Storage
Household Robots	• Provide assistance • Cleaning & Cooking	400	Habitats
AI	• Provide public services • Chat & psychological help	20	Habitats

Table 5-3-1 *Livability and convenience [Qinghao Huang Haoming Gu,ppt]*

Fig 5-3-2 *Household robot [Heziruo, Kita]*

5.3.2 Productivity and reduction of manual labor

Robots	Functions	Quantities	Places
Repairing Robots	• Fix broken machines	40	Inside the building
Research support robots and Data managementrobots	• Provide information for work	40	Habitats
Environmental management	• recycle waste and energy	0	Inside the building
External-use Robots	• Clean and repair some important outside device	20	Outside the building
Multifunctional modular and exterior Construction robot	• Moving containers and supplies	800	Outside the building
Mining robot	• Mining of ores and rare metals	15	Outside the building
Interior construction robot	• Interior construction	15	Inside the building

Table 5-3-3 *Productivity and reduction of manual labor [Qinghao Huang Haoming Gu,ppt]*

5.3.3 Personal communication devices

Device	Functions	Quantities	Places
PersonalTerminal（ring）	Solvequestionsforpeople Communication	400	Habitats
Stand-byCommunication	Emergencycommunication	400	Habitats
PersonalTerminal(glasses)	comunication solvequestions payforthings	400	Habitats

Table 5-3-4 *Personal communication devices [Qinghao Huang Haoming Gu,ppt]*

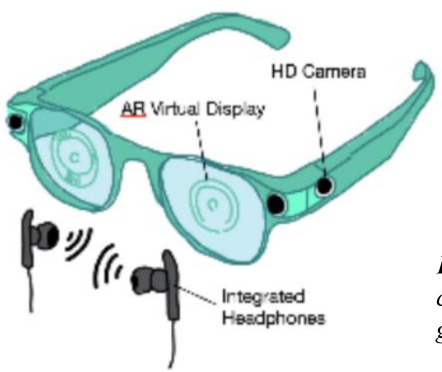


Fig 5-3-5 *Personal communication devices glsaaes [Ziruo He,procreate]*

System	Functions	Quantities	Places
Barometric control	• Regulate inside air pressure	1&1 standby application	Inside the building
Luminance control	• Regulate the light	1&1 standby application	Inside the building
Electric power control	• Control electric power	1&1 standby application	Inside the building
Irrigation & Sewage treatment	• Automatically watering • Take the polluted water to the disposal	1&1 standby application	Agricultural district

Table 5-3-6 *System [Qinghao Huang Haoming Gu,ppt]*

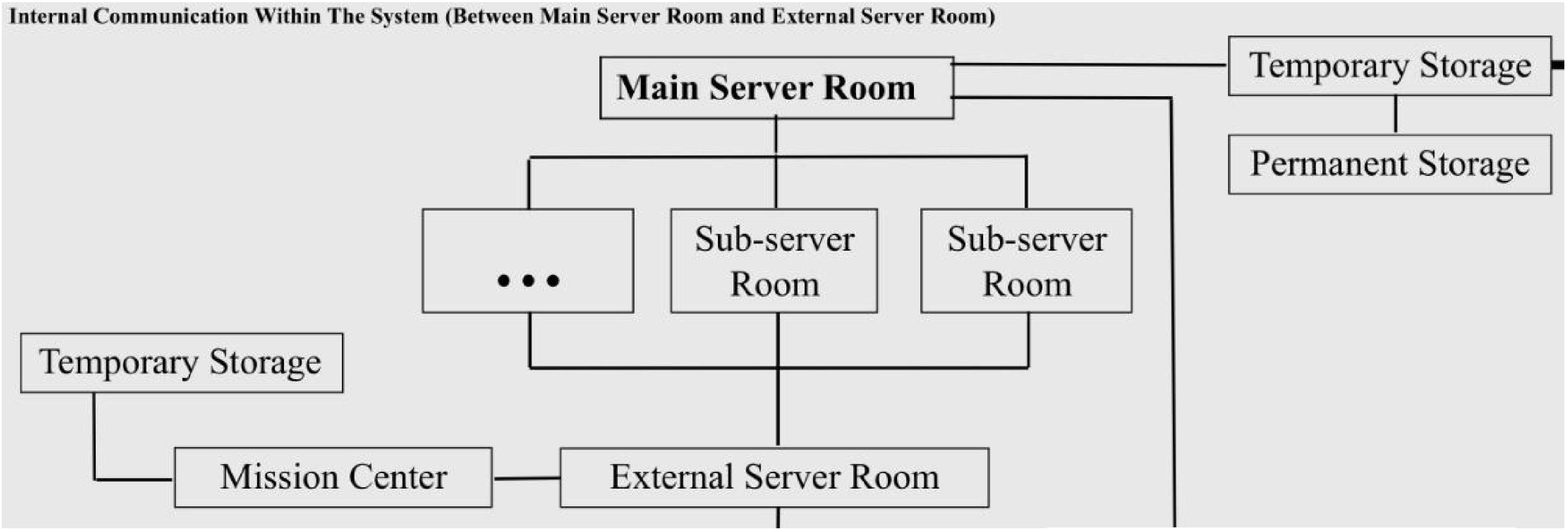


Fig 5-4-1 *Mission Center in overall Structure*

The control center, referred to as the mission center (see 5.0), is directly connected to the Externel server room and linked to a temporary storage architecture.
The control center integrates communication modules and mission instruction modules, which are used to issue tasks to robots and transport vehicles for mining operations, manage and coordinate task resources, with modules running parallel to those in the sub-machine rooms.

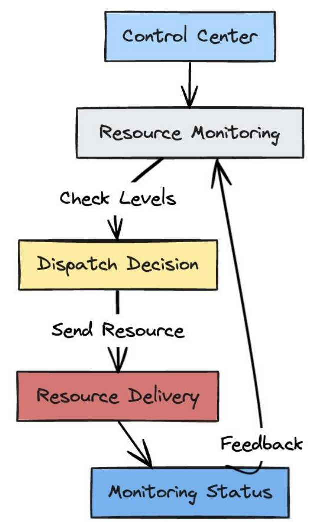
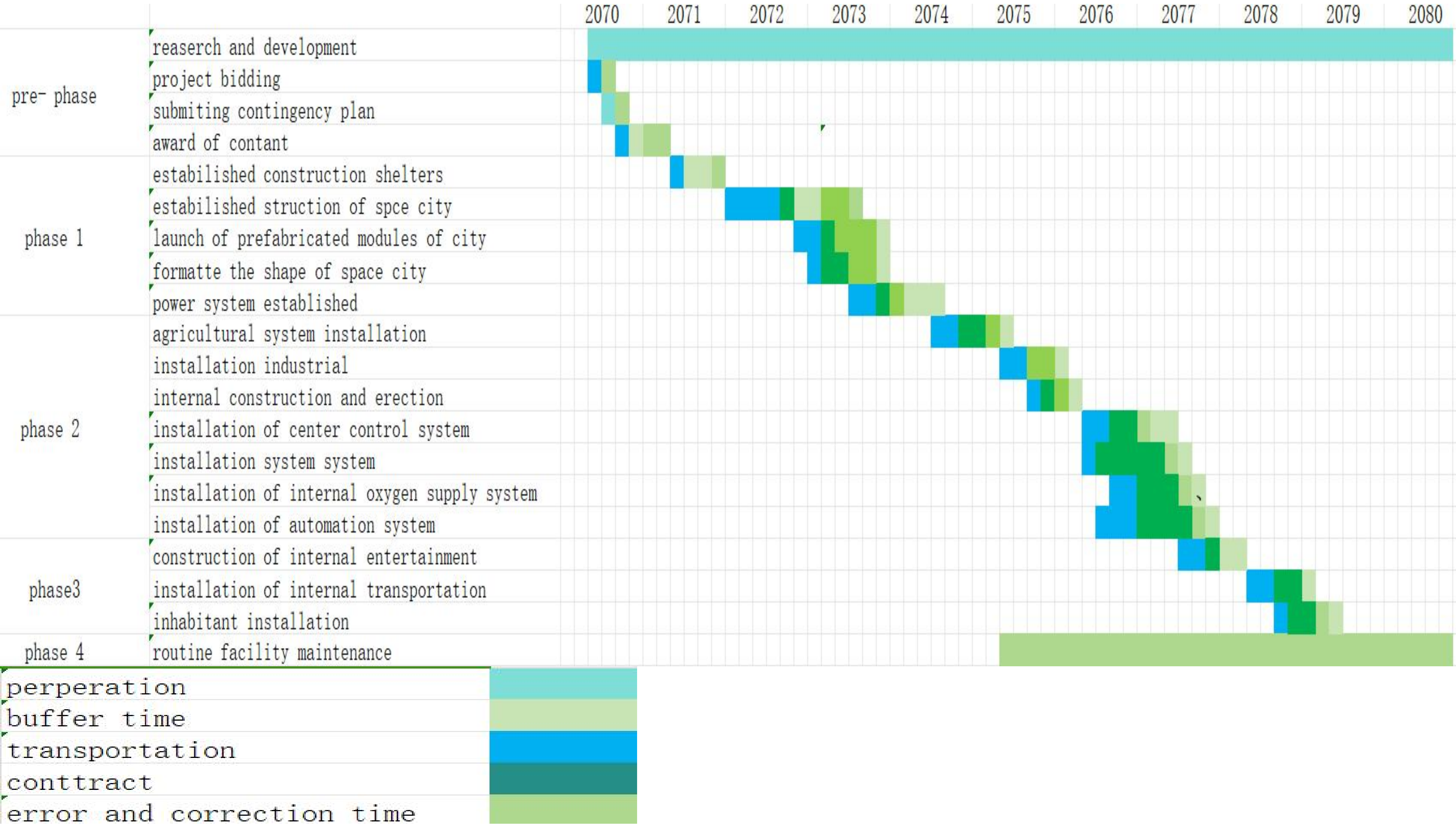


Fig 5-4-2 *Mission Center Structure [Jingming Wang,WPS office]*

Fig 6-1-1 Design and Construction schedule [Wangzhiru, Excel]



6.2.1 Costs While Constructing Exterior Structures

Meterials	Sources	Thickness	Amount	Unit Price	Total Price
Electro dynamic shields	Luna	1.22	569.946424	1000	569946.424
whipple sheld	Luna(processed at	0.7	328.1614	13000	4266098.2
Super Adobe	dirtbuilders	21.35	8624.56735	110	948702.4085
Lead Oxide	Earth (imported to	4.575	2089.102838	1200	2506923.405
Water&shield tight sealant	Earth/Mars (proces	4.575	2089.102838	112.3	234606.2487
Alexandrate	Earth or synthesiz	4.575	2089.102838	13460	28119324.19
Wolverine Fabric	Earth	2.287	1060.753641	1120	1188044.078
Silica Aerogel	Manufactured on Ma	6.862	3084.148682	1113.2	3433274.313
Carbon Nanotubes	Earth (advanced pr	8.845	3920.340162	11232	44033260.69
Aluminum	Luna/Earth (refine	0.091	42.83499766	1132	48489.21735
					85348669.18

6.2.2 Costs While Constructing Interior Structures

Type	Cost per unit ($)	Number	Cost ($)
House Type 1	247,676	580	143,652,080
House Type 2	83,073	350	29,075,550
House Type 3	111,841	500	55,920,500
House Type 4	88,204	275	24,256,100
Hospital	20,000,000	6	120,000,000
Restaurant	750,000	18	13,500,000
Police Station	3,000,000	6	18,000,000
School	10,000,000	12	120,000,000
Shopping mall	10,000,000	6	60,000,000
Lab	10,000,000	12	120,000,000
Construction machines	14,003	500	7,001,500

Total Cost: $711,405,730

6.2.3 Costs After Construction

Table 6-2-3 *Cost of consumables per year [Bianjuncheng, Word]*

name of materail	unit	daily for capital	monthly	annual demand	unit price		total price/year	
laundry detergent	kg	0.01	120	1440	US$	5.000	US$	7,200.00
dish soap	kg	0.005	60	720	US$	3.000	US$	2,160.00
toilet cleaner	kg	0.02	240	2880	US$	5.000	US$	14,400.00
toilet paper	volum	230	2800	33.6	US$	10.000	US$	336.00
body wash	milliliter	50	600000	7200	US$	10.000	US$	72,000.00
shampoo	milliliter	30	360000	4320	US$	15.000	US$	64,800.00
toothpaste	kg	1	14.4	172.8	US$	6.000	US$	1,036.80
toothbrush	month	1	4800	57.6	US$	3.000	US$	172.80
mouthewash	milliliter	10	120000	1440	US$	10.000	US$	14,400.00
skin care product	kg	5	600000	720	US$	60.000	US$	43,200.00
femininie hyginine product	month	1	4800	57.6	US$	8.000	US$	460.80
clothing	year	1	4800	57.6	US$	60.000	US$	3,456.00
laundry detergent	kg	0.02	240	2880	US$	5.000	US$	14,400.00
stationary	kg	0.005	60	720	US$	1.500	US$	1,080.00
restorative	kg	0.002	240	2880	US$	30.000	US$	86,400.00
cleaning tool	year	0.001	4.8	57.6	US$	20.000	US$	1,152.00
							US$	326,654.40

Total Cost: $326,654,40

6.2.3 Costs After Construction

Table 6-2-4 *Cost of living consumables per year [Bianjuncheng, Word]*

Bread	kg	0.2	292	US$	3.000	US$	876.00
potato	kg	0.2	292	US$	1.250	US$	365.00
vegetable	kg	0.175	255.5	US$	2.500	US$	638.75
fruit	kg	0.2	292	US$	6.000	US$	1,752.00
milk and product	kg	0.375	547.5	US$	1.500	US$	821.25
cheese	kg	0.03	43.8	US$	12.250	US$	536.55
meat	kg	0.1	146	US$	10.000	US$	1,460.00
meat product	kg	0.23	33.28	US$	8.000	US$	266.24
low fat spread	kg	0.03	43.8	US$	3.000		
butter	kg	0.015	21.9	US$	5.000	US$	109.50
potable water	kg	3	438	US$	1.250	US$	547.50
cooking water	/	3	438	US$	0.001	US$	0.44
saitary water	/	15	4380	US$	20.000	US$	87,600.00
oxygen	/	0.84	122.4	US$	30.000	US$	3,672.00
electricity	kliowatt-hour	6	730	US$	0.200	US$	146.00
						US$	98,791.23

Total Cost: $98,791.23

6.2.3 Costs After Construction

Table 6-2-7 *Cost of staff [Heziruo, Word]*

Type	Number	Cost per person per year ($)	Cost ($)
Scientific research Personnel	100	70,000	7,000,000
Construction Personnel	100	60,000	6,000,000
Maintenance Personnel	20	55,000	1,100,000

Total cost: $16,600,000

6.2.5 Subcontractors' Contract

Table 6-2-3 *Subcontractors [Bianjuncheng, Word]*

Type	Subcontractors
Cable	ZAP! Industries
Solar cells	ZAP! Industries
Machines	3D Logistics, Bottom Cleaners, Dirtbuilders, Fusion Founders, Nano Solutions, Wheels of Fortune, ZAP! Industries.

D.A4F.C

① Two Kinds of Energy supply

② Separation of personnel and cargo

③ Full coverage of green space in the community

④ Abundant recreational activities both in the lava tube and out of the lava tube.

⑤ Automation coverage of every aspect of residents' lives.