

XM Astral

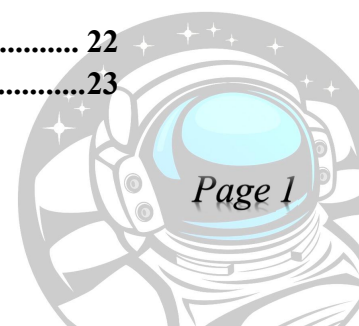
Cassandras Space Settlement Design

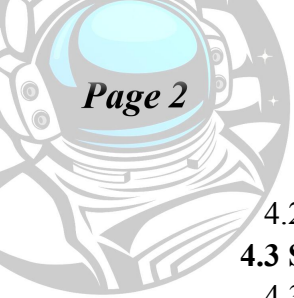




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Part 2 Structure

2.1 General Layout

2.1.1 Basic Description

The constructed space station model consists of three large enclosed modules. These modules are cylindrical in shape, with nearly identical volumes and external designs. Their annular surfaces are made of opaque material to simulate Earth's terrain, serving as foundations for buildings, while their circular planes are sealed with two large joined glass panels to ensure stable internal pressure and prevent oxygen leakage.

Additionally, a smaller ring is embedded within each large module, sharing the same thickness and rotational speed as the main structure. A central shaft connects all three modules, with its end linked to a fusion thruster. Once activated, the thruster rotates all three modules at the same speed and in the same direction.

The main central shaft has a diameter of 90 meters, while the auxiliary shafts connected to it—used for transportation and structural reinforcement—each has a diameter of 20 meters.

The outer ring of the habitat module has:

- A diameter of 1,600 meters
- A width of 600 meters
- A thickness of 30 meters

The inner ring inside the module has:

- A diameter of 800 meters
- A width of 600 meters
- A thickness of 30 meters

The fusion thruster measures:

- 630 meters in width
- 480 meters in diameter

Each enclosed habitat module is equipped with an artificial gravity system, maintaining gravity levels between 0.38g and 0.65g. The internal atmospheric pressure remains uniform throughout, ensuring identical air conditions on both sides of the rotating structure.

2.1.2 The thruster

The thruster is installed in both ends of the settlement's main axis in order to provide thrust and steering force, as illustrated in the figure 1 below.

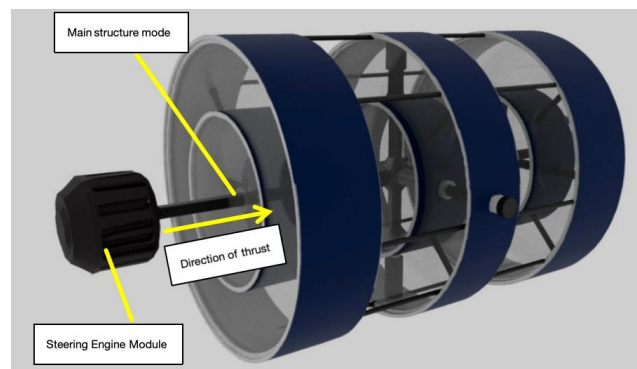
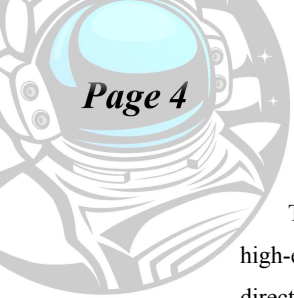


Fig 1 The layout of the engine



The main thruster module is directly powered by a nearby nuclear fusion reactor. The engine utilizes the high-energy particles or plasma generated by nuclear fusion, which are confined by magnetic fields and directionally expelled to directly convert fusion energy into thrust. Thus, space to store a large amount of propellant is saved and the power of the engine is improved.

The steering engine module uses traditional propellant-based propulsion engines to provide steering force. They are mounted on the exterior of the cylindrical structure, with the tail of each engine pointing directly outward.

2.2 Exterior Design

2.2.1 The settlement

The settlement has three modules of rings rotating along its main axis. The down surfaces of these rings are where the main facilities took place, as illustrated in figure.1. The three other rings are completely identical in size, the same for the three inner rings.

The following paragraphs will introduce the uses of each one of the six rings' down surface respectively.

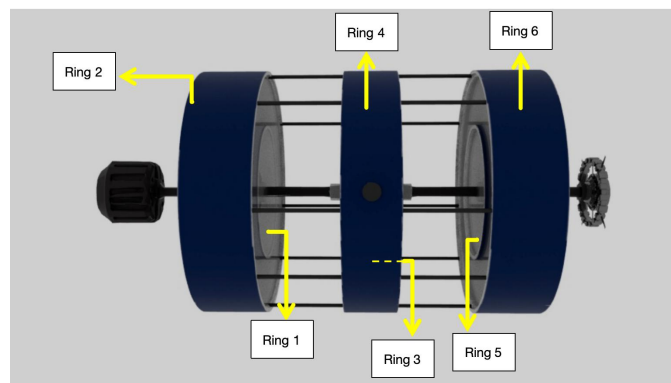


Fig 2 The general layout of the settlement

2.2.2 Ring 1

As mentioned in 2.1, Ring 1 is one of the three inner rings. The ring with a radius of 450 meters will serve as the settlement's bridge. The ring has its width of 400m, and the total area available in this ring will be 1.7 square kilometers. The 5 corridors will connect the ring with ring 2.

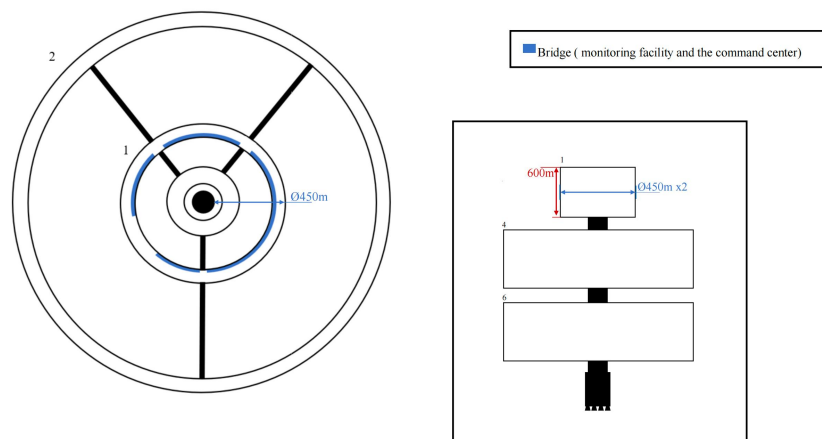


Fig 3 The general layout of Ring 1



0.2 square kilometers of the space will be used as the command center, and the monitoring facility system takes an area of 1.2 square kilometers. The radar antennas dissipate all around Ring1's perimeter of 2820m. Combined together, the antenna system has the same effect with a giant radar in the size of 63600 m². The real-time observation area took the space of 100 square meters, utilizing equipment to capture X-ray pulsar and provide absolute positional reference.

2.2.3 Ring 2

Ring 2 is the other ring that is directly connected to ring 1 with a radius of 1140m. The ring will have a height of 30m. The width of the ring will be 700m, and there will be a total area of 5.01 km². The down surface will be allotted to regions for electricity, water and air supply and the agriculture section.

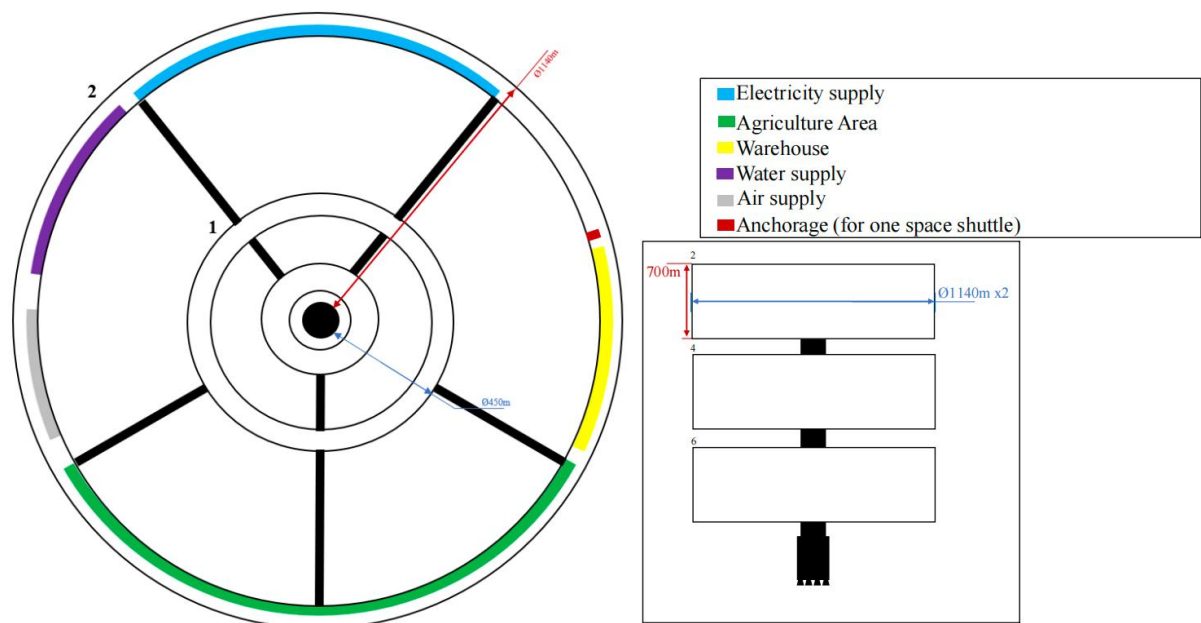


Fig 4 The general layout of Ring 2

There will be a logistics area of 0.5 km² to store the freight. This 0.5 km² logistics complex is organized into a modular grid of 17 standardized warehouses, each measuring 200m (L) x 100m (W) x 18m (H), providing 340,000 m² of total floor space. A primary 25-meter-wide ring road encircles the warehouse blocks. An anchorage for one space shuttle which takes an area of 1220 m² will be set right beside the warehouse to transport the freight efficiently.

The energy supply facility will take an area of 1 km². This facility powers all starship systems except propulsion. It employs sixteen fusion reactors. Electricity is distributed ship-wide. Approximately 15% of the area is dedicated to cryogenic fuel storage.

The water supply facility occupies 0.5 km². The storage sector (410,000 m²) contains 70 identical cylindrical storage tanks. Each tank has an 80-meter diameter and an 18-meter usable water depth (meet the available height), providing a total storage capacity of approximately 3.8 million cubic meters. The remaining area of 90,000 m² houses pumping infrastructure.

The air supply section takes 0.3 km². The oxygen generation plant takes 60,000 m², and the gas storage zone takes 75,000 m². This zone contains tanks for liquid oxygen and liquid nitrogen storage. The rest area of 90,000 m² is for atmospheric cycling and filtration.

There is also a 1.5 km² agricultural zone. The core is a 1.2 km² multi-tiered hydroponic farm. This zone is

projected to yield approximately 1,500 metric tons of fresh produce annually. A 0.2 km² synthetic starch production plant utilizes bioreactors that convert CO₂ and hydrogen into carbohydrates. A compact 0.1 km² closed-loop pig husbandry unit completes the system. It is designed to yield roughly 50 metric tons of meat annually.

2.2.4 Ring 3

Ring 3 is an inner ring which is identical to all the three inner rings such as ring 1. This ring is used as the medical area and the cultural and recreational amenities for the settlement's residents.

A hospital which is 0.15 square kilometers large takes place in the ring's down surface. It features 300 inpatient beds, offering a complete spectrum of comprehensive medical services.

Nestled within the settlement, a 0.5 km² verdant park offers a vital natural respite, featuring a simulated sky dome. There will be a sport stadium in the same size as the park. A 0.05 km² library will provide residents with spaces for research and focused work through its vast collection of research materials as well as academic literature. It also stores the settlements cultural archive.

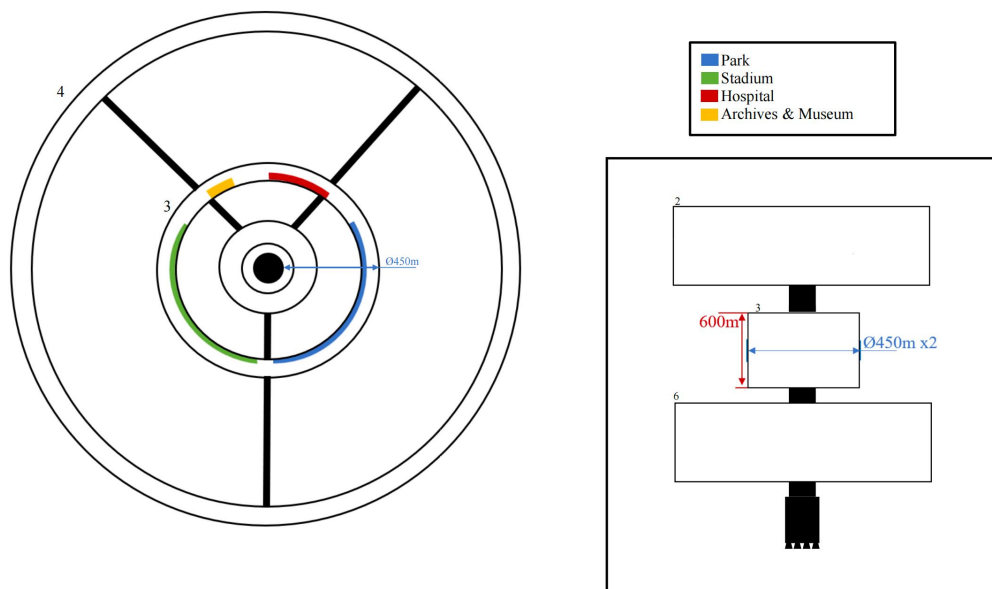


Fig 5 The general layout of Ring 3

2.2.5 Ring 4

As an outer ring, the general size as well as structure of ring 4 is same as that of ring 2. Its five square kilometers large down surface area will be allocated to the residential space and the settlement's commercial region.

Utilizing approximately 3.2 square kilometers of space, the residential area is amassed in this ring. The ring will have a vertical clearance of 30m, so the buildings can all be 6 stories tall. 40% of the area will be allocated to build roads, restaurants, theatres, and other public amenities, and the rest 60% of the residential area will all be used to build apartment buildings. All these 6-story-tall buildings will sum up to a total area of 11.52 square kilometers. Therefore, this is plenty of living space for each of the 2500 full-time residents and 7500 passengers. The three corridors leading to ring 3 will enhance the efficiency of resident's transportation. Each person will have a residential size of 1152 m².

Spanning 0.6 km², there is a vibrant commercial district. With the nearby entertainment zone of 0.8 km², the facilities will support both practical needs and quality of life in the settlement's little society.

Between the entertainment and residential area lies a space shuttle anchorage. This 2562 m² area will provide convenient transportation for passengers.

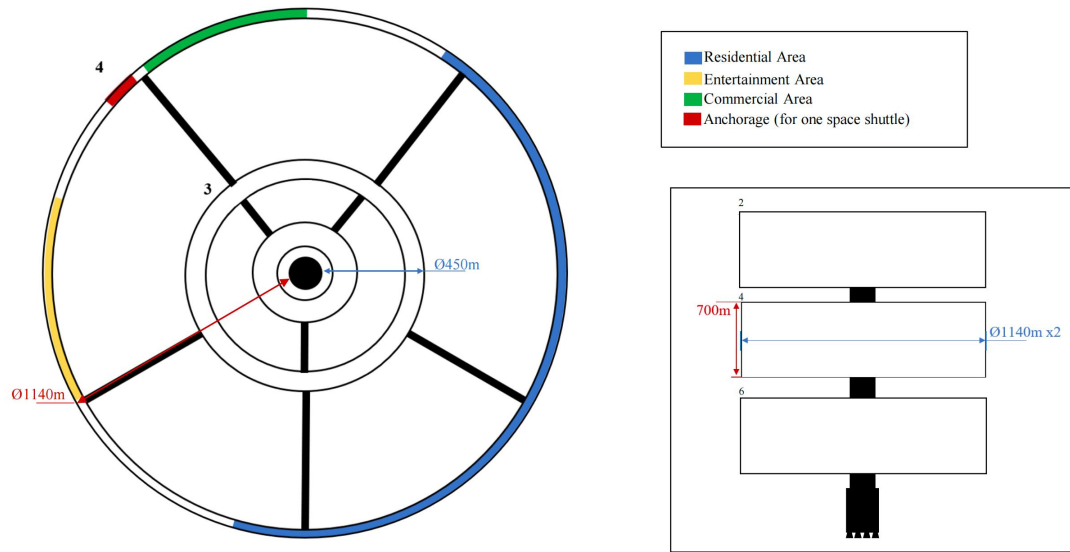


Fig 6 The general layout of Ring 4

2.2.6 Ring 5

The inner ring 5 contains some life-support facilities similar to ring 2. There will be a 0.2 km² air supply facility, a 0.3 km² water supply facility and a 0.4 km² electricity supply facilities. These facilities will supplement the resource supply of ring 2 and also serve as the emergency backup supply routes just in case any hazard took place in ring 2.

There will also be a 0.2 km² R&D department here. This 0.2 km² dedicated zone houses laboratories for a variety of research subject. The centerpiece is a powerful astronomical observatory.

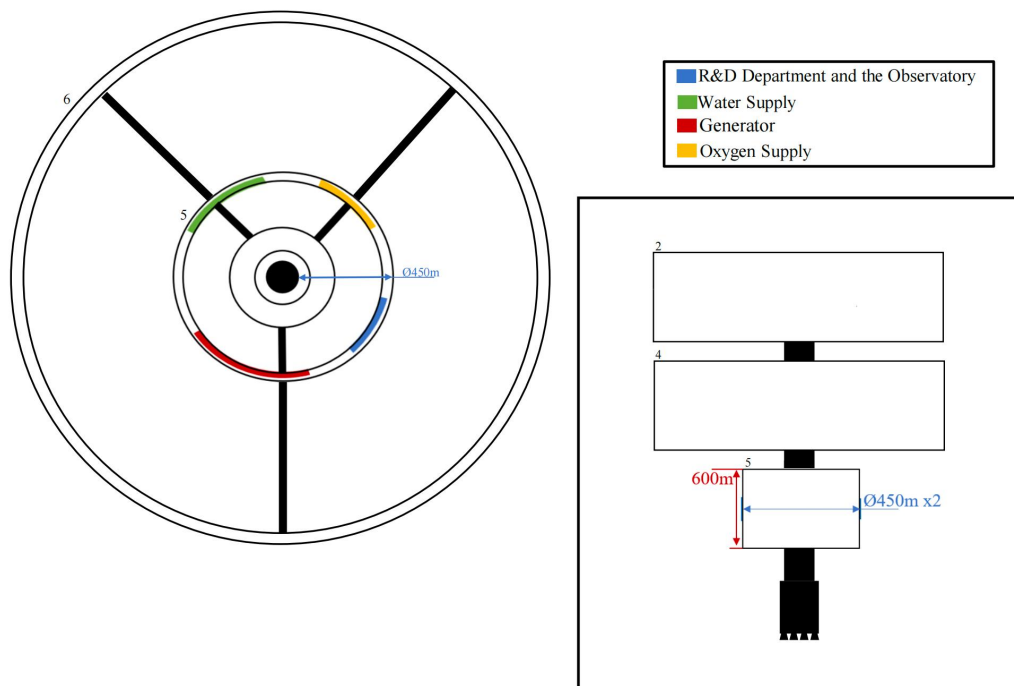


Fig 7 The general layout of Ring 5

2.2.6 Ring 6

Ring 6 is an outer ring that is identical to ring 2 and ring 4. It mainly serves as the industrial center.

The 1 km² large factory zones are the core of this ring. 80 percent of the area is allocated to factories organized into specialized sectors. The rest area is allotted to the road transportation system.

There is also a warehouse area nearby to store the transported freight and manufactured goods. This km² facility will have the same design as the logistic area in ring 2, but its area is doubled, and there will be a total storage space of 680,000 m². There is an anchorage nearby to transport the freight. The anchorage with a total area of 3904 m² can park three space shuttles.

There is an agriculture area that serves as the backup supply route for the same facility in ring 2, which is introduced in 2.2.2. The two facility is completely identical.

There is a 0.5 km² facility to process all colony waste.

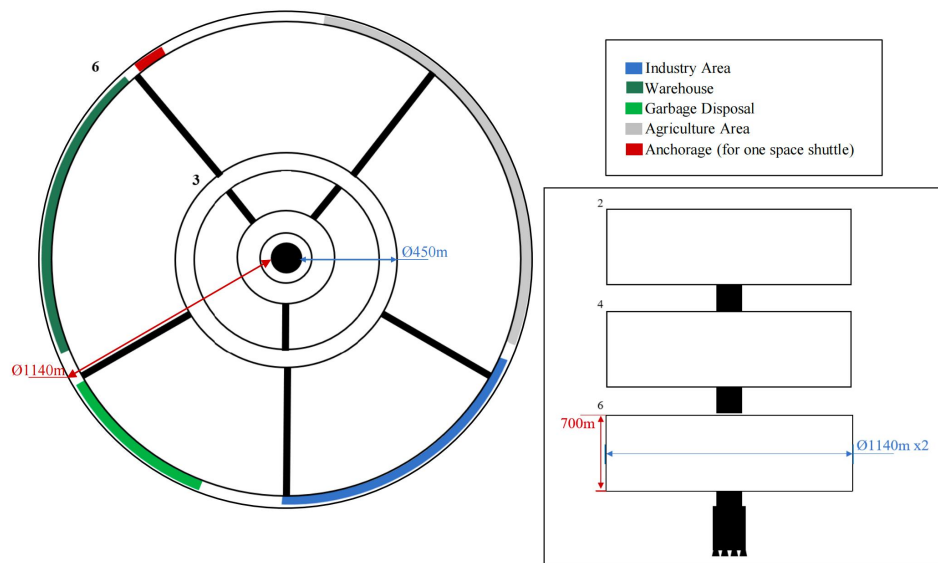


Fig 8 The general layout of Ring 6

2.3 Assembling Process

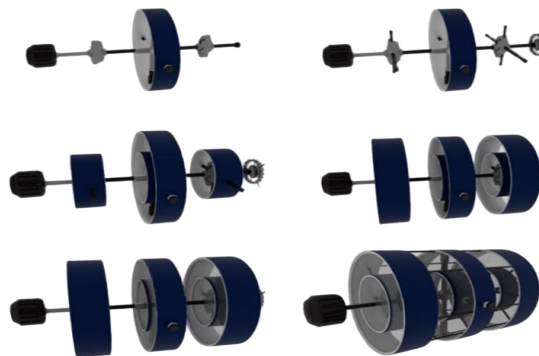


Fig 9 The assembling process (Xiran Wang, Blender)

1. First launch the main axis, engine and ring three. Ring two acts as a temporary control center and provides residence for crews.

2. Add the transportation passages, also serves as connection between rings and main axis, to the main axis.



3. Add ring one, ring four and ring five. As number of rings increases, demand for crews increases. Ring four serves as a temporary residence for crews.
4. Add ring two and ring six. The main structure is finished.
5. Add glass cover on each ring.
6. Add the transportation passages between each ring. Also, by doing so, reinforce the structure.

2.4 Cargo Storage and Accessibility

The cargo storage and accessibility system of Cassandras is achieved through the integrated docking mode of CASSSC containers and their supporting cargo spacecraft. This type of cargo spacecraft has a total length of 60 meters, a maximum fuselage width of 12 meters, a wingspan of 68 meters, and a cargo hold that can accommodate five standard CASSSC containers—each measuring 9.144 meters (30 feet) in length with a cross-section of 4.572 meters $\times$ 4.572 meters (15 $\times$ 15 feet)—along with 250 passengers. The cargo storage and transfer functions rely on three levels of docking areas distributed across three outer rings:

- The agricultural zone on Ring 2 features one docking point (20 $\times$ 61 meters, 1,220 m²) for docking life support and agricultural supply spacecraft.
- The commercial residential zone on Ring 4 features two docking points (42 $\times$ 61 meters, 2,562 m²), allowing two CASSSC container-carrying spacecraft to dock simultaneously while meeting passenger transfer and commodity transit needs.
- The industrial zone on Ring 6 features three docking points (64 $\times$ 61 meters, 3,904 m²), dedicated to bulk industrial material transportation.

Each docking point is equipped with a passenger waiting area to accommodate travelers, a dedicated refueling station, and a maintenance station to ensure the spacecraft remain in optimal operating condition. Additionally, each docking point includes a dedicated freight warehouse for storing CASSSC containers. Based on structural design and docking point capacity calculations, the space station can accommodate up to six CASSSC-carrying spacecraft simultaneously, with a one-time reception capacity of 30 CASSSC containers.

Our warehouse design, located within the terminal, measures 22 meters in length, 15 meters in width, and 14 meters in height. Each warehouse can hold up to 2 $\times$ 3 $\times$ 3, or 18 containers, ensuring a maximum reception capacity of 108 containers. Our design meets the external attachment requirements for CASSSC containers through a tiered docking strategy, ensuring efficient logistics operation for the route.

2.5 Docking Provisions

We designed three types of docks. The following is the design drawings. Each dock contains one refueling and repairing region, at least one air terminal, cargo storage and parking spot. Refueling and repairing region is used for refueling, repairing and handling emergencies. Air terminal is for at most 250 passengers and also for commercial use. Parking spot is for shuttle ships. Each cargo storage region can at most accommodate 5 CASSSC.

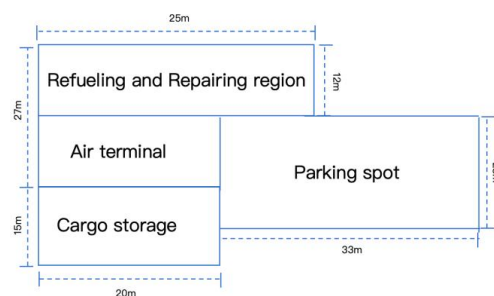


Fig 10 The first type (Zhenyou Wang, PowerPoint)



The first type can accommodate one shuttle ships. It is located on ring two. Ring two is mainly for industries, and it does not require much carrying capacity. One shuttle is enough for ring two.

The second type can accommodate two ships. It is located in ring four. Ring four is mainly for residents and visitors. It requires ships a lot. But three ships need a lot of space, which is not suitable. Two ships are enough.

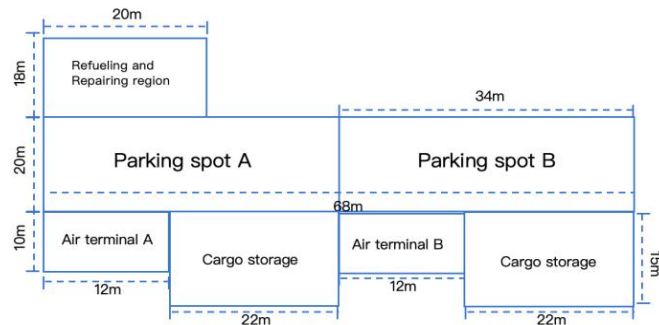


Fig 11 The second type (Zhenyou Wang, PowerPoint)

The third type can accommodate three ships. It is located in ring six. Ring six is for industries and garbage disposal. It requires three ships for carrying garbage from other rings. Also, the ships can stay here when they are not working. The refueling and repairing region is the largest here.

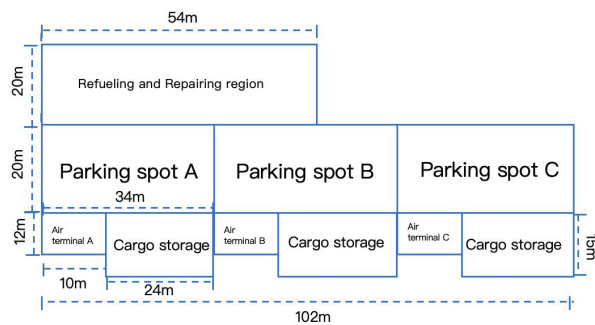


Fig 12 The third type (Zhenyou Wang, PowerPoint)

The following is the modeling of the refueling shuttles. It contains two fuel tanks and will fuel the Cassandra's He-3 at Earth orbit and deuterium at Mars. The two refueling interfaces are at each side of the ship. Each fuel tanks and interfaces fuel one kind of fuel. The refueling interfaces have flexibility and efficiency.

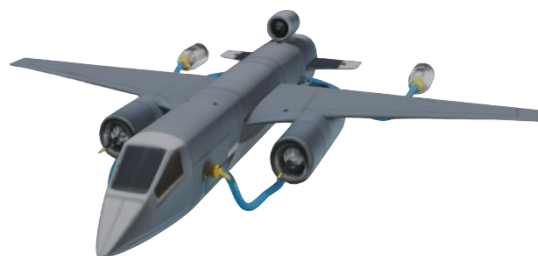


Fig 13 Shuttle Model (Zhenyou Wang, Blender)



Part 3 Operations & Infrastructure

3.1 Materials, Orbit, and Propulsion

3.1.1 Materials

The Cassandras uses a layered material system for its outer hull (Fig 14). Each component of the hull has a specific function, and together they guarantee protection for the residents during their long interplanetary journeys.

	Structural Layer (From top to bottom)	Material Composition	Thickness
	Outer Protective Shell	Basalt Fiber, BNNT, HDPE	80 cm
	Heat-insulation Layer	Polyester multilayer insulation material +Silica aerogel	120 cm
	Load-bearing Structure	Nickel-iron meteorite alloy	15 cm
	Window System	Sapphire Glass + AION + BNNT Shutters	15 cm
	Inner Shell	Antibacterial waterborne polyurethane	30 cm

Fig 14 The cross-section of the outer hull. (Tingfeng Lu, PowerPoint)

The hull is divided into 5 parts, which are the outer shell, the heat-insulation layer, the load-bearing structure, the window system, and the inner shell.

Table 1 The essential materials for the hull (Tingfeng Lu)

Material	Properties	Usage(s)	Source	Amount (m³)
Boron Nitride Nanotubes (BNNT)	High strength & temperature resistance, solar & space radiation protection	Windows & the outer shell	Earth	618114
High density polyethylene (HDPE)	Neutron radiation protection			839211
Basalt fiber	High temperature, radiation, and tensile strength	The outer shell	Martian surface	1210000
Polyester multilayer insulation material	Heat insulation & high-energy particle resistance	Heat insulation layer		251841
Silica aerogel	Heat insulation			125921
Sapphire	High hardness & abrasion resistance, good aesthetic effect	Windows	Earth	75552
Aluminum oxynitride (AION)	High shock resistance			
Antibacterial waterborne polyurethane	High abrasion, bacteria, and water resistance	The inner shell		126594
Nickel-iron meteorite alloy	high flexibility & sustainability; adaptive to the Martian environment	Load-bearing structure	Martian surface (craters)	52000

Table 2 The CASSSC transportation plan (Tingfeng Lu)

Material	Amount (m³)	Density (kg/m³)	Number of CASSSC loads
Boron Nitride Nanotubes (BNNT)	618114	1370	3228
High density polyethylene (HDPE)	839211	950	4383
Basalt fiber	1210000	2700	6318
Polyester multilayer insulation material	251841	150	1315
Silica aerogel	125921	3	2*
Sapphire	75552	3980	395
Aluminum oxynitride (AION)			
Antibacterial waterborne polyurethane	126594	1200	661
Nickel-iron meteorite alloy	52000	7800	272
		Total	16574

Note*: Silica aerogel will be produced on Mars, and 2 CASSSCs will be used for transporting silane gas, which is essential for this process.





This layered design has all the properties for a brilliant protective hull: it provides resistance against radiation, abrasion, shock, heat loss, bacteria, and water while being tough, flexible, strong, and light. The CASSSC transportation plan is given in Table 1 and Table 2.

3.1.2 Orbit

The Cassandras travels along a Hohmann transfer orbit between Earth and Mars, a path known for being energy-efficient. The average distance is about 225 million kilometers. This orbit is chosen to meet the RFP requirement of an 80-day transfer while keeping fuel consumption manageable.

Table 3 The pressure, temperature, radiation, and impact probability at the orbit. (Tingfeng Lu)

At Low-Mars Orbit:		
Pressure	$1.6 \times 10^{-14} \text{ kg/m}^3$	Little resistance helps save fuel
Temperature	20°C (day)/-73°C (night)	More stable than a lower orbit
Radiation	4.5 particles/cm ² /s	Exposed to 15 % weaker radiation than a lower orbit; help save anti-radiation costs
Impact probability	<0.01	Far away from Phobos and Deimos; ensure safety

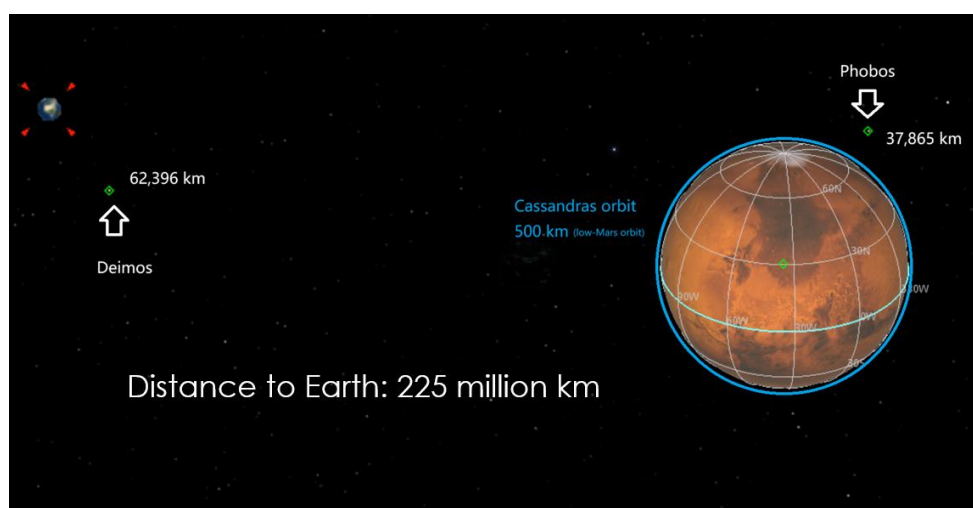


Fig 15 The relative position of The Cassandras, Mars, Phobos, Deimos, and Earth. (Tingfeng Lu, Celestia)

3.1.3 Propulsion

Fusion propulsion thrusters power the Cassandras. Each thruster uses 138 kg of deuterium and 138 kg of helium-3. This fuel mix is chosen because of its high energy yield and relatively clean reaction byproducts. Deuterium can be extracted from Earth's oceans, while helium-3 is available from lunar regolith.

Table 4 The parameters of the engine (Tingfeng Lu)

Parameter	Value	Technical Notes
Propulsion Type	Magnetic Confinement Fusion (D-He ³ Reaction)	Neutron-free, maximizes fuel efficiency
Thrust	500 N (continuous) ×2	Dual-engine redundancy, parallel operation up to 1,000 N
Specific Impulse (Isp)	55,000 sec	Achieved via Direct Energy Conversion (DEC)
Reaction Temp.	100 million °C	Confined by Nb ₃ Sn superconducting magnets (15 Tesla)
Fuel Consumption	0.02 mg/s (per engine)	Round-trip total: 276 kg (138 kg D + 138 kg He ³)
Power Output	1.8 GW (total)	600 MW for propulsion, surplus powers the habitat



The propulsion system achieves an average velocity of 32.55 km/s, allowing the spacecraft to complete the Earth–Mars transfer in 80 days, as required in the RFP. The total power output is estimated to be 1.8 GW. 600 MW will be used for propulsion, and the rest is for powering the habitat. Other parameters of the propulsion engine are detailed in Table 4.

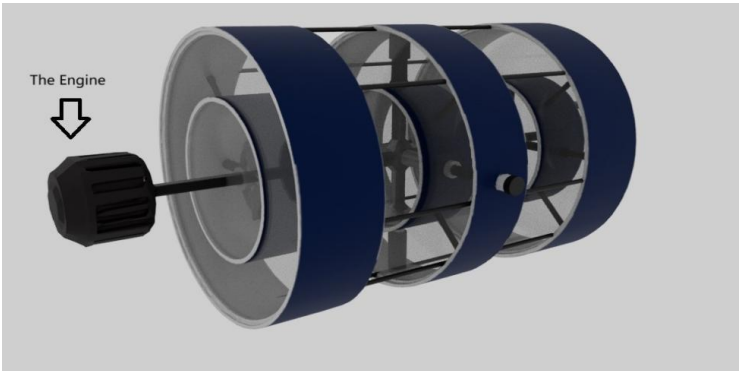


Fig 16 The relative location of the engine (Tingfeng Lu, Blender)

3.2 Basic Infrastructure

3.2.1 Atmosphere & Climate

The Cassandras maintains Earth-like conditions for its residents: the pressure is 101 kPa; the temperature ranges from 20°C to 25°C; humidity is kept between 40% and 60%; and the acceleration due to gravity is 0.38g, which is equal to that of Mars. The air composition is shown in Fig. 3.2.1.

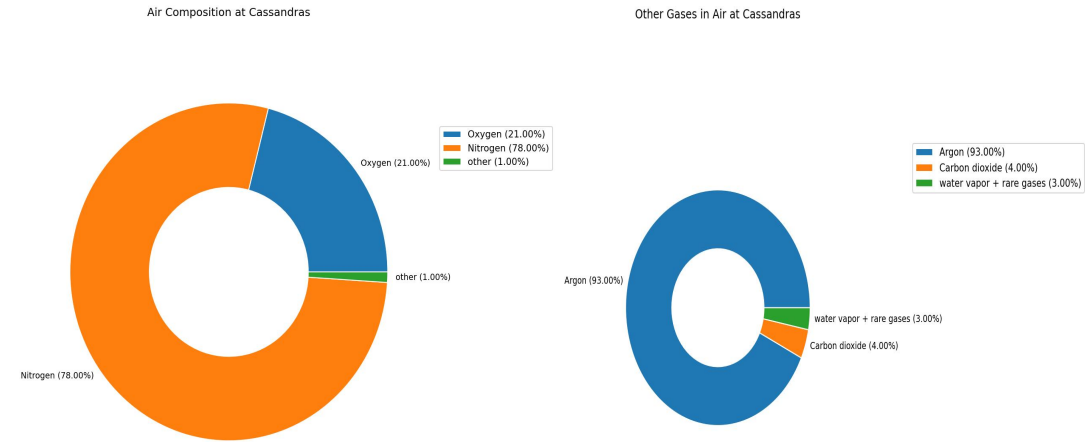


Fig 17 Pie chart of the air composition on The Cassandras. (Tingfeng Lu, Python)

3.2.1.1 Pressure Control

The dual-layer hull (BNNT+HDPE), together with backup compressed gas tanks (O₂+H₂), is designed to keep the internal pressure at approximately 1 atm.

Nitrogen and oxygen are stored in CASSSCs, with each CASSSC being able to support six individuals for the 80-day trip. Gases are transported in the liquid phase to save space and will be vaporized inside the habitat when needed. The gas tanks will be in redundant storage.



3.2.2 Agriculture

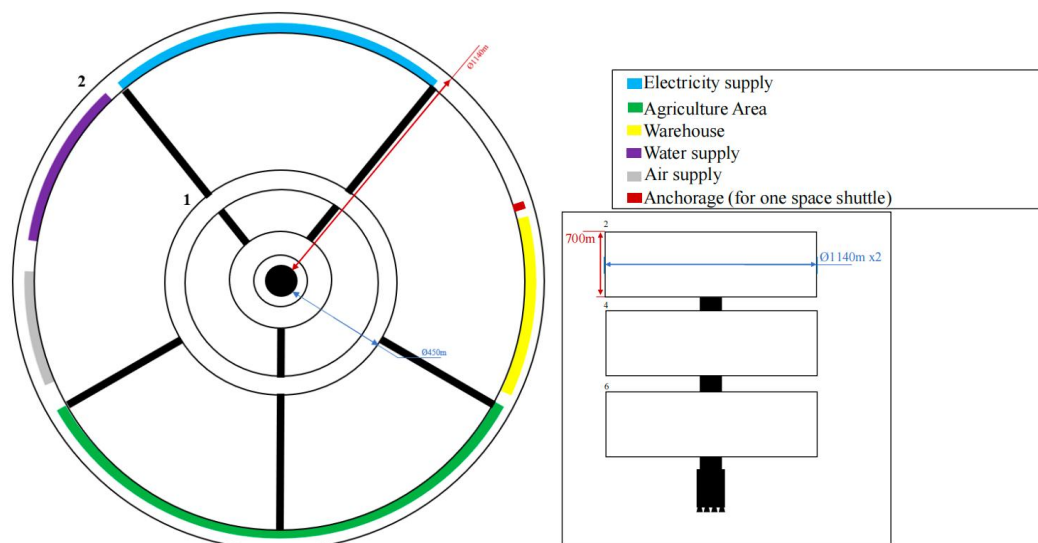


Fig 18 The location of the agricultural areas (Weibin Yin)

The annular structure of the space station is divided into 7 separated areas, of which two of them are identified as agricultural areas, as shown in the diagram.

To satisfy the various diets of the members in the space station, we separate the agricultural area into 4 different fields.

Table 5 The scheme of the agricultural areas and specific usages (Yiwei Wu)

Category of Agricultural Fields	Percentage of Total Agricultural Area	Area (Square Kilometers)	Key Details
Grain Production	40%	1.2	Grows specially developed wheat varieties (space-modified genetics, high yield, drought resistance); uses precisely calibrated drip irrigation systems.
Vegetable Cultivation	30%	0.9	Adopts advanced hydroponic and aeroponic systems (no traditional soil farming); grows leafy greens, cabbage, cucumbers, etc.; uses smart lighting systems that replicate natural sunlight cycles and adjust for ideal growing conditions at different stages.
Economic Crops	20%	0.6	Dedicates to high-value crops, including specialized flowers and medicinal plants enhanced through space breeding programs.
Livestock & Circular Agriculture	10%	0.3	Focuses on sustainable livestock production via innovative closed-loop systems; ecological breeding cabins for poultry and small livestock; integrates insect protein cultivation and advanced waste processing.
Total (All Agricultural Fields)	100%	3	Distributed in 2 separated agricultural areas among the 7 areas of the space station's annular structure.

Grain production covers 1.2 km² (40%), featuring space-modified, high-yield wheat. Vegetables occupy 0.9 km² (30%) using hydroponic and aeroponic systems. Economic crops span 0.6 km² (20%), including space-bred flowers and medicinal plants. The remaining 0.3 km² (10%) supports sustainable livestock in a closed-loop system.



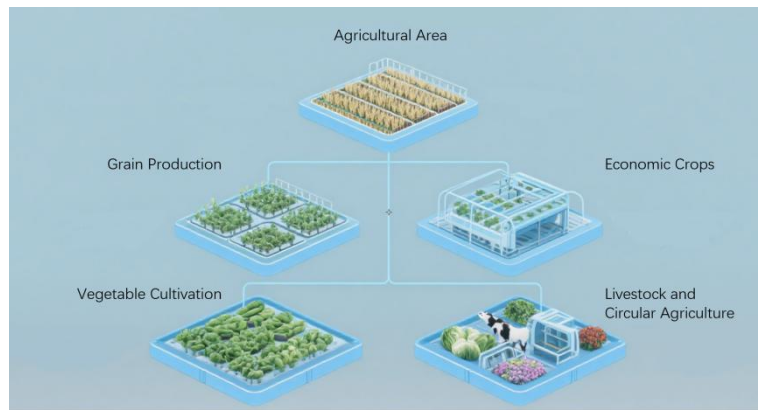


Fig 19 The simulation scenario of four areas (Yiwei Wu, Canvas, Doubao)

3.2.3 Electricity

Parameter↵	Solar (PV)↵	Nuclear (HTR)↵	Biomass (Biogas)↵
Installed Capacity↵	120 MW↵	50 MW↵	10 MW↵
Annual Generation↵	1.056×10^8 kWh↵	4.38×10^7 kWh↵	8.76×10^6 kWh↵
Efficiency↵	$\geq 25\%$ ↵	$\geq 40\%$ ↵	$\geq 20\%$ ↵
Key Role↵	Dominant volume↵ Baseload stability↵ Grid flexibility↵		

Fig 20 The amount and percentage of electricity (Yiwei Wu)

The solar array's substantial capacity dominates total generation volume, while nuclear's superior efficiency underscores its energy density advantages. Biomass, while contributing the least in absolute terms, plays a critical role in circular economy integration. This mix demonstrates how varying efficiencies translate into practical output differences, with solar's massive scale compensating for its lower efficiency compared to nuclear, and biomass serving niche sustainability needs.

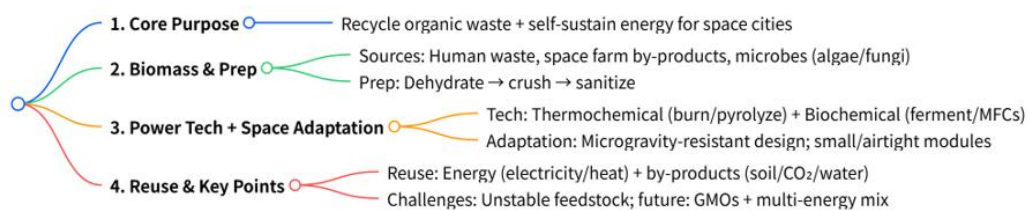


Fig 21 The process of biomass power generation (Yiwei Wu, Python, Bing)

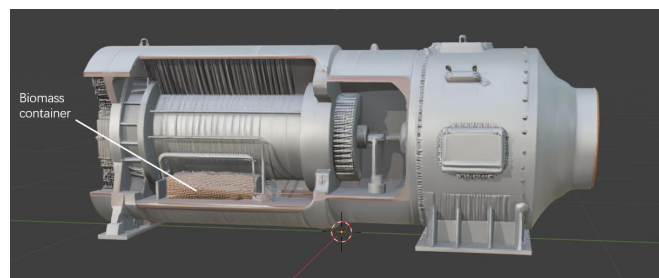


Fig 22 The 3D model of the biomass power generator (Yiwei Wu, Blender)

3.2.4 Water Management

In this part, we need to take control of the daily water quantity and find a capable storage container. According to the investigation, the average usage of water is approximately 80gallons per adult, considering all the factors, including drinking water, domestic water. To prevent the potential risk, providing 100 gallons of water for each person is more suitable. Despite the daily water supply, we must take charge of the agricultural water usage. For a 3 square kilometers agricultural area in the space station under temperate simulated climate conditions, the daily water supply should be around 5 million gallons.



Fig 23 The arrangement of water resources (Yiwei Wu, Photoshop, Bing)

3.2.5 Waste Disposal

The waste disposal takes two steps. The first stage involves careful waste sorting. Using collection systems, residents separate trash into four main categories: organic waste, recyclables, hazardous materials, and space-specific industrial waste. Special attention is given to isolating potentially dangerous space-generated waste that may contain lunar dust or radiation-affected components. The second stage is to appropriately recycle and prevent damage. In the recycling phase, each waste type undergoes specialized treatment. Organic matter is converted into biogas for energy production. Recyclables are processed into raw materials for manufacturing, while hazardous waste is neutralized for safety. Space industrial waste receives targeted processing, with valuable metals extracted and remaining materials compacted for storage.

3.2.6 Communication

For the internal communication system, different network protocol solutions are adopted for different needs, which are shown below in Table 6.

Table 6 The network protocol solutions and their functions (Yiwei Wu)

Network Area	Primary Technology	Core Purpose
Core Backbone	Fiber (DWDM)	Ultra-high-speed, reliable connectivity
Data Center	RoCE / InfiniBand	High throughput, low latency
Wireless Coverage	Wi-Fi 7 / 5G-6G	Ubiquitous high-speed access
IoT	Zigbee / MQTT	Low-power connectivity for massive devices

The internal communication system is built on a high-speed fiber-optic backbone (DWDM) for ultra-reliable core connectivity. Data centers use RoCE and InfiniBand for high-throughput, low-latency operations. Wireless coverage is provided by Wi-Fi 7 and 5G-6G, enabling seamless high-speed access across all areas. For IoT

applications, Zigbee and MQTT support low-power connectivity for massive device networks. This integrated architecture ensures efficient, scalable, and robust performance throughout the infrastructure.

At the same time, for external communication links, safety and stability are the priorities. We can use several methods in case one of the links breaks down. Lasers can send data quickly over long distances. Satellites around Earth and in space can help relay signals. Radio waves are a classic and reliable option for voice and basic data. We can also use special points in space where gravity balances out (like Lagrange points) to place communication stations for better signal coverage.

3.2.7 Transportation



Fig 24 The ring ling transportation craft (Yiwei Wu, Infinite Lagrange, Blender)

The transport system uses two sets of lifts in one tube — one goes up, one goes down. Both have the same passenger capacity. The capsules are sealed and use magnetic levitation, connecting directly to all ring stations. Emergency tracks are placed at regular intervals, with backup power and controls.

The ring line has two magnetic tracks running in both directions, carrying both people and goods. Every connection point works as a transfer station with quick and easy transfers. A priority channel is reserved for medical emergencies. Trains run frequently, and energy is recovered when braking on slopes.

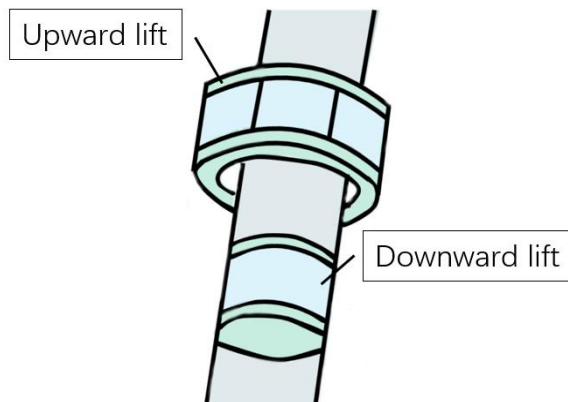


Fig 25 3.2.11 The hand sketch of the lift (Wenxuan Chen)

3.2.8 Sunlight Simulation System

The Sunlight Simulation System in community areas ensures that residents lead healthy day-night cycles. Light panels, electrochromic windows, and BNNT shutters emulate the natural 24-hour cycle of Earth:

06:00 – “Sunrise”: LEDs brighten gradually, windows & shutters clear.

12:00 – “Daylight”: Light peaks at 10,000 lux, suitable for work and activity.

18:00 – “Sunset”: Light dims to 2,000 lux, windows & shutters tint to 50%.

22:00 – “Night”: Soft moonlight spectrum provides 500 lux for comfort.

02:00 – “Deep night”: Only 50 lux of safety lights remain on; windows turn opaque.

Table 7 The components of the sunlight simulation system. (Tingfeng Lu)

Component	Function	Location
Ceiling LED Panels	Emit 5,500K sunlight spectrum (10,000 lux at 1m)	All communal spaces
Electrochromic Windows	Transition from transparent to opaque	Observation lounges, atria
BNNT Shutter Overlays	Block solar radiation when closed	Outer hull windows
Ambient Light Sensors	Monitor and auto-adjust brightness to match scheduled cycles	Walls/floors

Meanwhile, ambient light sensors (Fig 26) help monitor and adjust brightness to match scheduled cycles.



Fig 26 Ambient light sensors. (Tingfeng Lu, Rodin)

3.3 Construction Machinery

The transportation of construction materials and equipment to the orbital construction site relies on cargo spacecraft. Each spacecraft features a standardized cargo hold that accommodates four CASSSCs. Propulsion is provided by xenon ion thrusters that deliver 3,000 seconds of specific impulse, which balances fuel efficiency with enough transit speed for timely delivery to the construction orbit. Moreover, the spacecraft is equipped with an automated docking system incorporating magnetic locking mechanisms and a 6-degree-of-freedom robotic arm for precise berthing operations.

3.3.1 Construction bot

The construction bot maneuvers in microgravity, using its arms to bolt and align ship components, ensuring accurate assembly in the cosmic void. It is completely autonomous when constructing.



Basic Information	Length	Width	Height	Arm Length	Maximum Grip Diameter	Minimum Grip Diameter
	1.2m	1.2m	3m	1.8m	0.6m	0.1m
Features	The robot has an air propulsion system, radiation-resistant shielding, high-torque joints, a 24-hour solar power supply, and a 3D sensing eye.					

Fig 27 The construction bot and relevant information. (Tingfeng Lu, Rodin)

3.3.2 Jigs

The jigs are designed to ensure maximum accuracy.

Parameter Category	Performance Requirement	Implementation Method
Positioning Accuracy	± 0.05 mm	Laser tracking + vision-assisted positioning
Repeatability Accuracy	± 0.02 mm	High-precision encoder + temperature compensation
Maximum Load Capacity	1500 kg	Carbon fiber structure
Working Range	15 m (diameter)	3 articulated arms at different lengths
Temperature Adaptability	150°C below zero to 280°C above	Active temperature control system
Power System	48V DC $\pm 1\%$	Redundant power supply design



Fig 28 The jigs and relevant information. (Tingfeng Lu, Rodin)

3.4 CASSSC Warehouse

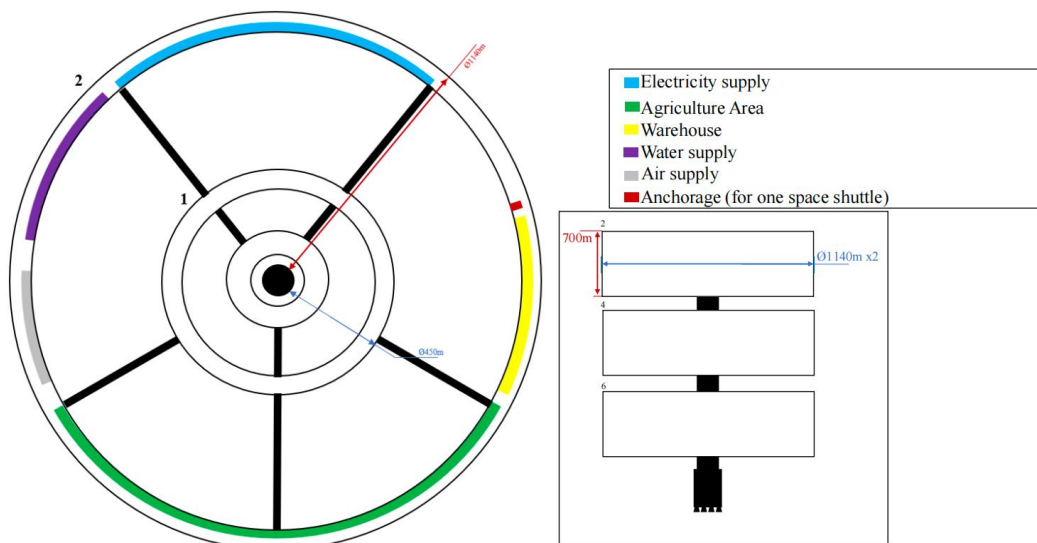


Fig 29 warehouse on ring 2 (Weibin Yin, PowerPoint)

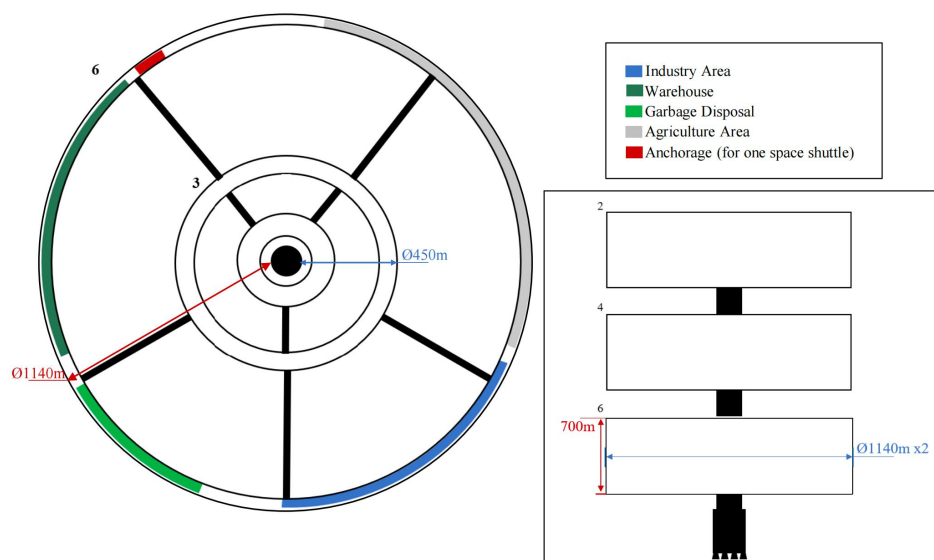


Fig 30 warehouse on ring 6 (Weibi Yin, PowerPoint)

To meet the requirements for accessible cargo during interplanetary transit, a streamlined system for

accessing CASSSC containers is essential. Currently available warehouses include: a 0.5 km² storage area in Ring 2 and a 1 km² primary storage center in Ring 6.

For CASSSC container access during transport, operators first complete the preparation: verifying biometrics keys, checking that pressurized storage parameters—pressure $\geq 101.3\text{kPa}$, temperature $5\text{--}25^{\circ}\text{C}$, oxygen concentration 19.5%–23.5%—meet standards. Next, to take out cargo, operators need to open the storage path, open the airtight gate, move the container to the access spot, retrieve the required good, and log the usage data. After use, they must inspect the container to confirm its integrity and sealing, then send it back to its original location and close the airtight gate.



Fig 31 airtight gate (Yiwei Wu, Rodin, Blender)

3.5 Assembly Factory

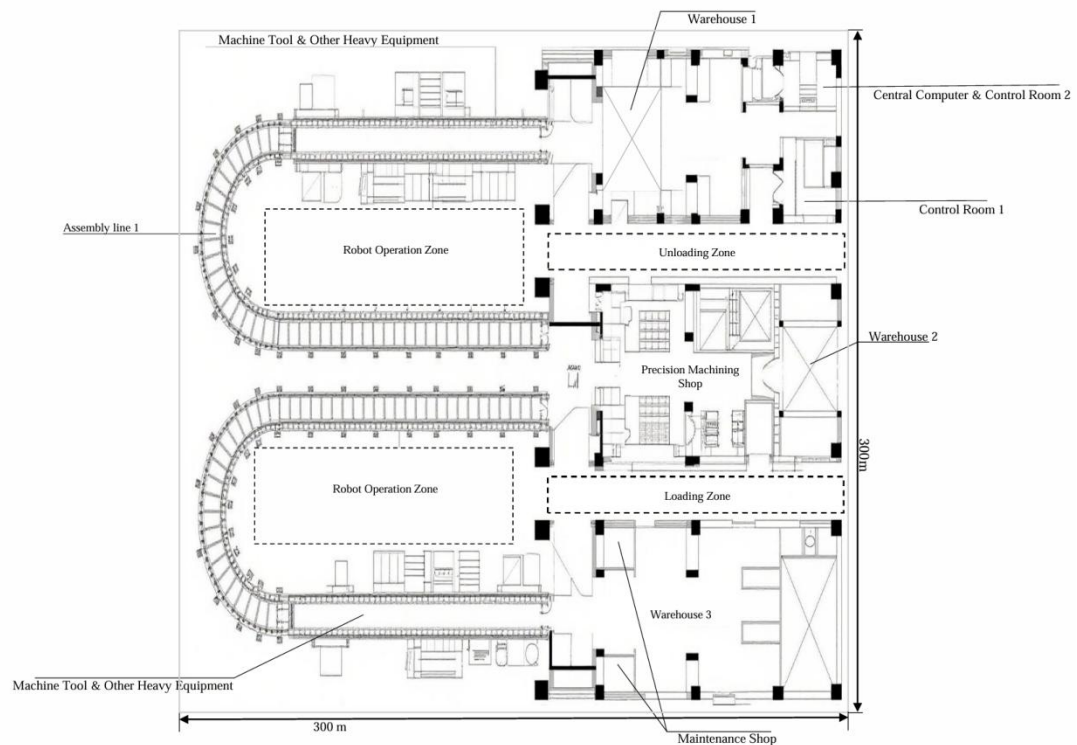


Fig 32 The configurations of the assembly factory in gravity areas (Weibin Yin, PowerPoint)

To meet the on-the-way assembly requirements of high-priority cargo for Mars and asteroid belt mining

operations, as well as the access needs to containers, the areas far from the space station's rotation center with relatively high gravity will be designated as gravity-equipped assembly zones. In contrast, the areas closer to the rotation center will serve as low-gravity assembly zones.

First, container latches similar in structure to those used on Earth will be employed to ensure that the containers do not experience any shaking. Meanwhile, the inner interlayers of the containers will be filled with nitrogen air cushions or sponge-like cushioning materials to prevent damage to the cargo inside.

The gravity-equipped assembly zones, accounting for 60% of the total area, will mainly be used for assembling lightweight industrial equipment and instruments. Additionally, they will provide equipment assembly support for the low-gravity zones, relying on gravity to ensure assembly accuracy and structural stability. The low-gravity zones will focus on assembling heavy-duty instruments, as hoisting operations are more convenient in a gravity-free environment. Furthermore, higher-precision assembly work can be conducted under weightless conditions—such as installing fixed chips, sensor modules, and other electronic devices onto various apparatuses—avoiding component deformation and precision deviations caused by gravity.

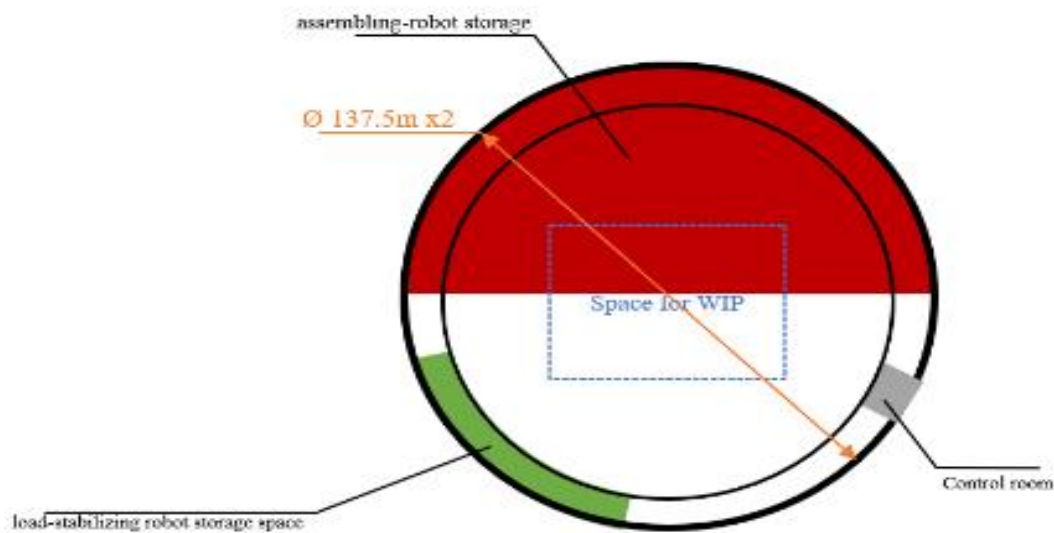


Fig 33 The cross-sectional view of the assembly factory in zero gravity areas (Weibin Yin, PowerPoint)

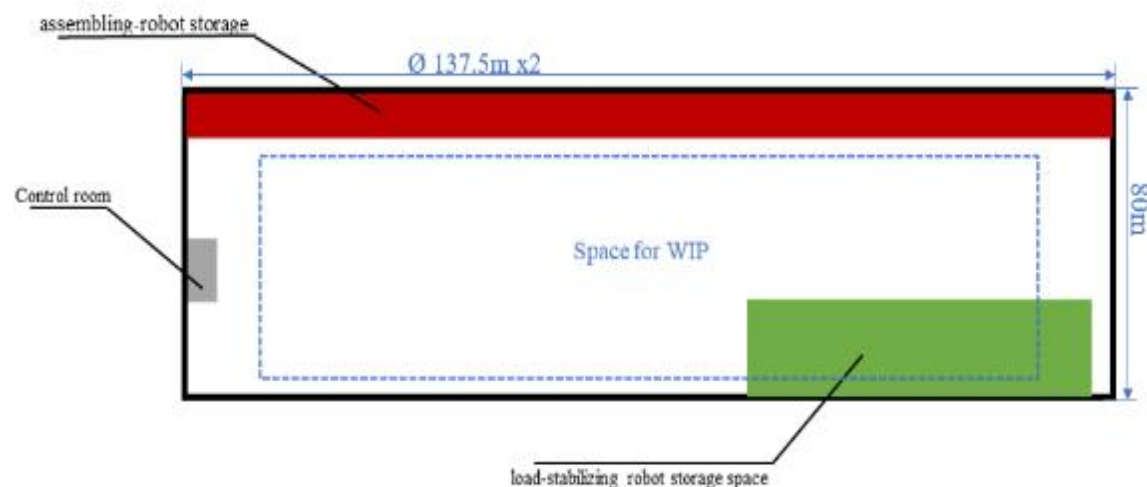


Fig 34 The bird's eye view of the assembly factory in zero gravity areas (Weibin Yin, PowerPoint)

Part 4 Human Factors and Safety

4.1 Community Design

As illustrated in Fig 35, the residential ring is thoughtfully designed to create a harmonious living environment that integrates comfortable residential spaces with amusing public areas, catering comprehensively to the daily needs of residents. The outer ring, with a width of 200 meters, takes over 26% of its total area to public functions, while the remaining part is designated as a residential zone intended for temporary living. The entire layout follows a symmetrical configuration, enhancing both aesthetic balance and functional coherence. Additionally, an inner ring measuring 80 meters in width is incorporated into the design, housing Public Zone 3. This zone accommodates essential facilities such as schools, a hospital, and other civic amenities, further elaborated in Fig 35. This area is strategically planned to support fundamental aspects of community life, incorporating essential amenities like green spaces (park), educational institutions (schools), and medical facilities (hospital). A detailed breakdown of the area allocation for each function is provided in the accompanying figure.

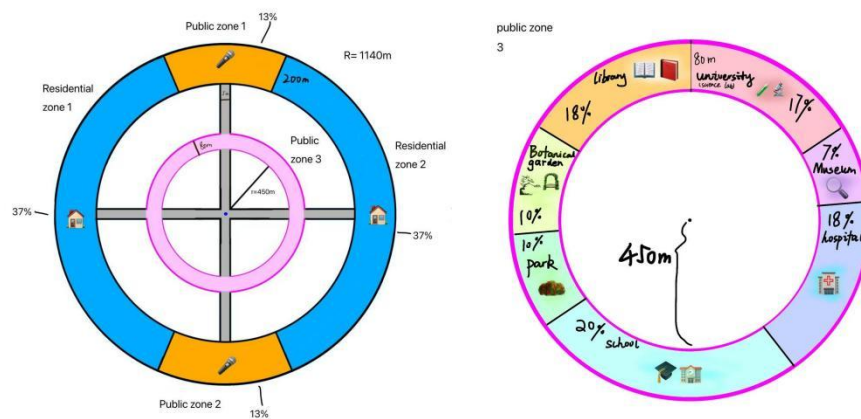


Fig 35 Public Zone (Bowen Xiao, PowerPoint)

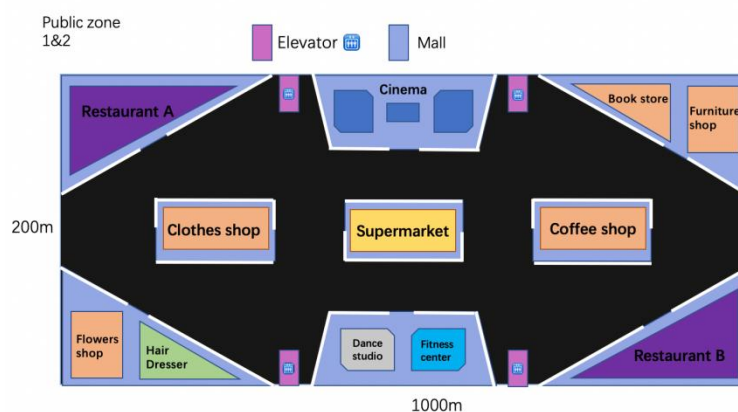


Fig 36 Spatial arrangement of Public Zones 1 and 2 (Bowen Xiao, PowerPoint)

Owing to their symmetrical positioning within the ring structure, both zones are identical in functional programming and architectural design. Each zone is configured as a massive mall, designed to accommodate a

wide range of daily needs—such as sports facilities (fitness centers), food and beverage outlets (restaurants), and clothing retailers (clothes store)—in addition to providing diverse leisure and entertainment options, including cinemas, flower shops, and bookstores.

4.2 Room Design

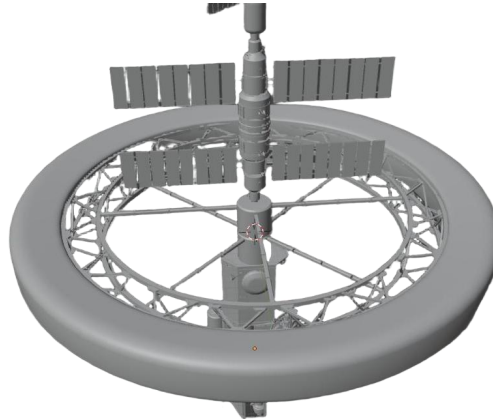


Fig 37 External Residential Design (Heyi Sun, blender)

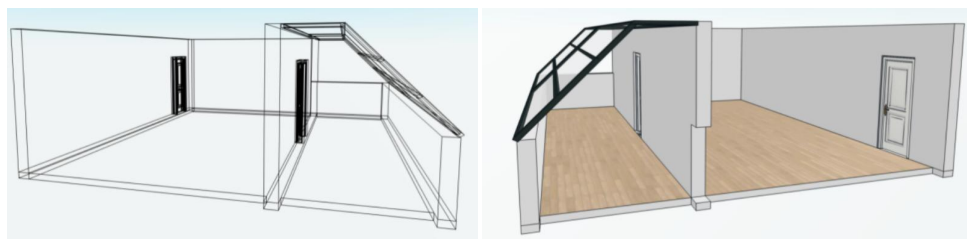


Fig 38 Internal Residential Design (Heyi Sun, Kujiale)

4.2.1 Residential room for a single Adult/ Teenager over 12

The lower room is the sanctum, containing a chair and a desk for studying. The room above includes a bed for two people and a closet.



Fig 39 Room for single person (Heyi Sun, Kujiale)

4.2.2 Room for a family of two/ three

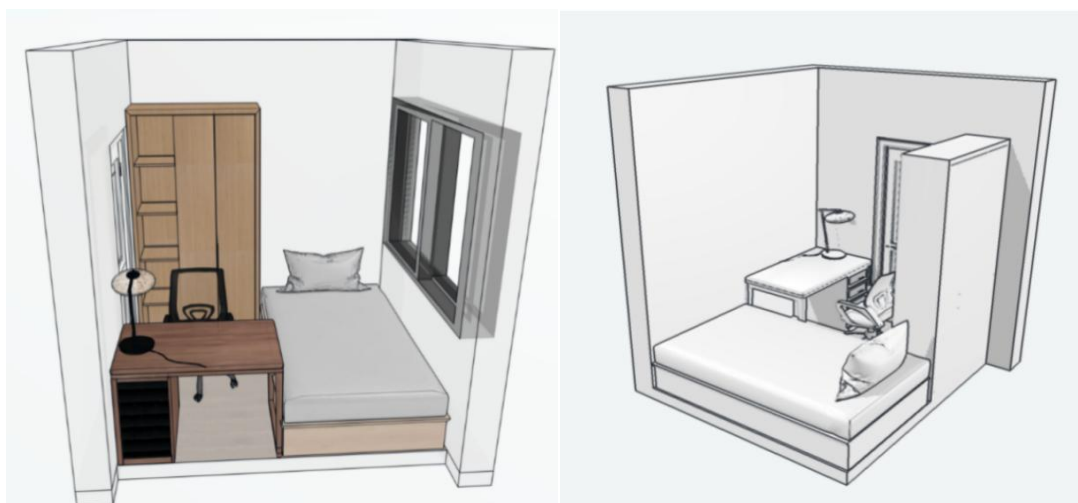
The left area is the bathroom, containing a toilet and a shower, while the dry area and wet area are separated. The middle part is the living room contains a sofa, a tea table, and a cooking space. The right part includes a bed for two people and a closet.



Fig 40 Room for a family of two/three (Heyi Sun, Kujiale)

4.2.3 Residential room for a single Child under 12

This room has only one bed, one table, one chair and one stool. Generally speaking, it is quite suitable for teenagers to conduct their own study activities here. Since the room does not include facilities such as a bathroom, etc., it is more suitable to be used as a basic guest room.



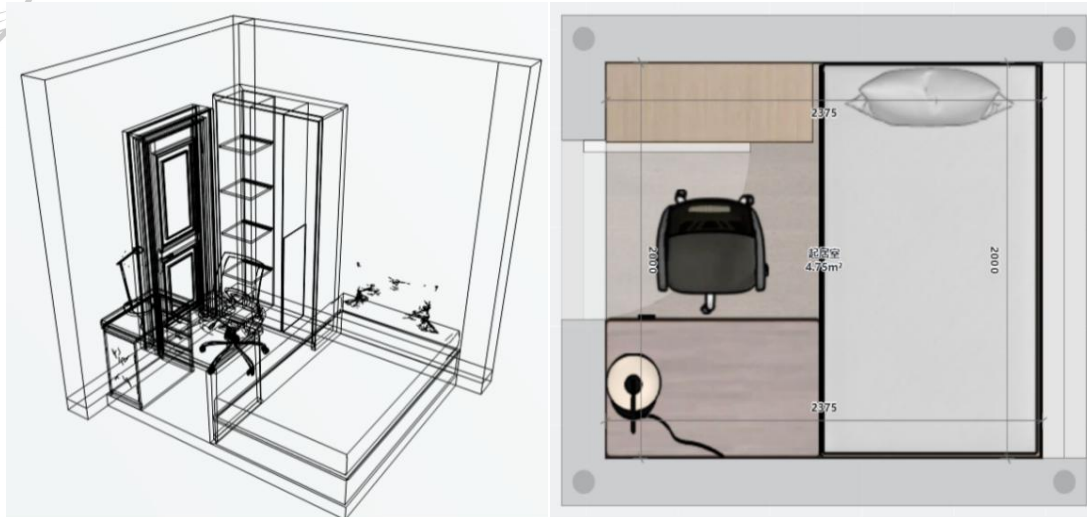


Fig 41 Room for a single child (Heyi Sun, Kujiale)

4.3 Safety Systems

4.3.1 Space suits:

The space suit will be divided into two parts: daily use and emergency space suit. A daily use suit will sustain for 8 hours for daily use, mainly for outboard maintenance. The emergency system can support the survival of the residents for 2 hours, in case of emergency issues, equipped in the cabins. The number of daily-used space suits is 500, 10 in children's size (from 0.8m to 1.5m), and the number of emergency suits is 2000, 40 in children's size. Emergency space suits have connectors on the top of the helmet, helping to fix the space suits to the hall of the cabins. Moreover, for the daily use of spacesuits, connectors for fixing the maintenance tools will be seen on the side of the spacesuits.

4.3.2 Radiation protection:

Type A: 5mm polyethylene + 0.5mm aluminum foil + ceramic coating (equivalent to 10cm water shielding)

Type B: 2mm polyethylene (equivalent 3cm water shielding) + ceramic coating

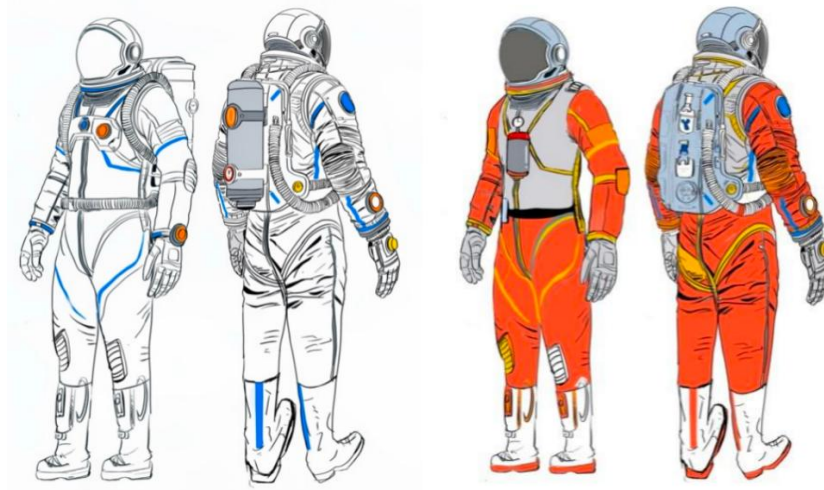


Fig 42 Space suit A&B (Chi Zhang, Procreate)

4.3.3 Daily service:

On the outer layer of the city, there must be one hook for every 1.5 meters for the human workers accessing different places. A magnet platform is also necessary for space work, and a small craft will help workers to complete some more serious fixing workload. As for individual workers, each of them should equip a uniform with an air injection bag used for space motions and AR glasses showing the broken parts.

4.3.4 Emergency:

A monitoring system working 24-hour detects any potential danger including radiation and small meteorites. The city can use an out layer with boron and polyethylene in order to prevent radiation. When there is an emergent situation, the city will be blocked into different areas with the wall on their connecting parts. The wall can prevent the danger spread.

4.3.5 Radiation Protection System:

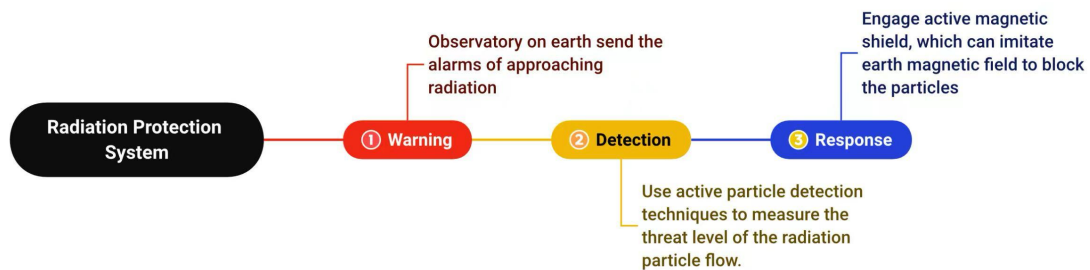


Fig 43 Radiation protection system mind map (Yu Chen, Xmind)

4.4 Corresponding to SOW paragraphs

CASSSC provides the passengers and the residents rental spaces for storing and transporting personal belongings, including clothes, small and big furniture for decoration in the cabins, and food and entertainment. The rental spaces have 3 sizes in total:\

The first box's size is $1.52\text{m} \times 1.52\text{m} \times 1.52\text{m}$, the total volume is 3.5118m^3 , which includes 54 boxes in one CASSSC. The box is for personal belongings such as food, clothes, books, etc. The price is 1000 dollar/ box.

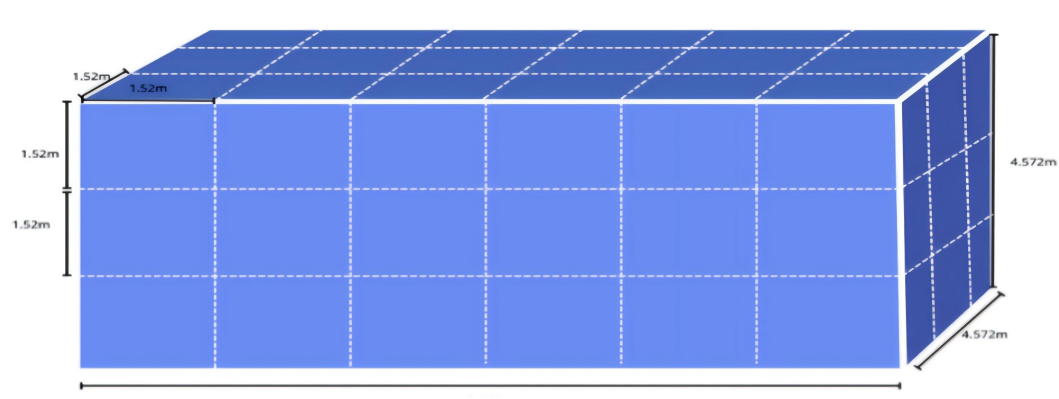


Fig 44 CASSSC size overview A (Chi Zhang, Canvas)

The second box's size is $3.048\text{m} \times 4.572\text{m} \times 4.572\text{m}$, the total volume is 42.475m^3 , which includes 3 boxes in one CASSSC. The box is for furniture and equipment. The price is 3000 dollar/ box.

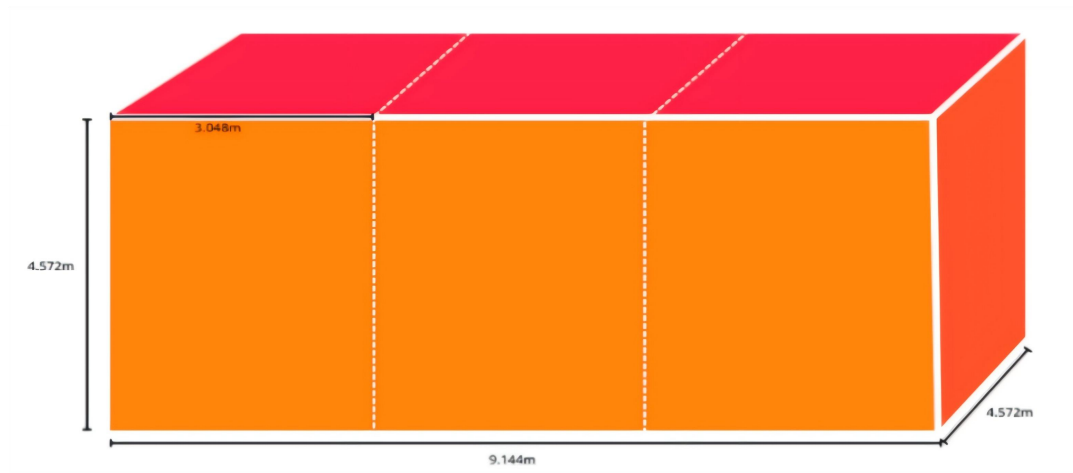


Fig 45 CASSSC size overview B (Chi Zhang, Canvas)

The third box's size is $3.048\text{m} \times 4.572\text{m} \times 4.572\text{m}$, the total volume is 42.475m^3 , which includes 12 boxes in one CASSSC. The box is for medium size equipment. The price is 2000 dollar/ box.

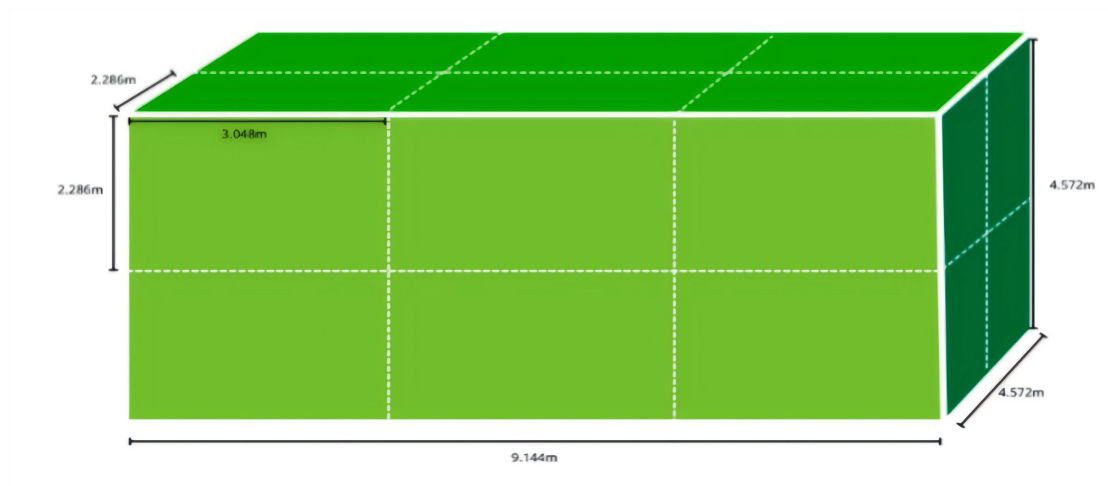


Fig 46 CASSSC size overview C (Chi Zhang, Canvas)

4.5 Corresponding to SOW paragraphs

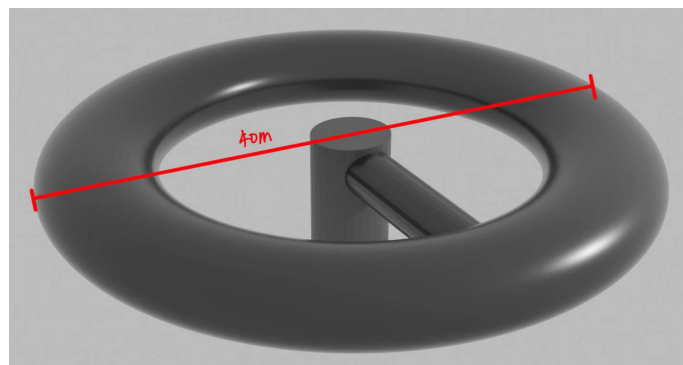


Fig 47 Centrifugal Chamber (Yu Chen, blender)

In order to reach the 1.1g minimal requirement for children, an intelligent sports watch can be implemented. The watch works as a monitoring device to detect whether the user stays in the 1.1g environment for over 4 h per day. This is a fundamental device to supervise children's health.



Then, with the supervising device, other specifically designed areas with multiple instruments to meet this standard are needed. The most essential device is a centrifugal chamber, which is 40 meters wide and rotates to provide a 1.1g region on its tube (Fig 47). Kids can stay in there and with VR glasses in order that they will not feel bored.

In addition, during the daytime, teenagers could also wear a heavy suit to pretend the higher force acting on it. However, this suit can only apply force on the kids' bodies and limbs, but not internal organs, meaning it can only offset a partial time spent in the chamber.

There are other assisting instruments as well. For instance, the treadmill with a rope intended to drag the user downward can imitate a higher g value. Moreover, a climbing wall is also practical. The user can put on a suit with two directions of ropes, one upwards to prevent falling and another downward to produce extra drag.



Part 5 Automation Design and Services

5.1 Automated Robotic Systems for Construction

Cassandra's construction should be automated due to the size of the structure, microgravity assembly environment and the risks of prolonged human extravehicular activity. Automated systems cut down labor requirements, enhance accuracy, and enable hazard-free efficient assembly. Supervision by human operators will take place at control hubs and intervening will take place only when required. Majority of the work is done by specialized robots. These include similar structural assembly, utility installation and material handling.

Two major robotic systems are being proposed for construction. For stability in zero Gravity, a fixed industrial robotic arm (Fig 48) can be attached to scaffolds jigs. It can handle payloads weighing up to 150 kg with six degrees of freedom. Using vision systems and torque sensors ensure accurate welding, fastening and alignment of hull modules and interior structures. While the arm is partially autonomous, it has been designed to be teleoperated during critical procedures, ensuring accuracy and safety.

Along with the system a mobile tracked construction robot as shown in Figure 49. Due to its two-way track, it can easily move up and down the uneven surface of any structure. Additionally, the 4-DOF manipulator with a claw gripper allows you to pick and place smaller panels, pipes, and tools. The transporting of materials, installation of piping and cabling, and delivery of parts to the fixed arm is possible with its payload of about 50 kg. The mobile robot uses stereo cameras, LiDAR, and inertial sensors to allow it to operate in semi-autonomous mode, although it can be supervised directly while performing delicate tasks.

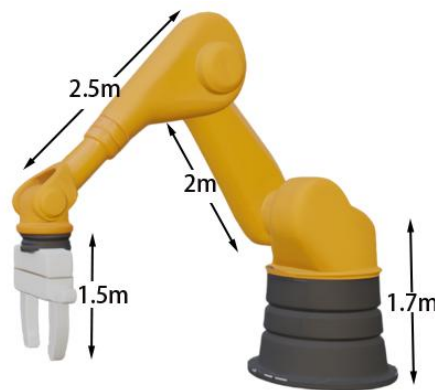


Fig 48 Fixed industrial robotic arm (Lyu Haoting, Blender)



Fig 49 Mobile tracked construction robot (Lyu Haoting, Blender)

5.2 Centralized Control and Security Robotics

The main control center (Fig 50) functions as the human-machine interface for the automated infrastructure of Cassandras. The machine is a cylindrical hardened module. Holographic and tactile displays give visual representation of robotic operation, environmental monitoring conditions, and safety indications. Only authorized users can access critical control functions through the use of encrypted biometric authentication. The operators can take manual control over automated systems, shut down systems during emergencies and assign robot assets when needed. The control hub ensure an ideal mix of autonomy and supervision. Most maintenance and monitoring activities can happen automatically while allowing human specialists to intervene at certain decision points.

Along with the hub, the settlement has a fleet of security and repair robots (Fig 51). These humanoid robots can manoeuvre in interior corridors and in access ports exterior. To detect fires, gas leaks and intruders, these robots are fitted with sensor arrays such as thermal cameras, gas detectors, and LiDar scanners. The modular arms of these machines are designed specifically for your welding, sealing, or electrical repair job, while they come with protective plating to make them even more resilient when the job gets tough. As part of standard procedures, the robots patrol living and technical quarters independently collecting and reporting data to the control room. However, on detecting a threat, the robot teleoperation mode can be activated allowing the remote operator to control the robot. When independent monitoring is combined with the ability to take immediate actions directed by humans, the safety envelope of the entire settlement is extended by security robots.

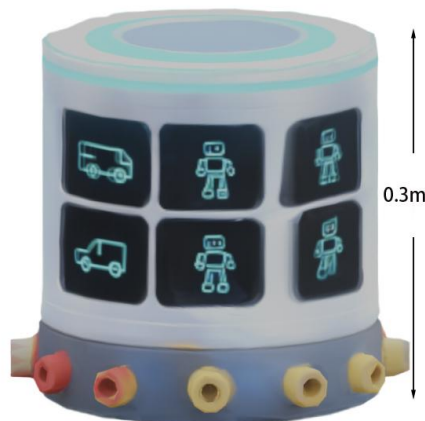


Fig 50 Main control center (Zhu Tianqiqi, Blender)

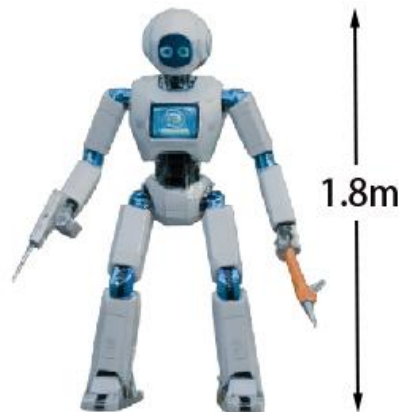


Fig 51 Security and repair robots (Zhu Tianqiqi, Blender)

5.3 Humanity Robots and Computer Networks



Fig 52 Smart Glasses (Zhu Tianqiqi, Blender)

Smart glasses (Fig 52) form the core of everything in space cities. They allow seamless interactions while significantly enhancing livability, productivity, and comfort through automatic information processing. Environmental information, such as oxygen levels and radiation, as well as microgravity hazard alerts, overlays at real time into the user's vision, allowing people to go about their activities without any manual checking. Directions through augmented reality and voice-activated home controls minimize physical labor in everyday life; at work, it reduces the need to consult manuals for machinery or perform tedious activities by projecting assembly guides and troubleshooting procedures and sharing first-person views for remote collaboration. Biometric monitoring ensures that users are not pushed beyond their limits with fatigue or health threats when productivity is sustained over longer periods. It then becomes the glasses' role to free residents from banal labor by consolidating vital information and automating mundane interactions and return them to pursuits that really matter.



Fig 53 Cleaning robots (Zhu Tianqiqi, Blender)

In microgravity, cleaning robots (Fig 53) transformed maintenance work because, apart from making the erstwhile laborious tasks automated, they enhanced the quality of life and work. These robots, using electrostatic adsorption and magnetic collection, could work independently and collect debris from the atmosphere, such as skin debris and metal shavings, which are hazardous to health and equipment. On a preprogrammed schedule along the set magnetic tracks, the robots travel along the cabin walls and surfaces. They autonomously return to their charging stations without the need for human involvement, which ensures that the living and working environments are clean at all times. In this respect, they would travel to places where it is necessary to clean oil stains and debris left from cleaning machines in industrial areas. Thanks to the thermal imaging from the smart glasses, they target and clean high-priority zones, extending the lifetime of the machines. When the debris collected is recycled through the resource recycling system of the space city, the robots minimize manual sorting, enabling the closed-loop system to minimize physical labor in accidents with safety violations.



Fig 54 Drones (Zhu Tianqiqi, Blender)

Drones (Fig 54) will add to the space city's operational capacity by performing logistics and surveillance autonomously, reducing heavy labor in critical operations. For livability, droughts suggest using magnetic levitation and microgravity gliding to convey supplies- food, tools, or personal belongings- straight to the respective residential module of each citizen, thus avoiding long and sometimes wearing corridors. Regular inspections of safety can be conducted when, using thermal imaging, hull cracks or pressure leaks are revealed; these are identified by persons wearing smart glasses and take much less time than manual patrols. In working environments, drones have been employed to oversee significant infrastructures, such as solar arrays and life-support systems; this could result in such anomalies as overheating being detected before leading to downtime. Depending on the required operation, the drones can be customized to functions such as aerial photography or delivery of documents and will fly quietly in low-light conditions. Integrating into the space city's IoT network equips the drones with an agile, automated extension of human effort so that residents focus on the strategic work of thinking ahead instead of the physical errands.



Fig 55 Computer Networks (Zhu Tianqiqi, Doubao)

The two diagrams present a view of modern data network architecture with secure communication processes.

Figure 55 illustrates the flow of data from the point of input and output, encryption and decryption, and into computing centers and data centers. All centers connect through an optical ring network that guarantees high-speed, stable transmission with redundancy. Moreover, the system—designed with an eye for global data exchange and sophisticated infrastructure—moves outward from Earth through satellite communications. Against this structural background, in which the engineering concept embraces the actual inseparable unity of encryption technology and network data delivery reliability, this document surely depicts the recent past and coming times.

On the other hand, the other picture is an illustration of how various terminals and devices are connected within a network. It is at the core of network-centric data processing units where traffic is routed via the TCP/IP protocol. The connection of home terminals, work terminals, and passenger cabin portable equipment in encrypted tunnels and permission controllers is safe. Privacy protection modules are installed to protect sensitive information. This explains how the diverse uses of devices and applications are unified under one secure network in personal

and professional scenarios. These two diagrams also portray layered modern communication systems, from the structural strength of the infrastructure to the end-user data security.

5.4 Automated Logistics and Cargo Management

Each passenger's belongings throughout the 80-day journey on the Cassandras create significant challenges in organization and safe handling. Passengers are entitled to specific amounts of cargo, which are transported in CASSSC containers and need to be correctly managed to redistribute them accurately upon arrival at Mars.

Our approach to this problem involves integrating a specialized modular storage facility and autonomous sorting robots into a full logistics and inventory management chain. The storage unit (Fig 56) is a pressurized cylindrical module with about 4 meters in diameter and 5 meters in height. Its structural design incorporates modular racks in a grid system. The racks also have RFID and barcode readers, allowing every item stored to be logged into one central inventory database at its exact coordinates. Secure stowage for up to 250 passenger cargo units is provided per module, expandable by linking multiple modules to scale with demand. Robotic loading arms are integrated at the top of the module to handle automated deposition and extraction, which entails little human intervention and fast turnover.

In support of the facility, a personal items sorting robot depicted in Figure 57 is a compact, autonomous unit. The mobility system allows traversing warehouse floors, and dual manipulator grippers handle sub-containers weighing up to 15 kilograms. The robot uses computer vision and embedded RFID readers to identify, retrieve, and sort passenger packages per assigned CASSSC and final destination. During loading and unloading, these robots will interact with the storage module by scanning and transferring items between racks and transport containers with high efficiency. They can operate in fleets, allowing simultaneous handling of multiple packages to reduce the time to pass through the logistics chain further.



Fig 56 Storage unit (Zhu Tianqiqi, Blender)



Fig 57 Personal items sorting robot (Zhu Tianqiqi, Blender)

5.5 Automated Cargo Handling and Assembly Lines

To facilitate the large-scale movement of supplies and manufactured goods aboard *Cassandras*, automated cargo handling and assembly lines (Fig 58) are employed. At the center of this system lies a conveyor-based packaging and transfer station, combined with a six-axis robotic arm mounted alongside a conveyor belt. The robot can handle 20 kg payloads and is fitted with a clamp-style gripper designed to hold standardized cargo boxes firmly. While passing through the conveyor, the integrated barcode and RFID readers automatically identify and scan each package, after which it is either stacked or arranged to prepare it for transfer. Hence, products can be quickly sorted, sealed, and palletized into compositions within CASSSC containers, thus providing a virtually uninterrupted outflow from the internal factories to the shuttle docking bays. Besides packaging, this robotic station also performs partial assembly processes under gravity, such as integrating subcomponents that have already been manufactured into more giant shipment units, ready for dispatch. A parallel assembly area in the zero-gravity section will have robotic jigs and arms piecing together lightweight items, such as inspection drones and modular electronics. Drift will be prevented by soft-capture fixtures. The whole conveyor system, in conjunction with the robotic manipulator, will thus form an efficient, automated chain process for packaging and distributing cargo—enabling settlement-produced or consumed goods to be smoothly integrated into a more extensive logistic stream.



Fig 58 Automated cargo handling and assembly lines (Zhu Tianqiqi, Blender)



Part 6 Schedule and cost

6.1 Project Timeline: 2025-2030 (5 Years)

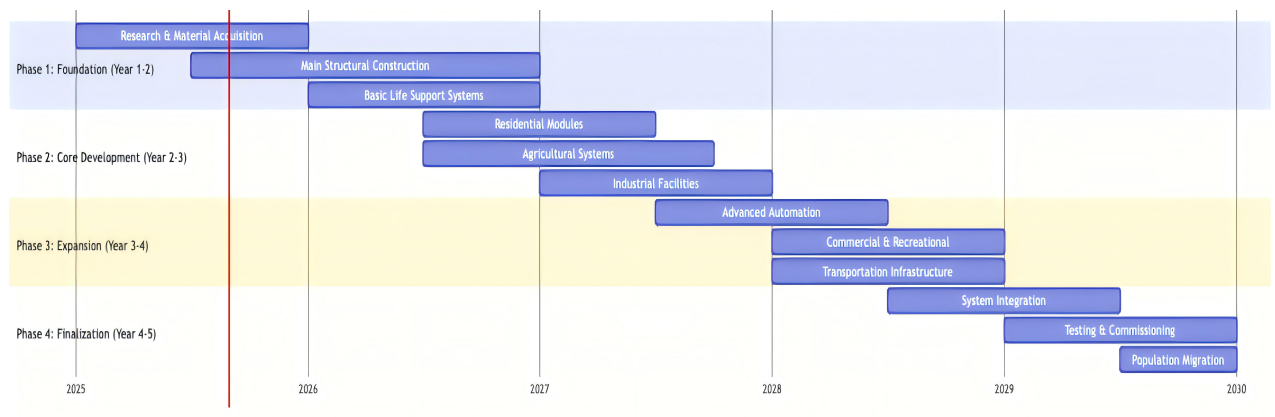


Fig 59 Space City Construction Schedule (Dou Zizhan)

6.2 Total Budget

6.2.1 Structure

Table 8 Structure Cost (Dou Zizhan)

Material Type	Unit Cost (\$/kg)	Quantity (kg)	Total Cost (\$)	Category	Cost (\$)
Titanium Alloy	18.1	3,200,000,000	57,920,000,000	Automation Systems	4,800,000,000
Nickel-based Alloy	23.7	4,800,000,000	113,760,000,000	Human Factors & Facilities	8,500,000,000
Advanced Composites	45.5	4,100,000,000	186,550,000,000	Structure	427,640,000,000
Radiation Shielding	83.5	540,000,000	45,090,000,000	Labor (5 Years)	8,500,000,000
Structural Framework	12.8	1,900,000,000	24,320,000,000		
				Total Budget	\$449,440,000,000

Total Structure Cost: \$427,640,000,000

Total Structure Cost: \$427,640,000,000

6.2.2 Automations and Labor

Table 9 Automation Cost (Dou Zizhan)

Automation System	Unit Cost (\$)	Quantity	Total Cost (\$)	Occupation	Number	Total Monthly Wage (\$)
Construction Robots	1,200,000	1,500	1,800,000,000	Engineers	1,200	30,000,000
Manufacturing Systems	800,000	1,500	1,200,000,000	Technicians	800	14,400,000
Maintenance Robots	600,000	1,500	900,000,000	Managers	500	17,500,000
Logistics Systems	400,000	1,500	600,000,000	Support Staff	500	6,000,000
Security Systems	200,000	1,500	300,000,000			

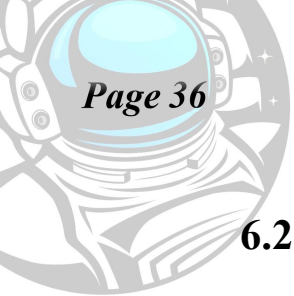
Total Automation Cost: \$4,800,000,000

Total Monthly Labor Cost: \$67,900,000

Annual Labor Cost: \$814,800,000

5-Year Labor Cost: \$4,074,000,000





6.2.3 Human Factors and Operation

Table 10 Human Factor Cost (Dou Zizhan)

Facility Type	Total Cost (\$)	Facility Type	Total Cost (\$)
Residential (7,500 people)	3,200,000,000	Commercial Centers	1,800,000,000
Medical Facilities	900,000,000	Educational Institutions	700,000,000
Recreational Facilities	1,100,000,000	Public Infrastructure	800,000,000
Agricultural Systems	500,000,000	Life Support Systems	300,000,000
Waste Management	200,000,000	Emergency Systems	400,000,000

Total Human Factors Cost: \$8,500,000,000

6.2.4 Consumables & Support Systems (7,500 Residents)

Table 11 Consumable Cost (Dou Zizhan)

Consumable	Monthly Usage	Annual Cost (\$)	System Type	Quantity	Maintenance Cost/Year (\$)
Food Supplies	225,000 kg	67,500,000	Life Support Systems	150	75,000,000
Water & Air	7,500,000 L	22,500,000	Power Systems	75	45,000,000
Medical Supplies	75,000 units	45,000,000	Communication Networks	50	30,000,000
Personal Items	225,000 units	33,750,000	Transportation Systems	100	60,000,000
Maintenance Materials	150,000 units	60,000,000			

Annual Consumables Cost: \$228,750,000

5-Year Consumables Budget: \$1,143,750,000

Annual Maintenance Cost: \$210,000,000

5-Year Maintenance Budget: \$1,050,000,000

Total Cost: 4.074×10^{19} USD

