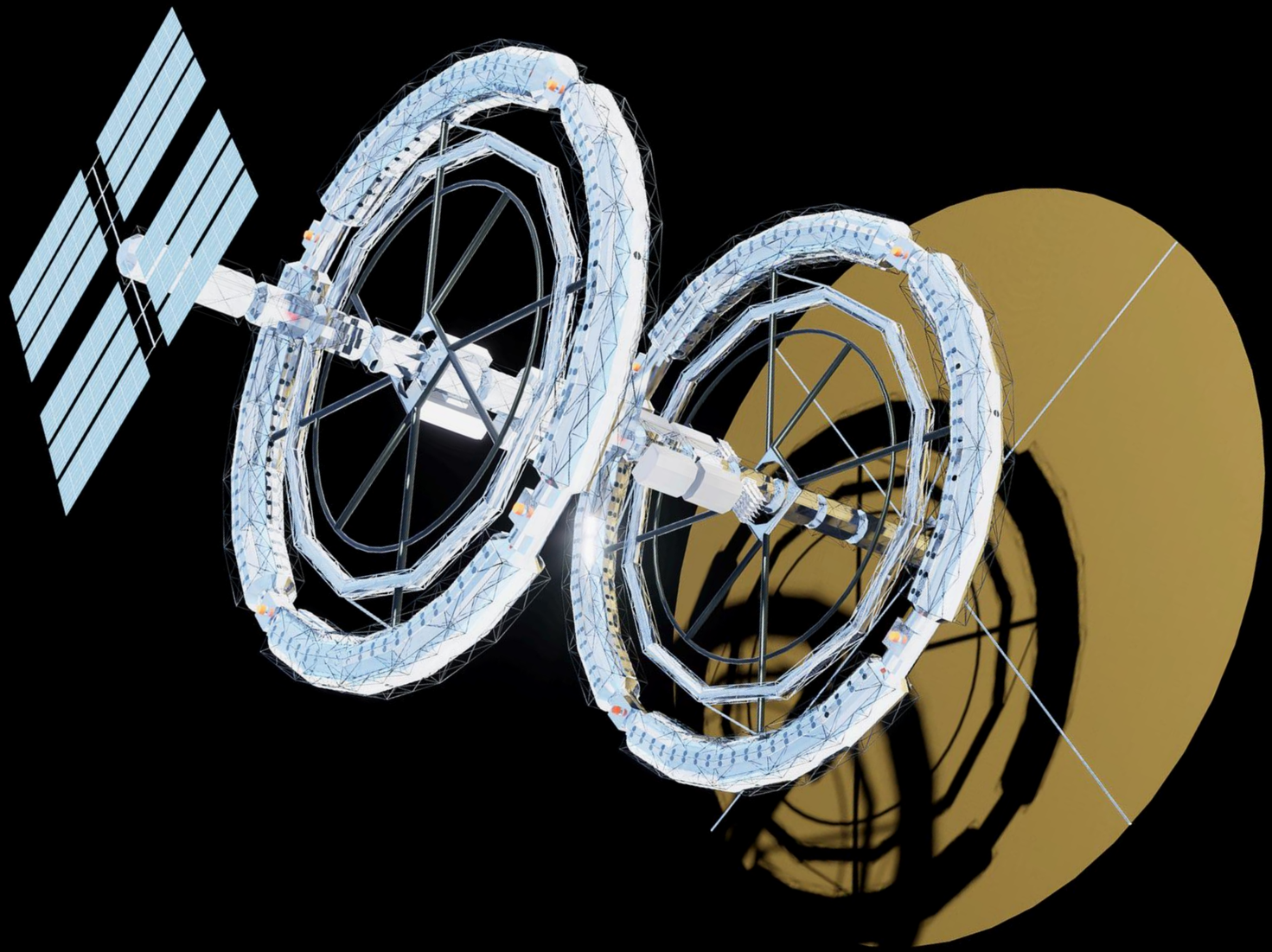
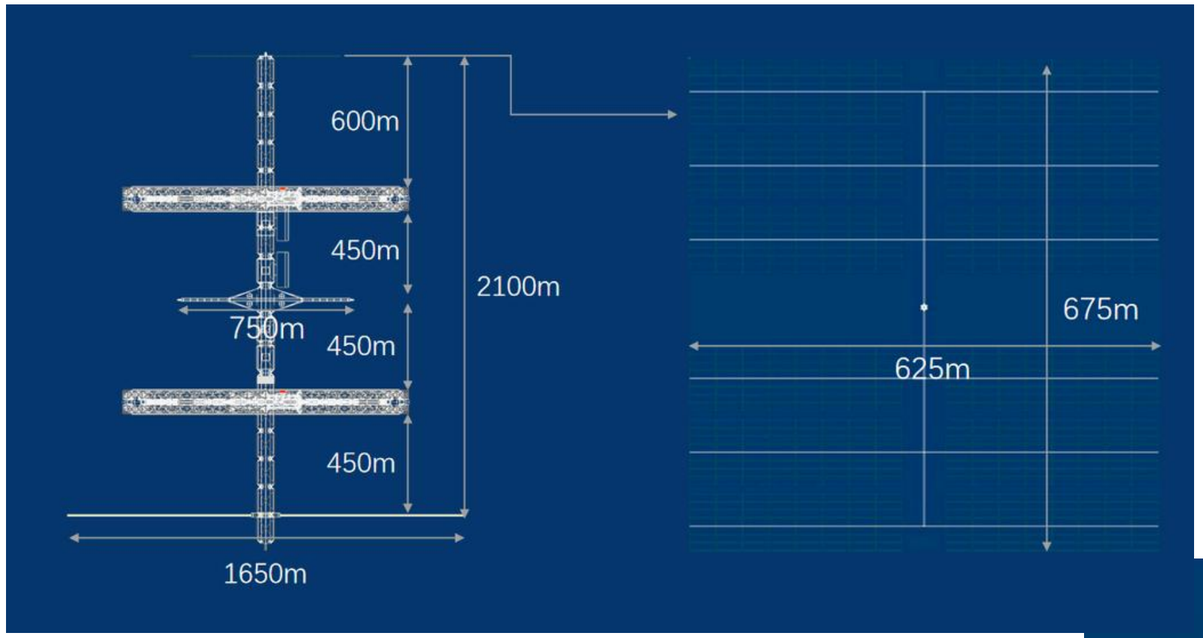
GRUMBO AEROSPACE



Dimensions and External Views



Side View

Top View (solar panels)

Figure 2.1.1 Dimension Diagram (By Jashraaj Sahoo)

top view (residential area)

top view (solar sails)

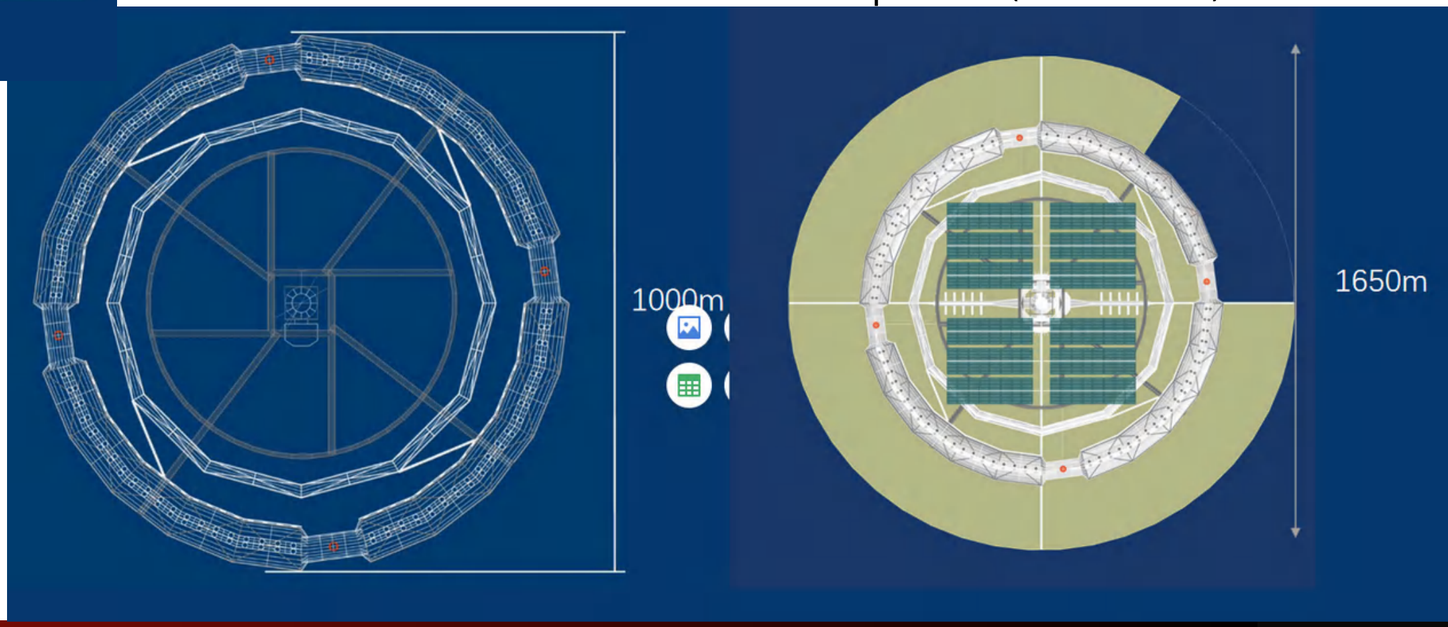


Figure 2.1.2 Dimension Diagram (By Jashraaj Sahoo)

Uses of Volumes

- **1 - DARK BLUE: Solar Panels**
- **2 - ORANGE:** Residential Volume
- **3 - BLUE:** Industrial / Operation Volume
- **4 - PURPLE:** Port
- **5 - GOLDEN:** Solar Sail
- **6 - Yellow:** Control Room
- **7 -** Non Rotating Recreational Volume

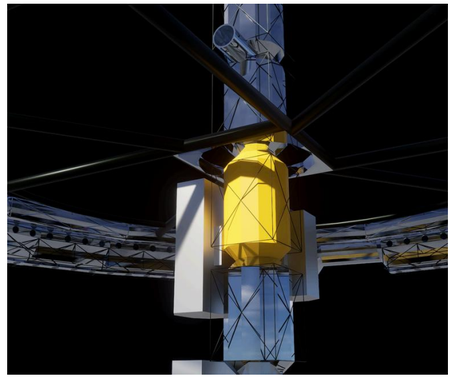


Figure 2.2 Control Room [By Sijia Zhou, rhino]

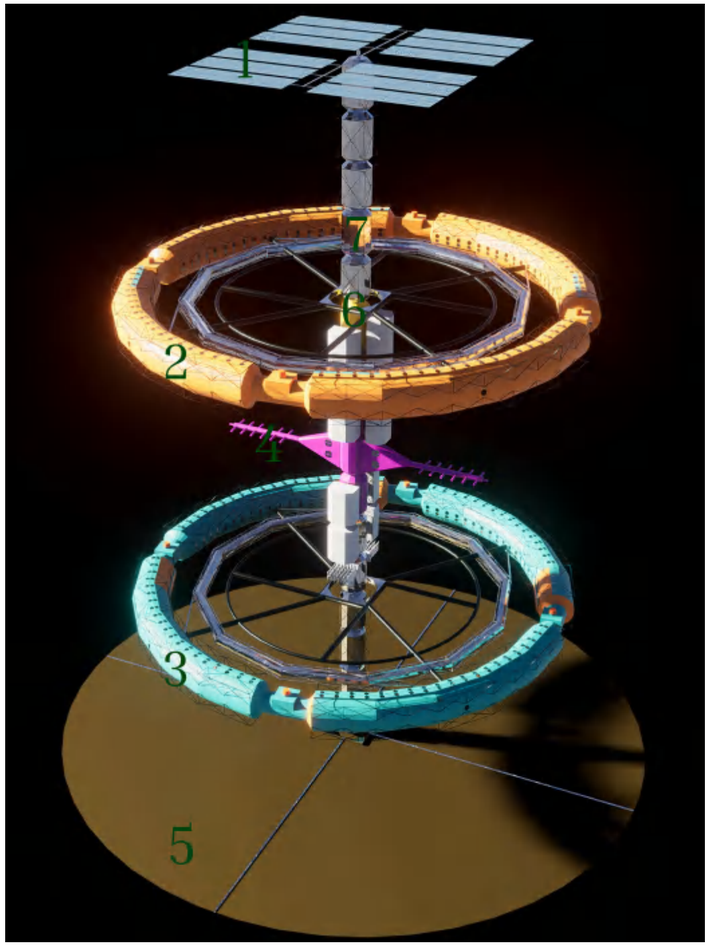


Figure 2.3 Various Volumes of the Settlement [By Sijia Zhou, rhino]

Design Features:

- Airlocks are located in every pressurized body along with dust mitigation facilities at each airlock. (subcontracted by Loseless Airlocks)
- Solar Sails placed on a rotational ball bearing to ensure its constant allignment with the Sun.
- RPM of rotating volumes **(Rotatating in directions opposite to each other)**
  RPM of Residential Volume- 0.935 Rotations/Minute
  RPM of Industrial Volume - 0.870 Rotations/Minute

Rotation and Pressurization

- Artificial Gravity:
  - Residential torus: **0.45g** for health benefits.
  - Industrial torus: **0.3g** for agriculture and industry light weight functioning.
- Pressurized Areas:
  - Residential, industrial torus, control center, observation deck, and docks are pressurized.
- Airlocks:
  - Used for transitioning between pressurized and non-pressurized areas. Airlocks subcontracted to Lossless Airlocks.

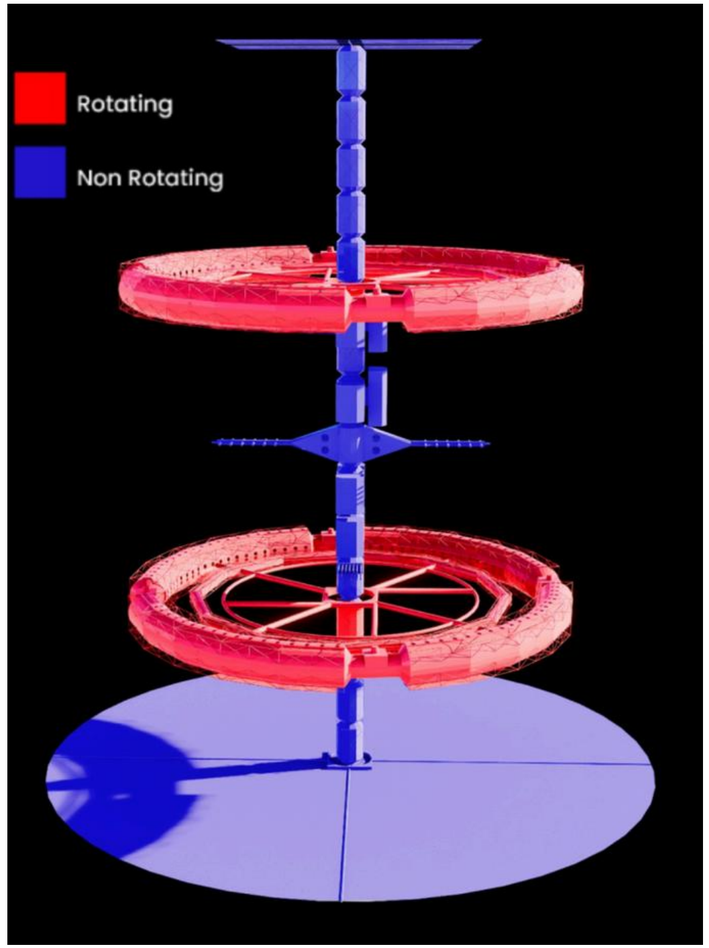


Figure 2.4 Rotating and Non Rotating Parts[By Sijia Zhou, rhion]

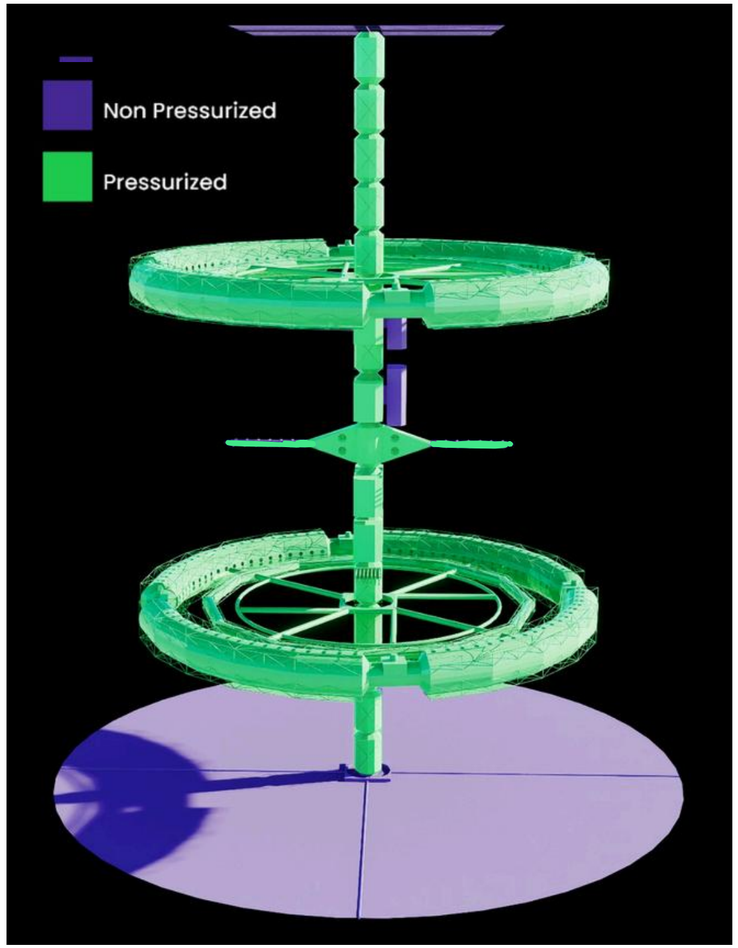


Figure 2.5 *Pressurized and Non Presurized Parts* [By Sijia Zhou, rhion]

Other Exterior Components

Port and Control Center

- Docking System:
  - Includes multiple pressurized docking ports
  - Cargo and personnel pass through an airlock to a rest area, then use an elevator to access other areas.
- Control Center:
  - Located in central axis.
  - Staff Manages Operation and Functionality

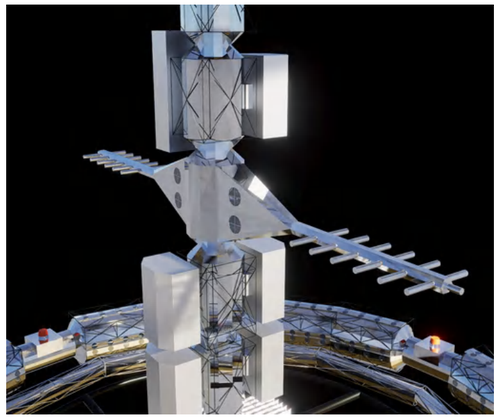


Figure 2.6 *Docking System*
[By Sijia Zhou, rhino]

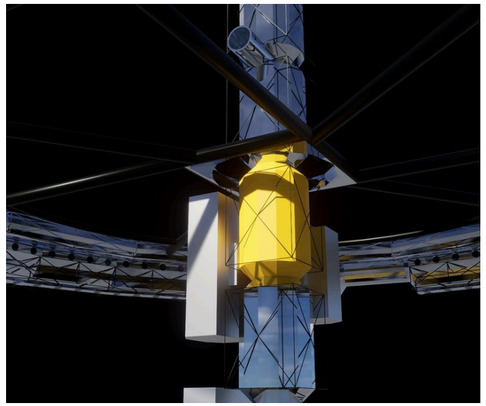


Figure 2.7 *Control Centre*
[By Sijia Zhou, rhino]

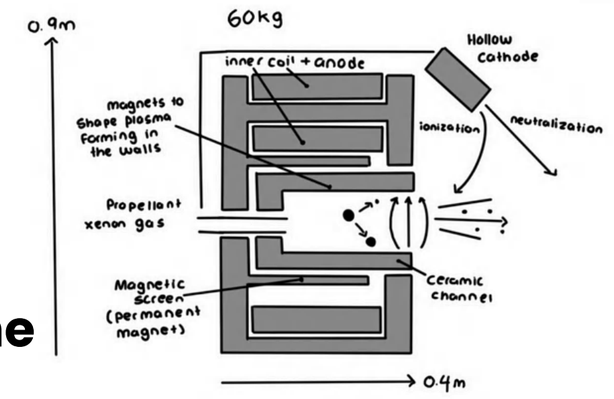


Figure 2.11 *Hall Thruster*
[By Iha Kotnala, Procreate]

Radiator and Engine

- Propulsion System:
  - Primary rocket engine and RCS thrusters for attitude control with hall effect thruster backup
- Thermal Regulation:
  - Dissipates heat from systems using water or liquid nitrogen.
  - Radiates heat via distributed radiators.

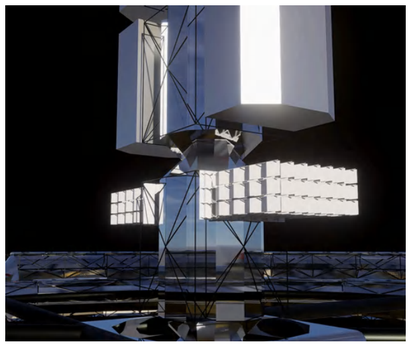


Figure 2.8 *Radiator Working*
[By Sijia Zhou, rhino]

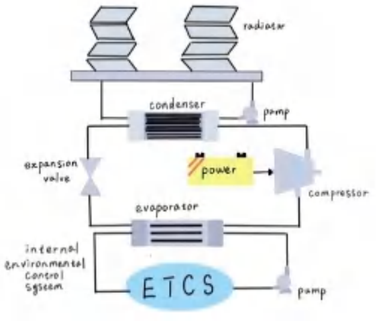


Figure 2.9 *Radiator*
[By Sijia Zhou, rhino]

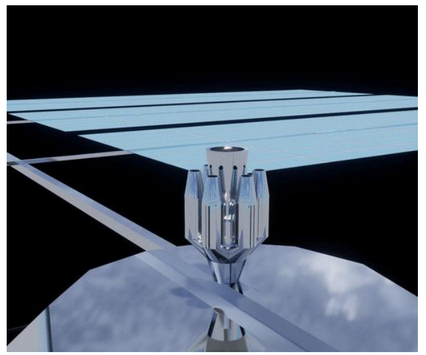


Figure 2.10 *Rocket Engine*
[By Sijia Zhou, rhino]

Other Exterior Components

Isolation of volumes & Entrence and Exits

- Airlocks:
  - Separate pressurized and non-pressurized sections.
- Residential Tori:
  - Divided into 4 segments with airlocks between them.
  - Ensures safety by isolating failures to one segment.
- Airlocks:
  - Present between each partial quarter Torii.

- Down Surface Area Orientation and Vertical Clearance

:

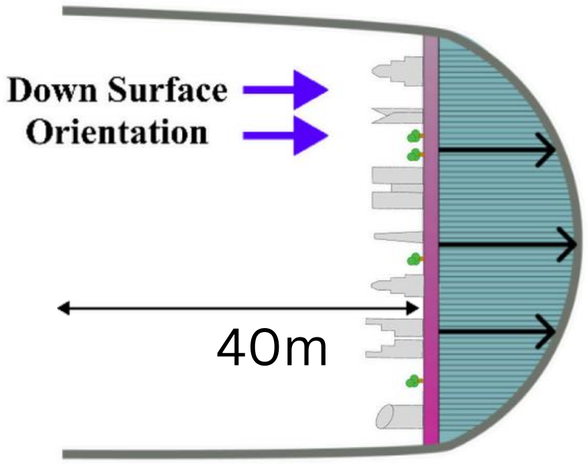


Figure 2.12 DSA Orientation and Vertical Clearance
[By Jashraaj, Kushagra on Figma]

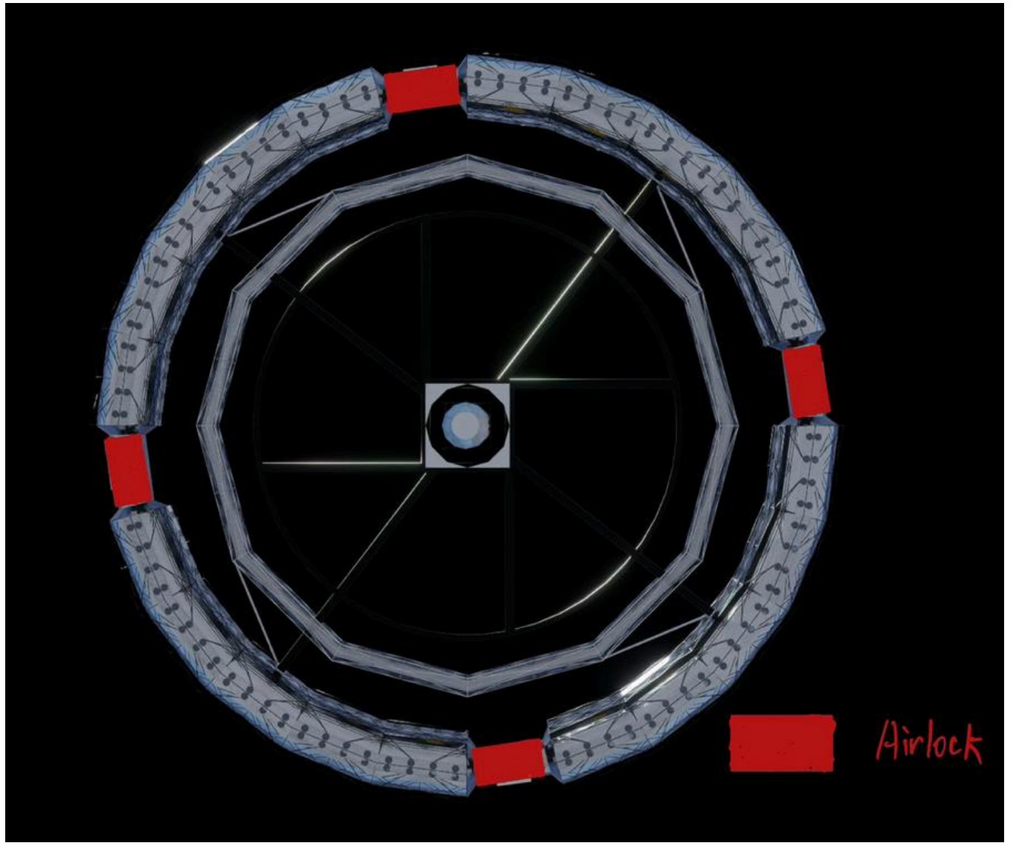


Figure 2.13 Airlock Placement
[By Jashraaj, Kushagra on Figma]

Radiation and Debris Protection

Rotation Mechanisms:

- Uses ionic thrusters to generate constant tangential thrust to develop artificial gravity.
- Utilising **magnetically levitated bearings of 45 teslas** to prevent friction and lubrication costs. Any deviations in bearings corrected by varying strength of electromagnets.

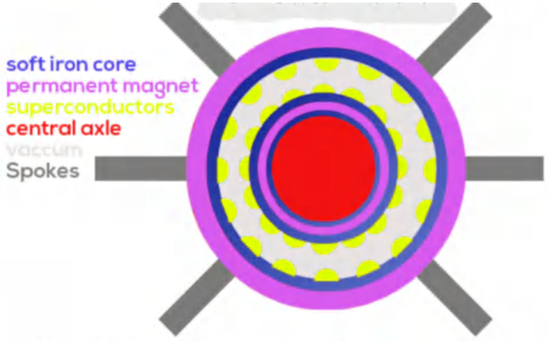


Figure 2.14 *Cross Section of Maglev Bearings*
[Adil Azfar]

Protection

Radiation protection

- Benevectoras will be protected from radiation due to material composition ensuring radioactive ray deflection.
- Elaborated upon in **2.1.1**

Debris and Space Junk

- Asteroid diversion bot: called the Debris-bot:
  - It will use electro-magnetic trays to attract and collect approaching debris
  - It will transport the debris and asteroids a safe distance away from the structures, or will divert their trajectory
- Aerogel whipple shields:
  - Aerogel can stand an impact of more than 2000 times their weight. These whipple shields will surround sensitive areas of the settlement such as spokes and absorb energy upon impact.

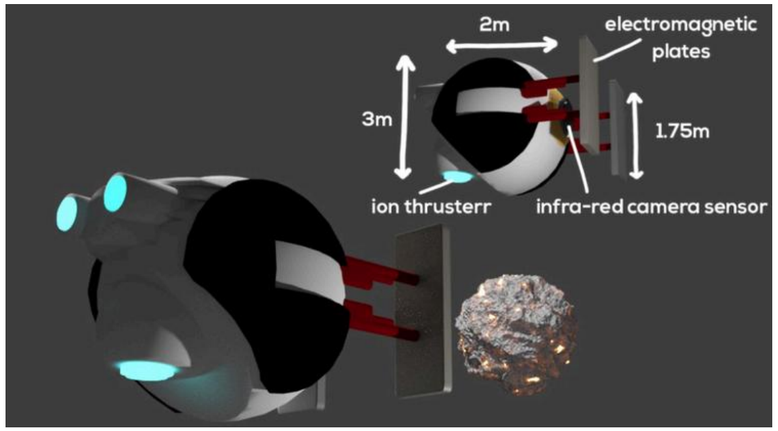


Figure 2.15 *debri bot*
[Adil Azfar]

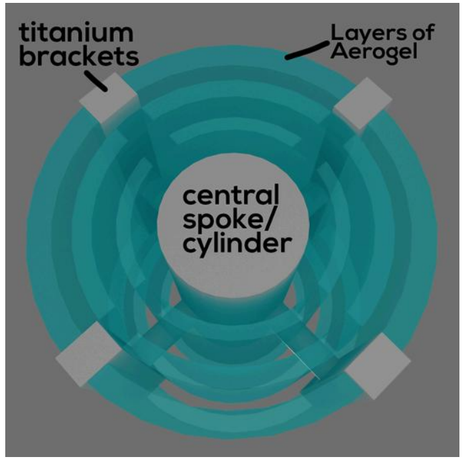


Figure 2.16 *Whipple shield*
[By Adil Azfar]

Residential Torus

Residential Torus:

- Includes housing, commercial areas, and community services.
- Contains research centers and workspaces for permanent residents.
  - Divided into 4 communities on the downward surface.
- Vertical Clearance:
  - 40 meters.

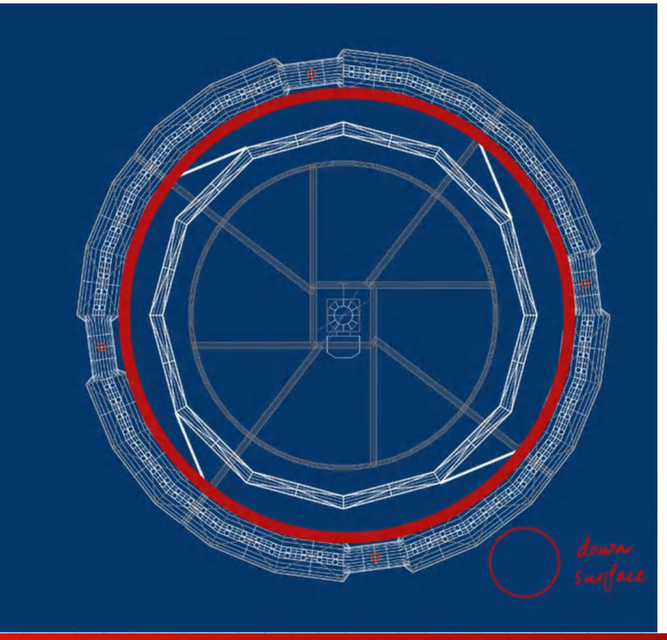


***Figure** 2.17 Residential DSA*
[Jim Chen using Notability]

Industrial Torus

Industrial Torus:

- Structure:
  - Three layers, each 18 meters high
- Manufacturing and Processing Area:
  - For constructing small components and routine maintenance.
  - some agricultural practice
- Assembly and Installation Area:
  - For assembling and processing large-scale equipment.
- Storage and Support Area:
  - Stores supplies, backup robots, and essential reserves.

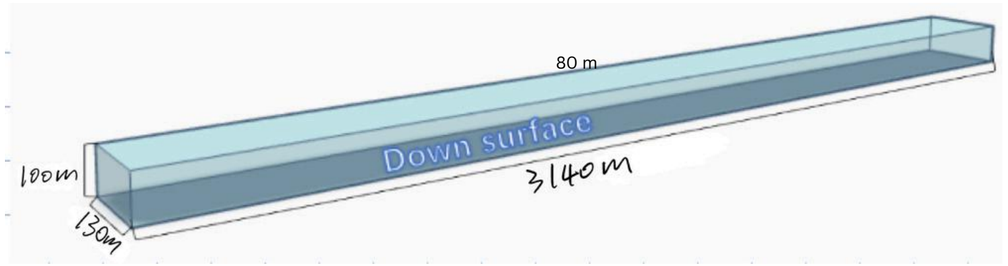


***Figure** 2.18 Available DSA for Res. and Ind.*
[Grace He using ThinkerCAD]

***Figure** 2.19 Floor Map of Industrial Torus*
[Grace He using ThinkerCAD]

Construction Sequence

Phase 1 - Pre Built construction shack is transported to Earth-Moon Lagrange Point 2. It is equipped with a power source, assembly area and will utilize incoming CASSSCs of materials using 3D printing, subcontracted to 3D Logistics.(***subcontracted to 3D Logistics and ElectroProtect**)

Phase 2 - Jigs are assembled and materials sourced. The Central Shaft is built by External Construction Bots and Jigs. Solar Panels are added on the Central Shaft.

Phase 3 - The Docks are built. Construction Shack is repurposed into the Control Center with internal rearrangement and pressurization. (Docks are subcontracted to Lossless Airlocks)

Phase 4 - The Industrial Volume is built. 2 Sectors (Manufacturing and Processing, Assembly and Installation) out of 3 are set up. All on-site assembly and 3-D printing is now shifted to this volume.

Phase 5 - The residential volume is set up. Both the Industrial Volume and Residential Volume begin rotating. IOC is achieved.

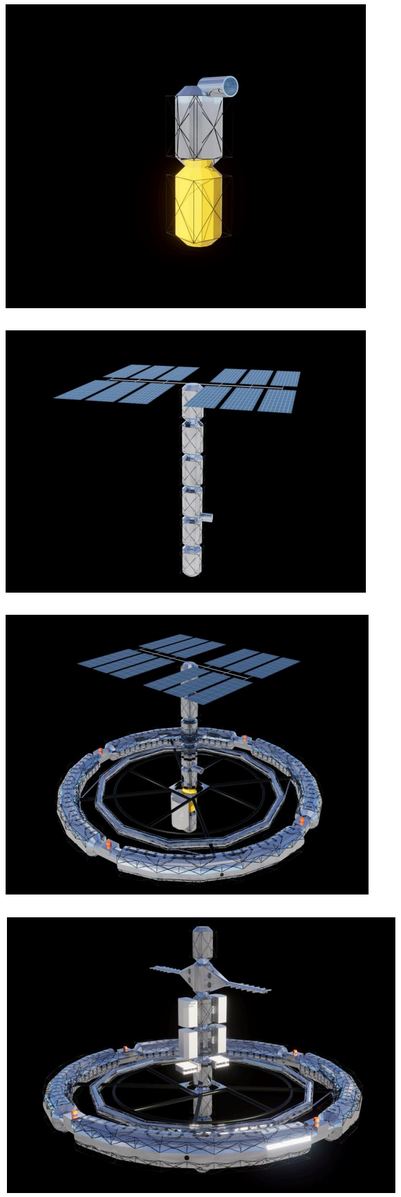


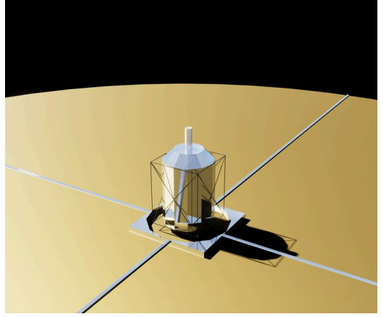
***Figure** 2.20-2.24 Construction Phases*
[Elvis Zhou using SketchApp]

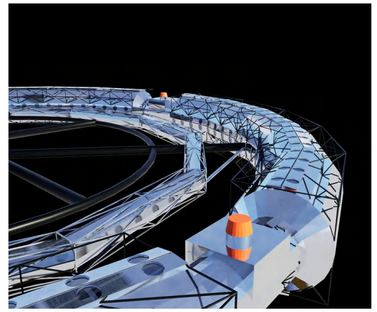
Construction Sequence

Phase 6 - The Solar Sail and Space Tugs are set up. Settlement is pushed up to Cycler orbit using propulsion from Hall and RCS thrusters and the Space Tugs.
Phase 7 - Storage volume is set up. Support equipment area within the Industrial Volume is established.
Phase 8 - Recreational 0 G Volume is set up above the residential volume. FOC is achieved.

Future Expansion

- Expansion Along Central Shaft Axis:
  - Possible to construct more tori and add modules as per needs.
- Small-Scale Expansion:
  - Use modular capsule-shaped cabins connected via docking interfaces.
- Large-Scale Expansion:
  - Additional cabins can connect to previously built cabins.





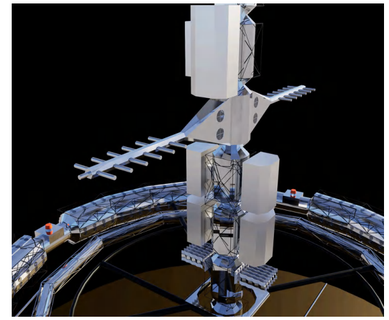


***Figure** 2.25-2.29 Construction Phases*
[Elvis Zhou using SketchApp]

Solar Sails

- Positioned at end of Benevectoras, stowed on central axle with 4 arms. Area of 13,73,750 m^2, radius of 661.43 meters.
- Arms fold around central cylinder, contains graphene-Kapton mesh acting as Radiator and heat exchanger.
- Modular design enables specific parts of sail to be opened to vary velocity and propulsion
- Ball socket with high-torque servo motors and gyroscopes
- 45° rotation for precise adjustments.

(refer auto 5.4)

Space Tug

- Cylinder with radius of 2.5m
- Flat circular interface provided a few metres front of the solar sail.
- The Space tug latches on to the electromagnetic actuators at the end of extended central axle of the solar sail
- The tug uses ion thrusters to propel itself and provides a constant thrust and acceleration of 10 m/s^2

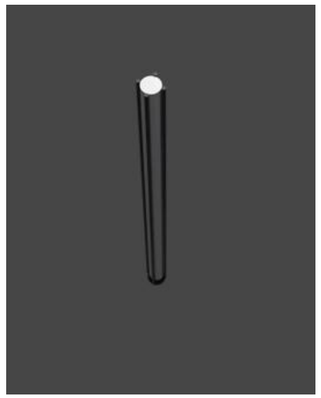


Fig 2.4.1- Stowed away Solar Sail Configuration [abdullah khan]

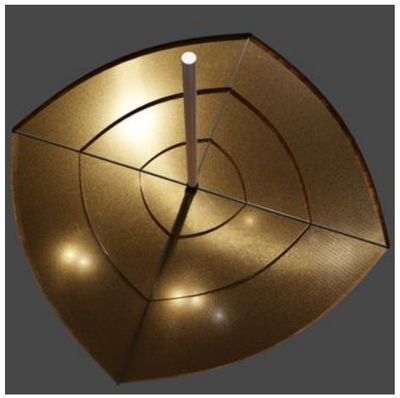


Fig 2.4.2- opened Solar Sail Configuration [abdullah khan]

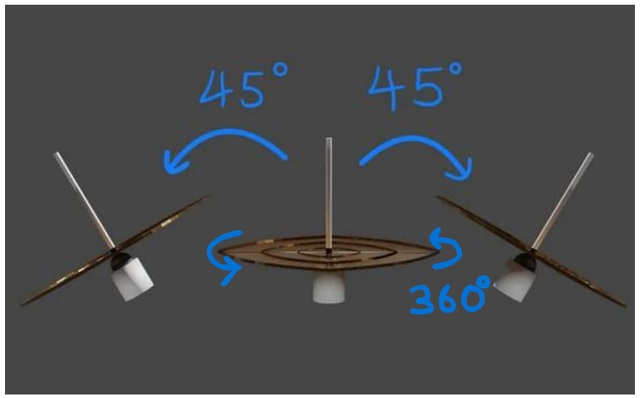


Fig 2.4.3- visualization of freedom of rotation [abdullah khan]

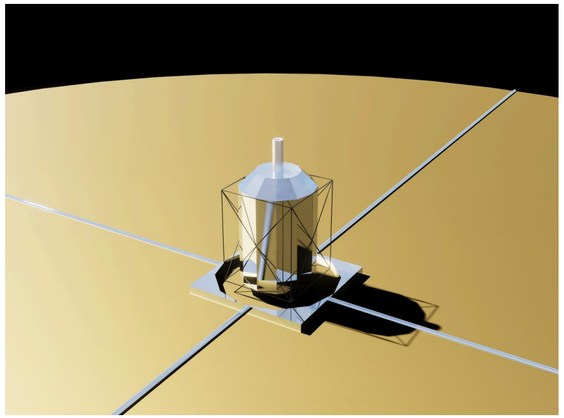


Fig 2.4.4- space tug [Sijia Zhou]

Orbital Location

Primary Orbital Location

- The Construction will take place in the Earth-Moon Lagrange Point 2
- The settlement will start detach when the Aldrin Cycler is at its periapsis relative to the target planet.

Orbital Path after Deployment

Fig 3.1.1 Orbital Path
[By Name on Software]

Process of Acceleration

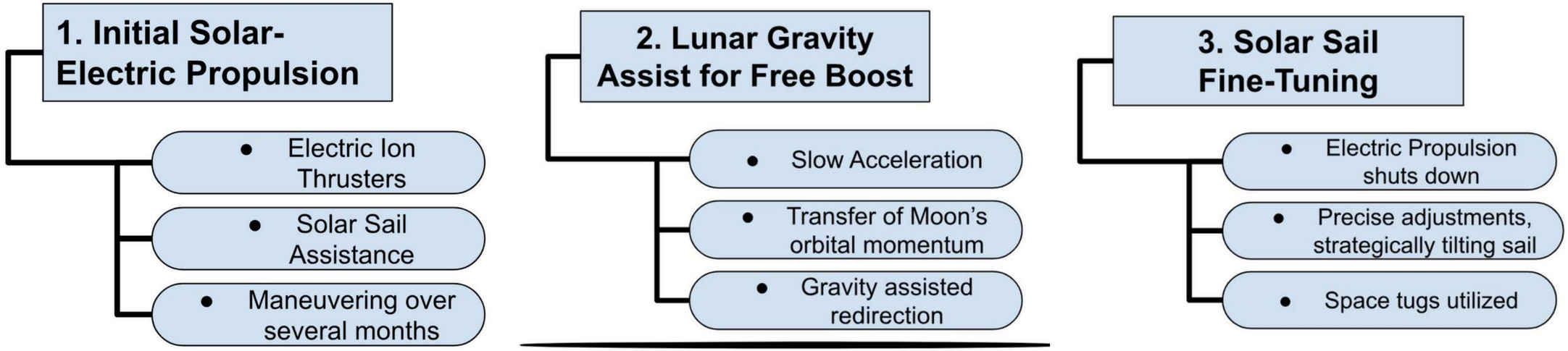


Fig 3.1.2 Acceleration of Settlement
[By Dawood on photoshop]

Materials

Window

Materials	Properties	Source	Thickness (m)
Magnesium Aluminate Spinel ($MgAl_2O_4$)	High Tensile Strength, Radiation Protection	Alaskol	1.25
ElectroDynamic Shield	Prevents accumulation of dust on the windows	Subcontractor ElectroProtect	0.2
Boron-Doped Aluminum Oxynitride (AlON)	Reduces Neutron and Proton Radiation, Structural Reinforcement	Alaskol	0.3
Graphene-Reinforced Silica Aerogel	Residual Radiation Absorption, Minimizes Heat Loss	Alexandriat	0.7
Electrochromic Glass	Light Control, Heat Protection, Transparency	Rockdonnell (asteroid mining and refining)	0.9
Water	Radiation Shielding	Stuff of Life	0.08

Table 3.1 [By Suhani G, Nemo W, Harsh S on Canva]

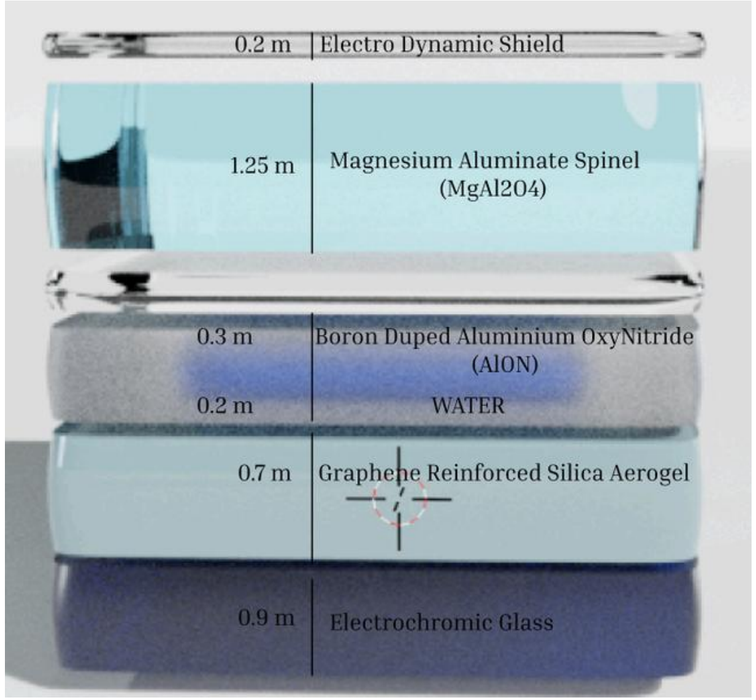


***Figure** 3.1.4 Window Configuration* [Sijia Zhou, rhino]

Food Production

Stem cell based food production:

- Induced pluripotent stem cells sourced from Earth
- Conducted in Multi-chambered Bioreactor System
- Nanobots from Nano Solutions are applied inside all 5 chambers
- Adapts to changing conditions to improve Cell Adhesion and Structural Integrity
- Nanobots optimally balances conditions in the bioreactor

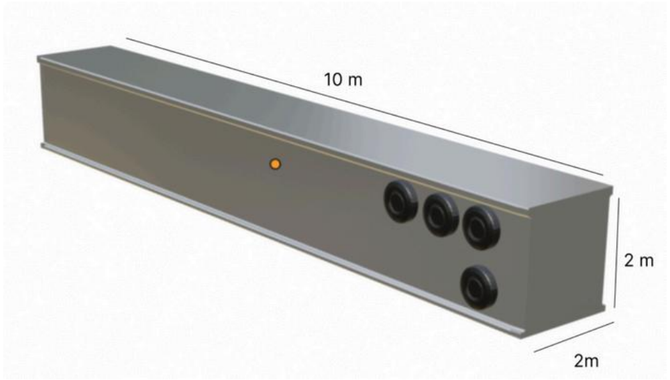


Fig 3.2.1 Bioreactor
[By Rayan on Fusion]

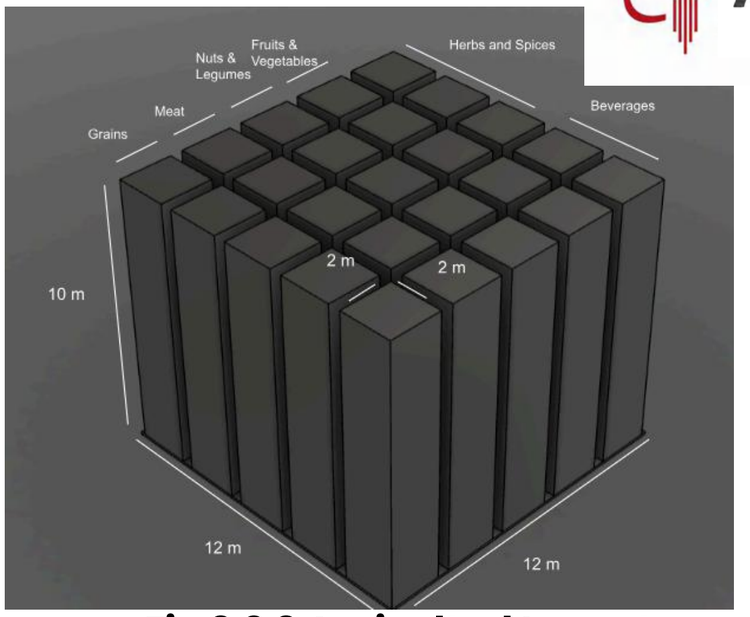


Fig 3.2.3 Agricultral Layout
[By Rayan on Fusion]

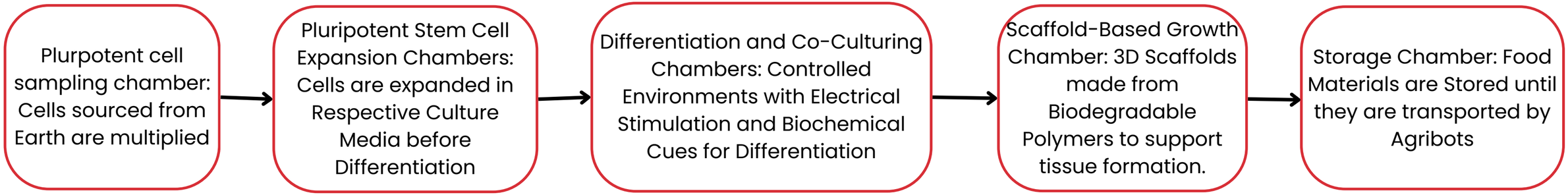
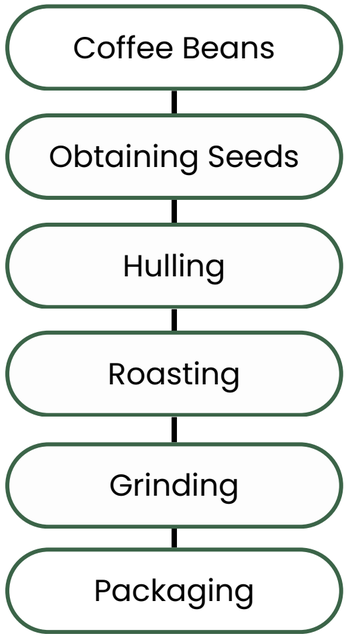


Fig 3.2.2 Argicultural Steps
[By Vanya S on draw.io]

Food Production

Packaging, Storing and Shipping

- The food materials pass through a conveyor belt system.
- Edible, good quality produce are separated.
- Some of the food products are processed before packing.
- The final packaging is embedded with **RFID tags.**
- Poor quality produce- repurposed into **microbial products.**
- Packaged goods are shipped to residential storage.
- Shipped to residential areas by self driving bots (from **Drone and Delivery**)



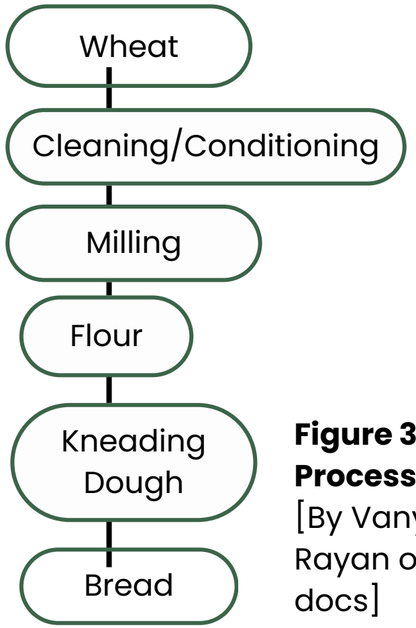


Figure 3.2.4 Food Processes [By Vanya & Rayan on Google docs]

Category	Crop	Amount Produced Per day (g)
Grains	Rice	1,161,900
	Oats	464,760
	HB4 Wheat	663,942
Herbs and Spices	Oregano + Peppercorns	46,476
	Ginger + Turmeric	46,476
Nuts & Legumes	Lentils	199,182
	Soyabean	154,920
	Almonds + Cashews	309,840
Fruits & Vegetables	Apple + Banana	697,140
	Strawberry	663,942
	Chilli + Capsicum	278,856
	Tomato + Potato	542,220
Meat	Beef + Pork	387,300
	Chicken	374,806
	Fish	410,565
Beverages	Coffee cherries +Tea leaves	371,808
Total	-	**5,616,954**

Table 3.2 Food list [By Vanya & Rayan on Google docs]

Power Generation

Primary Source: Solar Panels

- A **polygonal rollable** solar array using **flexible Perovskite Solar** Cells ensures high efficiency.
- Each **9m × 9m** panel adapts to varying irradiance (1361 W/m² near Earth, 604.44 W/m² near Mars, 2623.89 W/m² at periapsis).
- **4 panels** will be used
- **Six Lunettas** (by **LightWorks**) enable 24/7 operation, with wiring by **ElectroProtect** & **ZAP! Industries.**
- Solar Panels can be **rolled up** in times of solar storms etc.

Secondary Source: Methane

- Methane obtained from **Toss it To Me.**
- Energy density of approximately **55.5 MJ/kg**, highly dense source of power

Backup Source: ElectroDynamic Tethering

- Retractable, rigid **Electrodynamic Tethers** capable of interacting with the magnetic field and generating current.
- Approximately **1 km** in length, **90000kwH** produced
- Some have robotic arms to take in debris, some have magnets
- **Triple benefits** of electrodynamic tethering- space debris clearing, material acquisition, power generation.

Storage: Hydrogen Fuel Cells

- **Hydrogen fuel cells** store excess solar power via **electrolysis,**
- H_2 stored in **Metal- Organic Frameworks** for high-density, long-term use.
- Fuel cells generate electricity, heat, and water on demand.

Repurposing for storage of other gases:
A shared cryogenic system optimizes efficiency, ensuring self-sustaining power, life support, and propulsion in orbit.

- Nitrogen (N_2) in metal nitrides (life support)
- (Xe) , compressed 200kgs (for engines)

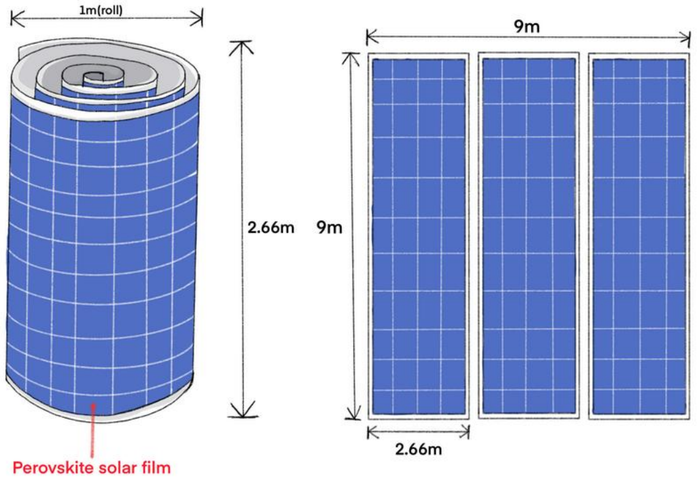


Fig 3.2.6 Rolling mechanism for solar panels
[By Kiki on Procreate]

Communication

External Communication

- Uses **different wavelengths** for external communication via a **multi frequency laser**.
- Transceivers secured in a **FSO** (Free-space optical communications) by a three-axis gimbal
- Sensors on- **Benevectoras**, **Colombiat**, **Earth** and **Mars** to receive lasers
- Benevectoras transmits and receives signals to and from Earth directly or indirectly through Colombiat on the occasion Earth's location is out of view due to the Sun
- Depending on which location is in view to Benevectoras, either Colombiat or Earth will transmit signal to and from Benevectoras and Mars

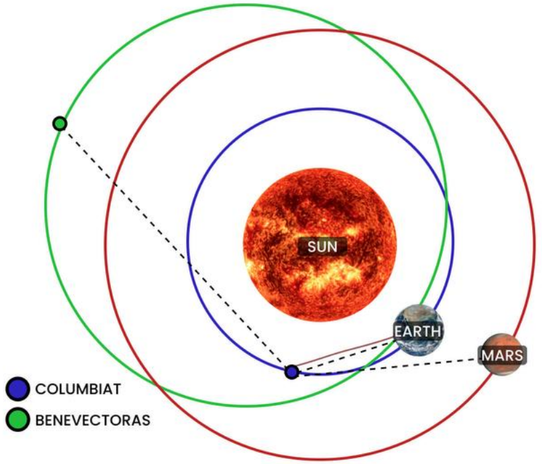


Fig 3.2.7 Locations of Relay Settlement
[By Ishani V on Canva]

Internal Communication

Internal Communications Network: Wi-Fi:

- Is compatible with visitors' devices
- Covers all living areas
- Routers are connected with cables embedded within walls
- Fiber optics are provided by subcontractor OrbitLink Communications

Internal Communications Device: Smart glasses:

- Uses bone conduction to transmit sound
- Can view augmented reality to view alerts via glasses lens
- Haptics sensitive ring used to send text messages and interact with augmented reality
- Sounds and display from glasses in case of evacuation
- Ring detects vital signs and sends SOS signal in case of health emergency

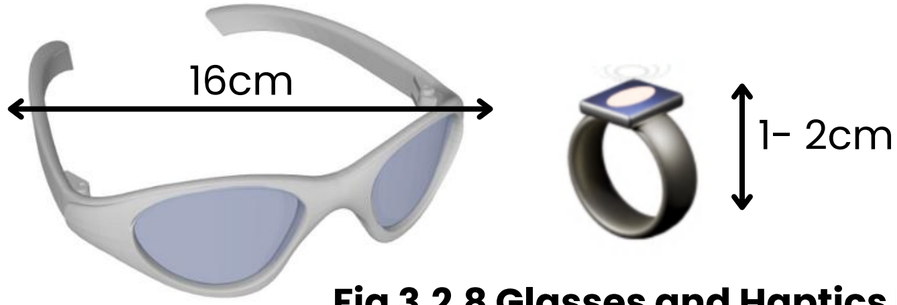


Fig 3.2.8 Glasses and Haptics Ring
[By Yuhan Xu on Blender]

Transportation

Hover Pods- Personal

- **CAB- like** System
- **Location:** Residential Areas
- **Accommodates:** 12 passengers,
- **Features:**
  - has transparent windows
  - hovers using Electromagnetic Propulsion technology
  - AI-driven navigation for efficient, autonomous travel
  - Adjustable climate control for personalized comfort
  - Advanced collision detection and avoidance system
  - Functions as an evacuation pod in emergencies
  - Charging stations will be there around the settlement
- **Number of PODS: 100**

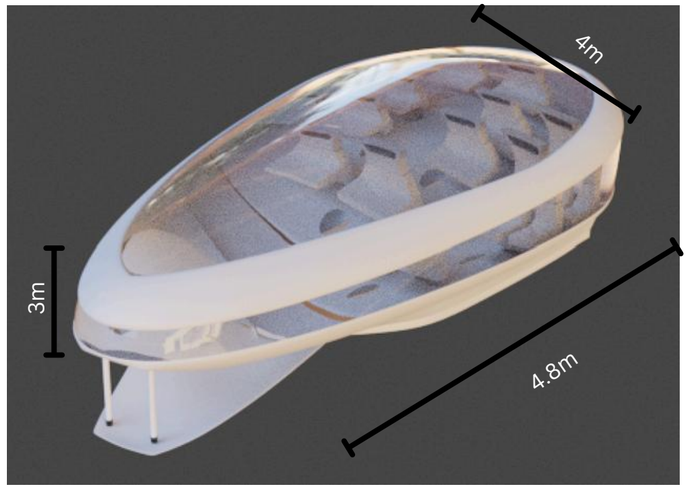


Fig 3.2.9 **HOVERPOD:** By Macauley B. using Blender

Elevators - Public

Location: I

- Zero-G docks connect to the outside so that external spacecraft can dock and unload
- Elevator is used for inter volume transport
- Internal passengers enter from another entrance and are kept separate from space conditions
- In case of emergency, go to the nearest exit. There are 2 exits: the residential area and the industrial area.
- It has seats with secure straps ensuring the safety of the people
- It accommodates 36 people
- There is a separate elevator which is used for the transportation of cargo

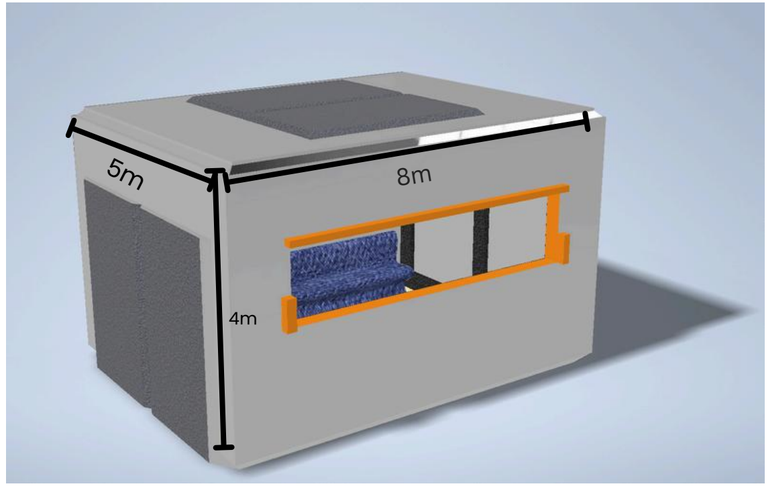


Fig 3.2.10 **ELEVATOR:** By Audi using Blender

Atmosphere

- **Volume of Air:** 53699120.3
- **CASSSC count**: 8068
- **Overall Pressure**: 0.8 atm
- Air Revitalization will be done by **Clean Up Your Act**
- Temperature is regulated with **Radiators** (Humidifiers and Dehumidifiers)
- Air, Humidity regulators are present.

More oxygen is provided in Residential areas and more Carbon Dioxide is provided in the Agricultural Areas.

Gas type	Nitrogen		Oxygen		Water Vapor (H2O)		Carbon Dioxide (CO2)		Temperature (°C)	Humidity(%)
Areas	Percentage (%)	Pressure (kPa)	Percentage (%)	Pressure (kPa)	Percentage (%)	Pressure (kPa)	Percentage (%)	Pressure (kPa)	-	-
Industrial	72.5	58.725	27.36	22.1616	0.1	0.081	0.04	0.0324	15-25	40
Agricultural	73	59.13	26.5	21.465	0.4	0.324	0.1	0.081	15-20	60
Research	75.4	61.074	24.07	19.4967	0.5	0.405	0.03	0.0243	15-20	40
Residential	73	59.13	26.56	21	0.4	0.324	0.04	0.0324	16-26	60
Storage	75	60.75	24.76	20.05556	0	0	0.04	0.0324	15-20	10
Overall	73	59.13	26.56	21	0.4	0.324	0.04	0.0324	15-26	50

Table 3.3 [By Kiki on Canva]

Managment - Power and Water

Department	Power Requirements
Operations	19906 kW
Automations	2014 kW
Human Factors	7435 kW
Misc (Engine, Settlement etc)	8391 kW
Total	37746 kWh

Table 3.4: Power Distribution
[By Suhani G on Canva]

Sector	Total Water Required (all people per day)	Total Water Required (All people, Quarterly: 3 months)
Residential	928,512.00	83566080
Agricultural	225,300.00	20277000
Industrial	427,200.00	38448000
Research	213,600.00	19224000
Total	1,794,612.00	161515080

Table 3.2.11: Water Distribution
[By Suhani G on Canva]

Water will be obtained from **Stuff of Life**

Initial Shipment during IOC and FOC, then recycling

Recycling is subcontract to **Clean Up Your Act**

CASSSCs
IOC: 286
FOC: 858

Fig 3.2.11 Distribution of Utility Lines
[By Zhifei W on Autodesk Sketch]

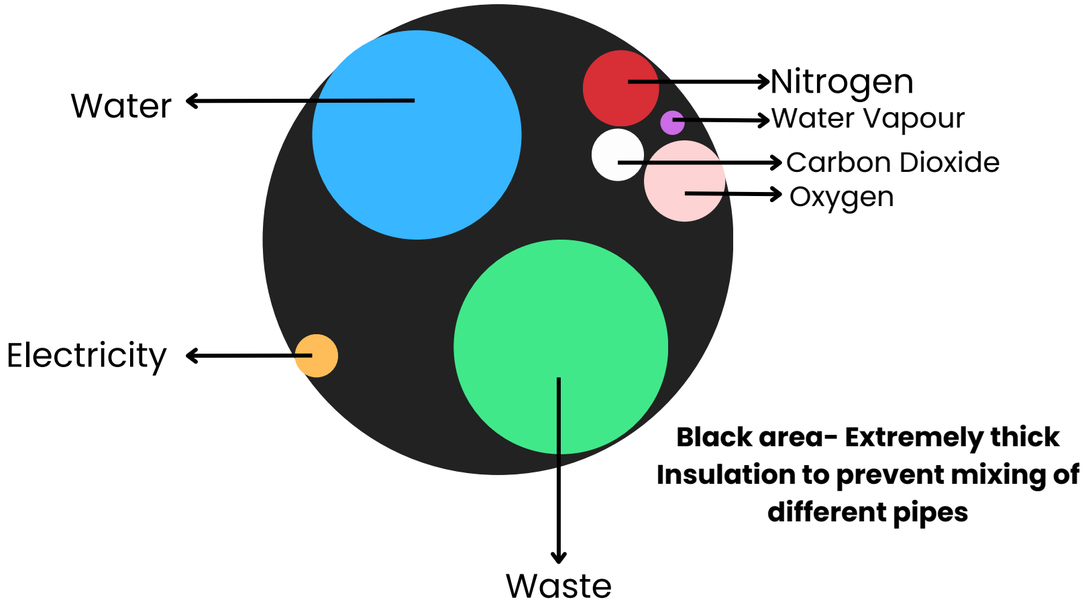


Fig 3.2.12 Combined Utility Pipe
[By Suhani G on Canva]

Waste Management

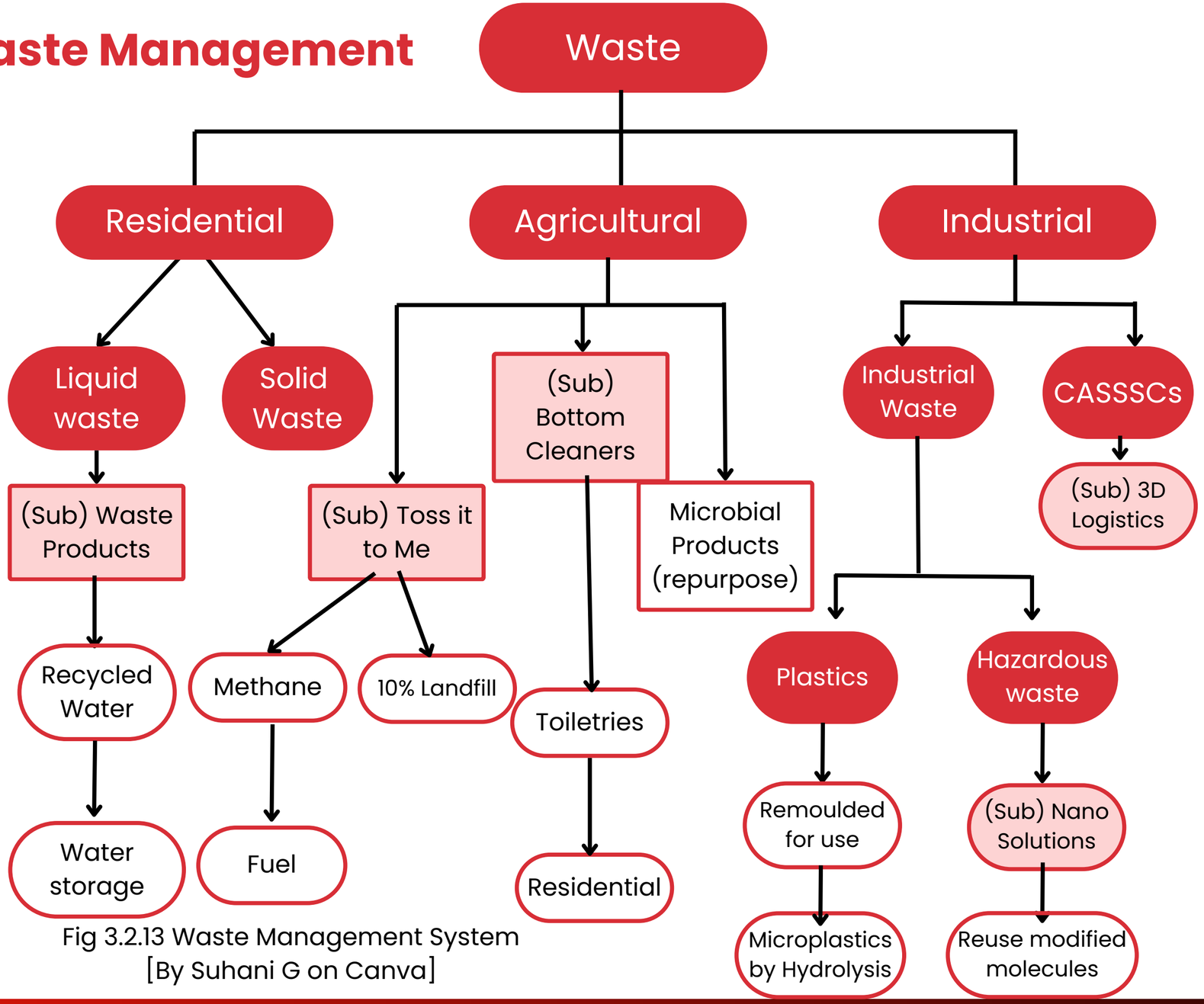


Fig 3.2.13 Waste Management System
[By Suhani G on Canva]

Maintenance, Repair and Overhaul

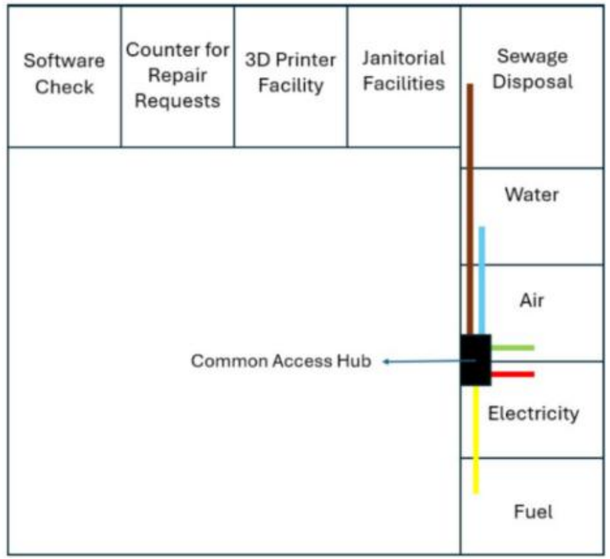


Fig 3.2.14 Utility provision under MRO
By Vanya on Powerpoint

- Advanced 3D printing capabilities to produce spare parts and repurposed bot assemblers for larger repairs in the spaceships (subcontracted to 3D logistics).
- Refueling facilities and reconfigurable maintainence and manufacturing workshops (refer to 7.2.1)
- Rigorous inspections every 2 months- assess material integrity, identify damage, and keep up with updates.

Jigs

Vertical Stability Jigs

- **Electromagnetic Clamps (x2)** connected with ball sockets for free movement.
- Ion thrusters with **RCS**.
- Use of **Inertial Navigation System** in the **Control Module Sphere** for detection and implementation of Deviation Correction.
- **Anterior Control Panel** for smooth communication .
- **IOC:** Structural assembly and the alignment of the modules to be attached together.
- **FOC:** Once purpose is fulfilled, dismantled and repurposed.

Assembly Jigs

- **Modular System**
- **Omni directional welding** and **Laser-cutting** mechanical arms.
- **Free-end** for attachment of choice.
- Self-repair.
- **Magnetic Tugs (x4)**
- **IOC:** Primary method of structural assembly, use of magnetic tugs and ion thrusters.
- **FOC**: Will be used for further expansions - Structural Reinforcements, Replacement of Components, Updation of Technology.

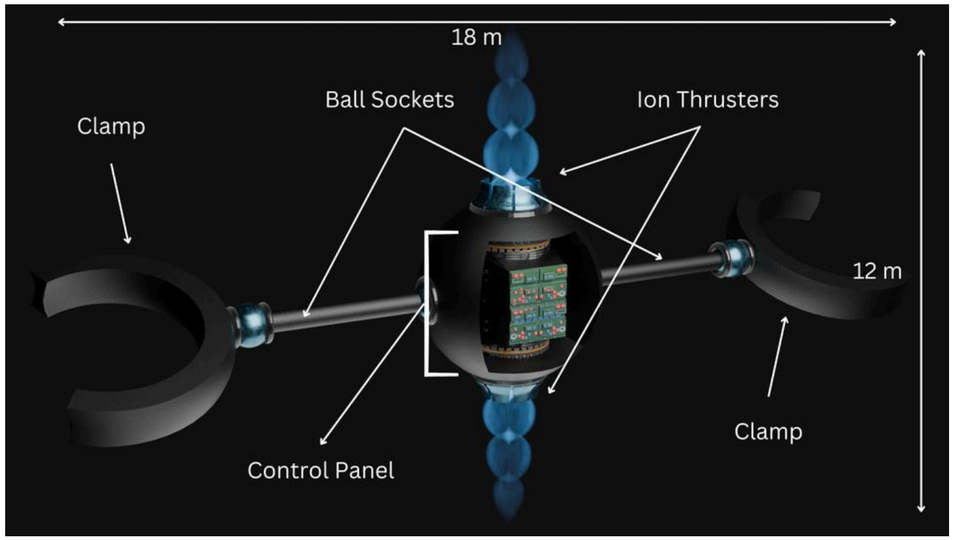
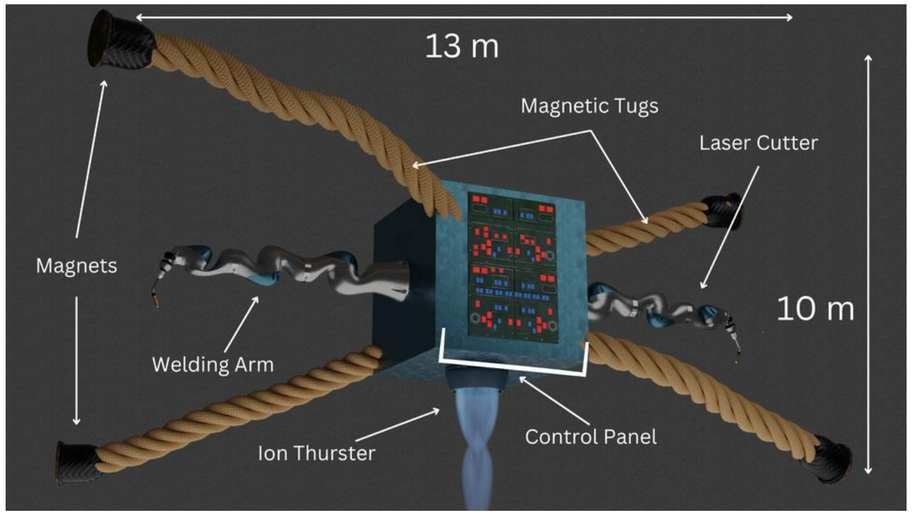


Fig 3.3.1 Vertical Stability Jigs
[By Daniyal on Blender]

Fig 3.3.2 Assembly Jigs
[By Daniyal on Blender]



Shuttle Ships

External Transportation

- 70 people shuttles and 30 cargo shuttles will initially be stored on the settlement
- During the first flyby of mars, 23 people shuttles and 10 cargo shuttles will be deployed and sent to mars.
- Then, 23 people and 10 cargo shuttles are deployed to earth.
- 24 people and 10 cargo are left on the settlement afterwards.
- With the second cycle then, each flyby will have 22 people shuttles transit from the settlement to the planet and vice versa.

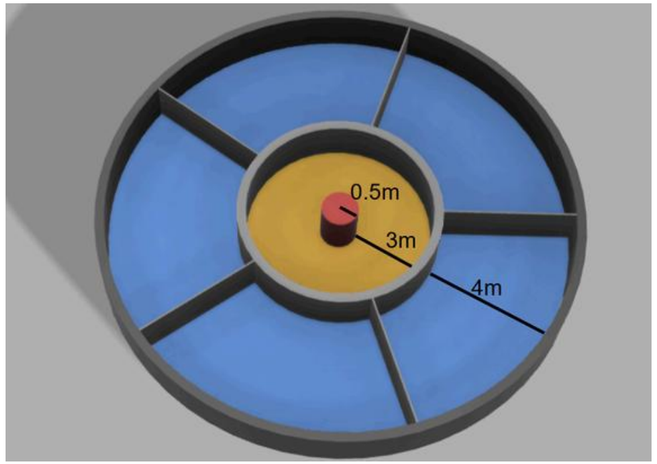


Fig 3.4.1 Floor Layout
[By Rayan on Fusion]

Passanger Shuttle

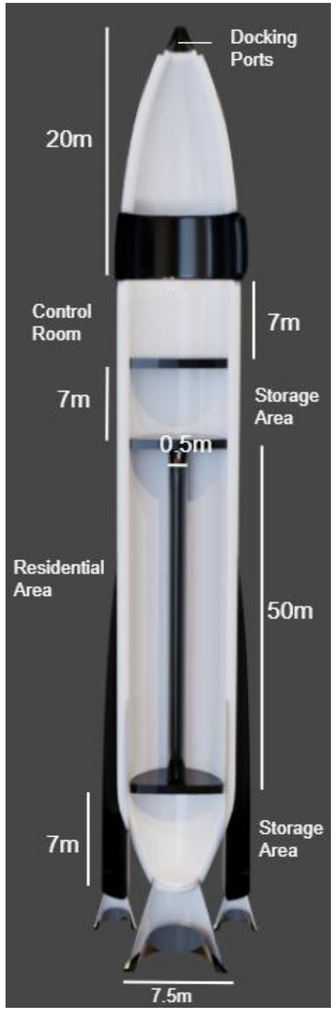


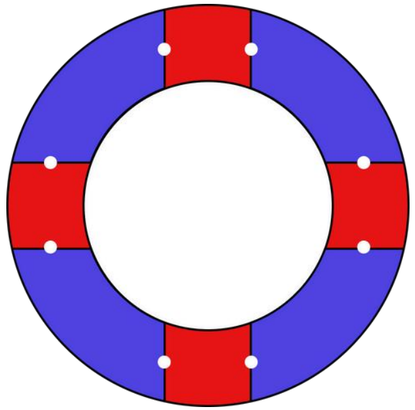
Fig 3.4.2 Passanger Shuttle
[By Macauley on Blender]

Cargo Handling Process

TASKS	M	T	W	T	F	S	S	M
Loading of Settlement Cargo								
Shuttle Travel from Settlement to Target Planet								
Unloading of Cargo on Target Planet								
Reloading of Cargo from Target Planet								
STEP 1								
Jigbots carry cargo from the settlement to respective floors								
Jigbots load cargo onto the storage areas								
Jigbots go into storage as the shuttle takes off								
PHASE 2								
After touchdown, the jigbots start unloading all cargo								
After the cargo is stored, jigbots start loading cargo from the planet								
Jigbots go into storage and prepare for lift-off								
PHASE 3								
Repeat Phase 2 at the settlement and repeat cycle								

Fig 3.4.3 Gantt Chart
[By Akshat on Excel]

Community Distribution



Solar Flares protection areas

Regular residential area

Fig 4.1.1 [Ishani, Figma]

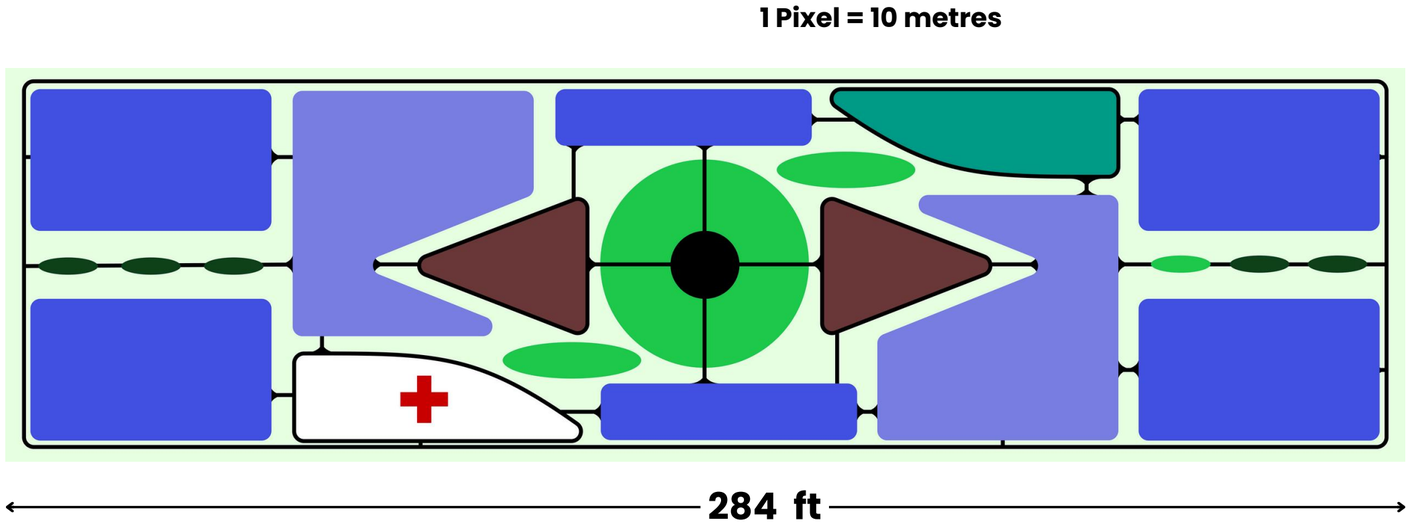


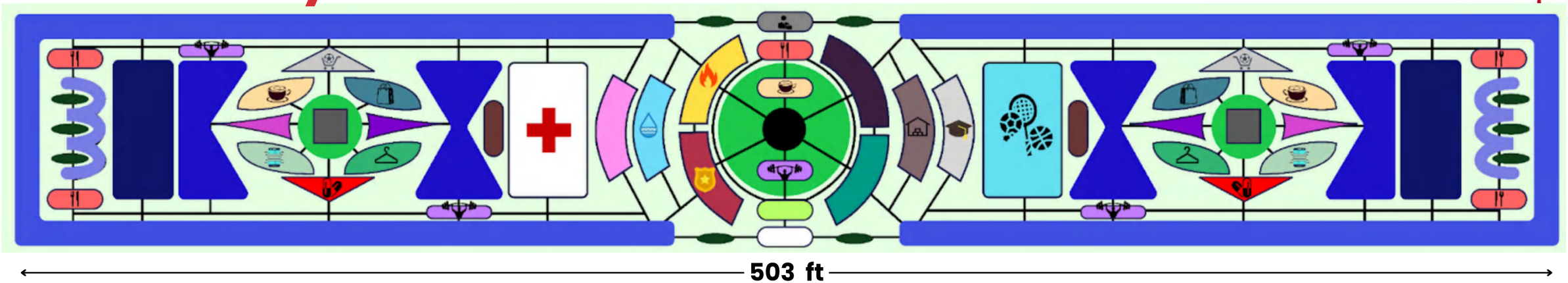
Fig 4.1.2 Solar Flare Protection Area Community Map
[Ishani, Figma]

- Residential volume divided into 4 sectors.
- Solar Flare Protection Areas (SFPA) also in between sectors, separated by airlocks
- Each SFPA has the capacity to accommodate full population of one sector in case of emergency.

Community Distribution

1 Pixel = 10 metres

Table 4.1 [By Ishani V, Armaan on Figma]]



Amenities	No. of Units	Floors	Area of a volume (sqft)
Small Family 2BHK House	45	12	1191
Single 2BHK Shared Space House	188	12	527
Married 1BHK Apartment	27	1	2435
Single 1BHK Apartment	10	1	3500
Restaurants	5	1	180
Clothing Shops	2	1	350
Club	2	2	450
Sports Shop	2	1	200
Hospital	3	1	1,750
Cultural Exchange Centers	2	1	500

Amenities	No. of Units	Floors	Area of a volume (sqft)
Food & Water Storage	1	1	180
Fire Station	1	3	230
Cinema	1	2	400
School	1	3	500
Sports Arena	1	2	900
Grocery Stores	2	1	350
Office	1	3	370
Recreation	1	1	400
Charging Stations	10	1	400
Gym	4	2	320

Amenities	No. of Units	Floors	Area (sqft)
Electronic Shop	2	1	300
Cafes	3	1	200
Pharmacy	2	1	300
Souvenir Shop	2	1	200
Art Gallery	2	2	400
Control Centres	1	1	130
Police Station	1	1	400
Administrative Office	1	1	170
Library	1	3	200
Park			
Green Spaces			

Amenities & Consumables

Table 4.2 [By Ishani Verma]]

Kit	CASSSCS per 1000 people	Items	Supply Duration
Basic Essentials	0.11	Toothbrush, Toothpaste, Dental Floss, Face Wash, Toilet Paper , Soap Bars, Body Wash, Shampoo, Conditioner, Q-Tips, Cologne, Shaving Gel, Razor,Tissues ,Hand Sanitizer	Bi-Monthly
Daily Wares	0.23	Clothing, Towels, Footwear, Brushes, Nail Clippers, Bedding, Socks	Bi-Annually
Medical Provisions	0.02	Vitamin Tablets, Painkillers, First Aid Kit (Bandages, Antiseptics, Medical Tape), Antacids, Allergy Relief Tablets, Cough Syrup, Lactaid, Epinephrine	Quarterly
Menstrual Hygiene	0.03	Sanitary Pads, Tampons, Painkillers, Heat Pads, Menstrual Cups, Feminine Wipes	Monthly

Non-Consumable	CASSSCS per 1000 people	Items
Utensils	0.06	Plates, Bowls, Cups, Knife Set, Spatula, Pans, Spoons and Forks Set, Grater, Frying Pan, Colander, Cutting Board, Full Set of Measuring Cups
Appliances	8	Refrigerator, Microwave, Washing Machine, Oven Cooktop, Flat Iron, Vacuum Cleaner, Television, Food Processor, Dishwasher, Toaster, Blender Coffee Maker, Electric Kettle
Tools	0.07	Screwdrivers, Wrenches, Hammers, Pliers, Drills, Sanders, Pruners, Maintenance Tools, and Measuring Tape
Stationery Items	0.2	Writing Instruments, Sports Gear, Musical Instruments, Art Supplies, Teaching Aids, Reference Materials and Files
Emergency Repair Kits	0.01	Duct Tape, Screwdriver Set, Hammer, Utility Knife, Pliers, Super Glue
Entertainment Supplies	0.12	Books, Board Games, Card Games, Art Supplies, Musical Instruments, Puzzles, Sewing Kits and Cloths, Writing Supplies

Amenities & Consumables

Table. Furniture [Shambavi, Google Docs]

Type	1BHK (Single)	1BHK (Couple)	2BHK (Small Family)	2BHK (Shared Space)
Furniture	Single Bed, Nightstand, Desk, L-Shaped, Sofa, Dining Table, Chairs Wardrobe, Coffee, Table, Kitchen Island, Television Stand	Queen Bed, Nightstand, Desk, L-Shaped, Dining Table, Chairs, Wardrobe , Coffee Table, Kitchen Island, Television Stand	Queen Bed, Nightstand, Desk, L-Shaped Sofa, Dining Table, Chairs, Wardrobe, Coffee Table, Kitchen Island, Television Stand	Queen Bed, Nightstand, Desk, L-Shaped Sofa, Dining Table, Chairs, Wardrobe, Coffee Table, Kitchen Island, Television Stand
CASSSCS	0.12	0.16	0.25	0.16

Art gallery	Art pieces from cultures around the world in each building
cafes	Treats and hot/cold beverages for quick sit downs and meetings
Cultural exchange center	Different programs for integration,(workshops, exchange programs, drives)
Clothing	Stores with a variety of clothing articles at multiple price points
Electronics	Day to Day electronics like chargers,phones,laptops etc as well as repair facilities
Club houses	Areas for mingling and group hangouts, equipped with pool tables,drinks, and ambient lighting

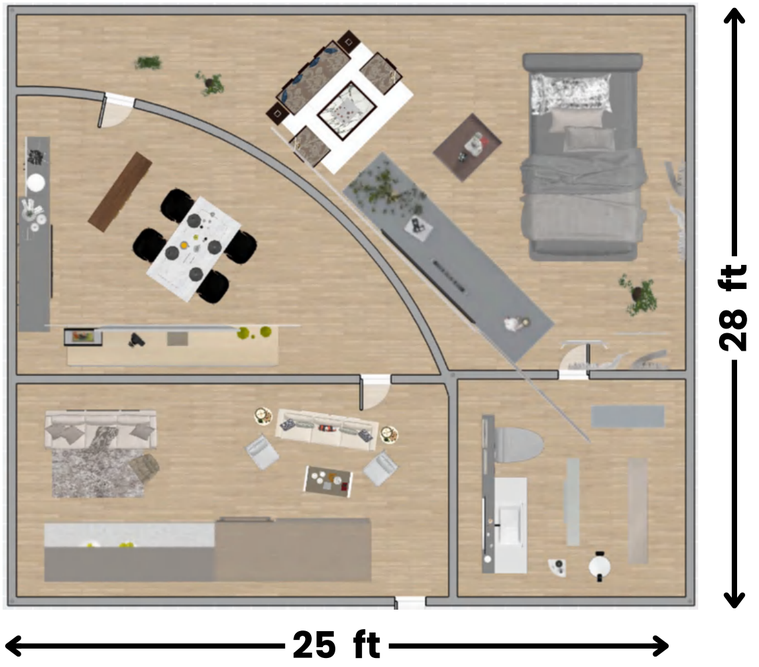
Table. List of Shops [Shambavi, Google Docs]

Recreations

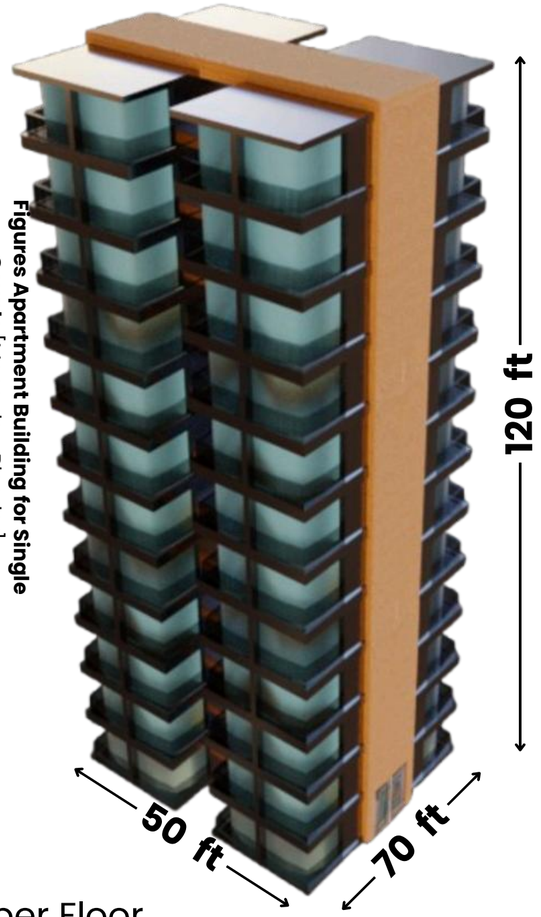
Table 4.3: Recreation[Wi Wei, Inventor Lynn Wang, Procreate]

S no	Name	Description	Depiction
1	Orbital harmonics	Residents control certain floating instruments with gestures to create enhanced symphonies	
2	SlipStream	A vortex ride simulating a dive into any environment The ride path shifts using generative AI, based on genres	
3	All in one	3D holograms are used to create a real life environment. Any location or sport can be experienced in low gravity here.	
4	Biolumeview	By using mars alignment we create a perfect space viewing setting, with bioengineered luminescent lighting.	

Housing Design and Layout



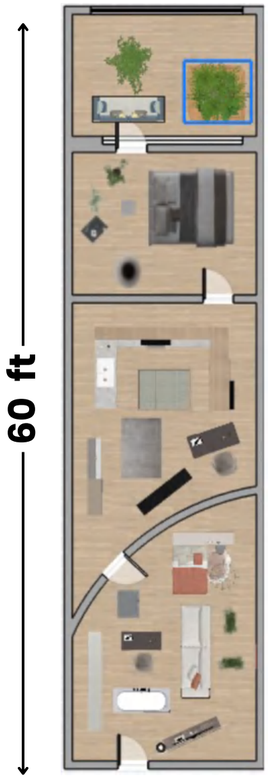
Interior [Will, SketchApp]



Figures Apartment Building for Single Couple [Maccauley, Blender]

1 **BHK Apartment**

- Total Buildings: 40 (10 Buildings per Sector)
- Total of 48 Apartments with 4 Apartments per Floor
- Occupies a **single person**
- Total height 120 feet, **12 floors** total.
- Base Area Covered **per Unit is 700 sq.ft**
- Base Area covered by **a floor is 3500 sq.ft (giving space for hallways)**

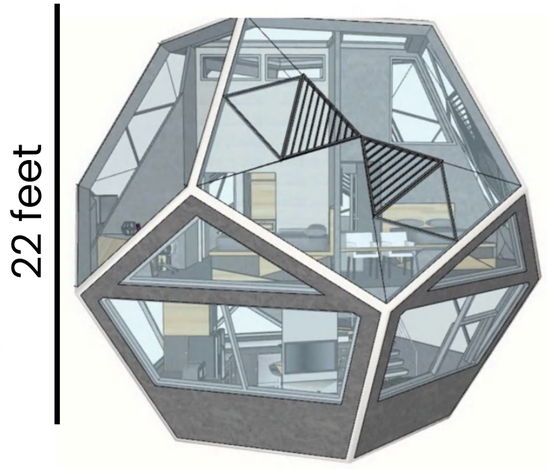


Figures Apartment Building for Married Couple [Liam, SketchApp]

1 **BHK Apartment**

- Total Buildings: 108 (27 Buildings per Sector)
- Total of 24 Apartments with 2 Apartments per Floor
- Occupies a **married couple**
- Total height of 120 feet, **12 floors total.**
- Base Area Covered **per Unit is 900 sq.ft.**
- Base Area covered by 1 **floor is 2435 sq.ft** (giving space for hallway)

Housing Design and Layout

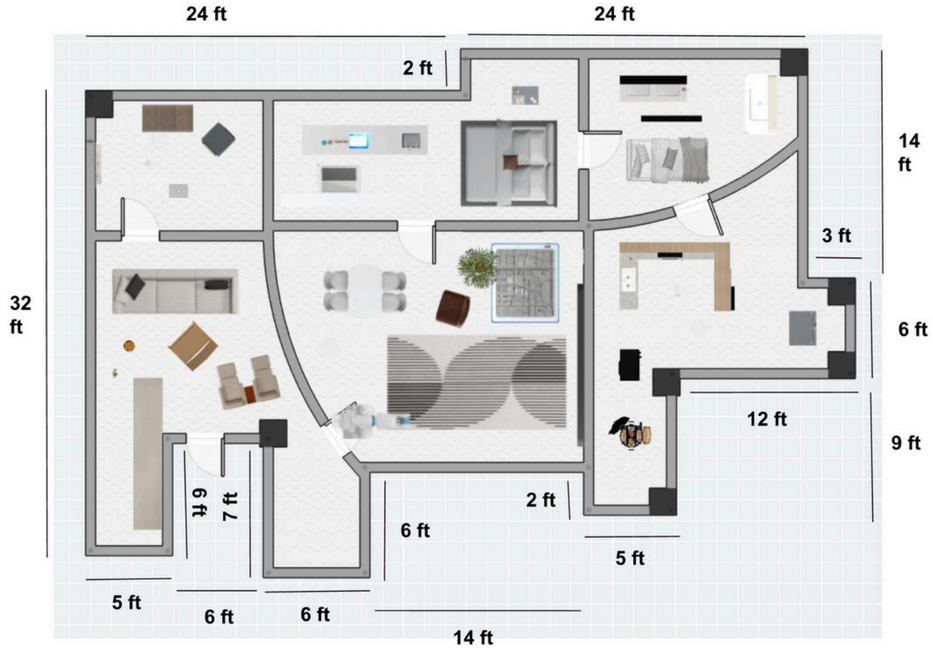


Figures 40- 43
[Will, SketchApp]

Dodecahedron Sharing Space

2 BHK House (Shared Space)

- 752 Total Houses (188 Houses per Sector)
- 2 People per House
- House shared between **two single people**.
- Height of **22 feet** with the edge of **17.5 feet**.
- Base Area Covered **per Unit is 527 sq.ft**



Triage Residence

2 BHK House (Small Family)

- 180 Total Houses(45 Houses per Sector)
- 3 People per House
- Occupies **a married couple with a child**.
- Height of **10 feet** with 1 floor.
- Base Area Covered **per Unit is 1191 sq.ft**

[Will, SketchApp]

Donning & Doffing of Spacesuits

By Soham M. using MS Powerpoint

1) Donning - PPE inspection and physiological medical tests of astronauts

2) Safety and life support systems checks

3) Pressurization of ppe suits before entering into the airlock

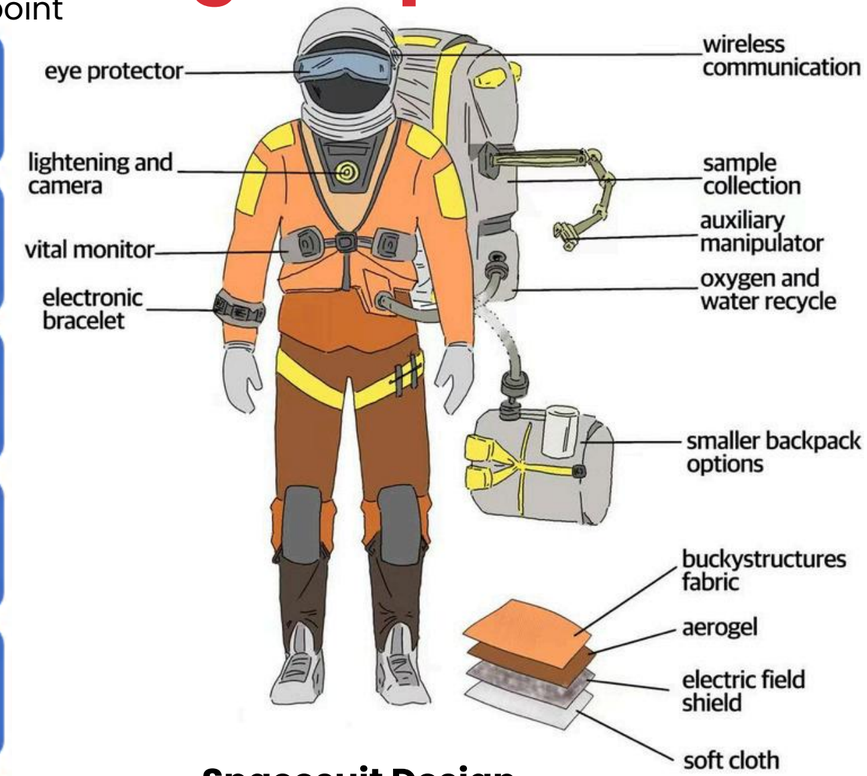
4) Pressurised airlock can be depressurized slowly for exiting the airlock going out of the spacecraft

5) Doffing - Decontamination and sanitization of suits and PPE (In pressurized airlocks)

6) Dust Absorption (In pressurized airlocks)

7) PPE suit is depressurized for removal

8) Pressurised airlock is depressurised for exiting the airlock and going into the spacecraft



Spacesuit Design

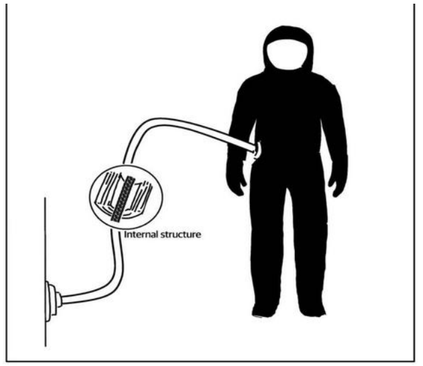
[Lynn Wang, procreat]

	Extravehicular suit
Layers	4 layers
Material	Writing Instruments, Sports Gear, Musical Instruments, Art Supplies, Teaching Aids, Reference Materials and Files
Numbers	1200

Features:

- **Monitors vitals** of the astronaut
- Provides life support, removes excess CO2, controls **pressure** and **temperature**
- Safety alarm and wireless communication
- Insulation against extreme temperatures and heat resistance
- Presence of foot restraints such as velcro and magnetic shoes

Buckystructures,Extreme survival technologies will be subcontracted for the materials in the space suits

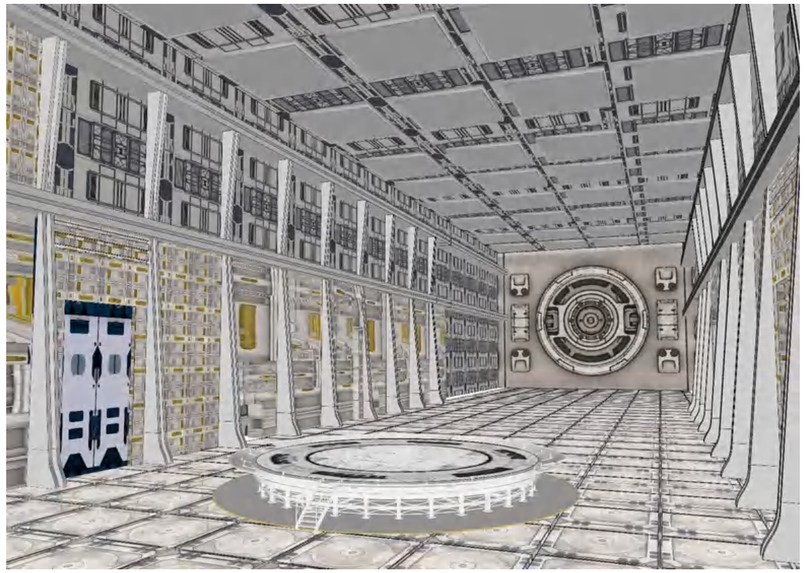


Tethers connected to astronaut

[Lynn Wang, Procreate]

Depiction of evacuation and safety

Safety and Evacuation



Manual Supports in 0g/Low G Interiors
[Will Wei, Inventor]

- In a low gravity environment, kevlar ropes, which are able to change shape to allow for easy grasp, are connected to a multi-strand tether for use.
- Handholds are on the wall
- Handholds have a staggered format so it can be accessible to kids and adults.
- For extravehicular activities, units such as SAFER or MMU are used.
- Very important if untethering occurs.

The 4 residential sectors have several emergency sirens, pathways and alarms, and sensors. → During solar flares or radiation hikes, there will be solar flare protection areas to where the residents will be transported using public pods. → During an emergency in one sector, the people of the sector can be transported to the protection area nearest to it, which is separated by airlocks.

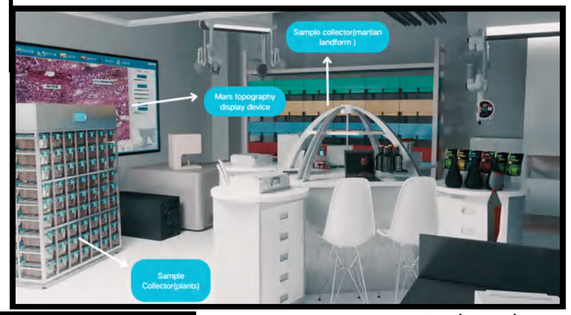
By Soham M. using MS Powerpoint

Educational Courses

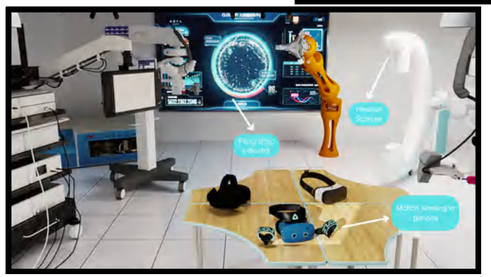
Table 4.4: [Denise, Canva]

Introduction to Mars and Martian Environment	Resource Utilization	Emergency Situations
Course A: The History of Mars • Duration: 1.5 hours • 6 instructors • evolution of Mars itself	**Course A: In-Situ Resource Utilization in Mars** • Duration: 1 hour • 9 instructors • valuable resources	**Course A: Medical Emergency Response** • Duration: 8 hours • 18 instructors • Health Effects of the Martian Landscape
Course B: The Mars Environment • Duration: 3 hours • 6 instructors • natural terrain and geology of Mars, through a series of VR simulations	**Course B: In-Situ Resource Utilization Techniques** • Duration: 8 hours • 9 instructors • Extraction Techniques for resources	**Course B: Environmental Emergency Response** • Duration: 5 hours • 18 instructors • Environmental challenges
		Course C: Breaches and Failures Emergency Response • Duration: 5 hours • 18 instructors • possible breach and failure situations
		Course D: General Evacuation Emergency Response • Duration: 2.5 hours • 6 instructors • location of safe zones in the Martian habitat

Classroom 1（Lecture)



Classroom 3（ Lab)


Classroom 2（VR)

[Will Wei, Inventor]

Construction & Repair

External Construction Bot (80 units):

- **Features:**
- **Multi-jointed arms**, **ion-stream propulsion**, and **modular construction** for precision and durability.
- **Magnetic Pulse Welding** – Solid-state welds for aluminum, titanium, and composites.
- Transitions to **maintenance roles** for **inspection**, **unwelding**, and **panel replacement.**
- Supports emergency response with **live camera updates** for critical tasks.

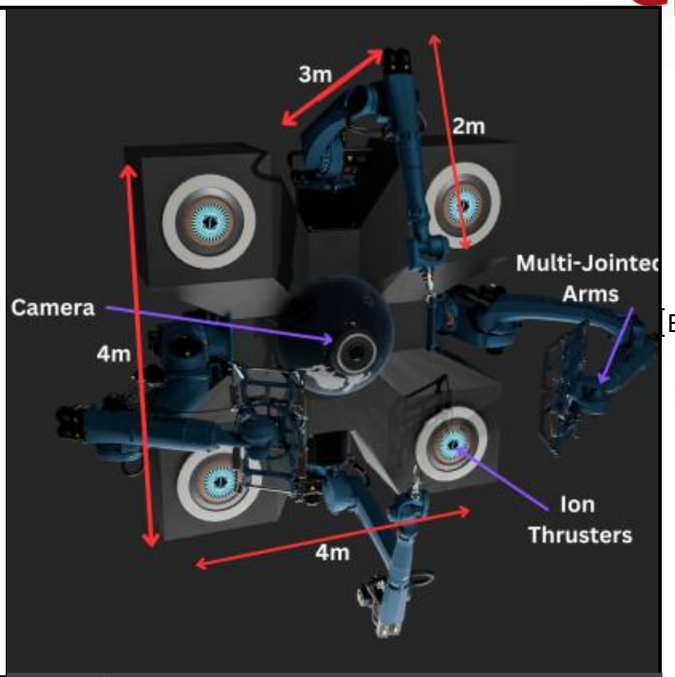


Fig 5.1.1 [By Daniyal Ali on Blender]

Jig Bot (120 units):

- Specializes in **zero-gravity construction** by securely holding robots in place.
- Equipped with **precision claws**, **powerful thrusters**, and **modular adaptability.**
- Operates with advanced navigation and **autonomous positioning** for space tasks.

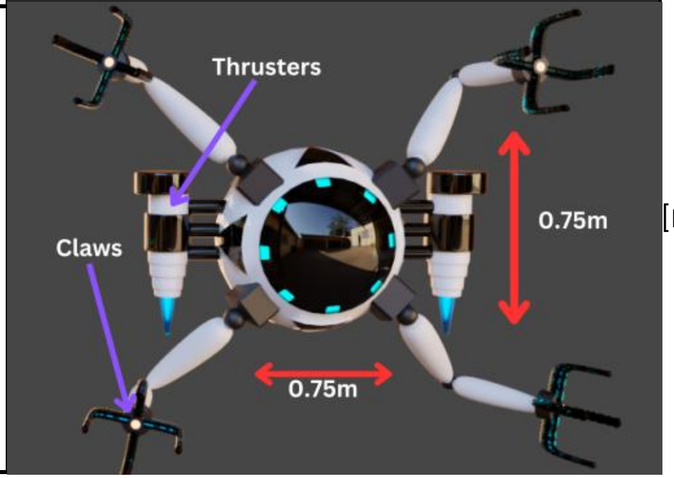


Fig 5.1.2 [By Daniyal Ali on Blender]

Internal & External Construction Jig (fixed-based) (150 Units):

Description: Equipped with **jointed arms** and a **precision claw**, these jigs are designed for **grasping**, **handling**, and assembling objects both inside and outside the space station. They provide **stability** and **dexterity** for various construction and maintenance tasks.

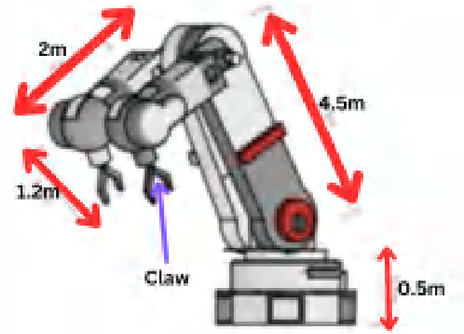


Fig 5.1.3
[By Yuhan]

Delivery robot (300 units):

Description: This robot receives Food transportation and material tasks from **residents** or **businesses** via a community app. It uses shared computing resources to access real-time data, optimizes routes, and adjusts delivery schedules, ensuring efficient and responsive service for all users

Feature: Provides self-driving air and ground vehicles capable of transporting food items whilst **keeping them cool.**

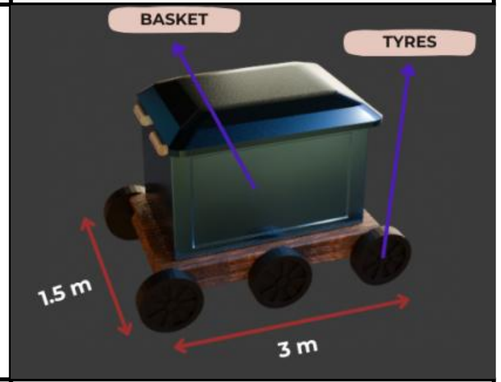


Fig 5.1.4
[By Prabjot]

Internal construction drone (150 units):

Description: Used for construction of site and holding of jigs inside the rings. Used for internal monitoring, maintenance, and repair work of the space station, equipped with **propellers** and a **camera** for movement and **visual inspection.**

Feature: Provides **self-driving air** and ground vehicles capable of transporting small items.

Subcontractor-Drone & Delivery

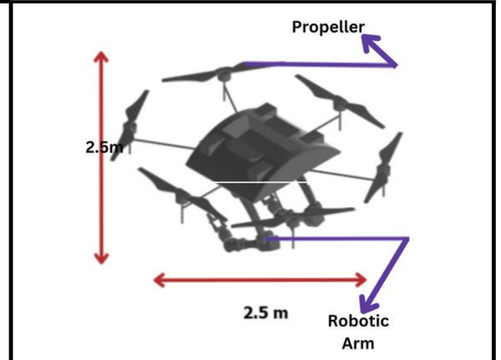


Fig 5.1.5
[By Yuhan]

The safety monitoring system

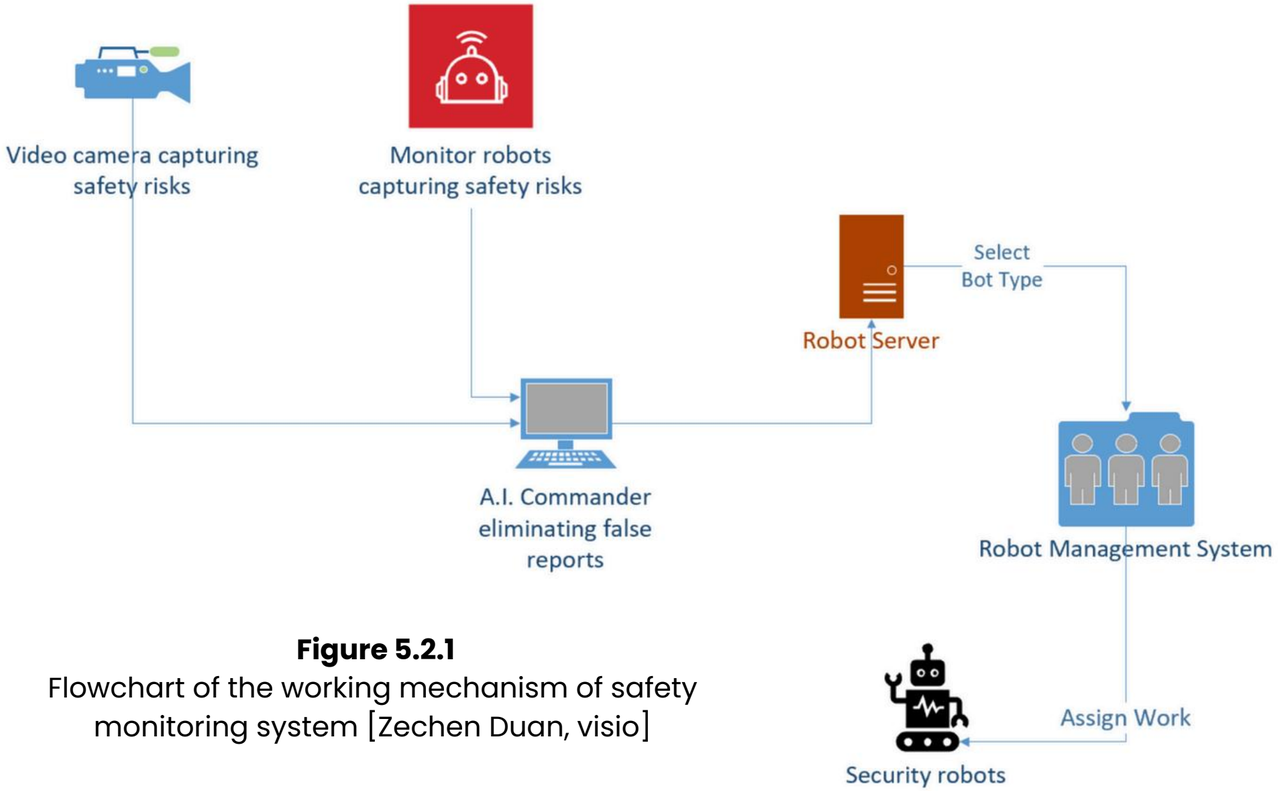
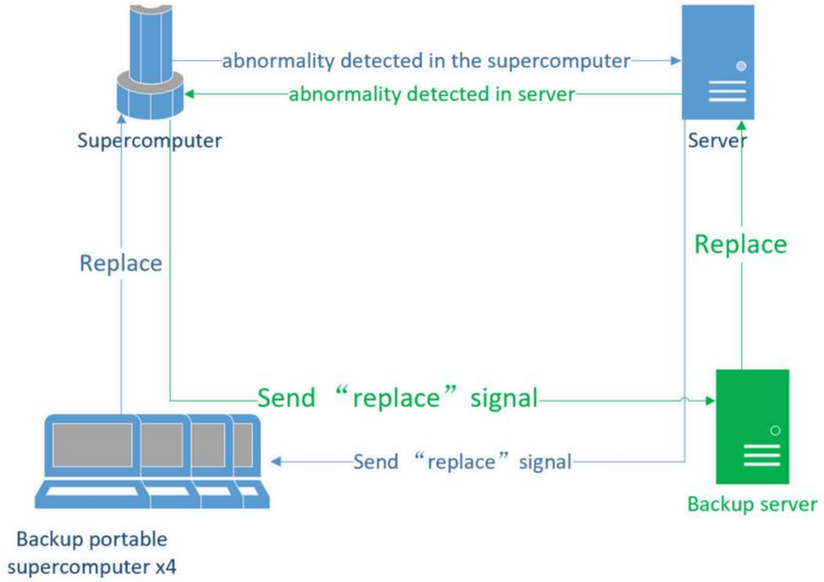


Figure 5.2.1
Flowchart of the working mechanism of safety monitoring system [Zechen Duan, visio]

- Capturing safety risks, monitor robots and cameras send signals to the central AI, where it assesses the information.
- After eliminating false reports, the AI will send information to the robot server, assigning work to security robots.

5.2.2 Flowchart of the working mechanism of backup and contingency system [Zechen Duan, visio]



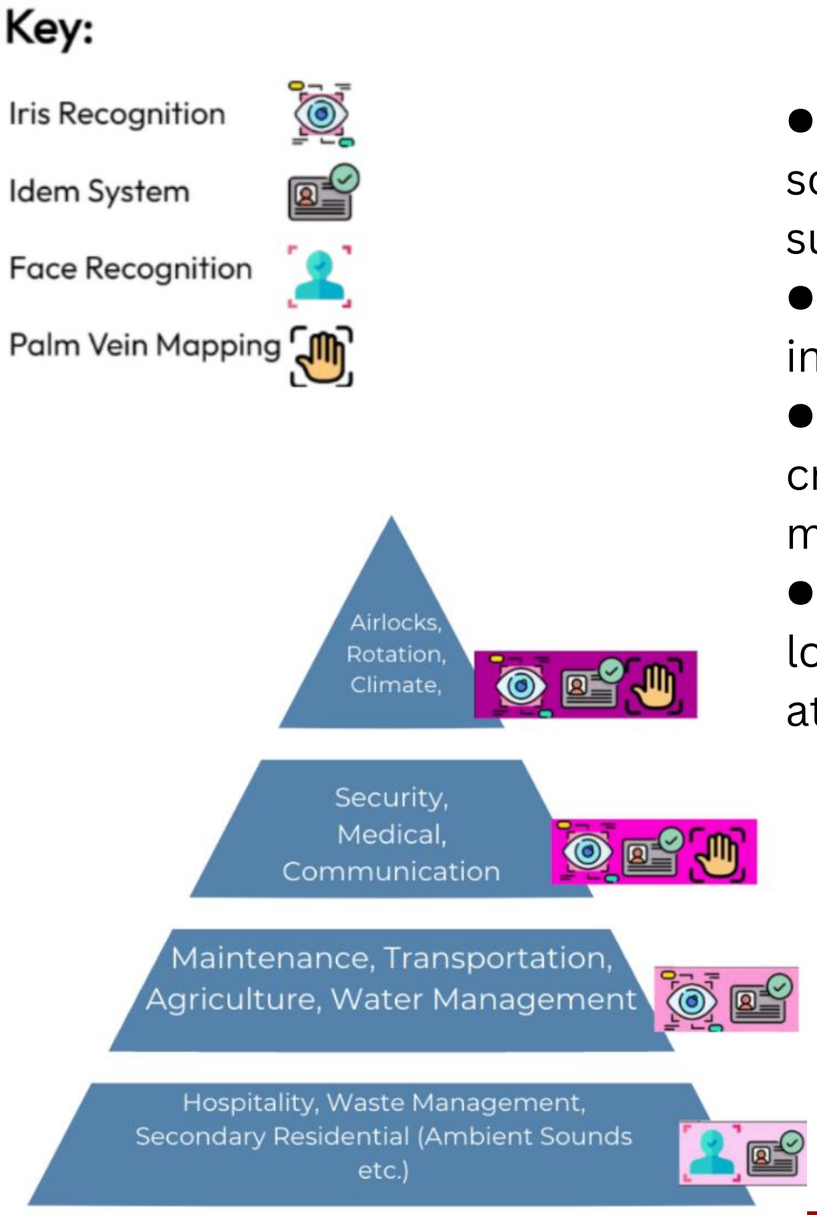
- Firewalls restrict access, while automated systems monitor threats under human supervision. AES encryption secures data, and industry standards govern transfers.
- Idem ID cards grant role-based access via microchip scans. Checkpoints and surveillance deter malicious activity.

Contingency Plans

Table 5.1: Contingeny Plans (By Abhay Bailei)

Contingency	Detection	Safety Measures	Contingency Plan
Fires	Smoke and Temperature	1. Residents are evacuated. 2. Fire extinguishing mechanisms are used. 3. Airlocks are used to cut off oxygen supply.	1. Robots extinguish fire. 2. Repair bot commences repairs. 3. The damaged volume is open for use again
Depressurization	Drop in O2 levels, Pressure	1. Repair bots deployed for repairs. 2. Beacons and evacuation pods are deployed in the event of complete failure.	1. Airlocks are closed and evacuation to safe rooms is done. 2. Repair bots seal the compromised areas.
Human Intruder	Surveillance Systems	1. Biometric systems in place all over the settlement. 2.Surveillance Bot looks for suspicious activity through human monitoring.	1. Surveillance bots all over the settlement activate high alert mode 2. Security Personnel close entry and exit points.
Electric Failure	Sudden Power Surge or Decline	Emergency Power sources running on different circuits are used.	1. Grid systems allow for easy identification of damaged location for the repair of which a repair bot is sent.
Cybersecurity Breach	Anomaly detection	Whitehat hackers are always on the lookout for any possible security weaknesses	1. All servers with sensitive user and company data are switched off for a while.
Control Centre Failure	Electric Failure or Manual Override	1. Isolated Power Generation and Access Levels. 2. Rerouting supplies.	Command transferred to other operational regions until fixed.
Robotic Malfunction	Unusual behaviour detected by bot controllers.	Routine automated software and hardware checks are conducted under human supervision.	1. Software override is present (Accessible to bot controllers). 2. In case of software failure, a physical override switch is present as well.

Security Protocol



- Firewalls will be used to restrict access of data, automation systems and softwares will constantly be checking for suspicious activity under human supervision.
- Data will be encrypted using Advanced Encryption Standard (AES), and the industry standard protocols at the time will be used for data transfer.
- Idem is an identification system for authorization, ID Cards are provided to all crew members with different permissions based on role. These cards contain microchips that can be scanned to reveal information
- 'Checkpoints' and surveillance equipment are strategically located to clamp down on any possible malicious attempts.

Fig 5.2.3
[By Daniyal Ali on PowerPoint]

Livability Robots

1.Education Bot (200 units):

- **BrainWave AI** to deliver lessons.; Immersive experiences for efficient learning.

2. Health Bot (75 units):

- **AI diagnostics** monitor health and delivers personalized care.; Provides **medications**, **examinations**, and emergency response.

3. Emergency Evacuation & Safety Bot (16 units):

- **multi-jointed arms** and **ion propulsion** help Navigates hazards; first aid and **coordinates evacuations** during emergencies.

4. Surveillance Robot (50 units):

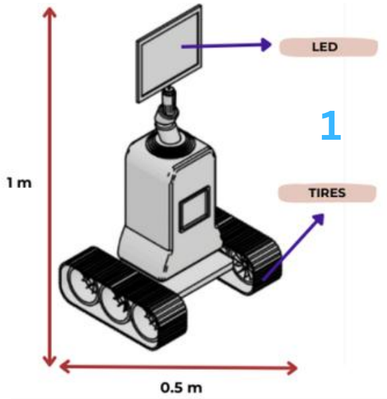
- Monitors areas and quickly reports issues;Ensures smooth and safe operations with agile detection capabilities.

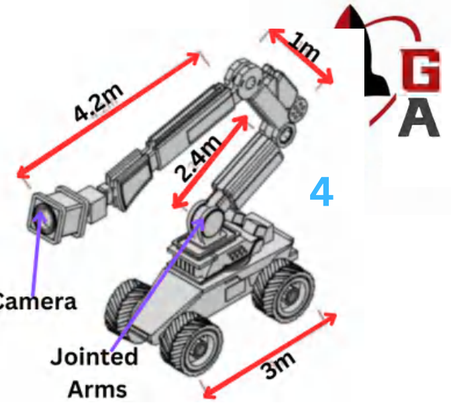
5. Maintenance Bot (Fixed-base, 35 units):

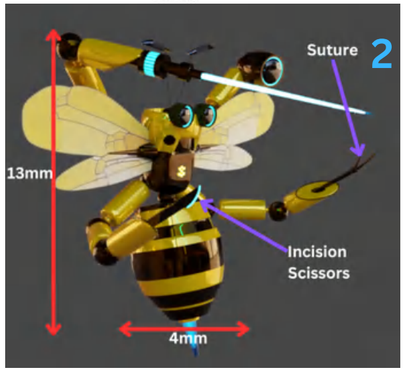
- real-time updates and detailed repairs with mechanical claws.;Streamlines maintenance tasks

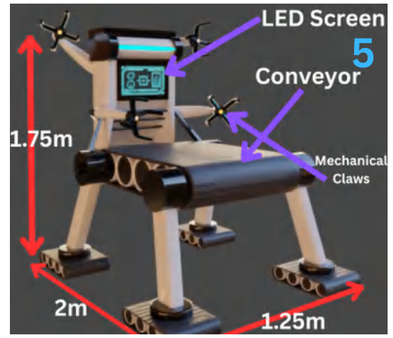
6. Companion Octopus Bots (400 units):

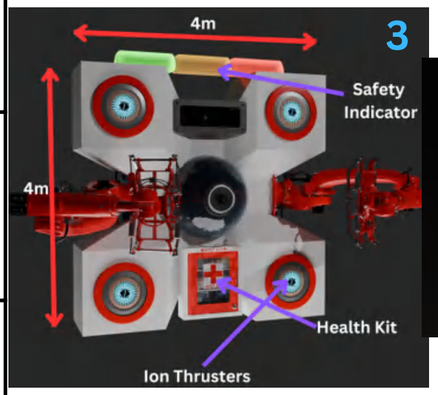
- touch-sensitive design, pixel-art LED face, and emotionally responsive functions.;Handles practical tasks with sensor-equipped tentacles.

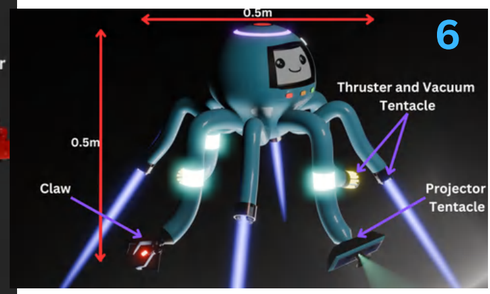












Livibility Robots

Agriculture Bot for Cultured Meat Production: (20 units)

- Equipped with **high-thrust propellers** and **multi-functional arms**, this bot ensures precise navigation, **scaffold handling**, and environmental monitoring. Sealed waste containers maintain sterility, while **electrical pulses** simulate physiological conditions for **stem cell differentiation** and 3D tissue growth.
- Operating **autonomously in bioreactors** and greenhouses, it optimizes cultured meat production through advanced automation and environmental control.

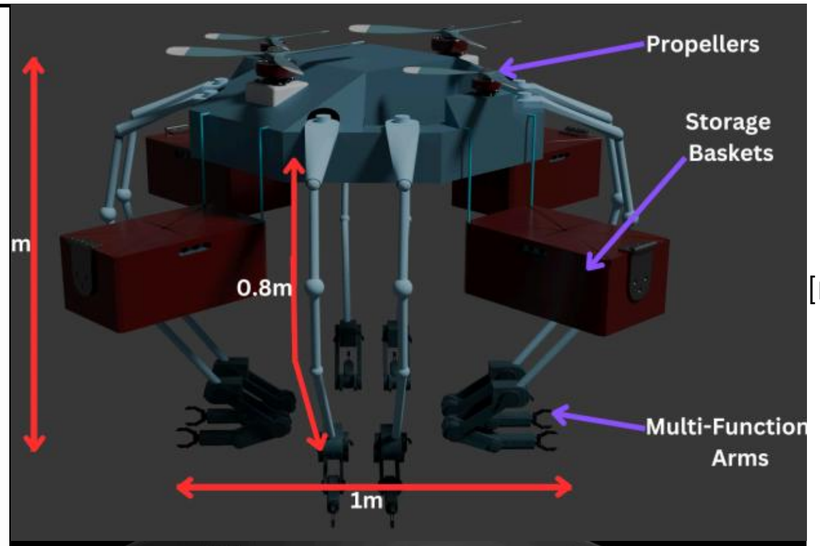


Fig 5.3.5 [By Daniyal Ali on Blender]

EyeLens: (4500 units)

- **Augmented reality lens** providing real-time notifications, navigation, and **health metrics.**
- Lightweight, **sleek design** with seamless smart device integration.

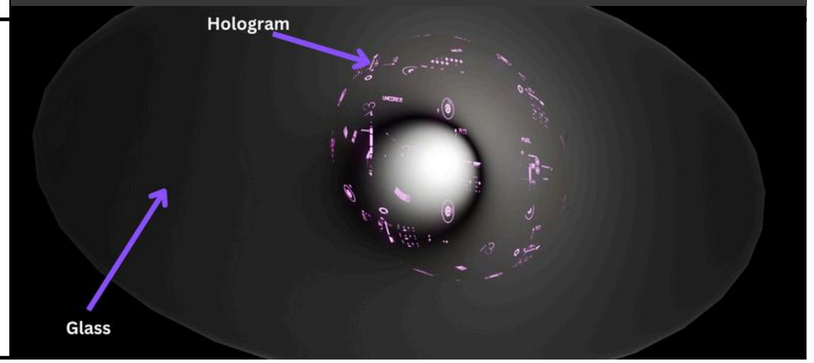


Fig 5.3.6 [By Daniyal Ali on Blender]

Overall Operation System: Maintenance, Repair, Failure Solution

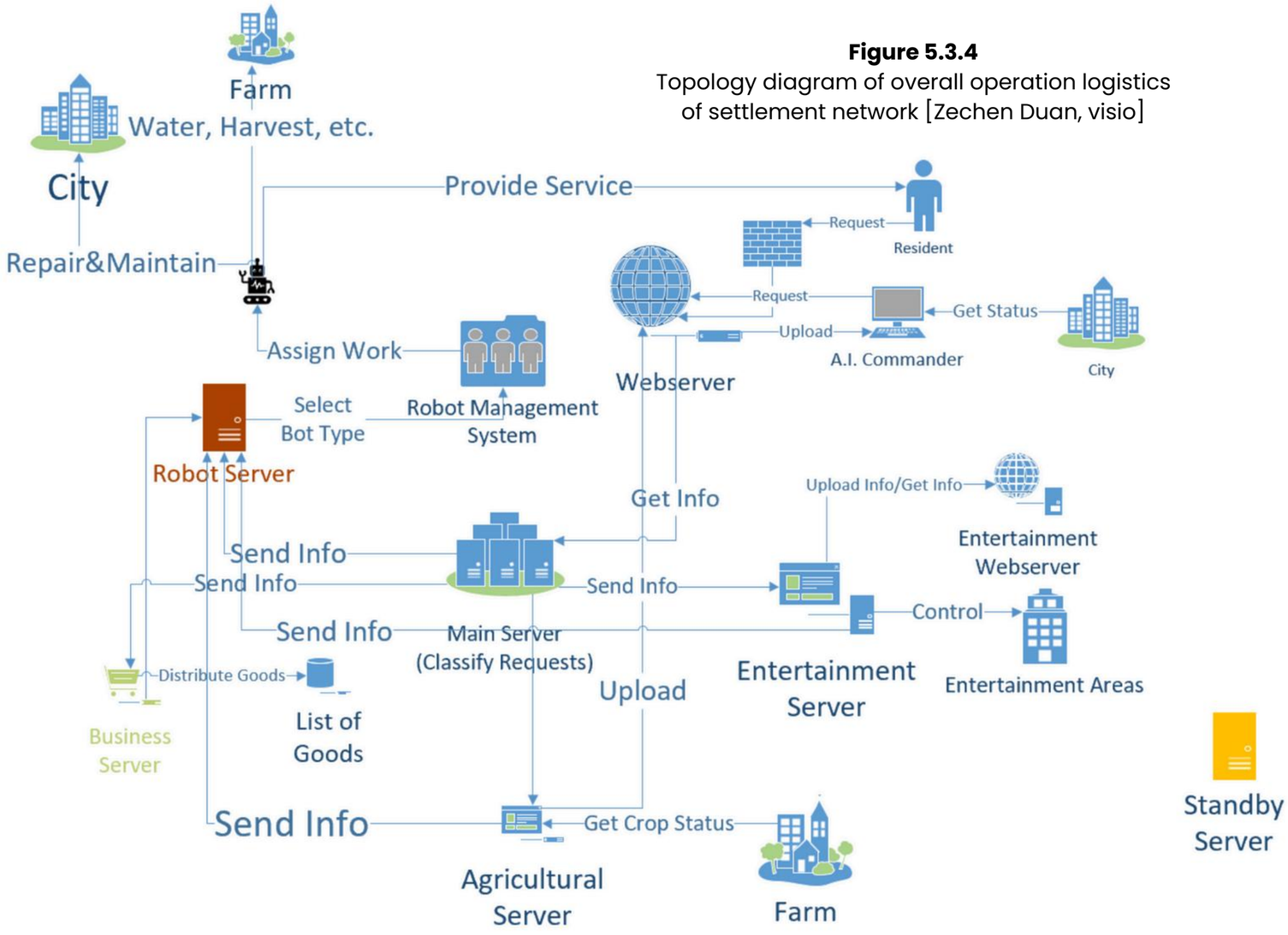


Figure 5.3.4
Topology diagram of overall operation logistics of settlement network [Zechen Duan, visio]

- The central (main) server classifies requests from different servers of different areas (industry, agriculture, entertainment, etc.) and residents, it then allows residents to access different online resources.
- The central server also assigns works based on requests to different types of robot.
- There is also a standby server that takes over the job of the main server if any error occurs.

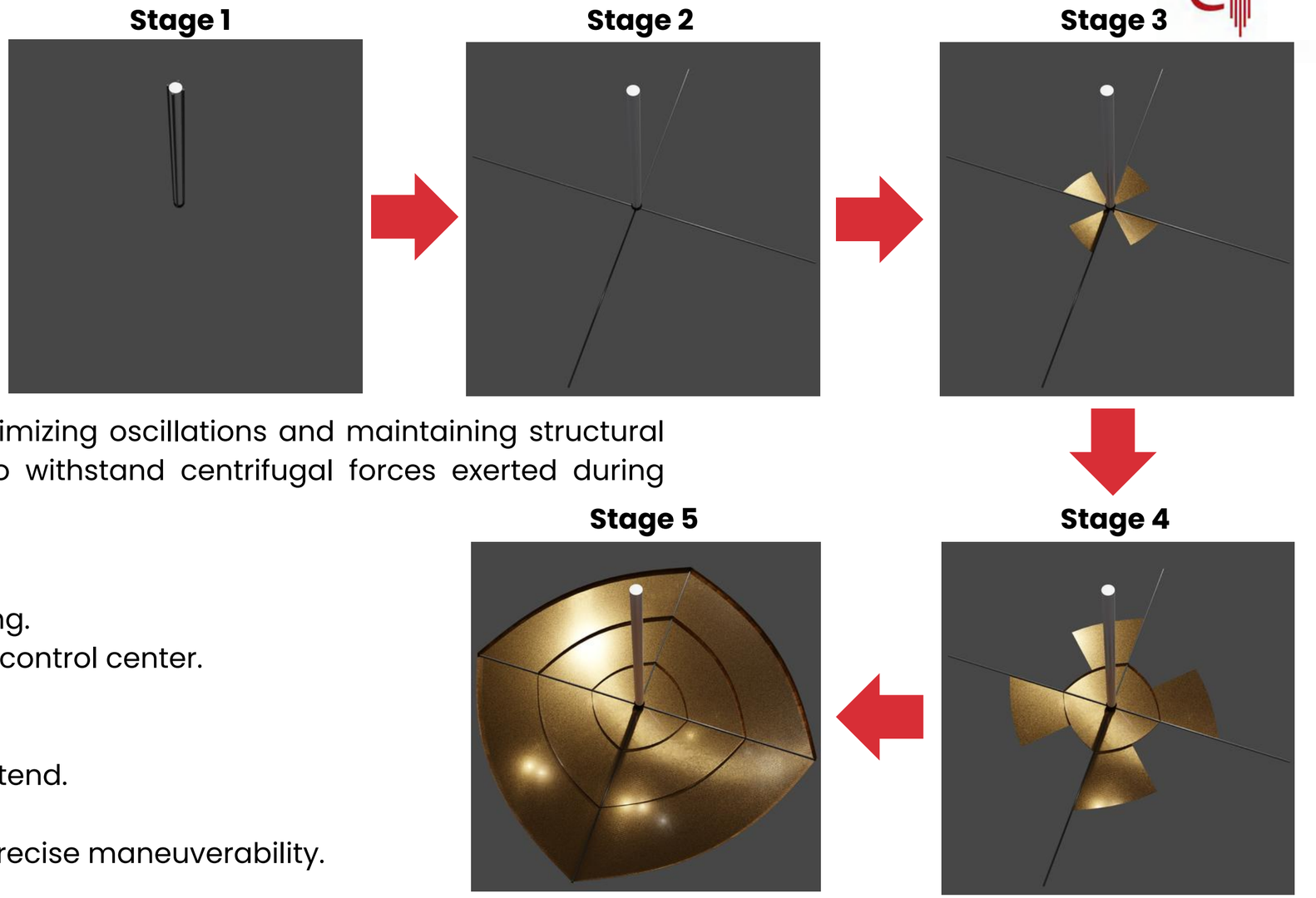
Access to Community Computing & Robot Resources

- **Phase Change Memory (PCM)** is used for storing high-priority data due to its high speed, durability, and non-volatility. Data retrieval involves applying voltage to PCM cells to measure resistance, identifying binary values based on whether the material is in an **amorphous** (0) or **crystalline** (1) state. This ensures efficient and reliable access to critical data.
- For low-priority data, **NAND Flash Memory** is chosen for its cost-effectiveness and high density. When a user requests data, the system locates it within NAND storage, and a controller facilitates retrieval and communication with the user's device.
- Robot resources are accessible through **AR/VR interfaces** or dedicated apps, enabling seamless interaction with automated systems. Security is maintained through **multi-factor authentication**, **AI monitoring**, and **firewalls**, ensuring robust protection against unauthorized access and cyber threats.

Solar Sail

Deployment and Stowage Process:
The solar sail unfolds in a controlled five-stage sequence:

- **Stage 1:** Rods folded, sail fully stowed.
- **Stage 2:** All 12 sub-sections closed, rods extended.
- **Stage 3:** Inner circle half open.
- **Stage 4:** Inner fully open, middle half open.
- **Stage 5:** Solar sail fully deployed.



Guide wires ensure stable, controlled extension, minimizing oscillations and maintaining structural integrity. The graphene sail material is designed to withstand centrifugal forces exerted during deployment.

Sail Trimming and Velocity Control:

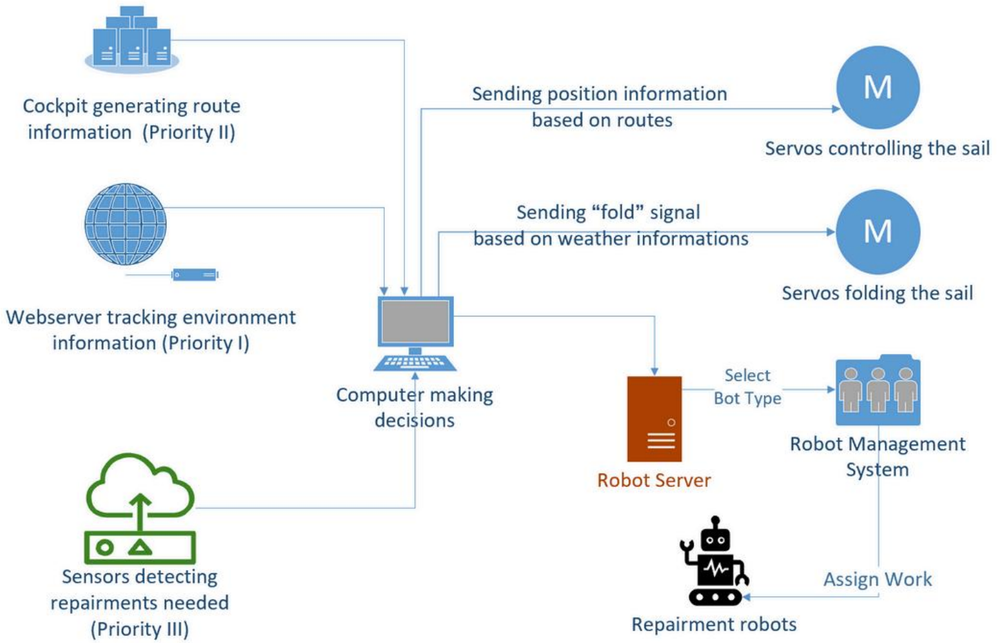
- **12 modular sub-sections** allow for precise trimming.
- **Gyroscopic and motion sensors** relay data to the control center.
- Three-tiered velocity control:
  - **Low Velocity:** Inner circle extends.
  - **Moderate Velocity:** Inner and middle circles extend.
  - **Maximum Velocity:** All three circles fully open.

This system enables efficient thrust adjustments for precise maneuverability.

Fig 5.4.1-5.4.5
[By Abdullah Khan on Blender]

Solar Sail

- **Motorized Deployment Mechanism:** Motors in the central cylinder drive gears that sequentially deploy the three tiers smoothly. Guide wires ensure consistent speed, reduce mechanical stress, and keep the sail on track.
- **Modular Repair Design:** Only damaged sub-sections of the sail are replaced, preventing full system failure and making repairs more cost- and time-efficient.
- **External Maintenance Bot:** A specialized bot autonomously inspects and repairs damaged graphene sail sections, ensuring seamless functionality.



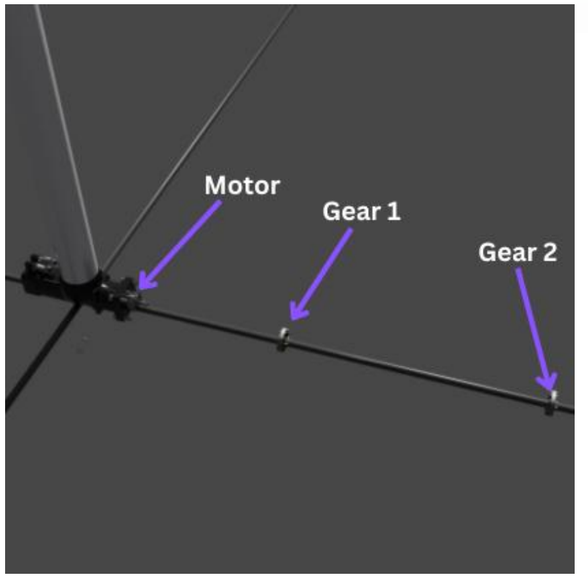
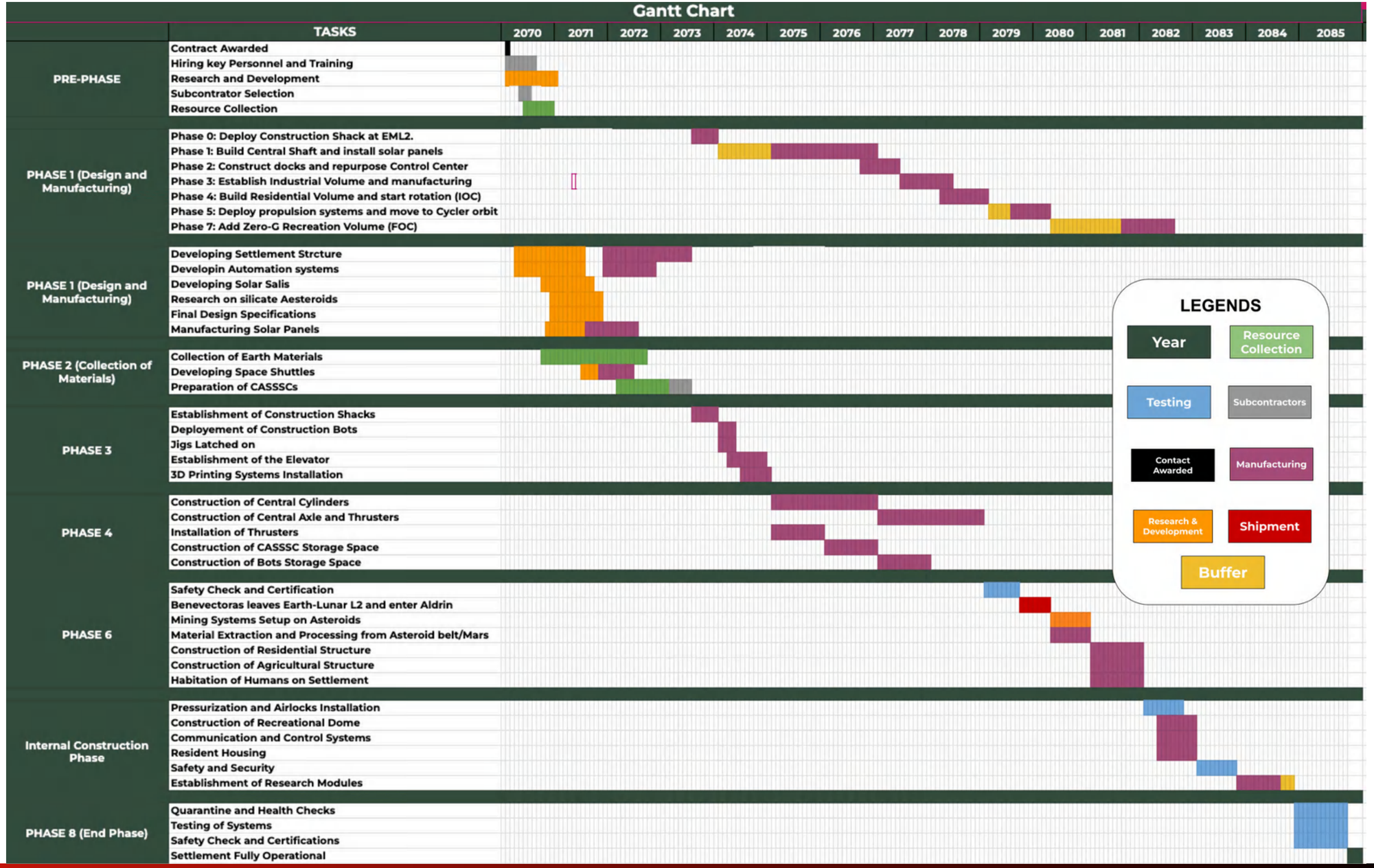


Fig 5.4.6
[By Abdullah Khan on Blender]

5.4.3 Solar Sail Operation System

- Designed an operational logic to protect the solar sail from damage.
- Ensures the sail's angle adjusts based on the spacecraft's relative position to the Sun for maximum propulsion efficiency.
- Includes a system to detect damage and deploy repair robots promptly.

Schedule


Gantt Chart
TASKS
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
PRE-PHASE
Contract Awarded
Hiring key Personnel and Training
Research and Development
Subcontrator Selection
Resource Collection
PHASE 1 (Design and Manufacturing)
Phase 0: Deploy Construction Shack at EML2.
Phase 1: Build Central Shaft and install solar panels
Phase 2: Construct docks and repurpose Control Center
Phase 3: Establish Industrial Volume and manufacturing
Phase 4: Build Residential Volume and start rotation (IOC)
Phase 5: Deploy propulsion systems and move to Cycler orbit
Phase 7: Add Zero-G Recreation Volume (FOC)
PHASE 1 (Design and Manufacturing)
Developing Settlement Strcture
Developin Automation systems
Developing Solar Salis
Research on silicate Aesteroids
Final Design Specifications
Manufacturing Solar Panels
PHASE 2 (Collection of Materials)
Collection of Earth Materials
Developing Space Shuttles
Preparation of CASSSCs
PHASE 3
Establishment of Construction Shacks
Deployement of Construction Bots
Jigs Latched on
Establishment of the Elevator
3D Printing Systems Installation
PHASE 4
Construction of Central Cylinders
Construction of Central Axle and Thrusters
Installation of Thrusters
Construction of CASSSC Storage Space
Construction of Bots Storage Space
PHASE 6
Safety Check and Certification
Benevectoras leaves Earth-Lunar L2 and enter Aldrin
Mining Systems Setup on Asteroids
Material Extraction and Processing from Asteroid belt/Mars
Construction of Residential Structure
Construction of Agricultural Structure
Habitation of Humans on Settlement
Internal Construction Phase
Pressurization and Airlocks Installation
Construction of Recreational Dome
Communication and Control Systems
Resident Housing
Safety and Security
Establishment of Research Modules
PHASE 8 (End Phase)
Quarantine and Health Checks
Testing of Systems
Safety Check and Certifications
Settlement Fully Operational
LEGENDS
Year
Resource Collection
Testing
Subcontractors
Contact Awarded
Manufacturing
Research & Development
Shipment
Buffer

Sub Contractor & Operational Cost

Sub contractors

Subcontractors	RFP point Contracted at
Buckystructure	4.3
Extreme Survival Technologies, Losless Aircosts	4.2
3D Logistics, Bottom Cleaners, Clean Up Your Act , Electroprotect, Light Works, Nano Solutions, Orbit Link, Stuff of Life, Toss it to Me, Waste Products, Zap! Inudtsries	3.2
Drone & Delivery	5.1, 3.2
Bots4U, Brainwave AI	5.3
Blown Away	MRO
Buckybreakthroughs, Hard rolls, Tubular Tech	3.1
Custom Cargo	3.1, 3.2
Guard Gizmo	3.2,5.3

Cost for personnel, Interior construction and Operational system

Type	Unit ($/ Square	Area (m^2)	Cost ($)
Residential Area	10500	269403	2828731500
Commercial Area	6300	27038	170339400
Fitness and Leisure area	7500	25282	189615000
Hospital	9000	15282	137538000
Machinery and support area	8000	3592	28736000
Server Room	19500	2000	39000000
Control Center	18000	800	14400000
Green Space and Public Transportation La	600	8100	4860000
Agricultural Area	600	128571	77142600
Libraries	2500	1600	4000000
Office Area	1500	30826	46239000
Industrial Area	2000	96106	192212000
Material Storage Area	1000	48010	48010000
Experimental Area	6500	13392	87048000
Port Area	3000	40178	120534000

Human resources allocation			
Type	Number	salary per person ($)	cost per year ($)
Space Station Commander	5	500,000	2500000
Mission Control Officer	15	300,000	4500000
Aerospace Engineer	150	350,000	52500000
Life Support Systems Engineer	105	240,000	25200000
Scientist	130	280,000	36400000
Communications Specialist	80	230,000	18400000
Psychologist	70	200,000	14000000
Cybersecurity Specialist	120	310,000	37200000
Orbital Mechanics Expert	100	290,000	29000000
Recycling & Waste Management Expert	125	150,000	18750000
Power & Energy Engineer	100	290,000	29000000
	1000	3,140,000	267450000
		Total	267450000

Table 6.1: Costing (By Harshprit)

Robot & System Cost

Cost for robots and materials

Cost of Robots			
Type of Robots	Unit Price	Quantity	Total Price
Health Bot	300000	75	22500000
Construction Bot	5000000	80	400000000
Agriculture Bot	300000	20	6000000
Companion Octopus	100000	400	40000000
Internal & External Construction Jig	150000	120	18000000
Surveillance Bot	100000	120	12000000
Construction Drones	500000	150	75000000
Evacuation Bot	25000	200	5000000
Delivery Robot	50000	300	15000000
Fire Bot	50000	50	2500000
Jig Bot	350000	120	42000000
Servers	1000000	7	7000000
Computers (Type A)	5000	100	500000
Computers (Type B)	1000	2000	2000000
Firewall	500000	1	500000
Total	/	/	648000000

Cost for operational systems

Cost for operational system	
Type	Cost($)
Atmosphere	1822493573
Weather Management	546748071.8
Waste Management	6900000
Water Resource Management	5000000
Power Ceneration and Storage	2000000000
Food Production	2800000000
Total	7181141644

Initial CASSSC Loads (For first 6 months)	
Materials	Nos. Of CASSSC's
Air	16754
Water	187
Food	119
Non-edible Consumables	7
Furniture and Non-Consumable Office Supplies	23

Cost of Materials							
Types	Surface Area (Square Meter)	Thickness (Meter)	Volume (Cubic Meter)	Density (Kilogram/Cubic Meter)	Mass (Kilogram)	Cost/Mass ($/Kilogram)	Cost ($)
Basalt Fiber	380332	0.03	11409.96	2600	29665896	3	88997688
Tunpsten-Tantalum-Titanium-Zirconium (W-Ta-Ti-ZrHEA)	380332	0.0625	23770.75	1000	23770750	250	5942687500
Graphene-Boron Doped Hydrogen Aerogel	380332	0.015	5704.98	20	114099.6	500	57049800
Silicon Bucky Structure	380332	0.05	19016.6	1350	25672410	500	12836205000
Gallium-Indium-Tin (EGaInSn)+Hydrogenated Ionic Liquid	380332	0.01	3803.32	3200	12170624	450	5476780800
Carbon Nanotubes	380332	0.025	9508.3	1300	12360790	550	6798434500
Water	380332	0.002	760.664	1000	760664	0.5	380332
Electro DynamicShield	20017	0.002	40.034	300	12010.2	300	3603060
Magnesium Aluminate Spinel(MgAL2O4)	20017	0.0625	1251.0625	3580	4478803.75	100	447880375
Boron-Doped Aluminum Oxynitride(AlON)	20017	0.015	300.255	500	150127.5	1000	150127500
Graphene-Reinforced Silica Aerogel	20017	0.035	700.595	100	70059.5	500	35029750
Electrochromic Glass	20017	0.045	900.765	2500	2251912.5	250	562978125
						TOTAL	32400154430

Table 6.2: Robot and System Cost[By Grady in excel]

Total Cost:
$46,788,151,747

Passenger and Cargo Terminals

The figure below shows the layout of the spaceport, an intergalactic airport, serving as a hub for passengers and both the arrival and departure of ships in Benevectoras.

Facility	Description
Pressure stabilizer	compressors will be used to recreate pressure after docking latches close
Cleansing	A chamber wherein plasma-based sanitizer sprays will and be used to cleanse passengers & equipment
Zero-G Transition Modules	Safe and convenient transfer through docking adapter
Standard waiting area & Storage management area	In-port park for recreation. Perchlorate ATMs and usher bots for guidance. Cargo handling & loading/unloading areas.

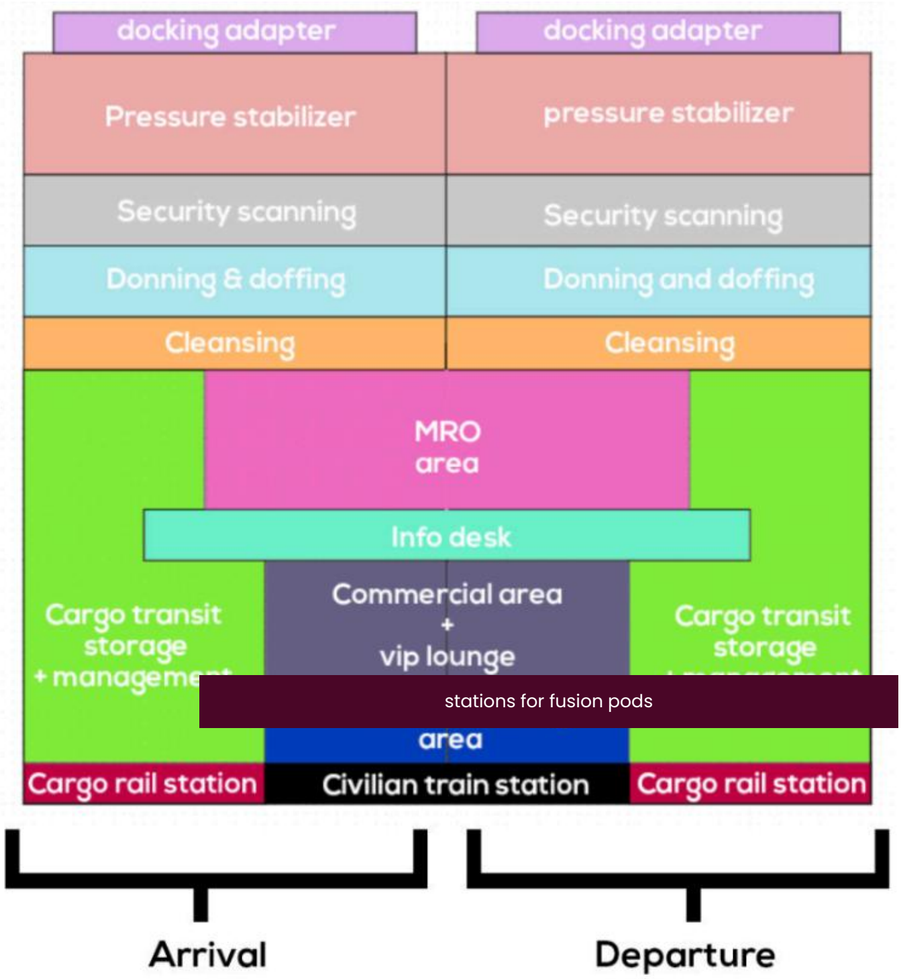


Figure 7.1: *down surfaces of passenger and cargo terminal* [By Adil Azfar]

Research and Development

Martian Manufacturing

The lab would consist of the following features:

1. **Advanced Materials Division**
2. **3D Printing & Manufacturing Lab**
3. **Integrated AI & Automation systems powering the research on the materials in the lab**

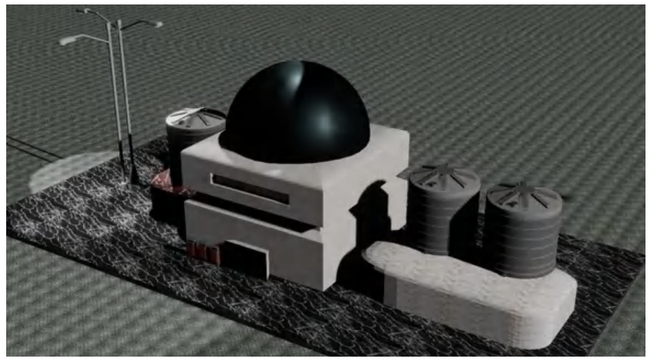


***Figure** 7-1-2 research facility*
[Abdullah khan]

Feature	**Rotating (Artificial Gravity) Environment**	**Non-Rotating (Microgravity) Environment**
Product Types	Large structures, refining mineral ores	High-purity crystals, lightweight composite materials
Reconfiguration Mechanism	Modular workstations that can switch processes based on demand	Adaptable lab environments powered by portable and adaptable construction bots (refer to 5.1)
Benefits	Supports Earth-like manufacturing for scalable production, **MODULAR CONVEYOR BELT WORKSTATIONS ARE RECONFIGURABLE AND PORTABLE**	

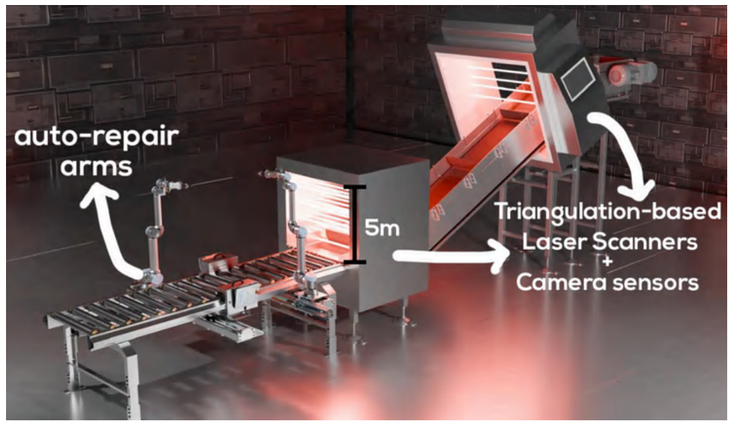


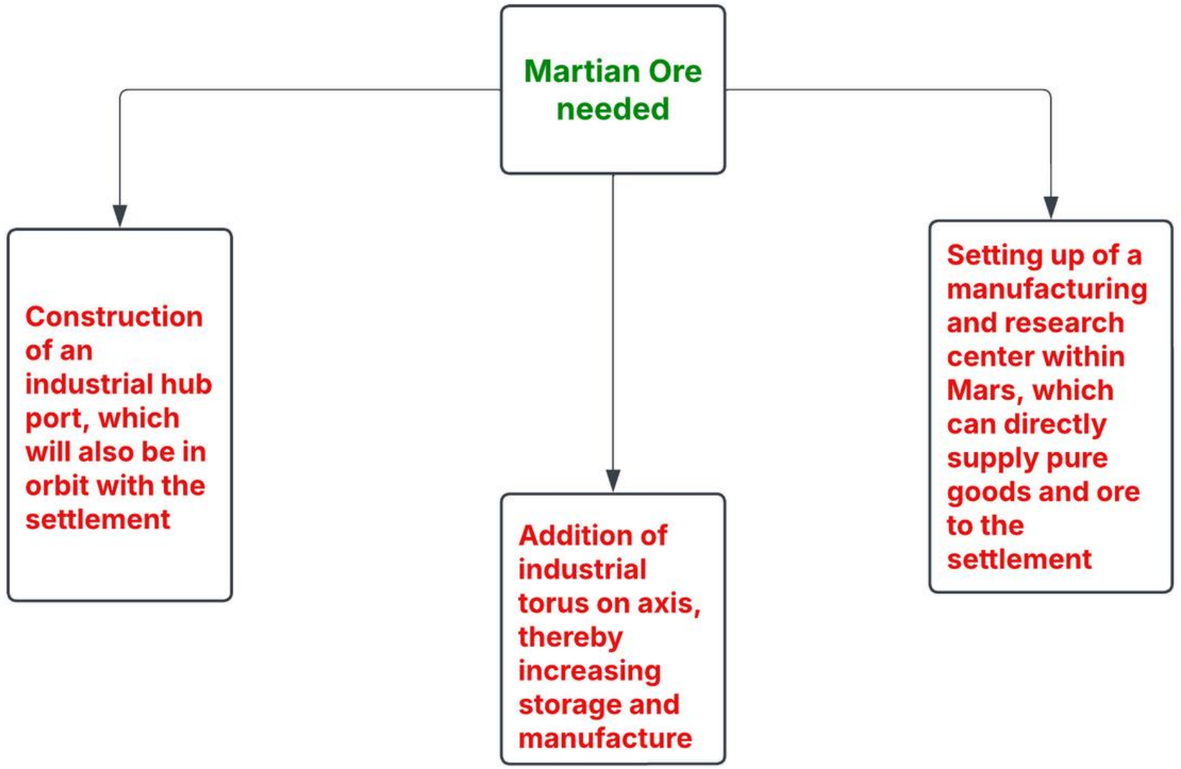
***Figure 7.2**: modular workstation conveyor belt*
[By Daniyal Ali]

Future Transportation of Passengers

- **Fusion Propulsion System** is utilized for high-speed transport of passengers and cargo
- **Smart Navigation & Safety Systems** – Equipped with autonomous piloting, obstacle detection, and emergency override features for safe and reliable operation.

Figure *7-1-4 Fusion pod ship*
[Daniyal Ali]

Manufacturing of Export Products



THANK YOU!

GRUMBO AEROSPACE

In loving memory of the SSTS-107 Crew