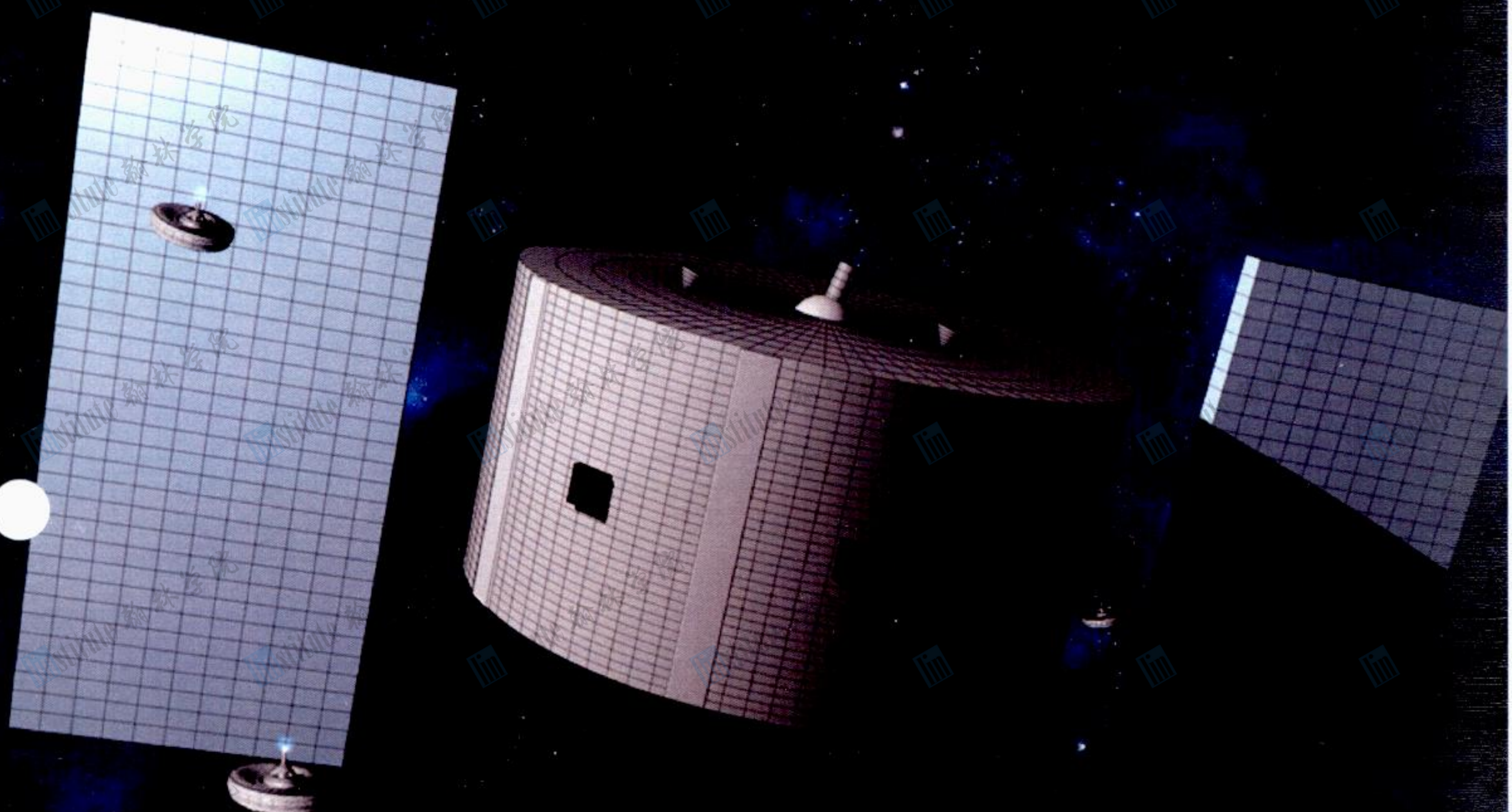
Bellevistat



PACE INNOVATIONS
Brother André Catholic High School
Markham, ON
Canada

bellevistat

Northdonning
Heedwell

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Section 1 | Basic Requirements

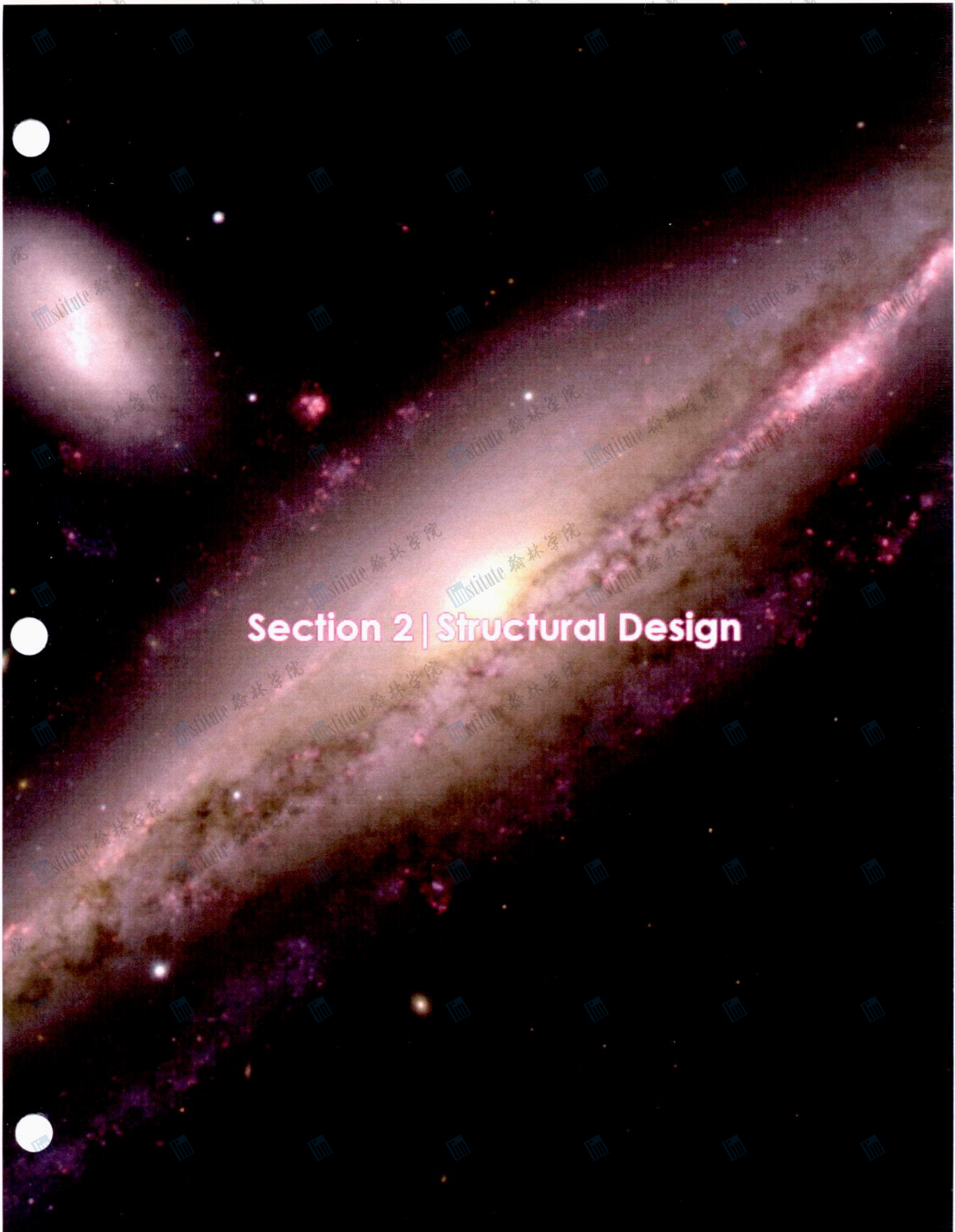
1.0 | Executive Summary

Housing 19,000 colonists in the desolate vacuum of space is a massive undertaking. It's dangerous. It's risky. So you need the best. You need Northdonning Heedwell.

Staying ahead of the curve, Northdonning Heedwell, straying from the inefficient torus structure, has pioneered a cylindrical design, allowing residents a comfortable and secure life style, as well as ensuring an economically viable settlement. With this innovative approach, Northdonning Heedwell is proud to be able to offer luxuries such as a sixty acre mountain biking area, sprawling pedestrian-oriented communities, spacious living space layouts, numerous non-centralized recreation opportunities, all while in orbit. Our proposed design will make use of a cylinder's characteristics to maximize available space, minimize material costs, provide more efficient transportation routes, and thus increase Bellevistat's overall potential.

In an effort to provide the absolute best quality of life possible for Bellevistat's residents, with an emphasis on safety and comfort, Northdonning Heedwell has blazed the trail in building automation. Utilizing the latest in robotics and nanotechnology, we have designed systems that free inhabitants from the routine of everyday life. Robots handle all the cleaning. Nanobot gum ensures hassle-free oral hygiene. Robots deliver the food that you order via digital interface with the station's main computer. Androids cook your meals and clean the dishes, the kitchen, and your entire house. In essence, we have created a station that takes care of itself, allowing residents to spend time living their lives, without being at the mercy of foreign and delicate technology. Our progressive approach to building automation has created a station that will care for itself. Nanobots will routinely monitor structural integrity, and facilitate any necessary repairs. Robots will attend to any emergencies, preserving life and property until help can arrive. Northdonning Heedwell has envisioned a utopia that will ensure a hassle and worry-free investment.

You need excellence. You need Northdonning Heedwell.



Section 2 | Structural Design

2.1 | Exterior Design

The proposed station design is a solid rotating cylinder, which will provide residents with sufficient living and agricultural space, as well as a multitude of low- to zero-g areas for education, entertainment, and manufacturing.

2.1.1 | Vital Features and Dimensions

In order to simulate earth's gravitational force, we propose to provide residents with pseudo gravity at magnitudes of $9.41 m/s^2$ to $9.80 m/s^2$ (0.96g – 1g) in the most frequented areas. If the cylindrical settlement has a relatively small radius, it must have a high rotational speed in order to create such magnitudes of centrifugal force. However, colonists would not be able to adapt to the extreme Coriolis effects associated with high rotational speeds, resulting in locomotion problems, nausea and possibly mental sickness. NASA studies have found that humans can eventually adapt to rotational frequencies below 3 rotations per minute. However, to allow for a more comfortable transition, we propose to use small thrusters mounted on the curved face of the station to maintain a frequency of one rotation per minute. These parameters, along with surface area requirements, produce the following station dimensions:

- Radius (main structure, without ports): 894m
- Exterior Length (without projections): 930m
- Interior Length: 900m
- External Circumference: 5621.21m
- External Surface Area: $5029089 m^2$
- Total Volume: $2263038375 m^3$

2.1.2 | Main Exterior Design Features

- The station has 6 ports that project out along the circumference of the cylinder, midway between the top and the bottom.
- Two solar panels, measuring 2000m by 3500m, are mounted on solar satellites that orbit on opposite sides of the station (Fig. 2.1.1).
- The Laser Energy Module is at the centre of the bottom flat face. It receives the energy (via a laser) from the Solar Satellites.
- Two communication satellite dishes sit on each of the two flat faces of the cylinder.
- The Telescope, with a 20m aperture, sits on a central, independently-rotating platform on the top flat face of the station.

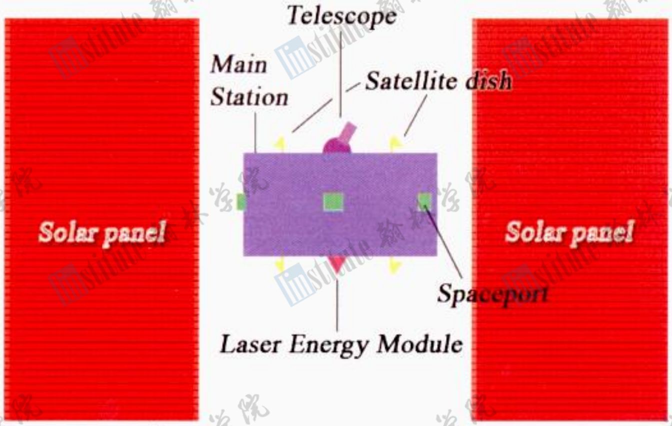


Figure 2.1.1 | Exterior Design

Table 2.1.1 | Exterior Volumes and Features

Volume/Feature	Dimensions: Length x Width x Height (m)	Rotating or Non-rotating	Magnitude of Pseudo Gravity	Pressurized or Un-pressurized
Main Station Volume (houses all residential, recreational, educational, commercial and industrial areas)	Radius: 894, Height: 930.	Rotating (1rpm)	Ranges from $9.745 m/s^2$ (0.9937g) to $0 m/s^2$ (0g).	All residential and most recreational areas are pressurized. The other recreational and all educational, commercial and industrial areas are in air locked chambers that can be pressurized to the desired level.

6 Ports (2 Docking Bays in each)	100 x 188 x 60.	Attached to exterior of main station; rotates along with it.	10.45m/s^2 (1.065g): Greater friction keeps vehicles stationary in bays.	Generally un-pressurized, except for air-locked tubes (see Ports 2.5).
Solar Satelites (one solar array and one laser emitter is attached to each solar satellite)	3500 x 2000 x 5	Independent of station; automatically orients panels to face the sun.	n/a	Unpressurized; can be repaired by maintenance robots.
Laser Energy Module	15x15x15	Non-rotating.	n/a	Unpressurized.
Communication Satellites	15 x 15 x 20	Independently rotates to always face communication target (usually Earth).	n/a	Unpressurized; can be repaired by maintenance robots.
Observatory and Telescope	30 x 30 x 40	Non-rotating; users control where to point telescope.	Microgravity in observatory.	Pressurized for human activity in the facility.

2.1.3 | Station Shielding

Protection from radiation and debris penetration will be provided by the station's hull, since powering a large electromagnetic coil (to surround station with an electromagnetic field) would require too much money and energy. The following table depicts the shielding that we propose:

Table 2.1.2: Hull Materials

Material	Description	Purpose
RAGuard	Transparent composite of ultra-dispersed metal particle matrices dissolved in a solvent.	Primary defense against alpha, beta, gamma, neutron and ionic radiation, including much of the radiation associated with solar flares and solar winds.
Aluminum Matrix Composite Reinforced with Monocrystalline Silicon	Light composite material with high tensile strength.	Rigid shell protection against debris; main structural support for hull.
Carbon Fiber Sheet	Light, woven carbon material with high tensile strength.	Protection against debris and absorption of shock. Provides structural support between hull and the station's frame.
Hydrophobic Carbon Silica Aerogel	Insulative, low-density solid-state material. Will not be damaged by moisture.	Insulates against convection, conduction and radiation heat transfer. Also seals volumes to prevent transfer of gases, asteroidal and space dust, etc.
Biostatic Polyethylene	Light plastic that prohibits growth of bacteria/viruses.	A sterile, paintable surface for the interior walls of the space station. Secondary defense against radiation. Panels can be easily replaced.

These materials will be set up as shown in Figure 2.1.3. In the case where residents are enjoying the view of space in the glass floor observatories, they will be protected by a thick layer of tempered glass for support, aerogel for insulation, and a coating of RAGuard for radiation protection. 3cm of RAGuard will be used so that residents will be exposed to less than the Threshold Limit Value (0.05Sv per year) of radiation.

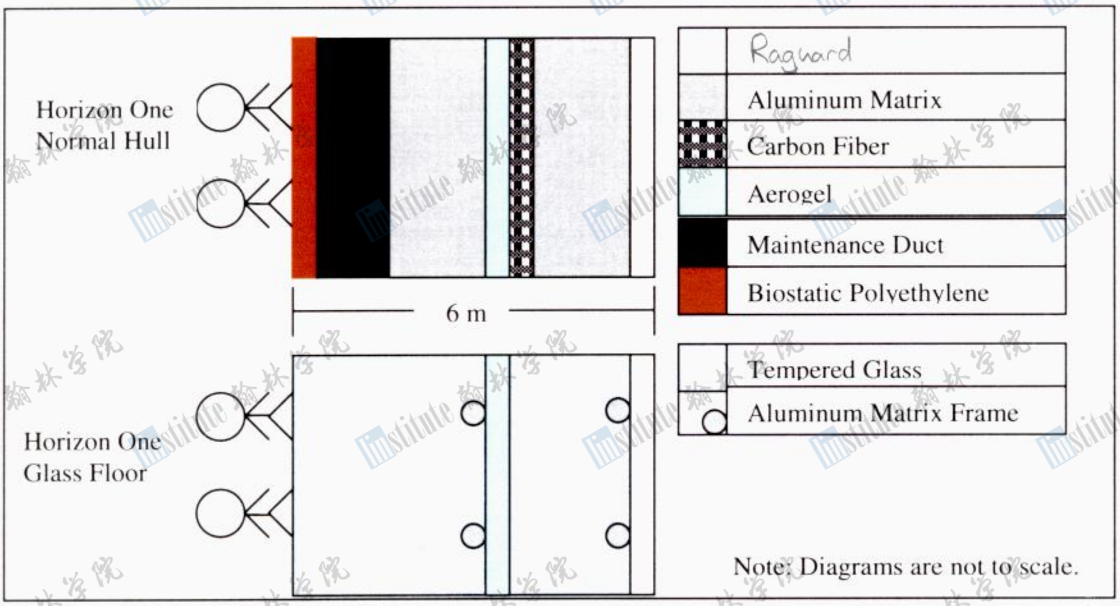


Figure 2.1.3 | Hull Layers

2.2 | Interior Design

The interior spaces of Bellevistat have been designed for comfort and efficiency. With large surface areas that experience equal magnitudes of pseudo gravity, interior arrangements are more flexible, allowing for a more comfortable, healthy and earth-like environment for the population.

2.2.1 | Interior Spaces

The station's interior structure consists of 5 "ring prisms", called Horizons, and a Core cylinder in the center. Support Towers connect all of these spaces together. Figure 2.2.1 and table 2.2.1 describe these spaces within Bellevistat.

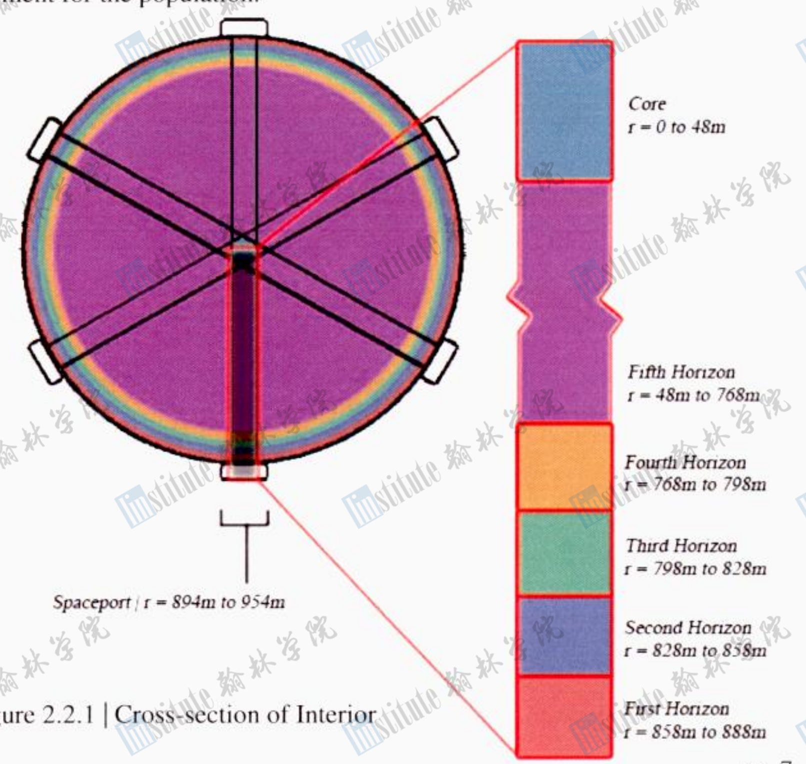


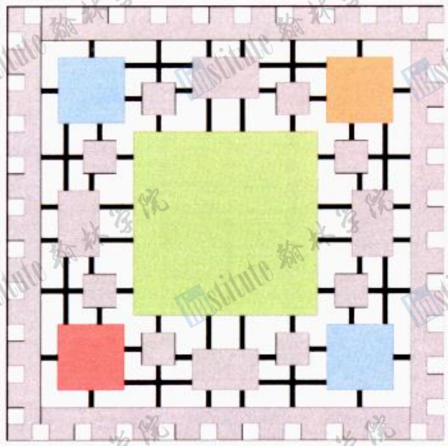
Figure 2.2.1 | Cross-section of Interior

Table 2.2.1| Interior Volumes

Volume	Interior Ground Area (m^2)	Interior Height (m)	Magnitude of Gravity	Pressurized or Un-pressurized
1st Horizon (buffer zone, goods and persons screening area, glass floor observation area, temporary storage of hazardous and asteroid materials)	5,021,522	27	$9.75 m/s^2$ (0.994g)	All pressurized except for areas within 100m of ports, which are vacuumed and have a reinforced hull.
2nd Horizon (residential and recreational area)	4,851,876	27 (homes: 3m, recreational: 6m)	$9.42 m/s^2$ (0.960g), to mimic earth's gravity)	All pressurized environment (see Atmosphere 3.2.5)
3rd Horizon (agricultural and storage area)	4,682,230	27	$9.09 m/s^2$ (0.927g)	Plant growing facility is pressurized with mainly carbon dioxide, animal raising facility is pressurized with mostly oxygen, and storage area is un-pressurized)
4th Horizon (educational and small-scale manufacturing area)	4,512,584	27	$8.76 m/s^2$ (0.893g)	Both pressurized and un-pressurized for both uses.
5th Horizon (educational, recreational, and large-scale industrial area)	12 stories within this Horizon; total ground area is 29,721980	Each story: 54	$8.43 m/s^2$ (0.860g) to $0.566 m/s^2$ (0.0578g).	Pressurized for recreational facilities. Researchers and manufacturers may pressurize/un-pressurize their facilities at any time.
Core (station mainframe server)	135,717	96	$0.533 m/s^2$ (0.0544g)	Pressurized, with air conditioning system to cool mainframe server.

2.2.2 | Internal Area Distribution

The core serves as a central mainframe for all the server and sensor systems onboard Bellevistat. Only authorized personnel under authorized conditions can enter this area (see 5.2 | Maintenance Automations and Plans).
Six Support Towers, in the form of the cylinder's radii, are situated half-way in between the two flat faces of the station. 100m by 100m by 840m each, the Towers connect the Core with the five Horizons. Not only providing structural support, they are also a means for efficient inter-Horizon transport, as well as energy, air, water and food distribution. Figure 2.2.2 further describes the functions of the Support Towers.



Colour	Name	Function	Dimensions
	Personnel elevator	MicroRail pod elevator	4 m x 4 m
	Bulk elevator	Used for bringing manufactured ships from industrial sectors to port, and also for large-scale movement of materials	44 m x 44 m
	Communications	Fibre optic lines and electrical wiring supplies computer access and power to Bellevistat. Also relays sensor signals from outside to core.	16 m x 16 m
	Water	Water storage	16 m x 16 m
	Maintenance	Contains air ducts, robot elevators	16 m x 16 m
	Support columns	Support the entire structure	Frame is 8 m thick Square columns 8 m x 8 m Rectangular 16 m x 10 m

Figure 2.2.2 | Description of Support Towers

Horizon One is the first level that all people and goods travel to after landing in the ports. Elevators for people and goods connect the ports with the buffer area in the first horizon. There, robots screen all humans and objects for dangerous substances, infectious diseases, weapons, etc. Once all imports have been documented by the port computers, "safe" people and goods are allowed to enter the settlement through the elevators in the six Support Towers (see 3.2.4 Transportation). All people and objects considered to be a threat will be placed in a quarantine location on the first horizon until Bellevistat robots or the Emergency Response Team can resolve the problem, or until a vehicle can transport them off Bellevistat to an appropriate location. Asteroid materials and other dangerous substances that are simply using Bellevistat as a temporary storage will be placed in a reinforced, air-locked facility on Horizon One so that residents will not be affected by these materials. The glass floor areas on Horizon One are open to all permanent and transient residents who wish to have an unobstructed view of space. The areas of Horizon One are allocated as shown in Figure 2.2.3.

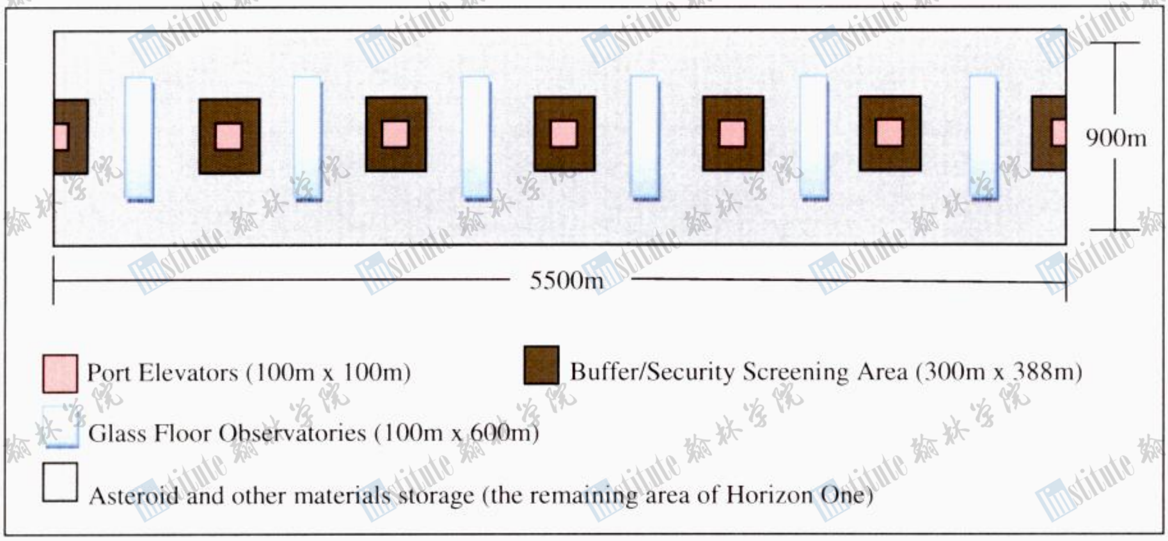


Figure 2.2.3 | Horizon One Interior

Horizon Two mainly serves as residential space. The high ceiling is fully paneled with PHOLEDs (see 3.2.8 | Day/Night Cycle). Integrated into the residential area are shops, recreation, transportation and education, as well as lots of green-space in between buildings where residents can grow their own herbs and vegetables (see 4.1 | Residential Neighbourhoods). Figure 2.2.4 shows Horizon Two area allocation.

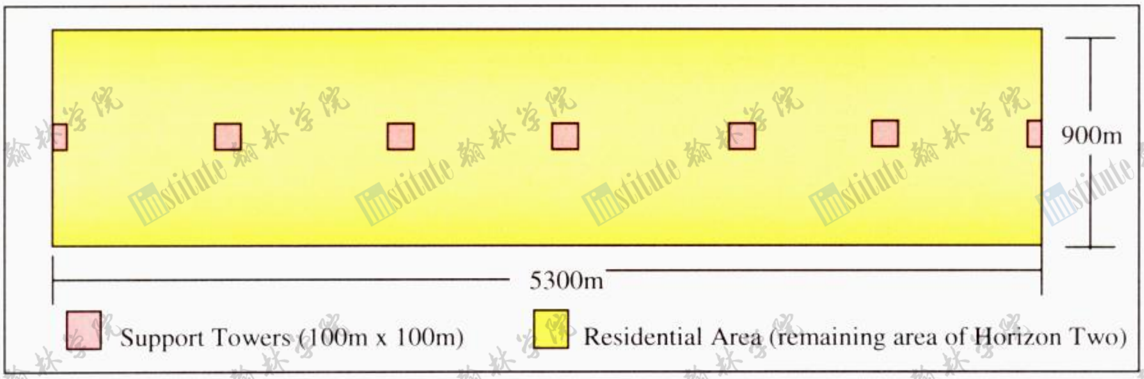


Figure 2.2.4 | Horizon Two Interior

Horizon Three is the main food production area. A total of 580,000m^2 is allocated for crops, livestock, fish, and the processing plant. Robots prepare meals in a 10,000m^2 kitchen adjacent to the processing plant. Both raw and prepared food is placed in a special 30,000m^2 biostatic storage facility (see 3.2.1 | Food Production). These areas that are related to food production are sealed off from the rest of Horizon Three, which also contains materials storage and a maintenance hangar. A total of 3,000,000m^2 on Horizon Three will be used for storage of resources, daily living supplies, resident's personal belongings, as well as chemicals and raw and manufactured products. Different materials will be securely stored in sealed compartments with appropriate environment (temperature, pressure, humidity) and protection. The maintenance hangar, with an area of 200,000m^2, serves as a control center and repair, recharge, and storage facility for all the robots onboard Bellevistat. Figure 2.2.5 depicts the area distribution in Horizon Three.

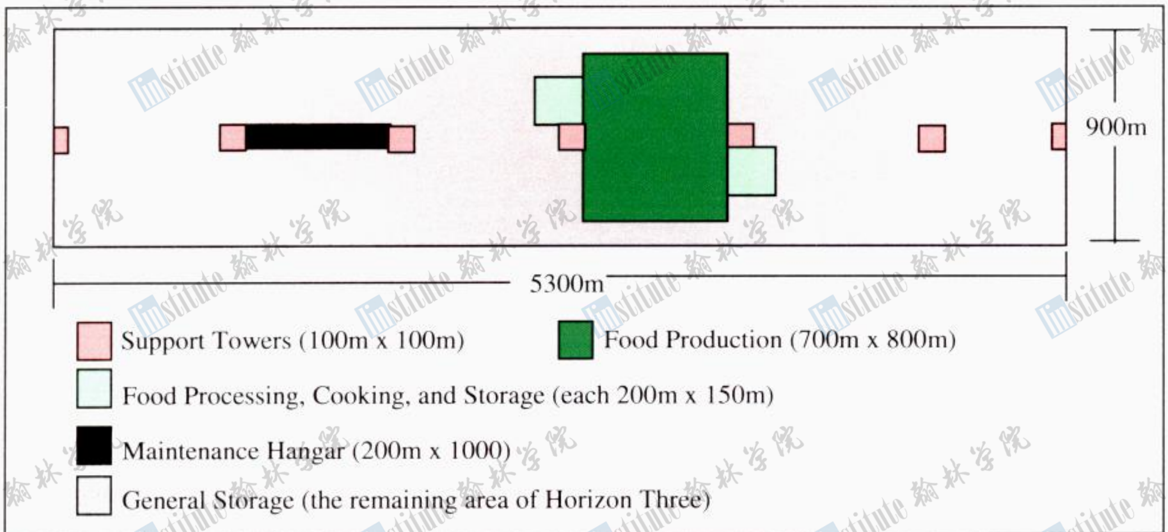


Figure 2.2.5 | Horizon Three Interior

Horizons Four and Five are areas used mainly for manufacturing, but also support educational and recreational purposes. In these horizons, there are many large air-locked facilities in which the environment (temperature, pressure, humidity, brightness, etc.) can be adjusted by the user. Also, a wide range of magnitudes of pseudo gravity allows researchers and manufacturers to choose the value that best fits their intentions. Robots, materials and resources can reach all parts of these two Horizons, resulting in very flexible area configurations. During construction, a portion (10,000,000m^2) of these Horizons will be installed with the proper equipment to produce steel, metal matrix composites, aerogel, carbon nanotubes, nanobots and space vehicles. Another 2,000,000m^2 will be used to conduct experiments, such as nuclear particle research or materials engineering. We anticipate that the remainder of the area of these Horizons will be rented out to businesses and researchers.

2.3 | Construction Process

Table 2.3.1 and figure 2.3.1 describe the construction process of Bellevistat.

Table 2.3.1 | Construction schedule

Phase	Timeframe	Description
Construction 1	2028 – 2030	The industrial core is constructed on earth in five segments. Once all facilities in the industrial core are completed, the segments will be launched into orbit where they will be joined.
Industry	2030 – 2031	An asteroid will be placed into orbit trailing Bellevistat. At this point, the industrial core will fire up, and mining and industry will commence. Other core facilities, such as rudimentary life support and energy modules, will be constructed.
Construction 2	2031 – 2032	With refined materials from the asteroid, most likely steel, the skeleton of Bellevistat will be constructed. Mining and industrial action will continue.
Construction 3	2032 – 2035	After the skeleton is complete, work will begin on Habitat One, which encompasses the two outermost horizons. Infrastructure required for inhabitation will be created and implemented at this point. Starting 2034 we expect to be at a stage where Foundation Society members can begin to move into the first altitude.
Completion	2035 - 2039	During this period, construction of the inner horizons will take place. By 2039, all transportation and business infrastructure will be complete.

Figure 2.3.1 | Construction Phases

2.4 | Asteroid facilities

Upon receiving the asteroid, we will place it into orbit trailing Bellevistat. This will ensure that it is easy to ship materials from the asteroid to our industrial core facilities. For convenience and utility, we propose to construct ore extraction and refinement facilities on the leading face of the asteroid. This means that the materials shipped to Bellevistat will be mostly refined and so more space can be allocated in Bellevistat's industrial core for manufacturing. The facilities will be located mostly underground, to minimize the risk of collision with debris. Included in these facilities will be a storage depot, an ore processing plant, a minor manufacturing hub, and two spaceports. One of these spaceports will be angled toward Bellevistat at all times, and one will point down toward the earth so that we can ship materials to terrestrial facilities in need of them.

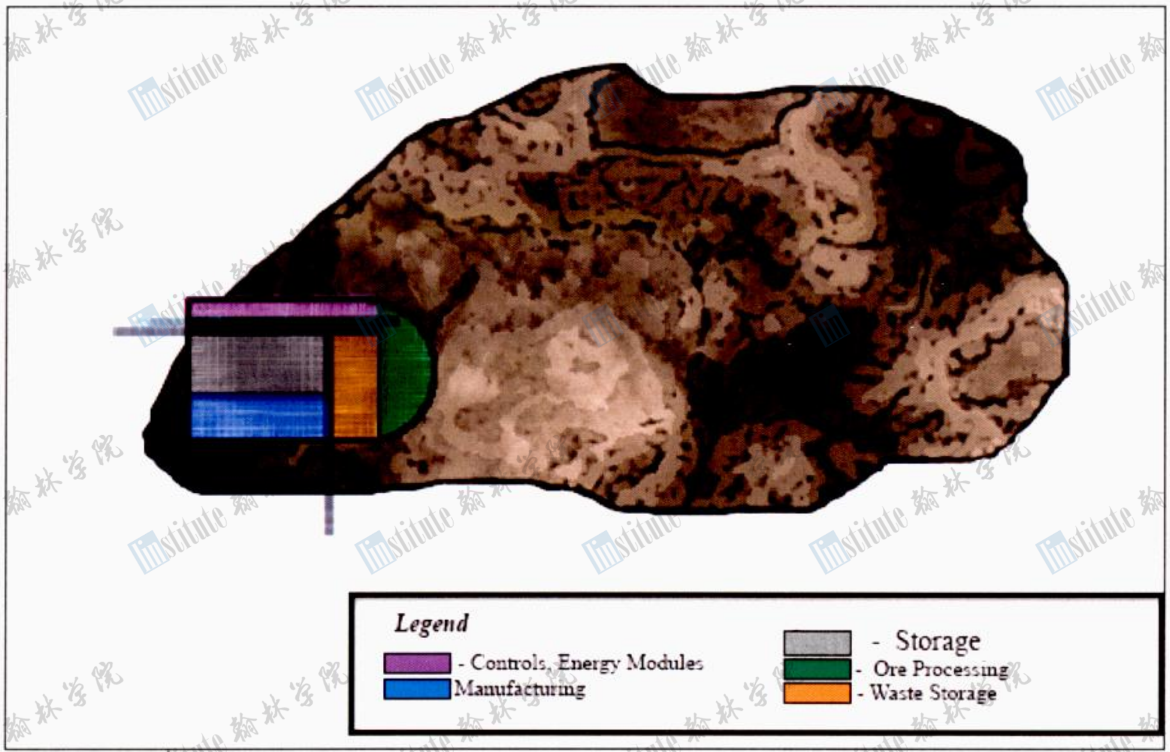


Diagram 2.4.1 | Depiction of asteroid facilities

To avoid the detrimental effects of dust on machinery, we will employ several different preventative methods. An electrically charged surface will be integrated into the structure of each ship and construction to attract dust away from moving parts. Therefore, damage by dust will be minimized. In the spaceports, there will be more of these surfaces as well as jets of pressurized gas to clean the ships of any dust they might be carrying before they make their journey to Bellevistat. Before loading each shipment of material, the material will be cleaned off with electrically charged brushes. This will also occur inside Bellevistat as the materials are being unloaded. With these preventative measures, it can be ensured that no contaminants from the asteroid interfere with industrial processes and that none will be transferred to Bellevistat.

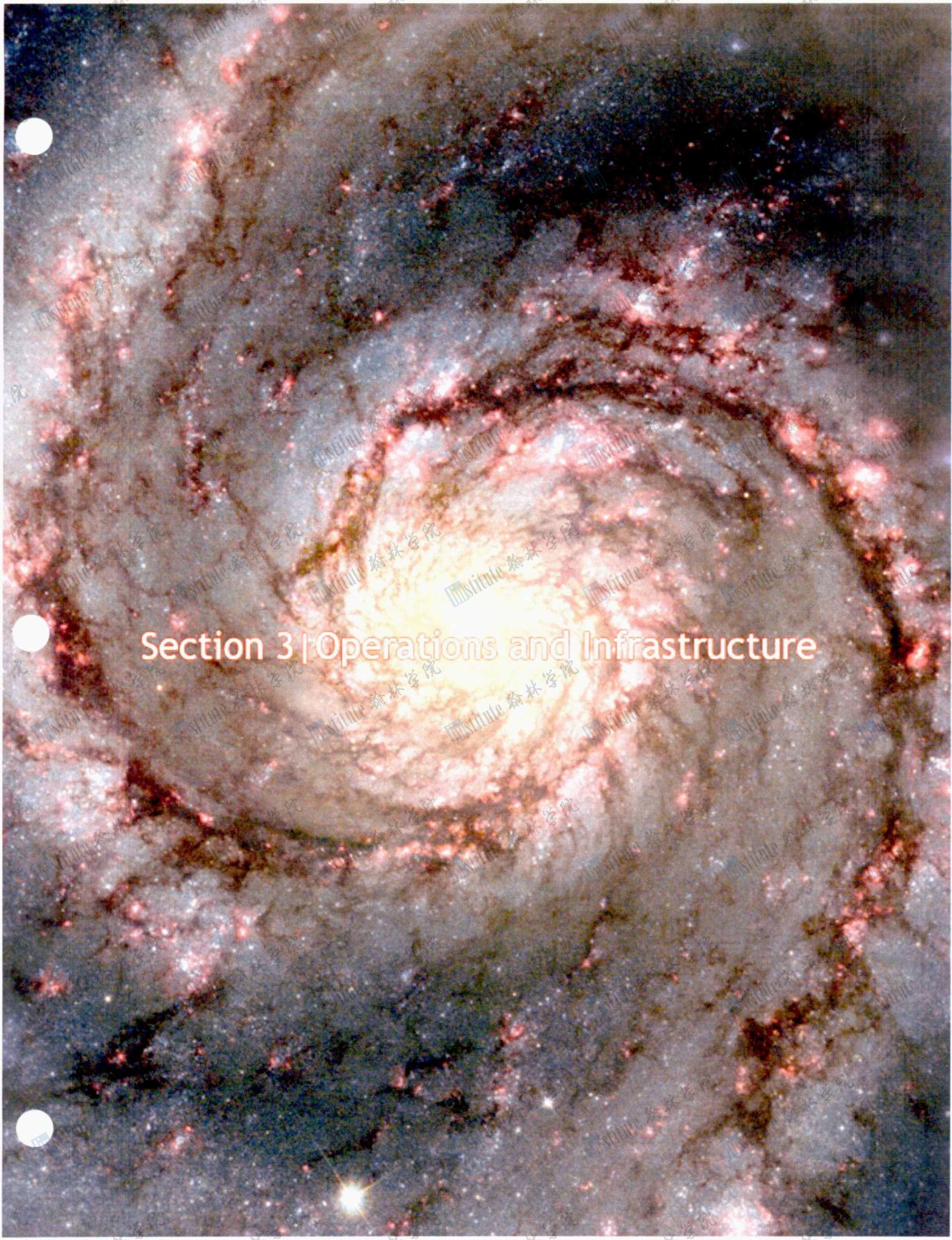
2.5 | Docking Port Facilities

Bellevistat will include 6 identical space ports, each located at the exterior end of a support tower. The spaceports will have 2 bays each, which equals a total capacity of 12 vehicles simultaneously. In between the two bays is a bulk elevator (see Transportation 3.2.4) which transports all cargo, while human elevators are situated on the two sides of a port. These elevators will travel to the first Horizon, where all passengers and crew will be screened for viruses and other harmful agents, while cargo will be checked for potentially harmful materials. Each bay includes all repair tools needed to perform quick services to all standard space vehicles.

Each vehicle can only enter/exit a bay traveling in the same direction as the rotation of the station. When entering a bay, streams of pressurized air clean the exterior of the ship of any asteroid and space dust. To address the problem of having spacecraft accidents, we have an automatic docking system (ADS) to land ships using LED scanning and laser tracking technology to check and guide ships into a docking bay, where robots will secure the vehicle to the floor. A pressurized tunnel connects to the vehicle and transports passengers to the elevators, while robots unload/load cargo and perform service checks on the vehicle.

The mainframe powers the ADS and also records all the information related to the ship, such as purpose of landing, specifications, arrivals and departures. If either the mainframe or ADS fails, no ship is allowed to enter the bays until the problem is resolved.

The buffer zones in the 1st Horizon within 100m of each port will be reinforced and air-locked from the rest of the station to prevent Horizon-wide explosive decompression in the event of a mislanding.



Section 3 | Operations and Infrastructure

3.1 | Station Positioning

The positioning of the settlement is of paramount importance; it determines the environment we will have to prepare for, the access to resources, ease of communication, etc. There are three regions that will be considered for the positioning: low earth orbit (LEO), medium earth orbit (MEO), and geostationary earth orbit (GEO).

Table 3.1.1 | Comparison of orbits

Orbit	Pros	Cons
LEO	• Easy transportation from earth • Within earth's magnetic field; less need for radiation shield	• Orbit is cluttered with space junk • Accidents could affect earth • Vulnerable to attack
MEO	• Orbit reasonably clean • Less risk of terrestrial catastrophe as a result of accident	• Less effect from earth's magnetic field • Harder to transport personnel from earth
GEO	• Useful for communications and earth imaging	• Far from earth • Much less effect from earth's magnetic field

We will place the settlement 13934.95 km above the Earth's surface (in MEO), which will give the station an orbital period of 8 hours. This is mainly for convenience, to synchronize with Earth time and with the rotational speed of the settlement. It also puts Bellevistat above the inner Van Allen Belt, minimizing the effects of the solar wind on the station. We will put an asteroid into orbit behind the settlement, and this will be our primary source of raw materials. Materials can also be shipped in from Earth, although at what cost remains to be seen.

Table 3.1.2 | Materials and sources

Required Materials	Purpose	Source
Iron	Steel manufacturing	Asteroid
Carbon	Steel manufacturing Aerogel manufacturing	Earth, Asteroid
Steel	Structure, ships	Produced on Bellevistat
Water	Life support	Earth, Asteroid
Electronic components	Processing core Automatons	Earth (preliminary shipment), produced on Bellevistat
Assorted minerals	Nature areas (parks, etc)	Asteroid, moon
Scientific instruments	Research	Earth, manufactured on Bellevistat
Seeds, animals, other living materials	Food production Nature areas	Earth (preliminary shipment)
RAGuard	Radiation shielding	Earth
Carbon fibres/nanotubes	Tensile strength	Earth, manufactured on Bellevistat
Medical equipment	Life support	Earth (preliminary shipment), produced on Bellevistat
Silicon	Outer shell Aerogel manufacturing Electronics manufactruring Solar panel manufacturing	Asteroid
Aluminum	Outer shell Ship manufacturing	Asteroid, Earth
Titanium	Outer shell Ship manufacturing	Asteroid, Earth
Copper	Pipes, wires	Asteroid, Earth
Biostatic polyethylene	Surfacing of walls	Earth

3.2 | Basic Infrastructure

3.2.1 | Food Production

Table 3.2.1 | Area used for food production

Product/purpose	Area used (all food production areas are on the third horizon) (m²)
Crops	480000
Fish	20000
Livestock	40000
Processing	40000
Total	**580000**

Table 3.2.2 | Overview of food production system

Product/purpose	Description of main features
Crops	Crops will be grouped by species and separated into several different greenhouse areas based on the optimal conditions for growth. The crops will be genetically engineered to provide humans with sufficient nutrients in their diets.
Fish	Two large areas, one of fresh water and one of saltwater, will hold the fish. The fish will be grouped by species and each species will be separated by dividers in the two areas. A reproduction area bordering each division will provide a safe place for the fertilization of eggs. Simple seafood such as shrimp may also be harvested. Fish will be fed a special diet of crops genetically engineered to provide the optimal amount of nutrients for survival.
Livestock	The livestock will be grouped by species and put into holding pens. There will be one alpha male per pen so as to encourage reproduction. Females who have had their first litter and older males will be harvested. Animal products such as eggs and milk will be produced inside the processing area. Animals will be fed a special diet of crops genetically engineered to provide the optimal amount of nutrients for survival.
Processing	The processing plant will border all three areas, the livestock area the most. In this area, all harvested foods will be processed for people on the settlement to eat. In addition, animal products such as eggs and milk will be produced here. Food will be packaged and labeled with expiry dates. Animal products will be stored in large freezers at a temperature of 0°C, while plant matter will be stored at 5-10°C in other storage facilities on the third horizon. The processing area will feature 20 biostatic chambers to maintain specific temperature, pressure and humidity in the interest of preserving food, both raw and prepared. Food products will be shipped to food stores on request.

Automatons will be used to harvest the food as they are fast and efficient. We will utilize HIRs and TSR Type 2s to pick the crops and HIRs to manage the fish and livestock. Inside the Processing Plant, we will mainly use TSR Type 2s in packaging and storing while HIRs will manage milking and egg production. To ship the foods to stores, we will utilize GTRs.

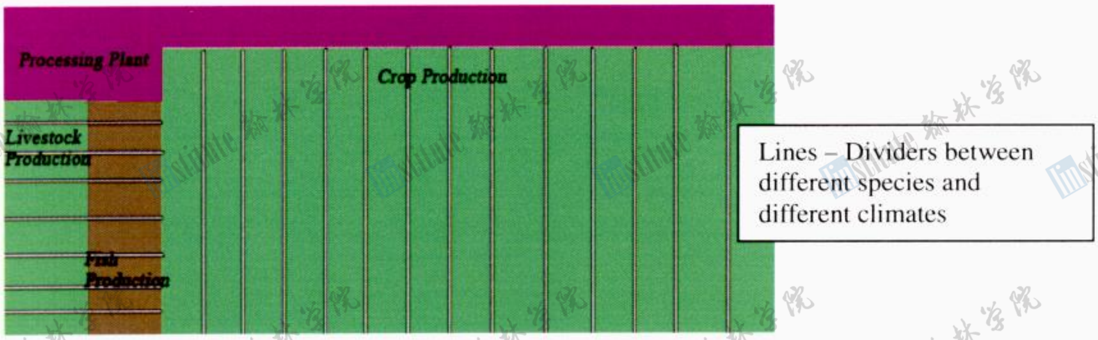


Figure 3.2.1 | Diagram of food production areas (overhead view)

3.2.2. | Power Generation

We will utilize photovoltaic solar cells (See Figure 3.2.2) that use curved acrylic plastic Fresnel lenses to focus sunlight onto small silicon cells. The silicon is then covered in an optical device called a prism cover which boosts performance. This innovative design cuts costs on silicon as the amount of sunlight acquired by the small silicon cells has been intensified by 20 times. To keep the silicon cells from overheating, an aluminum heat sink is extruded from the bottom.

Taking into account that our solar cells are 14% efficient and that we will be in the Earth's shadow for just less than 4 hours a day, 13,495,615m^2 of solar cells will generate the 591159.0271kW (see Table 3.2.3) needed to sustain Bellevistat. We will have two 7,000,000m^2 solar arrays mounted on satellites, which orbit earth beside Bellevistat and automatically adjust to constantly face the sun. The satellites will beam a concentrated laser to the Laser Energy Module on the bottom of the station, where the energy will be converted into electricity and sent straight to storage.

Energy storage on Bellevistat will be housed in several banks situated in different locations. This will ensure that a problem in one area will not cause the whole station to lose power. We propose to use Lithium Nano-Titanate batteries, as they offer the highest energy per kilogram (approximately 0.1kWh/kg), are very cost effective, have a long life with discharge efficiencies of 91%, and require very little maintenance. A total of 190,000kg of Lithium Nano-Titanate batteries will be installed onboard Bellevistat. In emergency mode, when industry is shut off and PHOLED lighting is replaced by safety LEDs in the ground, these fully charged batteries will sustain the station for seven days. In this time, energy can also be rerouted from the waste incineration generator.

Aluminum wires, cooled and insulated to 1.2 Kelvin for super-conductivity, will be used to distribute energy throughout the station.

Table 3.2.3 | Allocation of power consumption

NAME	POWER USAGE
Residential	68,200kW
Industry	84,700kW
Public (depots, rec. centers)	300kW
Mainframe, Life support, Station Processes	150,300kW
PHOLEDs	97,600kW
TOTAL POWER	**401100kW**

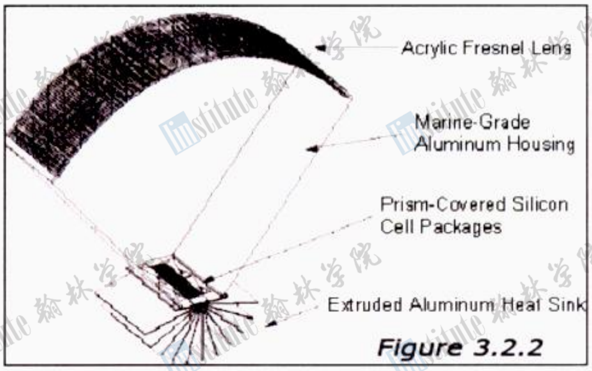


Figure 3.2.2 | Solar Cell

3.2.3 | Internal and External Communication Systems

Communications within the settlement will be facilitated by means of "intelligent personal interface devices" or iPIDs. The iPIDs will interface with a centralized computer core, which will store information and facilitate computations, thus making the iPID truly only an interface unit, minimizing initial and repair costs. These iPIDs will be networked by means of a fiber optic system throughout the station. Wireless microwave-based internet routers to facilitate wireless access to the network, allowing for transfer rates as high as 5 Gigabytes per second, will be installed throughout the station.

The iPID will utilize a touch sensitive screen, dominating the front portion of the unit. All auxiliary devices will be connected to the iPID by means of microwave wireless technology. The iPID will feature voice and writing recognition software, simplifying the user interface. The iPID will also feature a high speed wireless router, providing a high transfer rate with the centralized computing core.

Communications outbound from the settlement will be transmitted through a constant data stream beamed to earth via a satellite dish mounted on the top and bottom of the station. One dish will be mounted upon a rotating platform, ensuring constant exposure to Earth based stations. A similar dish, mounted on the opposite end of the cylindrical station will act as a receiver for a constant data stream from Earth. The size and power of these transceivers will permit a data transfer rate of 100 Gb/s. For redundancy, an extra dish, capable of both inbound and outbound transmissions, will be mounted on each end of the station, preventing loss of external communications in the event of a disaster. Due to the station's 10 000 km proximity to Earth, all communications will experience a 3.3 millisecond delay.

3.2.4 | Internal Transportation Systems

Table 3.2.4 | Internal transportation systems overview

System	Description	Purpose
MicroRail	Similar to a Maglev in function, but on a smaller scale. Individual pods with dynamic pathing allow passengers to change destinations on the go. Speed is limited to 100 km/h in order to provide the passenger with maximum control over route. Seats up to six. Radius 1.5 m.	Short range intra-Horizon transportation
MacroRail	Multiple MicroRail pods can attach together in strings and travel the MacroRail, a superhighway of sorts that traverses the ceiling of each horizon. The number of MicroRail pods that can be attached in this manner is limited to 20.	Long range intra-Horizon transportation
Pillar of Ascension	Each of six support columns of the station that provide structural stability and access to space will contain elevators for industrial as well as commercial and transportation usage. MicroRail pods have their own elevators, numbering over 50. Each elevator holds one pod.	Inter-Horizon transportation

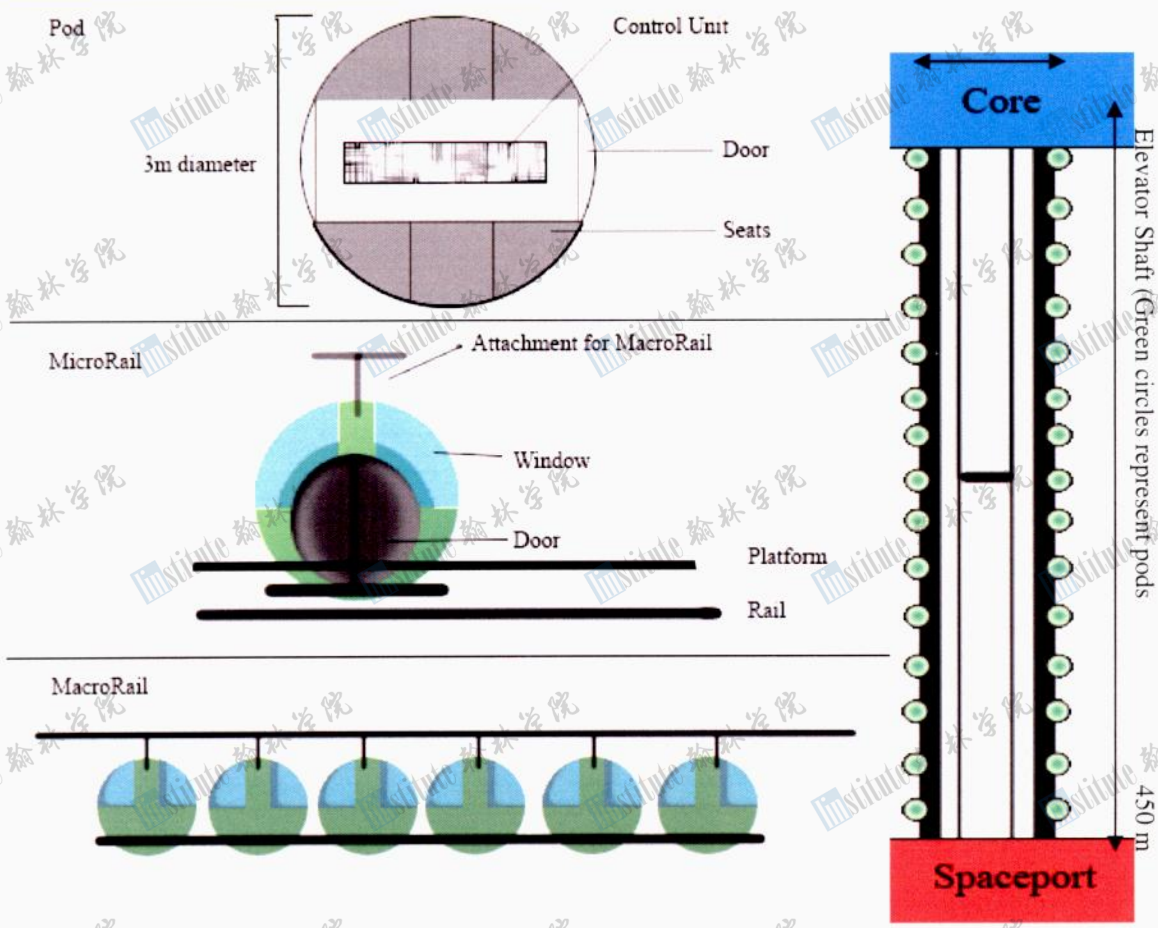


Figure 3.2.4 | Internal transportation systems diagrams

3.2.5. | Station Atmosphere

A number of issues need to be dealt with in regards to the atmosphere, including temperature, air pressure, air composition, outgassing, and heating in order to ensure a safe, functional lifestyle for all.

Temperature will be consistent year-round, with the entire second horizon being maintained at 22 degrees Celsuis to maintain the perfect balance between comfort, function, and efficiency. Bellevistat aims to maintain percentages of oxygen, nitrogen, and other gases similar to Earth. Increased or decreased oxygen runs the risk of causing nausea, dizziness, and blurred vision, among other things, and maintaining percentages at an earth like level will ensure a consistent, predictable, problem free result.

An air pressure similar to that of what is on earth will be used in the residential area of Bellevistat; the station will be maintained at or around 101.25 kPa.To maintain the standard of air, a reservoir of compressed air that consists of the correct air composition will exist in each neighborhood and park area to compensate in the case that Bellevistat's natural ecosystem does not adequately sustain the composition of air. The resevoir will regulate air composition and pressure and feature large fans that circulate air and could also potentially be used to provide Bellevistat residents with a periodic, pleasant breeze to enjoy.

To prevent poisoning from outgassing - when molecules from materials such as plastic break off and enter the atmosphere – a filtration system will be implemented that separates additives that unbalance the air composition from the desired volume of air. Water vapour molecules will be separated and condensed in order to turn into liquid again, which will be directly injected into the water circulation. Carbon dioxide molecules will be sent to the agricultural or wetland area to encourage photosynthesis through a series of pipes, unless the agricultural and wetland areas have already been detected as over saturated with the gas. To filter the air, Pressure Swing Adsorption processes will be used; air will be put under pressure and a bed that attracts carbon dioxide and oxygen will be used to separate the molecules individually

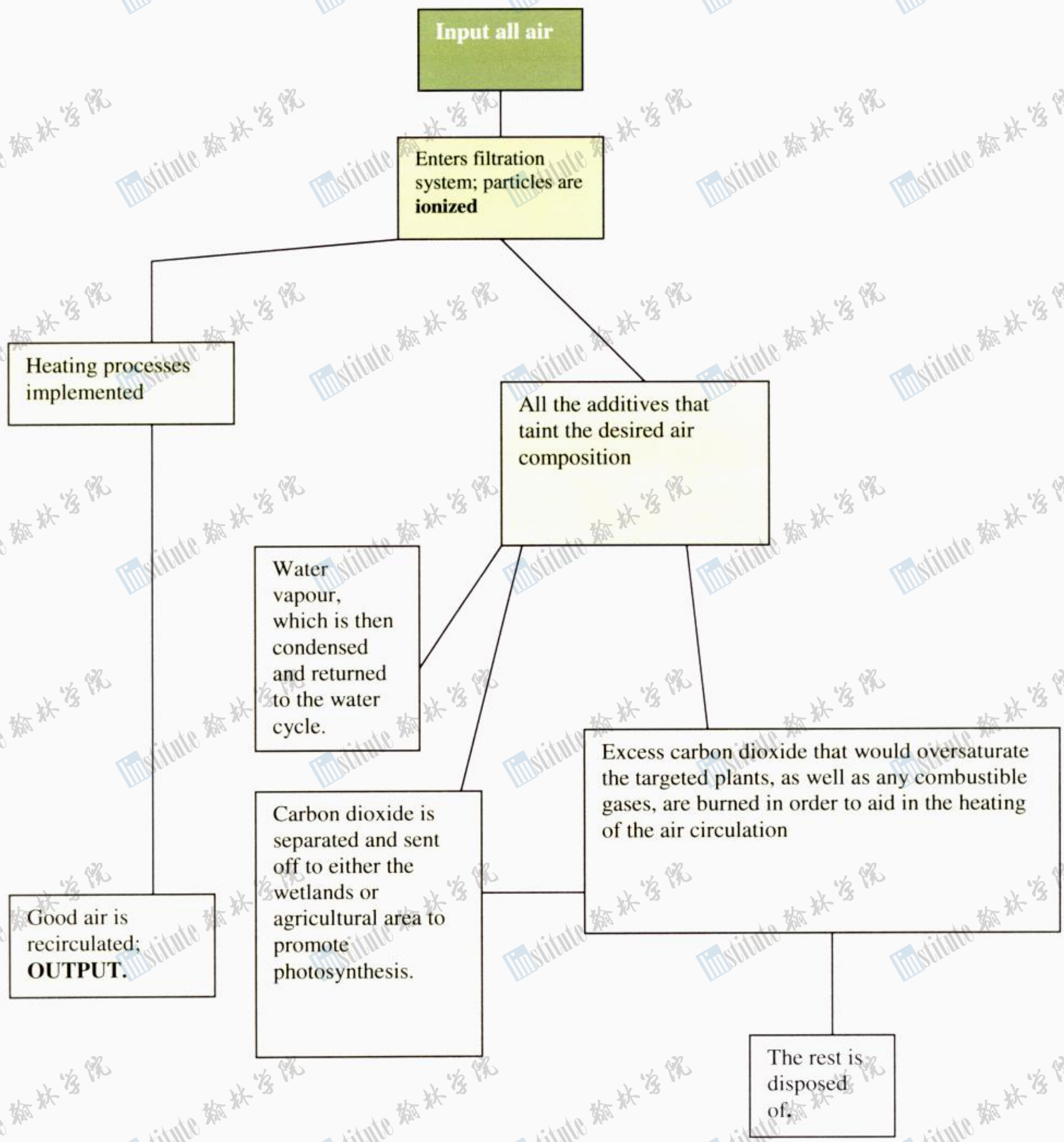
The air circulation system will also ensure that the correct temperature is maintained at all times, using three methods to maintain the desired temperature. Primarily, the excess gases will be burned in order to aid the heating of the output air, with a device that constantly monitors the temperature of the second horizon at a number of different locations to maintain the desired 22 degrees Celsius. Heat given off by the waste incinerated in the waste management section will also lend itself in heating the air. If this is insufficient in the heating of air, an electric heater will be utilized to make up the difference in desired temperature.

Sunny and cloudy weather patterns as well as night will be simulated through the use of PHOLED's mounted on the ceiling, 30m away from residents on the second horizon, to allow a variety of environments throughout Bellevistat and to simulate the nature of earth.

Table 3.2.5. | A summary of the atmosphere on the second horizon

	Temperature	Pressure	Air Composition	Humidity
First Horizon	22 degrees Celsius	101.25 kPa	78% nitrogen, 21% oxygen, 1% carbon dioxide; anywhere from 1% to 4% water vapour.	55% humidity

Figure 3.2.5. | Flow chart detailing the air filtration process



3.2.6 | Household and Industrial Solid Waste Management

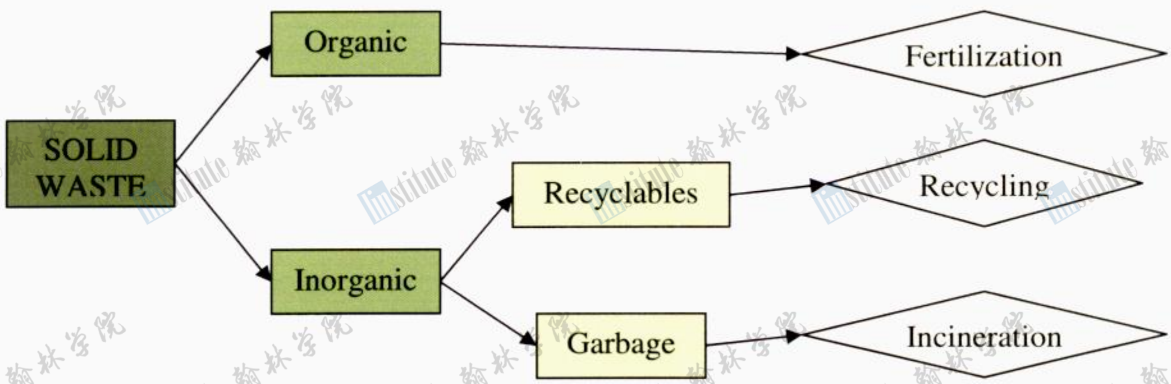


Figure 3.2.6. | Flow chart of waste system

Solid waste throughout the station will be placed in a disposal unit, which will sort the waste by means of electronic sensors, which will analyze the physical properties of passing material. Organic material will be removed and sent to the agricultural sector, where it will be used as fertilizer. Inorganic material will be sorted into refuse and recyclable material, the latter of which will be sent to the appropriate locations to me melted down and reformed, depending on need. Refuse will be burnt in a waste to energy incinerator, contributing to the station's power grid.

3.2.7. | Water Cycle

The cycle of water begins at one of 16 shafts, designed to be able to hold all the water accounted for in Bellevistat. Water will be stored in these long shafts in the horizons above the second, feeding water into the water tower periodically for use on the second horizon. The shafts will be 16m X 16m X 100m. The total volume of water aboard the station will total 307200m^3 of water.

From the reservoir, water will pass through a simple filter that kills any last bacteria before it flows into a large pipe that spans most of the station, under the flooring. Smaller "tributaries" of pipes will be used to reach the homes and industries that require water. Waste water will then flow out a different set of pipes, meeting at a large waste pipe. The wastewater will meet up at a large wetland environment, measuring 200m in length and 100m in width. It will also offer the chance to grow and harvest a number of plants, such as blueberries, wild rice, and mushrooms from the wetlands to strengthen Bellevistat's food production.
This wastewater will be pumped from the pipe into a natural filter, resembling an artificial wetland environment. The water will then be further purified by means of an ultraviolet light process as well as water fluoridation before returning to the long shafts at the end of the water cycle.

Table 3.2.6 | A table listing the uses of water on Bellevistat

Usage of Water	Reasoning
Humans	Including drinking water, food preparation, and everything humans aboard Bellevistat use in their personal daily lives.
Agriculture, Wetlands, Plant Maintenance	Plants will be artificially sustained, and as such there will be water allocated for its maintenance. This includes the parks, the wetlands, the agricultural land, and all the plants on the station in general.
Manufacturing	Bellevistat will be self-sustaining; as such, there will be a number of manufacturing processes implemented aboard the station, such as steel processing.
Emergency Control	The rest of the water will most likely be stored in the water reservoir. In the case of fire, special events, unforeseen problems, or any fluctuations in water requirements, Bellevistat will be prepared to accommodate all needs.

Figure 3.2.7. | A flow chart detailing the direction of water flow

3.2.8 | Day/Night Cycle Provisions

The Bellevistat residential environment will attempt to mimic an earthly environment in order to allow first-generation residents to have a smooth transition from Earth to outer space. So, Bellevistat's day and night cycle will do the same. Phosphorescent Organic Light Emitting Diode (PHOLED) panels will cover the entire high ceilings of Bellevistat's residential horizon (Horizon Two). A system of reflective panels and fiber optics in the formation of a ring are installed on both sides of Horizon Two. Starting at 5 am, the PHOLEDs will display dawn, slowly brightening up the entire second horizon. At midday (11 am to 2 pm), the side panels will begin to open and angle natural sunlight through RAGuard-coated glass panes (left exposed by the panel extension) and into all parts of the residential horizon. After 2 pm, the extension closes back in and PHOLED panels continue to provide light until 7 pm. At this time, the PHOLEDs mimic sunset, gradually changing into a dark, star-filled sky for the rest of the night, until 5 am, when the day cycle begins again. This Earthlike day-night cycle is not seasonal, and repeats itself every day at all times of the year. It is only used in residential sectors (to alleviate psychological detachment upon leaving an Earth environment and to provide natural sunlight to citizens) and is not needed in other sectors such as food production, which need light at all times in order to ensure plant growth. In summation, our residential areas are provided with PHOLED daylight from 5 am to 7 pm, natural sunlight is provided from 11 am to 2 pm, and a night environment takes place between 7 pm and 5 am of the next day.

3.3 | Orbit Infrastructure

Table 3.31 | Orbit infrastructure

Infrastructure	Purpose	Proposed Designs	Institution
Earth Passenger Transport	A transport vehicle will be required to facilitate the conveyance of human cargo to and from Bellevistat, most notably during construction and for pioneer residents. The transports will also serve transient residents, adding to the economic viability of the settlement.	As the vehicle would only operate in space, a design similar to an ocean-going freighter could be employed, with a rocket engines for propulsion, and thrusters for precision steering	Due to the heavy usage of this vehicle, the Foundation would benefit by using an outside contractor, and instituting a 'docking fee'. The transfer of liability, and increased competition add to the project's economic viability.
Earth Cargo Transport	A vehicle capable of transporting cargo and bulk goods would be necessary to supply materials for construction and station upkeep.	See above.	See above.
Emergency Evacuation Pod	To ensure the safety of Bellevistat occupants, an evacuation system, capable of quickly bringing inhabitants to earth, would be necessary.	Escape pods could be modeled after rocket command modules, due to their simplicity in both design and operation.	The safety aspect of this vehicle would boost the Foundation's image and reputation, as well as the marketability of the project. Thus it should be included within the Foundation Society's contract.
Solar Collection Satellites	Satellites placed near the station could store solar energy that could later be used aboard the station. They would orbit Earth near the station to be harvested by spacecraft when full. Energy reserves would be added to the station's power grid.	Satellites could be spherical to minimize cost. They would be covered in photovoltaic cells which would store the energy in a lithium ion battery.	As this satellite would ensure a more reliable supply of electricity, the Foundation Society's inclusion of this in their contract would add to Bellevistat's marketability.

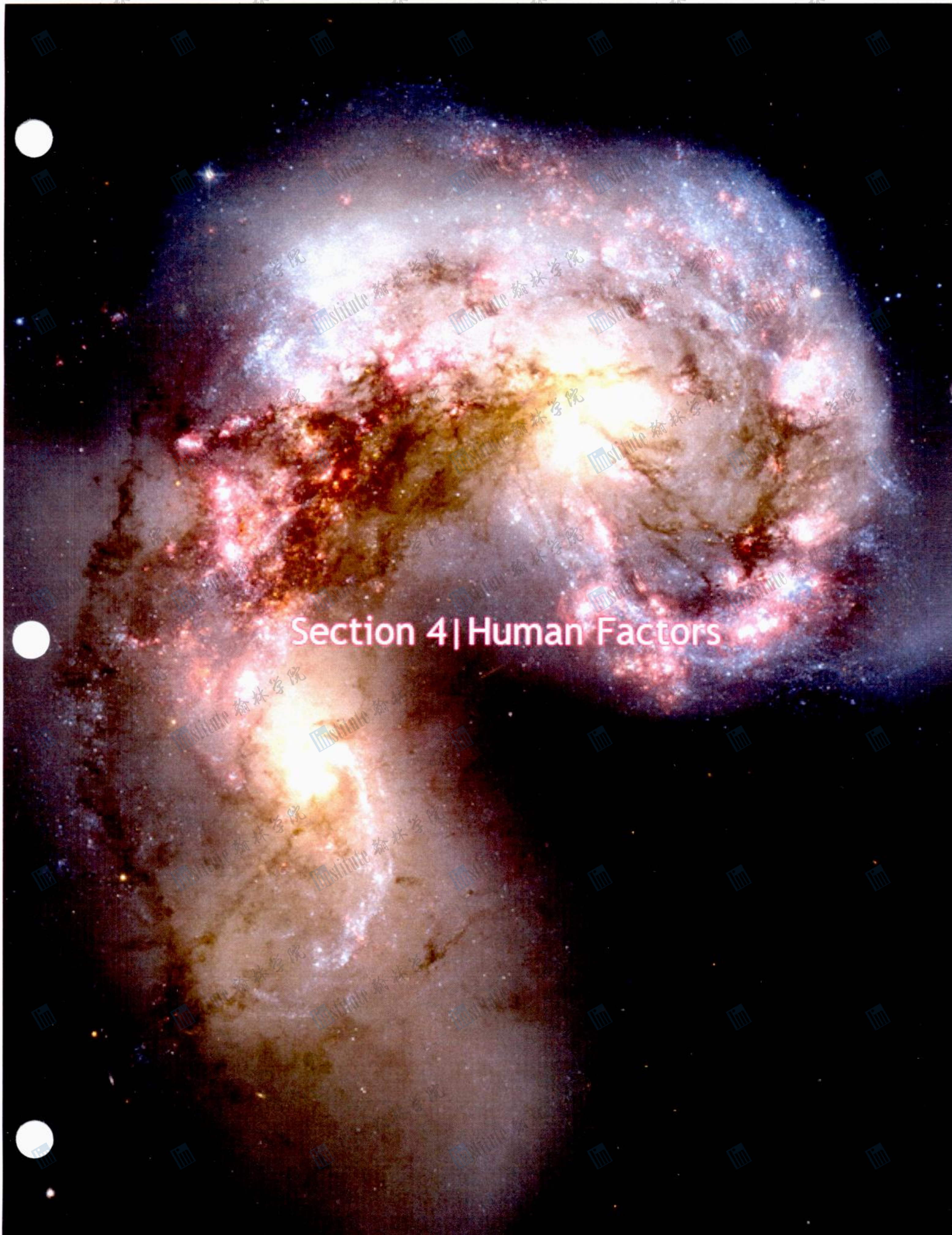
3.4 | Plant and Animals Systems

Bellevistat will survive upon two main categories of food: plant and animal. Small plants fit for consumption, such as canola, will be grown in the landscaped areas of the convenience centres. Larger plants for both animals and residents such as corn or wheat will have to be grown in separate fields for sheer necessity's sake. Animals will be kept entirely separate, and once harvested from the fields, the grains that go into their feed are processed at a different place than where human food is processed. Cows and chickens are at the forefront of these animals, and will be the main source of meat, milk and eggs for the residents. Fish will also be provided to residents in the form of farmed salmon, all of which will be kept separate from both the other animals and the plants.

3.5 | Living Materials

Table 3.5 | Living materials

Object	Material/appliance	Reasons
Floors	Biostatic Polyethylene	Hard surface, structurally sound, prevents bacteria growth, blocks radiation well
Walls	Biostatic Polyethylene	Hard surface, structurally sound, prevents bacteria growth, blocks radiation well
Toilets, sinks, tubs	Biostatic Polyethylene	Same as above, Easy to mold
Bedding and couches	visco-elastic polyurethane foam, porous biostatic polyethylene	Hard surface, structurally sound, prevents bacteria growth, blocks radiation well
Surfaces and storage	Biostatic Polyethylene	Hard surface, structurally sound, prevents bacteria growth, blocks radiation well
Faucets	Stainless Steel	We manufacture it, does not rust
Stove top	Induction Cooker	Prevents burns of spills and people, high heat effieciency
Oven	Microwave/Steamer/Oven/toaster	Molded polyethylene multipurpose oven, saves space, creates healthy/tasty meals
Television	PHOLED(1m^2 area)	Power efficient television
Lighting	LED (1watt/m^2)	High power efficiency
Power	Wireless power hub	No need for outlets


Section 4 | Human Factors

4.1 | Community Design

Bellevistat is divided into six main villages, each associated with a constellation. The villages are provided with a large variety of facilities to ensure comfortability for residents, including, recreation centres, education, entertainment and housing. The six villages also include a village especially for transient, or visitors which includes hotels, and a state of the art science center.

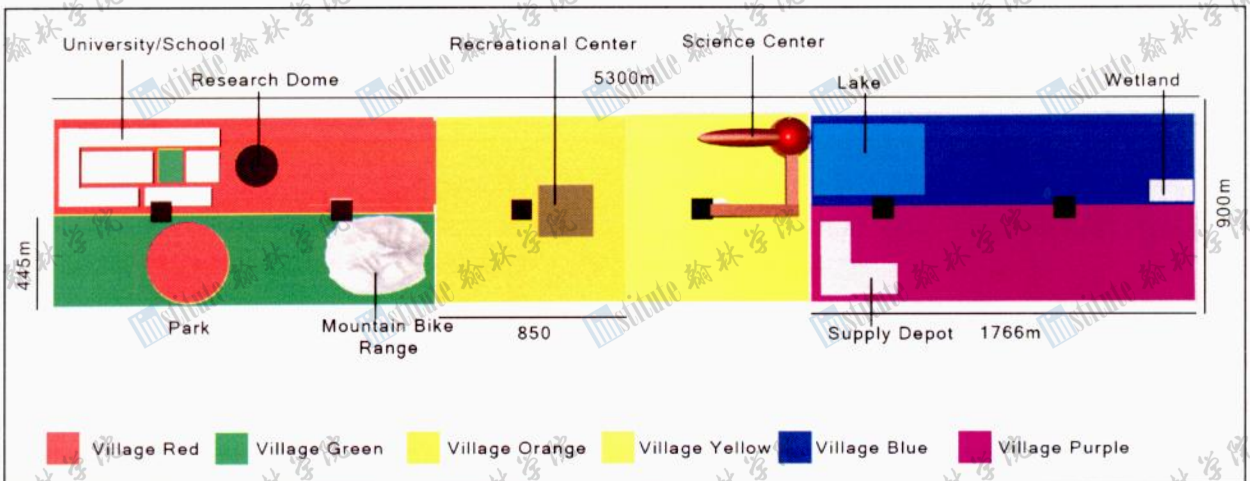


Figure 4.1.1 | The general layout of the second horizon

The space in Bellevistat is used very wisely and very efficiently to provide our residents with comfort, usability, and enjoyment. We have dedicated about 40% of the total available area to residential houses. We expect more than just individuals to settle into the space station – we expect couples, families of 3 and 4 to also colonize the station. To ensure this, we have instilled the best quality education, research center, and recreational activities. The houses are state of the art, large and spacious, luxurious, and very versatile Our education system composes about 5% of the total space on the station. We have a large university that is dedicated to teach students about all space-realated sciences, and how it is possible to run such a state of the art space station. The elementary school prepares students for a life in Bellevistat, and is composed of all the major activities performed at Earth Schools. Recreational activities, which use up about 18% of the area in Bellevistat, include large recreational center where people could do all sorts of things such as recreational swimming, yoga, basketball, baseball etc. They could also enroll in productive and fun activities such as treasure hunts, and more! There is also a large mountain biking range for those interested in extreme sports, and large parks and a huge lake for families to spend their time. In addition, large depot centers are created for families to go and experience the typical "mall" session at earth. Teenagers are free to spend their time in the

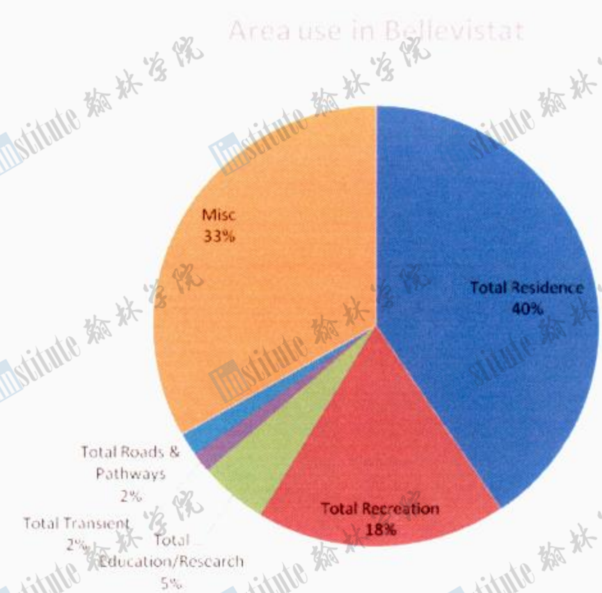


Figure 4.1.2 | Area use in Bellevistat

arcade, parks, malls, cinema and much more! Transients are given about 2% of the total area where large, luxurious hotels are placed for the typical tourist to have that once in a lifetime experience at the station. They will get to experience what it really feels like to spend life on Bellevistat. They will get to experience all that a typical resident would experience. This would be a major money maker and would even encourage the tourists to consider Bellevistat their next home. Finally, there is about 33% of miscellaneous space which is accounted for by technical stations, storage stations (for robots etc), depot centers, small recreational centers and many other things. We look to make Bellevistat the one perfect place for anyone to live in.

4.2 | Floor Plans and External Design

The houses in Bellevistat are carefully made for the inhabitant. We have taken in consideration how many people will live in that house. The typical necessities in a typical households – bedroom, bathroom, kitchen etc. The typical luxuries such as the television, computer etc. We have also carefully designed our houses so that there are enough windows, and doors, so the resident can feel as relaxed as possible, and not have any sense of uncomfortability. The houses can be altered according to the resident's needs as there are robots especially designed to alter the various houses' look, and style.

Figure 4.2.1 | A typical singles house has one large bedroom, a living room, a kitchen, a lavatory, an office, and an outdoor deck. Area: 1076.4ft^2 (100m^2).

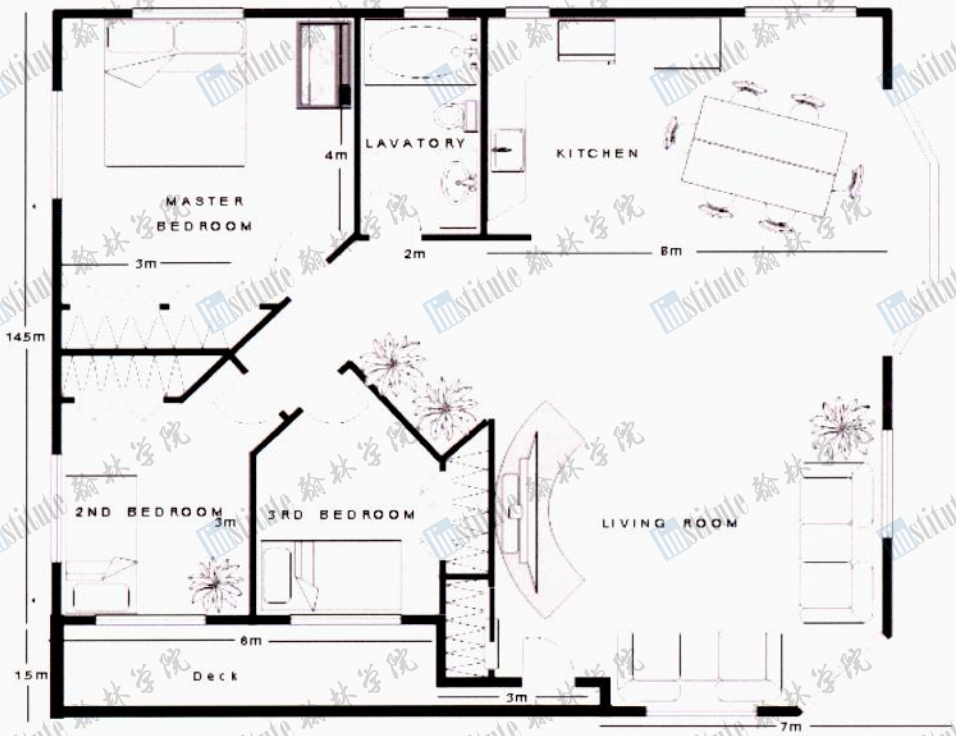


Figure 4.2.2 | A typical house for a family of 4 includes three rooms – one master bedroom, and two smaller bedrooms, a kitchen, a lavatory, a living room, and an outdoor deck. Area: 2756.25 ft^2 ($256m^2$).

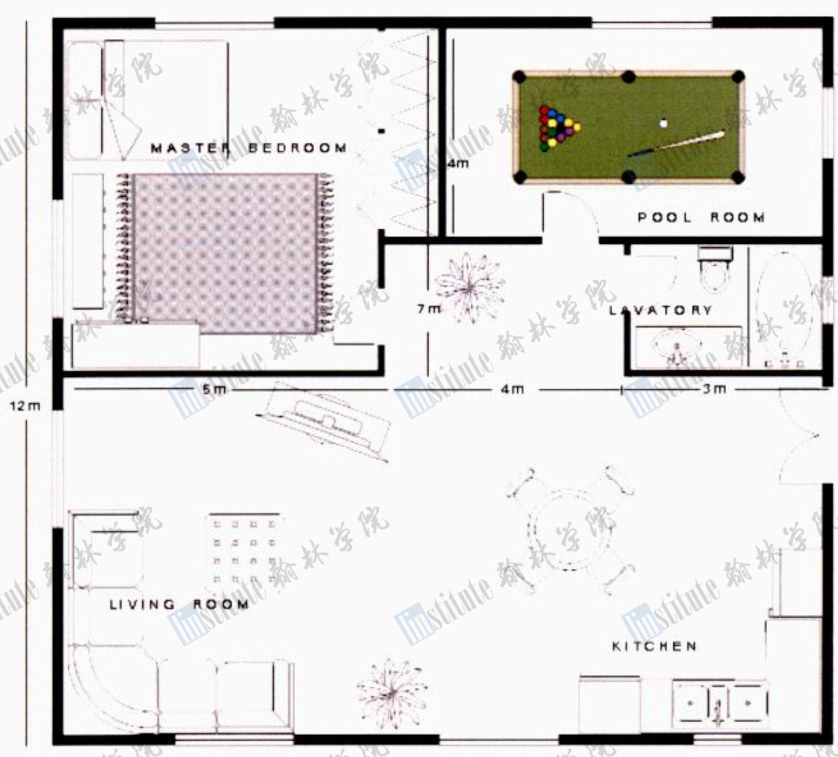


Figure 4.2.3 | A typical Singles Executive Transient Sector has a masterbedroom, a living room, a lavatory, a pool room and a kitchen. Area: 1500 ft^2 (144 m^2).

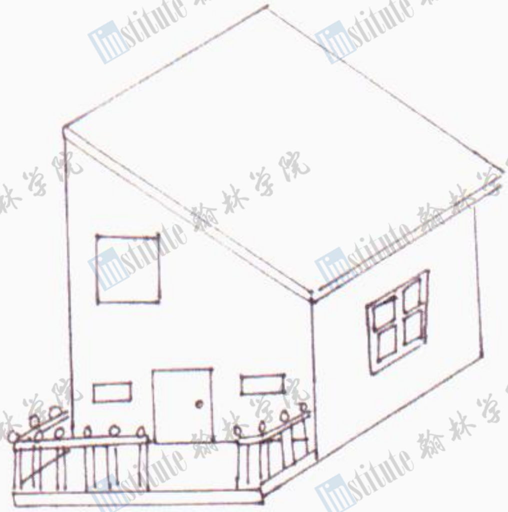


Figure 4.2.4 | A typical Single Bedroom House. It is versatile, unique, and the perfect house for any singles or couples. One of the designs for a singles/couple house

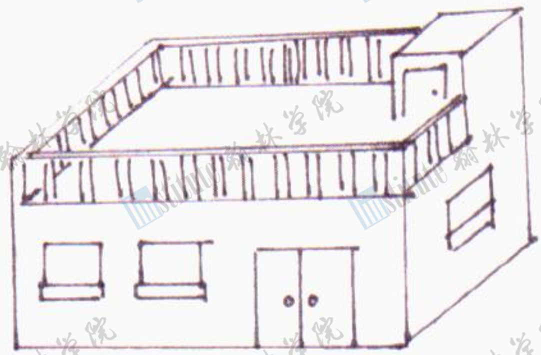


Figure 4.2.5 | A typical Executive Single Transient Home. It is easy to construct, yet elegant and homely. Allows for a perfect space experience

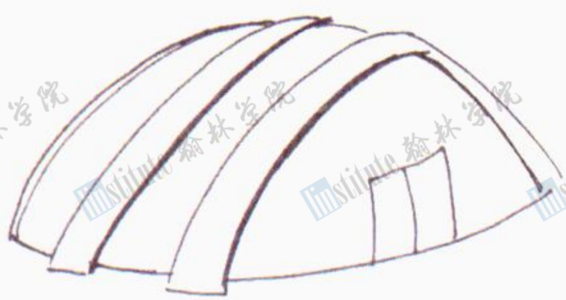


Figure 4.2.6 | The Research Dome. Huge research on asteroids and space-environment based experiments are constructed here. Made of a special alloy that is indestructible, it is the safest place to conduct any experiments

Figure 4.2.7 | The University. A classic university look will give the students a feeling of achievement. Based on Greek style architecture.

4.3 | Jobs and Services of the Population

Table 4.3.1 | Typical Jobs and Services found on Bellevistat

	Services & Jobs	Description	Tools
Hospital	Doctor	Fitness Check	Surgical Robots, and Robotic Nurses, medicines
	Nurse	Take care of people	Robotic Nurses, medicines
	Psychologist	Prevent people from expected psychological problems	
Businesses,	Manager	Keeps the business, production line and	GTR, HIR

Supply Depots		robots in check.	
Recreational	Instructors	Instructors for yoga, swimming, etc	Depends on program – sporting equipment, gym equipment
	Event Coordinator	Coordinates competitions, and events	Depends on program – sporting equipment
	Counselors	They lead kids activities	
University	Professors	Teach university students	Stationary, Books, Computers, instructional material
	Researchers	Research in the space environment	Varies with research
Elementary School	Teachers	Teach kids all the necessities of life in Bellevistat and Earth	Stationary, Books, Computers, instructional material,
	Gym Teachers	Force kids to be active in school and out – Important part of Physical Education – Crucial in a space environment	Gym equipment
	Music Teachers	Teach kids different instruments, vocals etc.	Instruments, Recording equipment
	Art Teachers	Allow children to develop their creative side	Stationeries – pencils, paint, etc.
Mines	Miners	Quality control and managing of mining operations	Tools, Laser Blasters, XRay machines, Purifiers (Robots), system monitors
Emergency	Emergency Crew	Transport people to rescue hubs	Rescue jets, rockets
		Fix ruptures, malfunctions in case	HIR Mechanic, Space Vehicle, Repair kit

4.4 | Neighbourhood Design

Bellevistat offers five different villages for residents to live in and one transient area for visitors. Each is unique and built to provide comfort, satisfaction, and an Earth-like atmosphere.

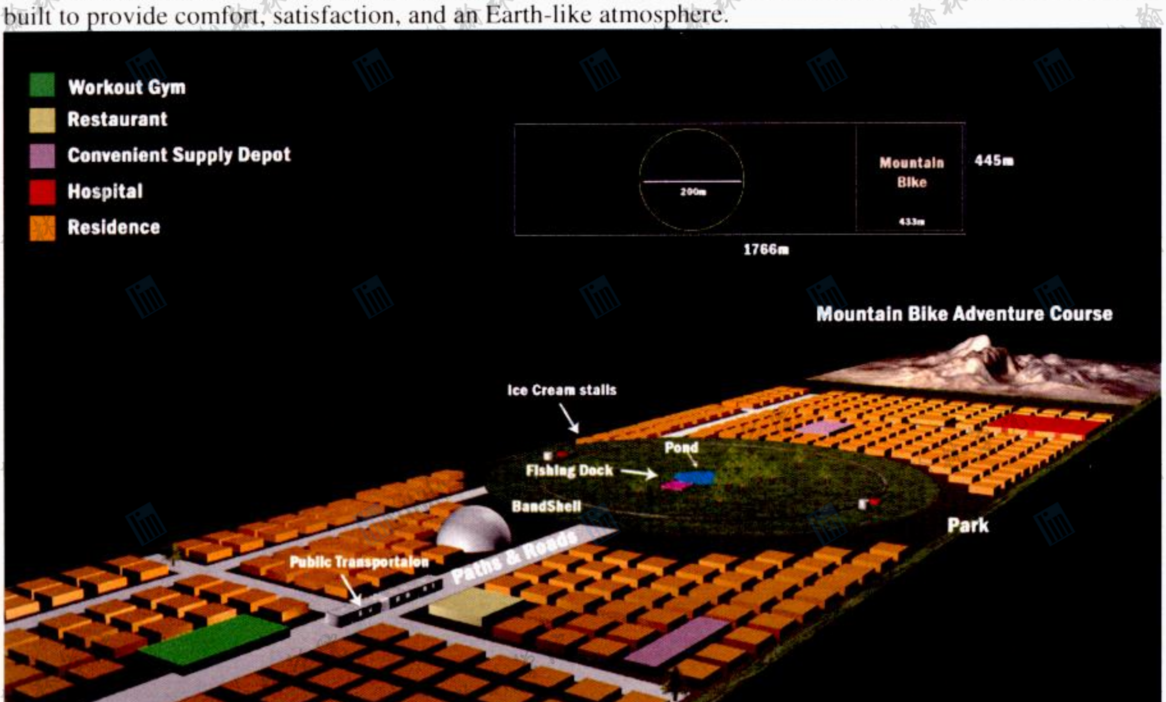


Figure 4.4.1 | The basic layout of Village Green

Table 4.4.1 | Breakdown of all major elements present in each village area

VILLAGE RED – 794700 m^2			
Community Element		*Area (m^2)*	*Details*
Education	Elementary School	68270	Capacity for **600 students** Aged **3 to 18**
	University	137000	Capacity for **5000 students** Includes library, computer labs, lecture halls, research centers
Research	Dome	31416	Facilities for space based research
Open Space	Park	18004	Area for a football field, baseball diamond, and playground
VILLAGE GREEN – 794700 m^2			
Community Element		*Area (m^2)*	*Details*
Residence	Singles	250000	2500 houses Capacity for **1 occupant** each
	Couples	79200	550 houses Capacity for **2 occupants** each
	Family of 3	15680	80 houses Capacity for **3 occupants** each
	Family of 4	5120	20 houses Capacity for **4 occupants** each
Necessities	Hospital	100000	Large hospital, primarily managed by robots
	Supply Depot	16000	Everyday necessities for civilians
Open Space	Park	114009	Includes pond area available for fishing, ice cream and coffee depots. Pond Area includes a fishing dock
	Mountain Biking	218063	Biking trails to suit a large range of skills
	Band shell	75000	Offers musical entertainment on a weekly basis
VILLAGE ORANGE - 751225 m^2			
Community Element		*Area (m^2)*	*Details*
Residence	Singles	400000	4000 houses Capacity for **1 occupant** each
	Couples	86400	600 houses Capacity for **2 occupants** each
	Family of 3	15680	80 houses Capacity for **3 occupants** each
	Family of 4	5120	20 houses Capacity for **4 occupants** each
Recreation	Recreational Center	62876	Includes track, weight room, pool, yoga, rock climbing, courts, skating rink, and food area
Necessities	Supply Depot	16000	Everyday necessities for civilians
Entertainment	Theatre	85000	Showcases a variety of Earth movies for civilians
VILLAGE YELLOW (Transient Area) - 751225 m^2			
Community Element		*Area (m^2)*	*Details*

Economy	Single	24500	500 houses Capacity for **1 occupant** each
	Married	15000	150 houses Capacity for **2 occupants** each
	Family	7200	50 houses Capacity for **3+ occupants** each
Executive	Single	1800	100 houses Capacity for **1 occupant** each
	Couple	600	25 houses Capacity for **2 occupants** each
Research	Science Center	164000	Showcases scientific phenomenon from space. Includes space rocks, space suits, and a variety of other space related exhibits. Also includes a glass floor.
Food	Restaurant	1600	A small restaurant for visiting tourists

VILLAGE BLUE - 794700 m^2			
Community Element		*Area (m^2)*	*Details*
Residence	Singles	235000	2350 houses Capacity for **1 occupant** each
	Couples	79200	550 houses Capacity for **2 occupants** each
	Family of 3	17640	90 houses Capacity for **3 occupants** each
	Family of 4	7680	30 houses Capacity for **4 occupants** each
Food	Restaurant	1700	Variety of food from many cultures including Chinese, Italian
Recreation	Workout Gym	2500	Keep citizens healthy and in shape
Open Space	Lake	171950	Aesthetic feature
	Wetlands	84263	Facilitate water circulation

VILLAGE PURPLE - 794700 m^2			
Community Element		*Area (m^2)*	*Details*
Residence	Singles	321000	3210 houses Capacity for **1 occupant** each
	Couples	80640	560 houses Capacity for **2 occupants** each
	Family of 3	17640	90 houses Capacity for **3 occupants** each
	Family of 4	7680	30 houses Capacity for **4 occupants** each
Supplies	Supply Depot/Mall	78328	Includes clothing, groceries, accessories, furniture, daily necessities Arcade, community halls
Entertainment	Cinema	7854	Uploaded Earth movies, 5 screenings

4.5 | Recreational Activities & Entertainment

Not to be left on the wayside of the many things necessary to be accomplished in this project, the physical and mental fitness of Bellevistat residents cannot be overlooked. Especially in an isolated environment with a plethora of new hazards, it is important that Bellevistat stay active and strong to withstand the potential challenges

Monthly, residents will undergo mandatory checkups to ensure that they are physically able to effectively carry out their role on Bellevistat. Those that are deemed unfit to perform their duty on Bellevistat will be advised on how to improve their abilities physically in order to meet their demanding lifestyles; a solution such as a compulsory exercise program at a community centre would be enforced for an obese resident, for example. Failure to comply or inability to meet by what the doctor deems physically safe will result in a designation of the patient to an appropriate designation, whether it be off the station or a job reassignment.

There will be a recreational centre included on the second horizon equipped for a variety of physical fitness activities. Instructional physical fitness activities, such as dance or yoga lessons could also be introduced in order to provide job opportunities for residents and a chance to improve health and relationships as well. Community centres may host a variety of methods for residents to immerse themselves in physical activity as well as entertainment, such as exercise rooms and open gym space for a plethora of sports. The dividable floor ensures that the interests of all the residents are accounted for in a simple, efficient way. In addition, a swimming pool will be constructed to further encourage physical fitness and a proactive mindset within residents, as well as a mountain biking course designed to create a unique and distinct attraction for residents.

Yoga/Dance	Dance/Yoga	Big Storage
Soccer	Rec. Room	

Diagram 4.5.1 | Community Centre layout

Activities will be rotated in the four multipurpose rooms, based on the interests of the residents, and can be adjusted according to demands.

A Likeness to Earth

Every residential area will be designed to emulate the general familiarities of Earth, with implementations such as artificial sunlight and plants in parks. This influences residents to venture outside, experience the unique atmosphere within each neighborhood and intermingle with one another. Earthly familiarities, such as shopping, playing at an arcade, or mountain biking are supported in Bellevistat, as well as a number of other entertaining pastimes enjoyed on Earth.

Room for More

In the name of expanding the culture, entertainment, and way of life for Bellevistat residents, a number of innovate activities and implementations could be proposed.

- Street performers
- Daily word puzzles for all residents to enjoy
- Organized, competitive sport; neighbourhood Olympics
- Activities co-ordinators, people that lead activities in fitness
- Curved sports fields
- Public equipment lockers that depend on identification
- Micro gravity sports on the upper horizons
- Create a culture of music, movies, Nobel Space Prize
- Hologram conferencing

Section 5 | Automaton design and services

5.1 | Construction Automation

ETV (Figure 5.1.1)
The earth orbit transfer vehicle (ETV) will be a large vehicle used to transfer material from earth for construction. It has a large payload and is controlled by a computer that is given coordinates.

Table 5.1.1 | ETV Specifications

Materials	**Titanium/Carbon fibber**
Dimensions	**50mx20mx20m**
Payload	**400tonnes**

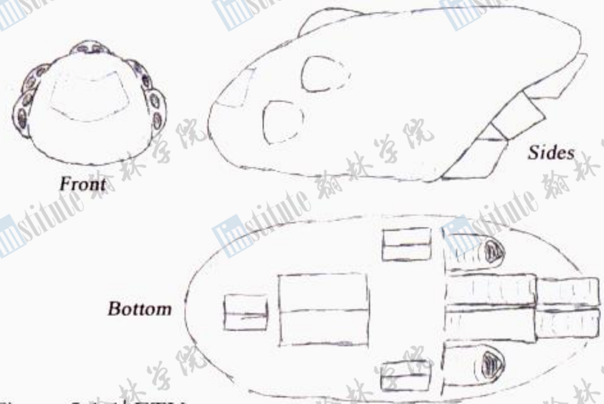


Figure 5.1.1| ETV

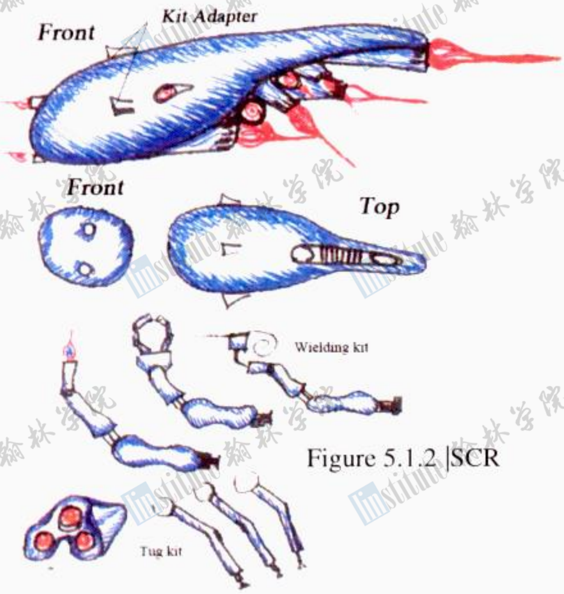


Figure 5.1.2 |SCR

SCR(Figure 5.1.2)
To undergo construction in space the Space Construction Robot (SCR) platform was developed. With many powerful rotateable thrusters this platform is very stable and accurate and is created for precision work, such moving, holding, welding parts in space. The two kits allow it to do the different jobs. The wielding has a torch arm (a hot metal conductor that is hot on demand). The Tug kit come with extra booster for more thrust, and advanced versions of the Canadarm. These are only the two main kits; there ware more kits for specific jobs. Since the some jobs will not be required for the whole construction process, the kit system will lower the amount of total robots, lowering cost and saving time.

Table 5.1.2 | SCR Specifications

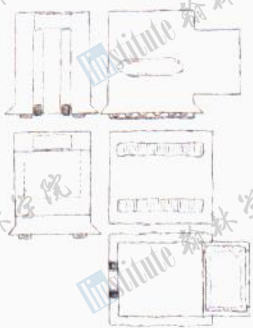
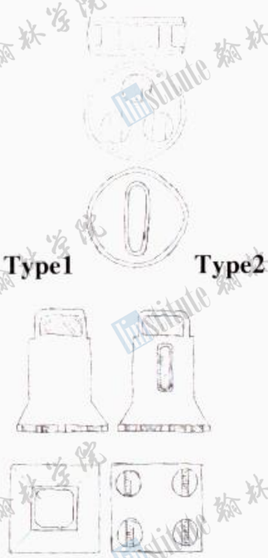
Materials	**Polymer shell, titanium mechanics**
Dimensions	**3mx1mx1m**
Communications	**Robot communication wireless**
Wielding kit	**Steadying arm, wield wire hand, torch, all 2m long**
Tug kit	**3 Canadarms (hot swappable tools)**

5.2 | Maintenance Automation and Plans

5.2.1 | Maintenance Automations

The table below shows the three versatile platforms that will be used to maintain and improve the liveability of the station. The SCR in section 5.1 will be use to maintain the exterior of the station.

Table 5.1.2.1 | Maintenance Automation

Image	Platform	General Specs	Description
	Goods Transfer Robot (GTR) platform	Materials: titanium and polymer shell, titanium mechanics Visual Scanner: 2 (1 with movable arm) Multiple attachments tread Humanoid torso Truck Bed (Various sizes) Height 2m Width 1.6m Length 1.7m	• Accompanied by HIR on deliveries to residents • Expertise at locating goods in supply depots • Can be configured to life very heavy loads, such as cargo • Will be used during finishing process
	Tight Space repair robot (TSR) platform	Materials: polymer shell, titanium mechanics Magnetic treads Height 0.1m- 0.5m Width 0.5m Length 0.5m	• Type 1 of this platform adds both visual and tactile sensors to match the contents inside the walls to the version in the maintenance mainframe. The locations of deformities will sent to the mainframe sending a type 2 to fix the problem. It can scan 600m^2 a day thus having aprox. 16000 units(likely 2k-3k will be need in reserve), the mechanics between walls will be check every 48 hours • The Type 2 adds the robotic arm attachments that will allow repairing pipes, cracks, wires ect. Required material is provided before the Type 2 leaves its storage area.

	Human Interfacing Robot (HIR) platform	Materials: Polymer shell, titanium mechanics Visual Scanner: 2 (1 with movable arm) Multiple attachments Optimized for human contact Humanoid Height 1.5m (mean) Width 0.6m Length 0.3m (greatest length)	• This platform is used in any area where robots will come in contract with humans, it has special programs and sensors that make interaction intuitive and safe • HIR can perform many tasks by altering its hardware(tools and attachments) and software(instruction to tasks) • HIRs are humanoids and ascetically pleasing, they need to be around humans • Uses: maid, handyman, defense, general repair, etc.

5.2.2 | Servers

Since there will not be computers, we will need to allocated large rooms for the mainframes. Since each mainframe is used for a specific purpose, it would be logical to place them where needed to decrease cable length. There will be enough space in the areas for additional hardware to be added. All hard drives can and will be upgraded when filled with data the same goes for other dated parts. Table 5.2.2.1 shows the mainframes and there locations:

Table 5.2.2.1 | Location and Purpose of Servers

Mainframe/Servers	Location	Purpose and requirements
Education	2nd horizon (University)	• Large processing power for simulations • Enough RAM and hard disk space for strange of work files • Runs telescope, lab, teaching facilities ect
Main life support	Core	• Monitor all important factors of life support, air mixture, location of station, water filtration ect
Transportation (x6)	1st Horizon (near ports)	• Enough processing power for laser guider • Large HD to archive, arrivals, departures, cargo, visitors ect • Laser guiding peripheral also allows data transfer and sensors to find location of space vehicles in proximity (100km)
Other Life Support/General infrastructure	2nd horizon	• Powers climate control, water pumps, as well as things such as transportation, PHOLED skies, supply depots • Will take colossal amounts of ram and CPU power
Agriculture	3rd Horizon	• Monitors food growth and storage
Industries	4th horizon	• Enough RAM and processing power to control many robots simultaneously • Industry archives will need large data storage • Wireless transmitter allowing all robots to be connected at once
Maintenance	3rd Horizon Maintenance hanger	• Enough RAM and processing power to control many robots • Maintenance archives will need large hard disk • Wireless transmitter allowing robots to communicate
Commutations	Core	• Enough RAM to store all incoming and outgoing, data • Large processing power to regulate data • Attach to the comsat system that exchanges information with earth
General Computing	2nd Horizon	• Wireless transmitter allowing full bandwidth for 20000 iPID and other peripherals • Is the iPID's "brain"
Foundation	4th Horizon	• The hub that will archive everything in the Bellavistat, Thus will need petabytes of storage range will be needed • Large multi-CPU platforms will be need to run all the It act as a link between all the servers and mainframes

Digtial security is at the utmost of importance to our settlement. Thus the entire system will use a voice, finger print, and/or retinal scan randomly on top of password, to protect files from being stolen. To add to the security, earth's network cannot access our databases, we have a team of experts to ensure that is a fact. Also there will a monitor recording important information every time critical files are accessed.

5.2.3 | Contingency Plans

In order to detect any accidents, disasters, or distress within the settlement, a network of sensors will be installed throughout the station. These sensors will monitor things such as gravity, air quality, temperature, chemical concentrations, pressure etcetera, which will provide indication of a problem. Should sensors detect any abnormal values in regards to atmospheric conditions, auditory and visual alarms will instruct all residents to evacuate the affected area and Foambots will be dispatched to the scene of the problem. Once the station's sensors have confirmed that no life signs remain in the affected area, the Foambots will explode, filling the room with high density polyurethane foam. This will extinguish any fire, compensate for pressure losses or hull breaches, plug any gas leaks, or contain any chemical spills. Foambots containing regolith, Regobots, will be dispatched to any area with high levels of radiation, indicating a hole in radiation shielding. These Regobots will fill the room with lunar soil, preventing the radiation from further penetrating the station.

In the case of gravity loss (as measured by the station's sensors), thrusters located on the docking ports will fire, temporally providing the gravity necessary to rectify the situation.

Should any domestic disturbances arise, residents can use panic buttons or their iPIDs to call for a lockdown. This will dispatch Justicebots to the area and seal off all entrances. The Justicebots will then stun everyone in the area by means of electric shock, until the authorities can arrive on scene to attend to the situation. In the event of a medical emergency, as sensed by the residents watch monitor, the Stretcherbot, an automated, motorized stretcher, will retrieve the causality. He or she will then be transported to the nearest medical facility equipped to handle the situation, as detailed by the watch monitor. This information will be made available to medical personnel who can prepare for the victim.

5.3 | Lifestyle Enhancing Technologies

Table 5.3.1 | Lifestyle Enhancing Technologies

Image	Object	Description
	Food Processing Robot	• Non movable robot that is attached to the ceiling of the non residential kitchens • Is a series of precise arms and clamps allow it to make food exactly as programmed • Recipes can and will be updated
	The surface cleaning robot(SCR)	• Similar to the current robot vacuum in shape and function • Includes a mop and vacuum • Uses magnetic propulsion and thus can clean walls and floors
Appearance depends on animal being replicated	Robot pet	• Animals are complications • many tactile, visual and audio sensors to make it life like and reactive
	Nano-bot gum	• Replaces the need to brush teeth • Nano-bots trapped in chewing gum will scrub mouths • Nano-bots are indigestible so will not cause harm
	Information watch	• Watch • same uses as IPED but due to smaller size it will suffer from smaller screen, less intuitive interface, and less computing power

	**IPID (master of controls)**	• Cooking timers • Power consumption in house • Lights and doors • Transportation • Orders food • Computing and Communications (see 3.2)
	**IPID TVs**	• TV functions as an extended screen of the IPID system
	Wireless Energy	• using electromagnet frequency peripherals are completely wireless • IPEDs are charged when a hub is in range • each unit is equipped with one of these hubs

The GTRs and HIRs (maid and handyman) are a large part of the lifestyles or our settlers. The HIR especially for it will meet all most needs of the settlers, needs like cleaning, repairs, and later upgrades may allow it to cook, tutor etc. Figure 5.3.1 shows the required bandwidth of the systems in order for everything to run smoothly.

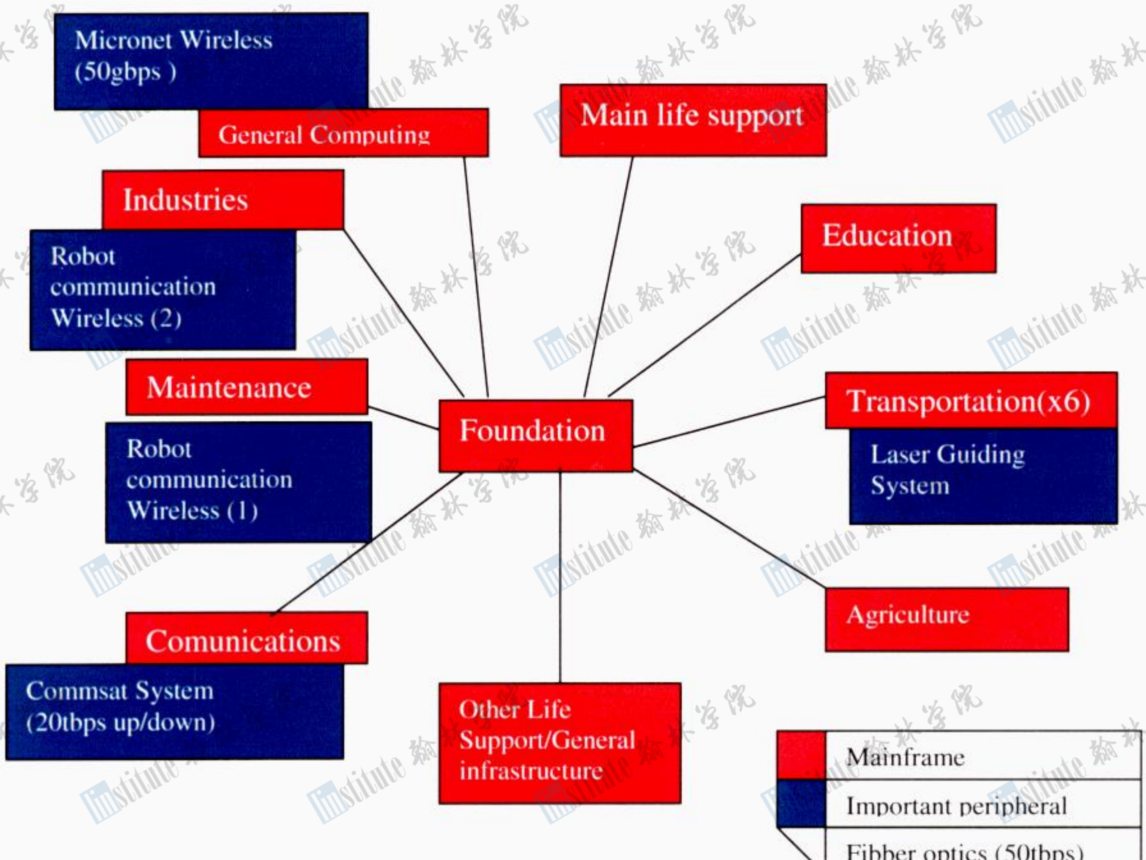


Figure 5.3.1 | Bandwidth

5.4 | Finishing Automation

Finishings will be performed by the GTRs, the TSRs and the HIRs. The GTRs will be use as transport for transporting the finishing materials to the site. The HIR's and TSR Type 2's will be doing all of the true finishing as they are maneuverable and not very large. The TSR Type 1 will come into the area preceding the finishing and accurately deduce what needs to be finished and with which tool. We will need to use a combination of GTR's, TSR Type 2's and HIR's to complete each interior. To finish a regular room on its own with all supplies at area, a GTR could take an estimated 14 days to complete. To finish a regular room, a TSR Type 2 will take an estimated 11 days to complete (granted all supplies are at location). It takes less time to complete the task than the GTR as it is more maneuverable and faster as it is lighter and smaller than the GTR. The HIR on the other hand will take an estimated 17 days to complete a room. The HIR is not very strong and not very stable but it is very maneuverable. To finish a room as quickly as possible, we will need to utilize all three robots to effectively finish a room. As an average, we will need 1 GTR's, 3 TSR Type 2's and 1 HIR's per $4m^2$. We will not need many GTR's as they will be used primarily as transport for supplies and we will not need many HIR's as they will used for hard to accomplish tasks such as installing piping and wiring as they need maneuverability as they are in tight spaces. We will need many TSR Type 2's as they are the builders and will be the fastest in finishing the area. We will only require one or two TSR Type 1's as their job begins and finishes before the finishing commences. Two arms are used by the robots and vary in size and length but the average will stem around 1.1m in length and 0.05m in radius.

The first detachable arm (or Arm A) will be the aesthetically pleasing model that will be found on nearly every HIR. The Arm A will look and act just as a regular human's hand does. It will be complete with four fingers and a thumb yet it will have a sensor on the palm.

The second detachable arm (or Arm B) will be the model for performance. The basic arm will be the same as the Arm A model yet this model's hand is much more complex. Each hand on the Arm B will be equipped with three similar tools (Plumbing tools, Carpentry tools, etc). The tools will be attached to a rotational fixture held by the Arm B's hand. There will be a sensor on hand holding the rotational fixture so the robot will be able to accurately, and quickly perform its task. All three types of robots will be programmed to use all accessible tools. Simply plug arm into shoulder to connect it to the robot.

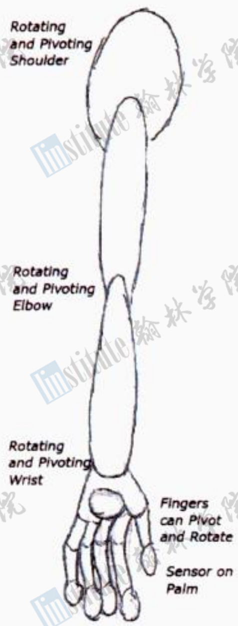


Figure 5.4.1 | Arm A

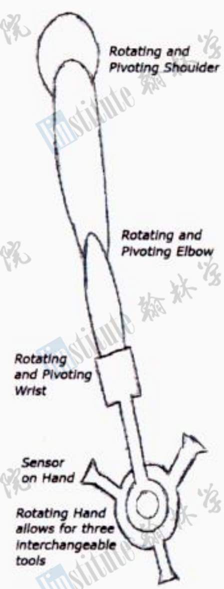


Figure 5.4.2 | Arm B

5.5 | Mining Automation

As materials harvesting and transport is an arduous task, we will employ machines to do the work for us.

Name	Role	Description	Dimensions	Mass (kg)
Selachis	Primary extractor	A central power hub and storage unit is outfitted with drills for extracting large portions of the asteroid. Will mine one area continuously to a depth of 200m before moving in order to maintain the asteroid's structural stability. Can hold materials until picked up by the transports; acts as a sort of hub.	Height:40 m Radius: 20 m Capacity: 14500 m^3 Drill radius (base): 8m	8,500,000
Cathartes	Transport	A class of small ships that interface with the Selachii, delivering harvested materials to Bellevistat. Roughly cylindrical in shape.	Length: 15 m Radius: 5 m Capacity: 1100 m^3	Empty: 750,000 Full: 2,000,000

Table 5.5.1Mining Robot|specs

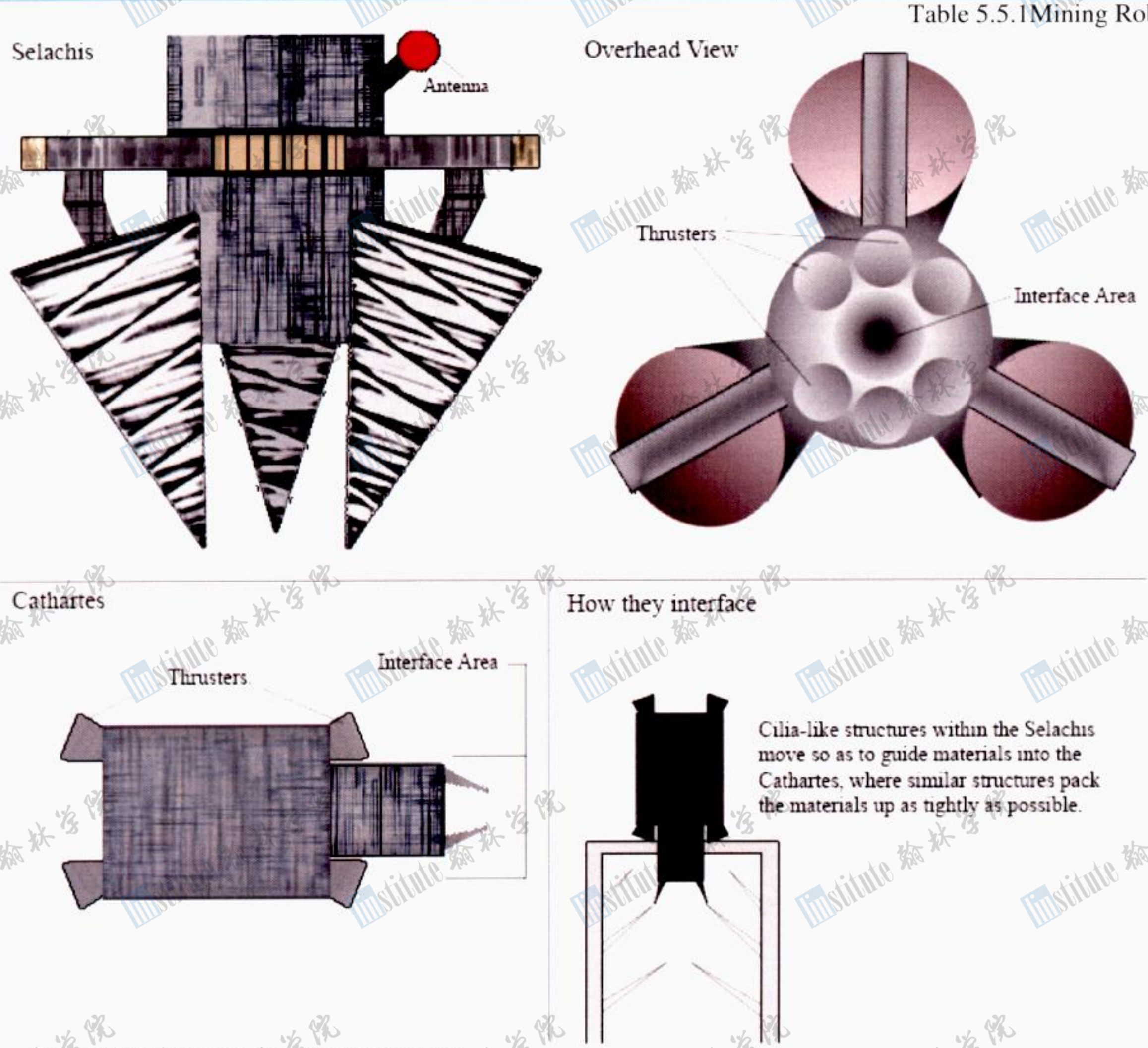


Figure 5.5.1|Diagrams of Mining Robots

Section 6 | Schedule and cost

6.1 | Construction Schedule

Table 6.1.1 | Schedule of key events in Bellevistat construction

Timeframe	Event
10 May 2028	Construction begins on Earth
June 2029	Core segments launched into orbit
December 2029	Assembly complete Asteroid pulled into orbit
2030	Industrial and mining operations begin Rudimentary life support installed
2031	Construction begins in space
2032	Skeleton complete Construction of Habitat One begins
2033	Habitat One structurally complete Construction of infrastructure begins Interior finishing begins Construction of rudimentary transportation systems begins
2034	Habitat One habitable Foundation Society members may move in Trade with earth market begins
2036	Habitat One fully complete Rotation begins Entire population will be fully housed and supplied Construction of inner horizons begins
2037	Construction of inner horizon structure complete Construction of infrastructure of inner horizons begins
2038	Business and recreational areas complete Communities fully established
2039	All transportation infrastructure complete
To 2049	Observational period

6.2 | Financial Overview

The Foundation Society's investment in Bellevistat would be approximately seven billion dollars over eleven years, with an initial investment of one billion. The majority of the costs would be incurred within the first five years of construction. Once fully operational, the station will generate a profit of roughly seven hundred million dollars annually. This will allow the Foundation Society to begin to see a profit after ten years of operation, or around 2050. After fifty years of operation, Bellevistat will yield a 400% return, and a 900% return by 2140, after one hundred years.

Table 6.2.1 | Construction costs

Construction required	Cost (millions USD)
Core segments	900
Life support	1200
Five horizons	3400
Infrastructure	1000
Transport systems	500
Total	**7000**

Table 6.2.2 | Annual expenditures

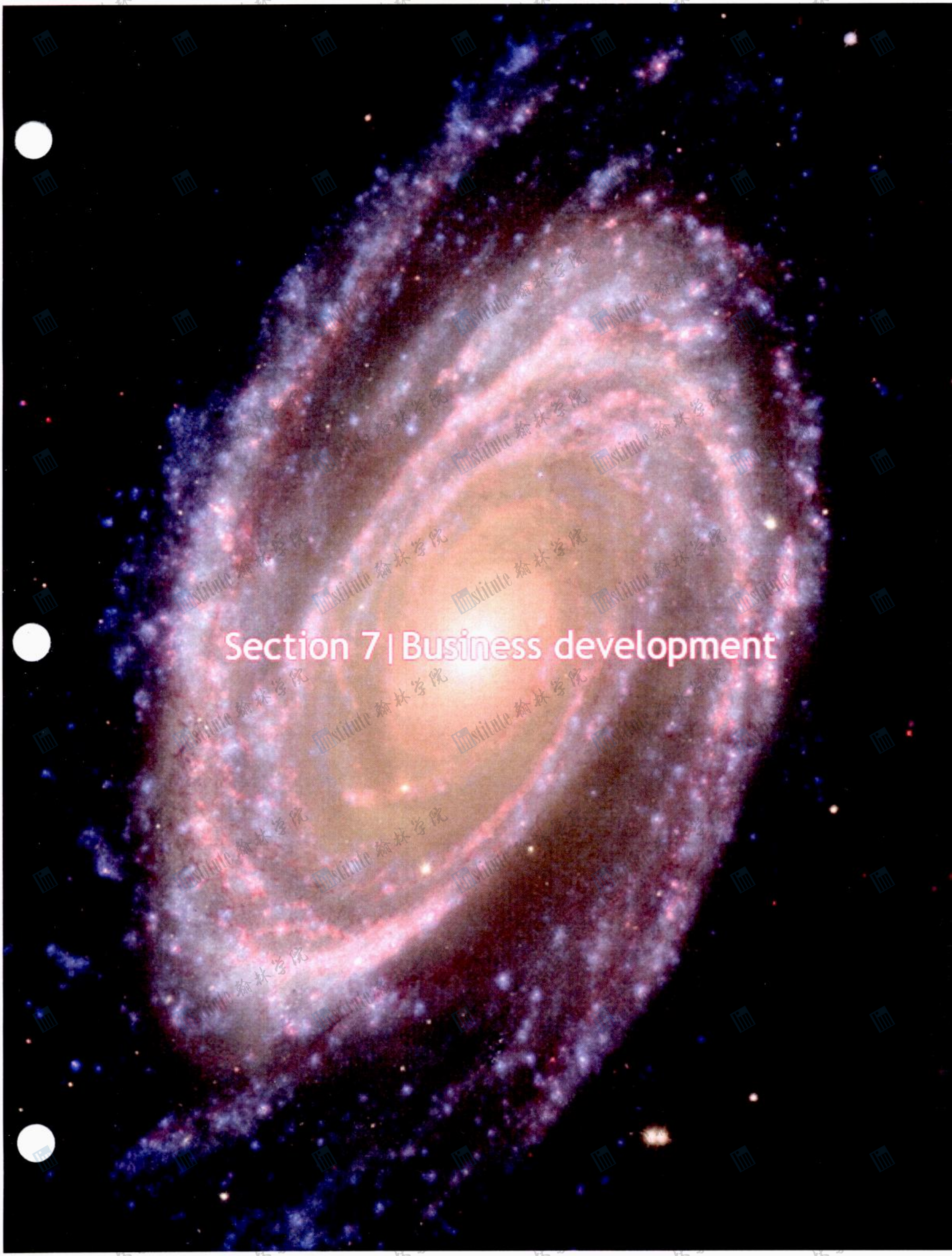
Type of expenditure (annual)	Cost (millions USD)
Maintenance and upkeep	250
Salary	50
Imports	100
Infrastructure	100
Total	**500**

Table 6.2.3 | Annual revenues

Type of revenue (annual)	Revenue earned (millions USD)
Industrial lease payments	400
Institutional lease payments	25
Docking fees	200
Tourism	350
Manufacturing (by contract)	175
Manufacturing (sales and exports)	50
Total	**1200**

Table 6.2.4 | Employee headcount estimates

Employee role/deployment	Earth-based	Space-based	Total
Core segments (industrial)	100	10	**110**
Life support	15	50	**65**
Habitat One	25	225	**250**
Infrastructure	15	150	**165**
Transportation systems	15	125	**140**
Inner horizons	15	150	**165**


Section 7 | Business development

7.1 | Materials: Earth-bound

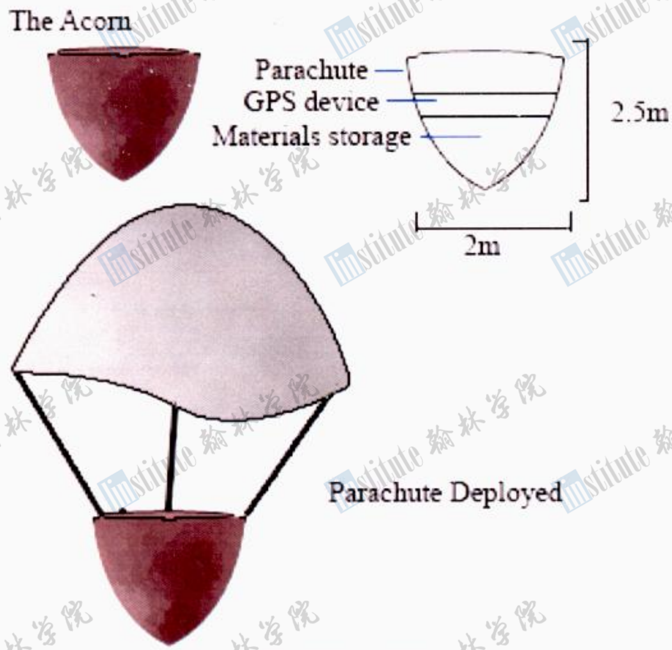


Figure 7.1.1 | Acorn Earth Re-entry System

Table 7.1.1 | Details of Acorn System

Component	Material	Recyclable?	Reusable?
Shell	Aluminum	Yes	No
Parachute	Synthetic fibres	No	Yes
GPS device	Electronics (silicon, wiring, etc)	No	Yes

7.2 | Space manufacturing

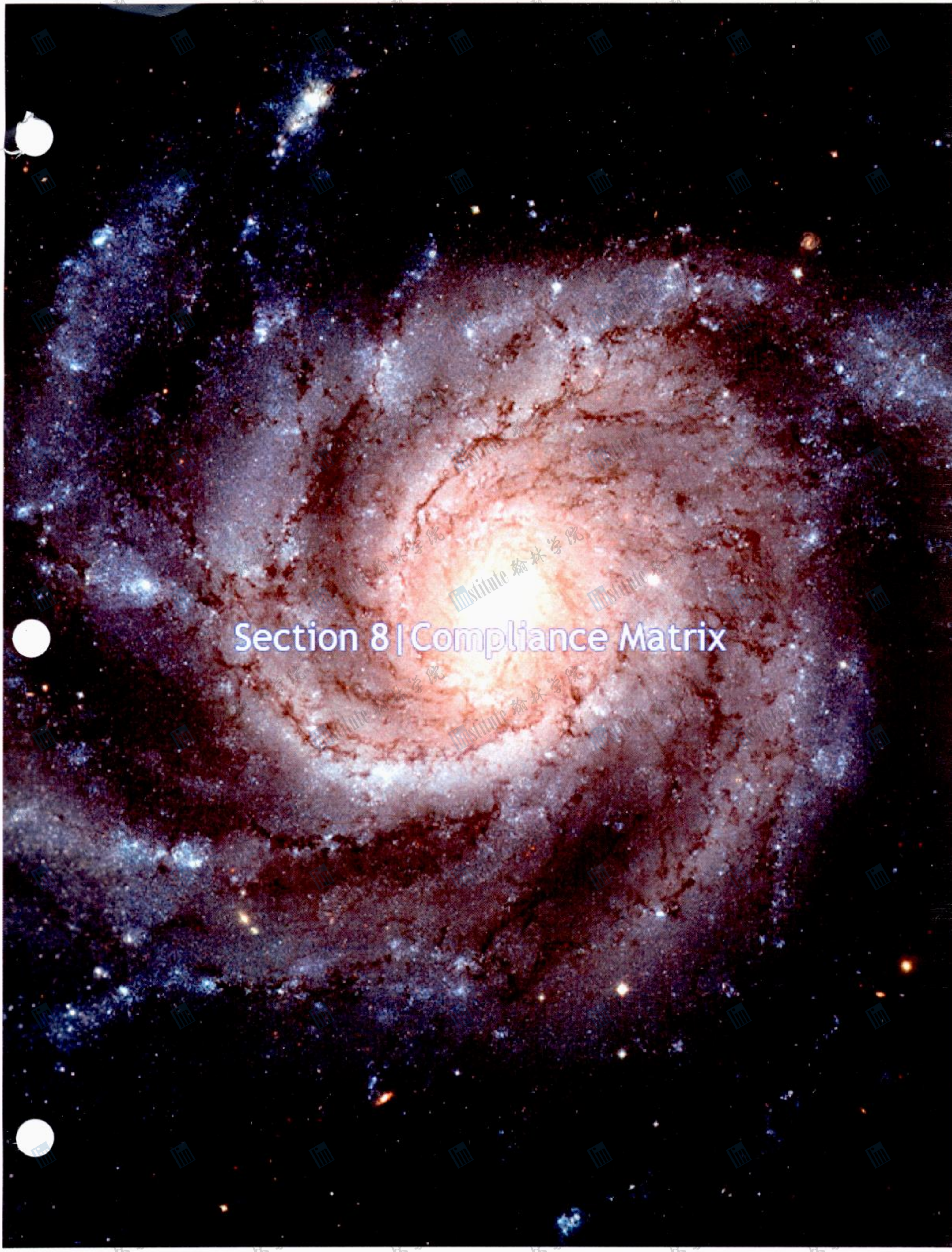
Table 7.2.1 | Manufactured Products

Product	Materials	Why manufacture this?
Various spaceships	Aluminum, titanium, steel, electronic components, interior finishing components	Interplanetary and lunar missions can rely on Bellevistat to provide top quality spacecraft without the cost of an earth launch.
Refined materials (as requested)	Aluminum, titanium, steel, electronic components, silicon, various others as required	With the industrial core already refining many materials useful in large-scale construction, it only makes sense to supply space and lunar construction projects with refined materials.
Specialized equipment (as requested)	Aluminum, titanium, steel, electronic components, silicon, various others based as required	Bellevistat is in an ideal location to supply large-scale space and lunar construction projects with the equipment they need.

7.3 | Tourism

To ensure tourists to Bellevistat receive the most authentic experience possible, all visitors to the station will receive full, non-voting, citizenship status for the duration of their stay. Upon their arrival, tourists will receive "smart" identification cards allowing them resident privileges, such as access to communication systems, recreation facilities/equipment, public databases and media, and all public areas, as well as food and necessity allotments from the supply depots. Essentially, tourists become temporary station residents. They will be encouraged to assimilate into settlement culture by living as the locals do, allowing them the full experience of Bellevistat life. A key component of Bellevistat tourism will be job shadowing. Visitors wishing to maximize their experience will be encouraged to volunteer to assist a resident in their job, acquiring an understanding of everyday life aboard B-stat. Tourists will live in one of nearly one thousand transient residences, akin to a hotel room. These rooms will be slightly smaller than those belonging to permanent residents, though executive suites will be larger and feature a bar and lounge area.

The cost of the visitor's stay will be tabulated upon leaving the station, when he or she will be billed. The revenue accumulated from tourists will be put toward station maintenance and improvements, creating a more viable and prosperous settlement.


Section 8 | Compliance Matrix

8.0 | Compliance Matrix

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