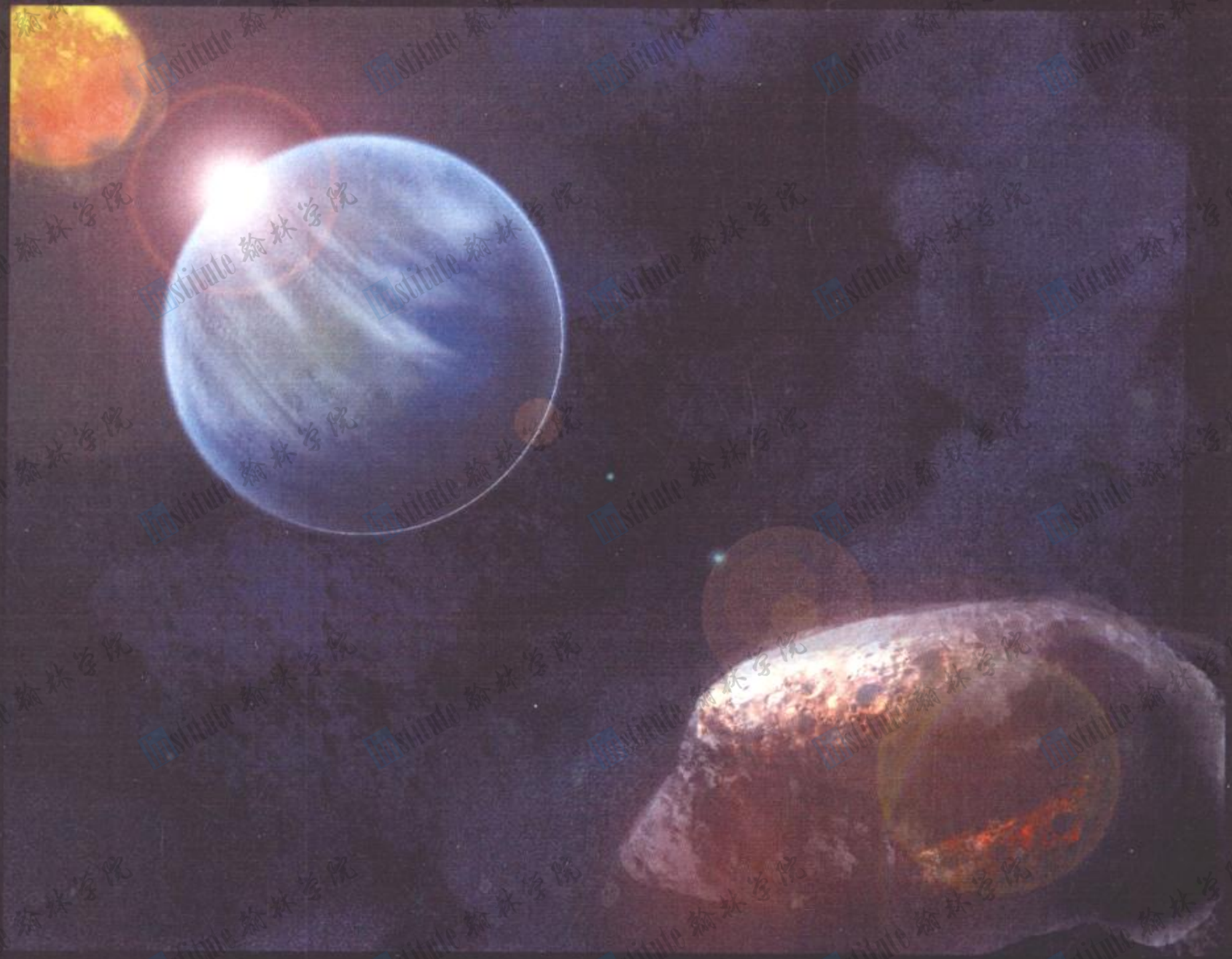
Bellevistat



NORTHDONNING HEEDWELL

Division: **Phoenix Quintessential**
Cerritos, California, USA

1.0 EXECUTIVE SUMMARY

Ever since our ancestors first emerged from the jungles of primordial earth, humanity has looked upward at the night, gazing in wonder at the twinkling points of light that would inspire and illuminate the ever-progressing world. For many millenia, we have wondered about the unknown world there, holding the heavens in eternal awe.

Little more than a century ago, humanity was still constrained by the surly bonds of earth, not yet having discovered powered flight. Four years and half a century later, a new dream was realized with the launching of the first satellite, Sputnik I. For the first time, one of the many motes of light in the night was one crafted by human hands. And as the aerospace industry continued to develop in leaps and bounds, we found ourselves no longer restricted in simply exploring space, instead in a new position to colonize it and use it to better mankind. This goal was realized with the construction of Alexandriat, the first settlement commissioned by the Foundation Society to mitigate the effects of global warming on Earth.

But Alexandriat, for all its uses and famous innovations, was but the first step. The next step in this poignant vision of life among the stars is Bellevistat, marking the dawn of a new era in space colonization.

As the next generation of pioneers, Northdonning Heedwell is proud to present the pinnacle of space colonies, Bellevistat. Instead of relying on cumbersome, damage-prone space station designs, the design of Bellevistat centers around an asteroid, 1866-Sisyphus. Spread into six microcities and three industrial sectors, the colony of Bellevistat is built into the asteroid. The natural radiation shielding and inherent stable, strong structure of the asteroid ensures the complete safety of all residents inside the colony. From the same asteroid, Bellevistat has access to a reservoir of natural resources, providing raw materials while enabling independent production of goods. As the colony is built inside the asteroid, the sheer volume of the asteroid ensures possible colonial expansion. In addition, portions of the spinning asteroid are suspect to low-G environments, promoting not only industrial interest in the colony but also interesting experiments for the advancement of science.

Since Bellevistat translates into "beautiful view", it offers a plethora of awesome views of different aspects of space. For instance, through a series of mirrors, inhabitants can gaze contently at either the Earth or the moon, safe from potential radiation exposure. If they are more partial to a gaze at the starry skies, Bellevistat offers them a chance to not only see the stars but "swim" in the stars through its innovative "Pool of Stars". Besides astral views, the colonists are surrounded by the natural beauty of Bellevistat; the numerous community orchards and simulated wilderness entices transients and residents with pleasant aroma of flora.

Colonists will discover the wealth of innovations that serve to make Bellevistat different from Alexandriat. One noticeable illumination is the universal Health Monitoring System, automatically tracking the health of each colonist and offering advice for better living. In terms of transportation, Bellevistat breaks new ground with the introduction of an efficient personal rapid transport network dubbed SkyTran, eliminating excess use of resources. In addition, the introduction of a Smart Home enables everyone to have access to an automated maintenance system, food distribution, and other services. Everywhere in Bellevistat, innovation can be seen in many ways and form.

Orbiting the Earth-Moon L4 Lagrangian point, Bellevistat is situated at the nexus of space colonization: the Moon. By being situated between the Earth and the Moon, it provides mankind the opportunity of tapping into the next gold mine of history. From the Moon, a limitless source of materials exist, capable of powering the constantly growing needs of humanity and colonization. Thus, Bellevistat is the new gateway for the future. Through it, humanity now has a new method of reaching the vast horizons of space. Even if the frontier of colonization changes, Bellevistat will remain a home to all.

Konstantin Tsiolkovsky once stated, "The earth is the cradle of humankind, but one cannot live in the cradle forever." Alexandriat is but the first major effort out of the cradle. With Bellevistat, humankind will finally walk on its own, out of the cradle.

2.0 STRUCTURAL DESIGN

Bellevistat is a settlement designed to accommodate population of 18,000 permanent residents and 1,000 transients. This space colony is structured to imitate a functional, self-sufficient, manufacturing community that aims to better humanity's expansion into space by attracting motivated young residents to mine extra terrestrial materials and use them for possible space settlements elsewhere. Bellevistat will provide a platform for future expansions of space colonies onto other asteroids.

This space settlement will be located on the asteroid Sisyphus 1866, one of the largest near earth objects suitable for the construction of a community equipped to support its population and produce excess products to send back to earth to sell as a source of income. Between the time of proposal acceptance and the time when the asteroid gets within range to transport all of the prefabricated material and raw material onto the asteroid, there is a window of 4 years to plan and fabricate all that is going to be brought onto the asteroid.

When constructed, the asteroid will feature 3 industrial micro-cities that are located near the center of the asteroid. Then farther away from the center there will be 2 rural residential micro-cities, 2 infused suburban residential and commercial micro-cities, and 2 urban cities. The micro-cities will be interconnected through the use of a tunnel system that runs from all micro-cities to major junctions.

2.0.1 Population Growth Even with multiple micro-cities located throughout the asteroid, there will be ample space for the expansion of the colony for population increase. Minerals are continuously mined from the interior of the asteroid. As more space is created by mining the asteroid, the mined material can be utilized to construct housing for the increasing population. The agricultural/rural areas of the colony have a capability of producing more than 10 times the amount of food that is needed by the colony's inhabitants.

2.0.2 Natural View A natural view of space will be provided through a system of mirrors that refract images of outer space through a radiation reducing medium, to a designated area inside the colony for the enjoyment of the people.

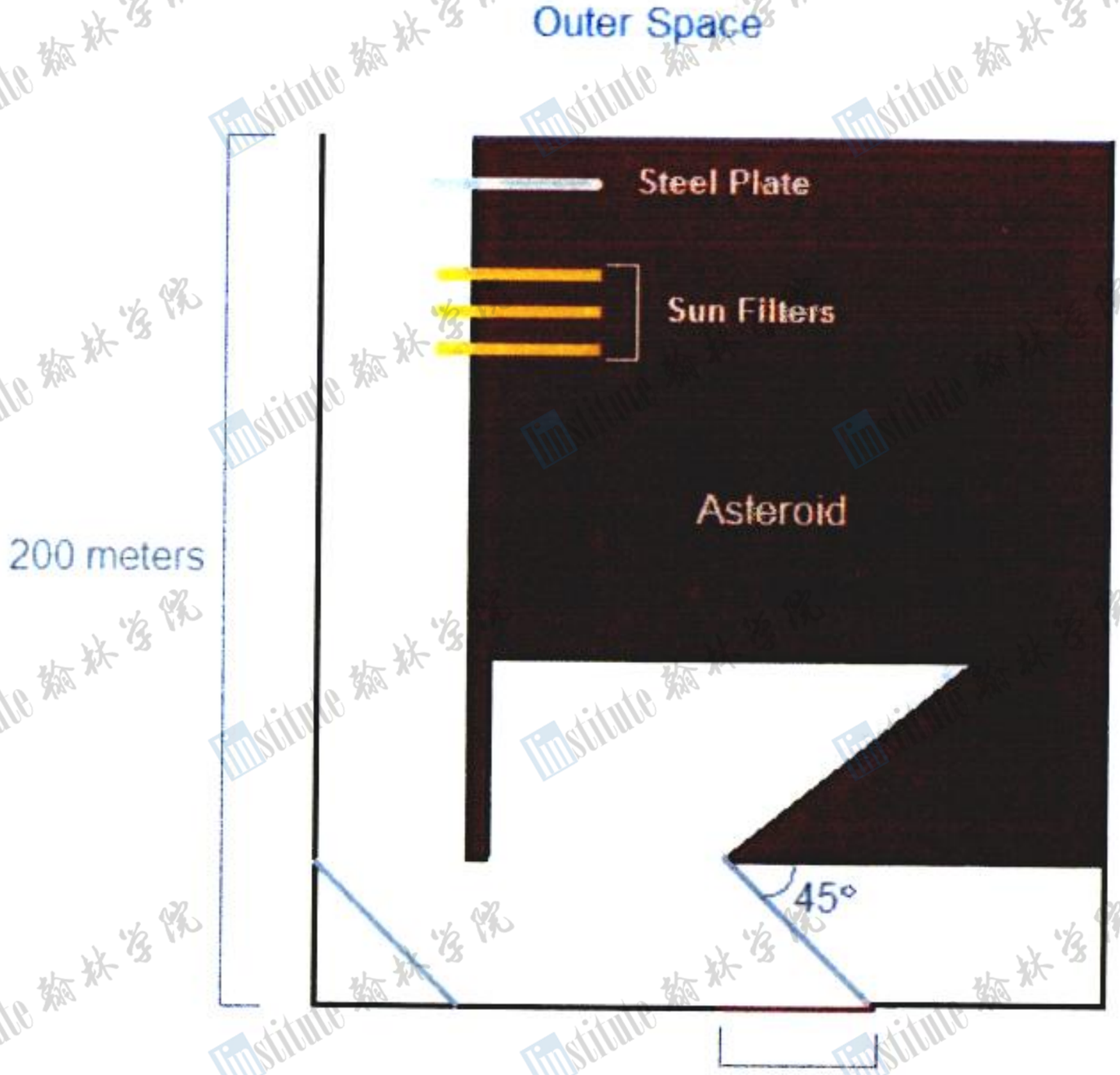


Figure 2.0.2 Mirror-based Natural View System

2.0.2.1 Shaft A shaft measuring 30 by 30 meters will be dug 200 meters below the surface of the asteroid. At the bottom of the shaft, a 30 meter wide by 150 meters long by 30 meters high volume will be hollowed out to make space for the mirror arrays and the viewing glass. A cavity will be dug out above the second mirror array to prevent flying objects from ricocheting off the walls of the asteroid and hitting the viewing glass. By digging such a deep shaft, there is almost no chance that any object could hit the viewing glass. Even if an object was to come into the shaft at the perfect angle, it would bounce off the walls of the shaft multiple times, resulting in a substantial reduction of energy; as a result, it would do only infinitesimal damage.

2.0.2.1.1 Steel Plate In the side of the shaft, a moving steel plate will be installed to cover the shaft if repairs on the mirror arrays or viewing glass are needed. It can also protect the residents in the case of the malfunctioning of sun filters.

2.0.2.1.2 Sun Filters In the side of the shaft under the steel plate, 5 moving sun filters will move over the shaft when the shaft is exposed to the sun directly in order to protect the eyes of the residents who are in the pool of stars or in the outer space viewing rooms.

2.0.2.2 Reflecting Mirrors Two subterranean mirrors arrays located at the bottom of shaft are positioned at 45 degrees, reflecting images of outer space into the colony. Near the top of the shaft, a steel plate is built into on side of the shaft. When there is a possibility of damage to the mirrors, the steel plate can be moved over the hole in the shaft to protect the mirrors. If a mirror is damaged, the steel plate will cover the shaft so that technicians can safely go out and repair it. Multiple sun filters will be installed under the steel plate to protect the inhabitants when the sun is shining in through the shaft. By reflecting images off of 2 arrays of mirrors, radiation from the sun is eliminated up to a tolerable extent.

2.0.2.3 Viewing Glass The outside layer will be composed of 2 layers of 5 meter thick glass with 5 meters of pure water between the two layers. The water between the glass serves as a barrier that stops most of the radiation not eliminated by the reflection of the image off the 2 arrays of mirrors. The pieces of glass are thick enough to withstand virtually anything striking it and the pressure exerted by both the water from the pool of stars and the layer of pure water.

2.0.2.3.1 Pool of Stars The pool of stars is a swimming pool located over a section of the viewing glass. The pool's design will allow the swimmers to look at views of stars and outer space reflected off the mirrors, creating the illusion of literally swimming in a pool of stars.

2.0.2.3.2 Viewing Room The viewing room, adjacent to the pool of stars, is similar to the pool of stars except there is no water. Residents can walk on the glass and look through it to see the outside right under their feet. There is enough glass so that the residents can walk on the glass without breaking it.

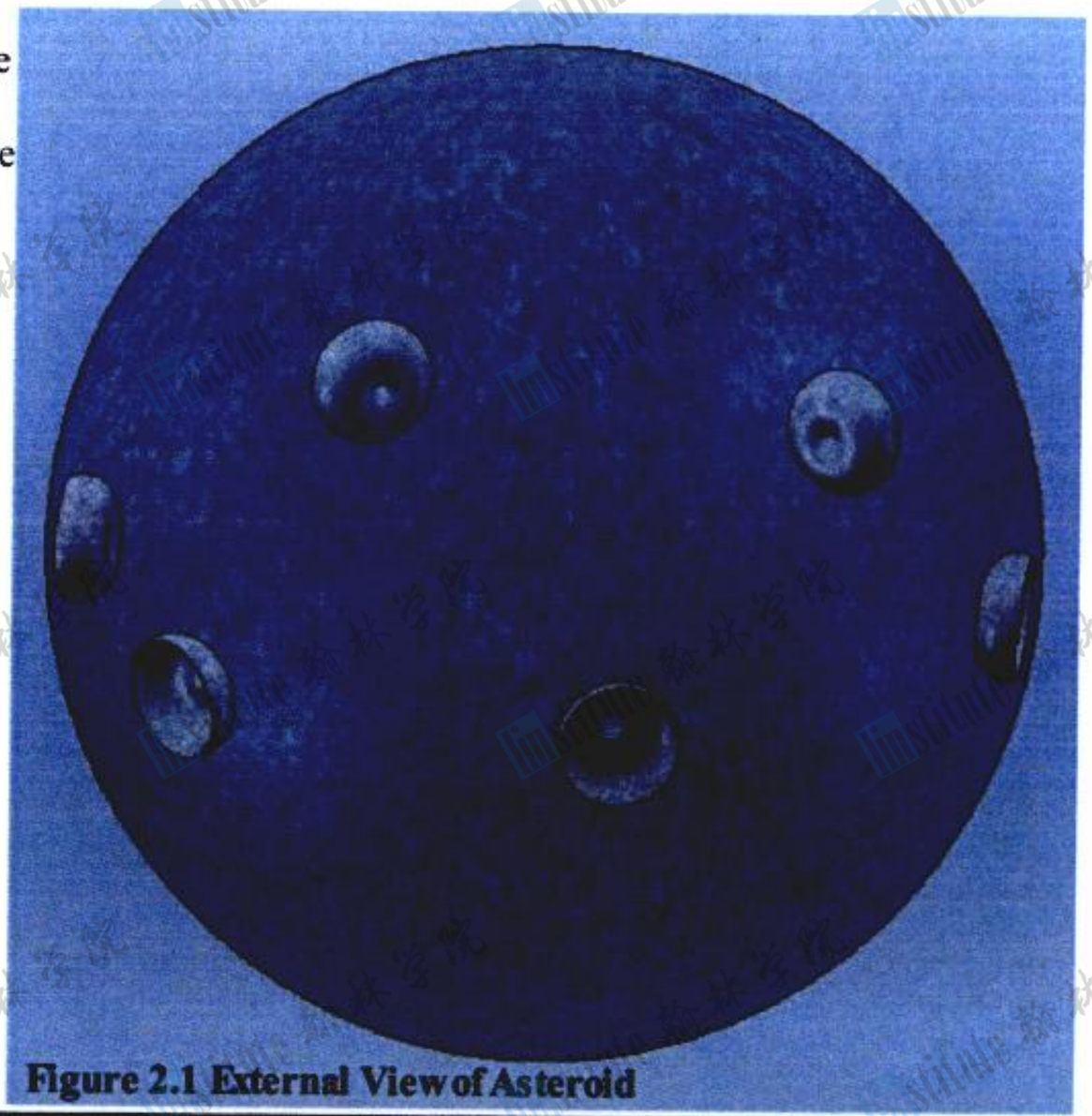


Figure 2.1 External View of Asteroid

2.1 Exterior View of Asteroid

2.1.1 Construction Material The asteroid body itself will be used as an outer shell to protect the settlement, and it will also serve as the walls of the tunnels that connect the different micro-cities. Iron will be used extensively throughout the asteroid, since a big mass percent of the asteroid is iron. Steel can also be used by using the available iron and carbon that can be mined directly off the asteroid. The building material for most of the buildings in the industrial area will be made of concrete since the materials mined from the asteroid warrants it, and it also makes the best use of mined material, rather than letting it go to waste.

Table 2.1.1 Construction Material

Material	Application	Purpose
Concrete	Industrial Buildings	Material used to build buildings in Industrial sector
Ferromagnetic fluid	Base	Fills in any gaps created by hull breaches, and instantly solidifies
Glass	Windows, Viewing glass	Allow people to see outside their houses and outer space
Rock Wool	Dome, Base, Houses	Provides insulation
Steel	Dome, Base, Houses	Structural material

Figure 2.1.1 Hull Base Composition

2.1.2 Areas of Induced Gravity Gravity will be artificially supplied to the colony by spinning the asteroid with VASIMR rockets. The asteroid rotates 0.47 times per minute, generating approximately 1G (or 9.8 m/s^2) at 3.9 km from the axis of rotation. Gravity will be stronger farther away from the axis of rotation; as a result, residential areas are located farther from the axis to allow residents to live in an earth-like environment. Due to the lack of gravity in space, VASIMR rockets can maintain a constant speed with minimal power. In the case the asteroid's rotation rate is affected, rockets can appropriately decelerate or accelerate to correct the offset.

2.1.3 Regions of Low and Zero Gravity, Pressurized and Unpressurized Environments Mining facilities and the industrial microcities are all located in low gravity for ease of transport and processing. However, these areas are still pressurized, so that in case of a malfunction that cannot be repaired by robots, humans can go in without spacesuits to effect repairs. Residential and commercial sectors are kept pressurized with moderate gravity to be suitable for human residence. Two of the docking ports will have no gravity and be unpressurized while the other two ports will have moderate gravity and still be unpressurized.

2.1.4 Radiation and Debris Protection The colony will be protected from radiation and debris by the 100 to 200 meter thick asteroid shell that surrounds each microcity except at areas of outer space viewports. The asteroid shell is the ultimate hull material as it is free, thick and sturdy, and a natural barrier against radiation. In addition, it is nearly impossible to penetrate the microcities due to the asteroid's dense shell and cushion space from the asteroid surface to the base of the microcities. *Refer to Section 2.0.2 for information on protection of natural viewports of outer space.*

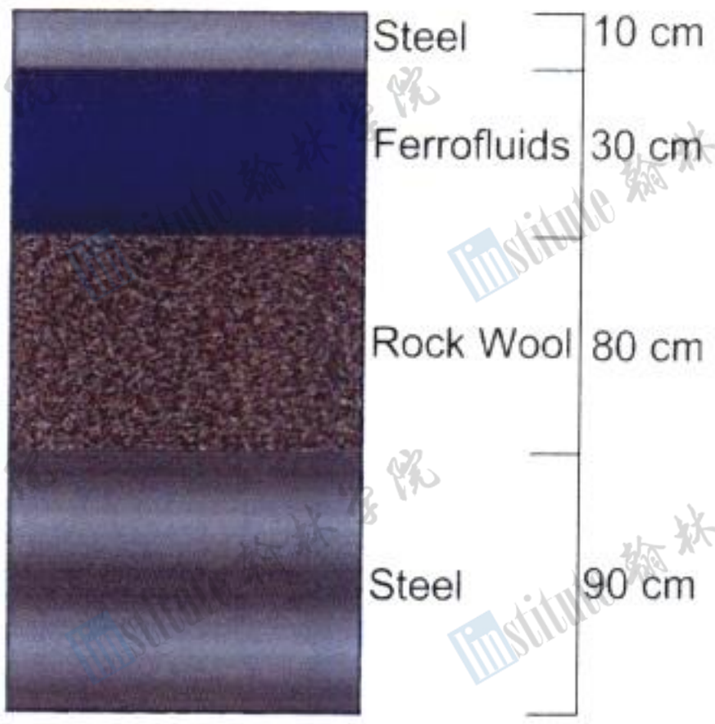


Figure 2.1.1-2 Dome Composition

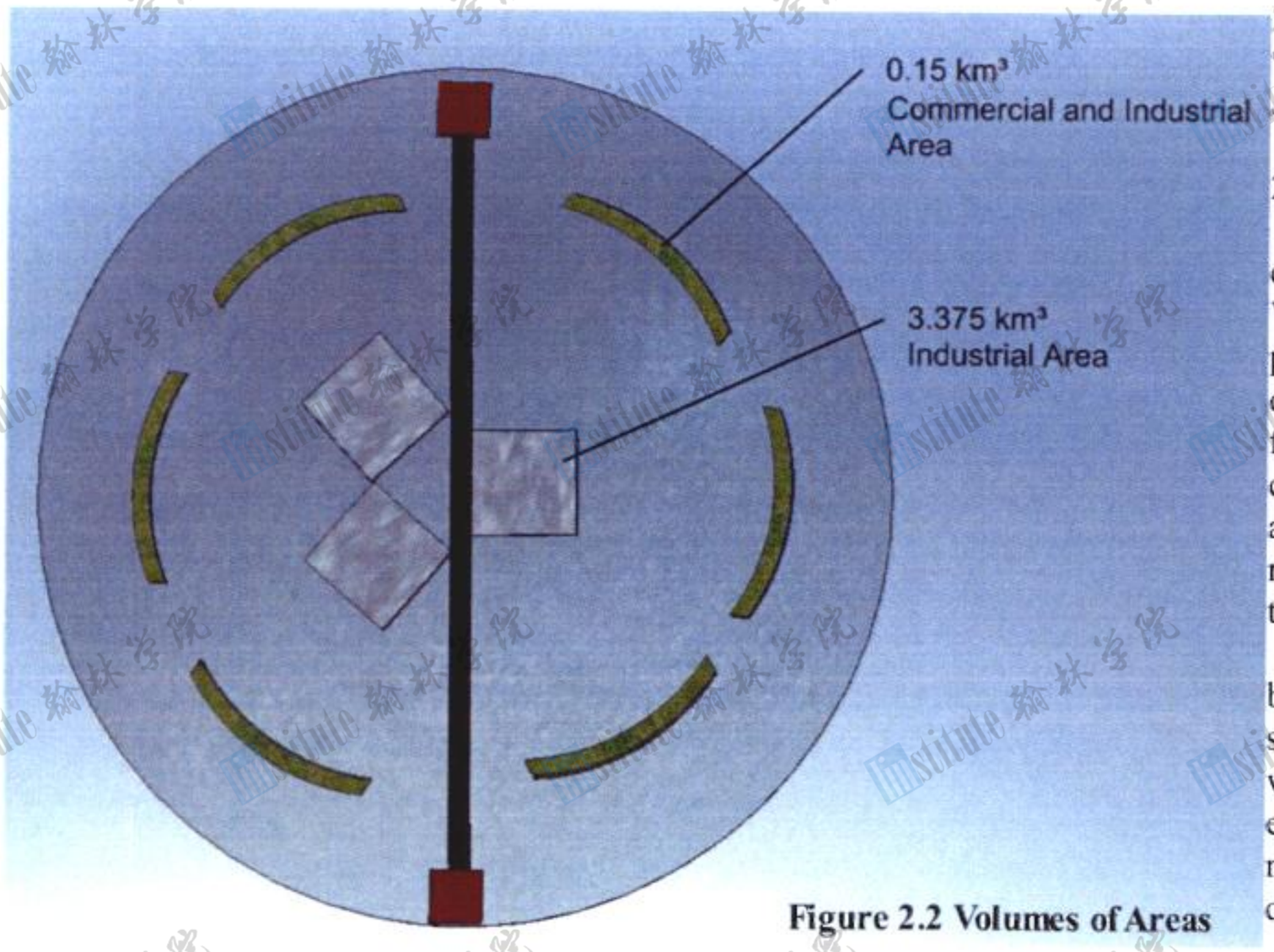


Figure 2.2 Volumes of Areas

2.2 Allocation of Interior "Down" Surfaces *Refer to Section 4.1.1 for more details.*

2.3 Assembly Sequence

2.3.1 Phase One The colony will be stabilized using VASIMR rockets, a nuclear powered high yield propulsion device. The rockets will be fired in set times to completely "capture" the asteroid. After capture, the rockets will continue to spin the asteroid. *See Figure 2.3.1.*

2.3.2 Phase Two Ports will be first assembled to allow subsequent transportation vehicles to dock easily and efficiently import construction materials. At the same time, dish satellites measuring 50

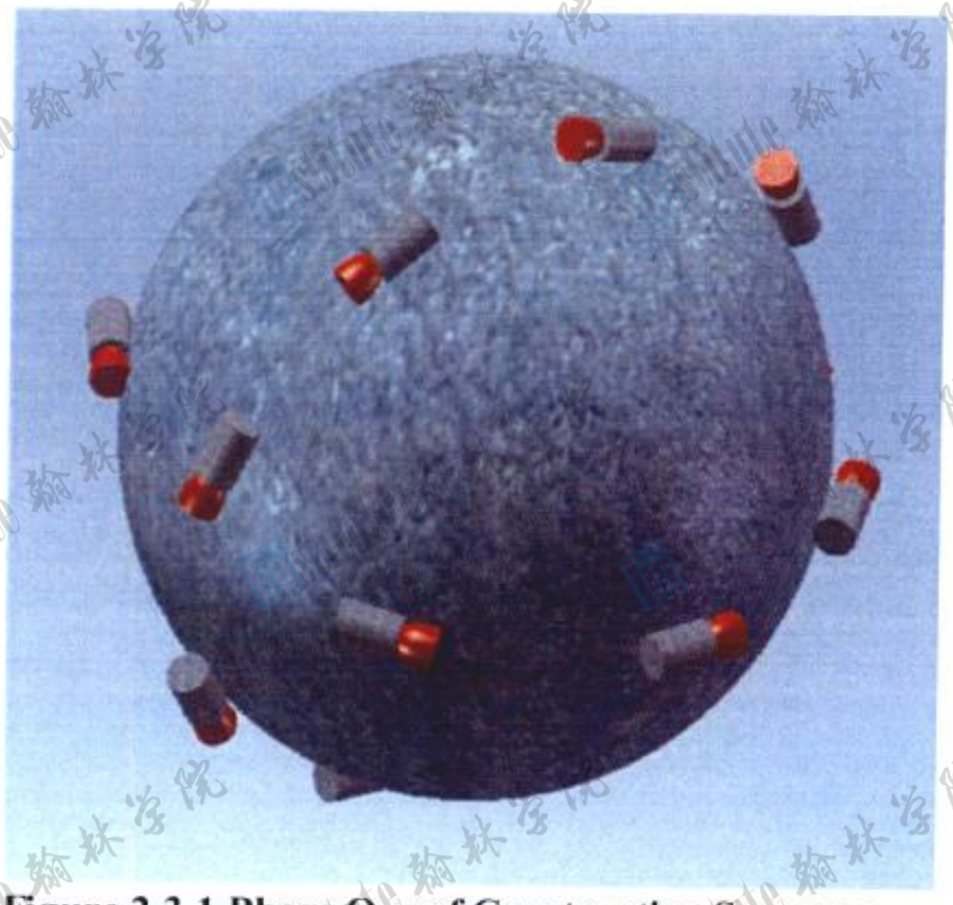


Figure 2.3.1 Phase One of Construction Sequence

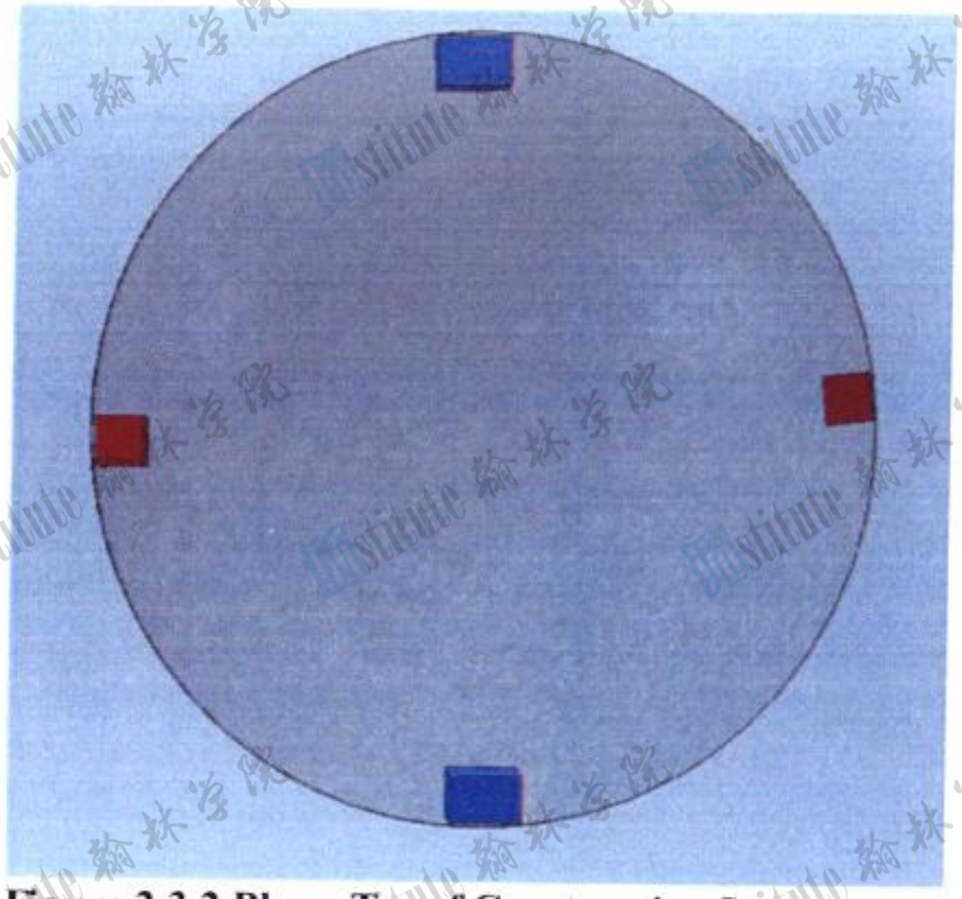


Figure 2.3.2 Phase Two of Construction Sequence

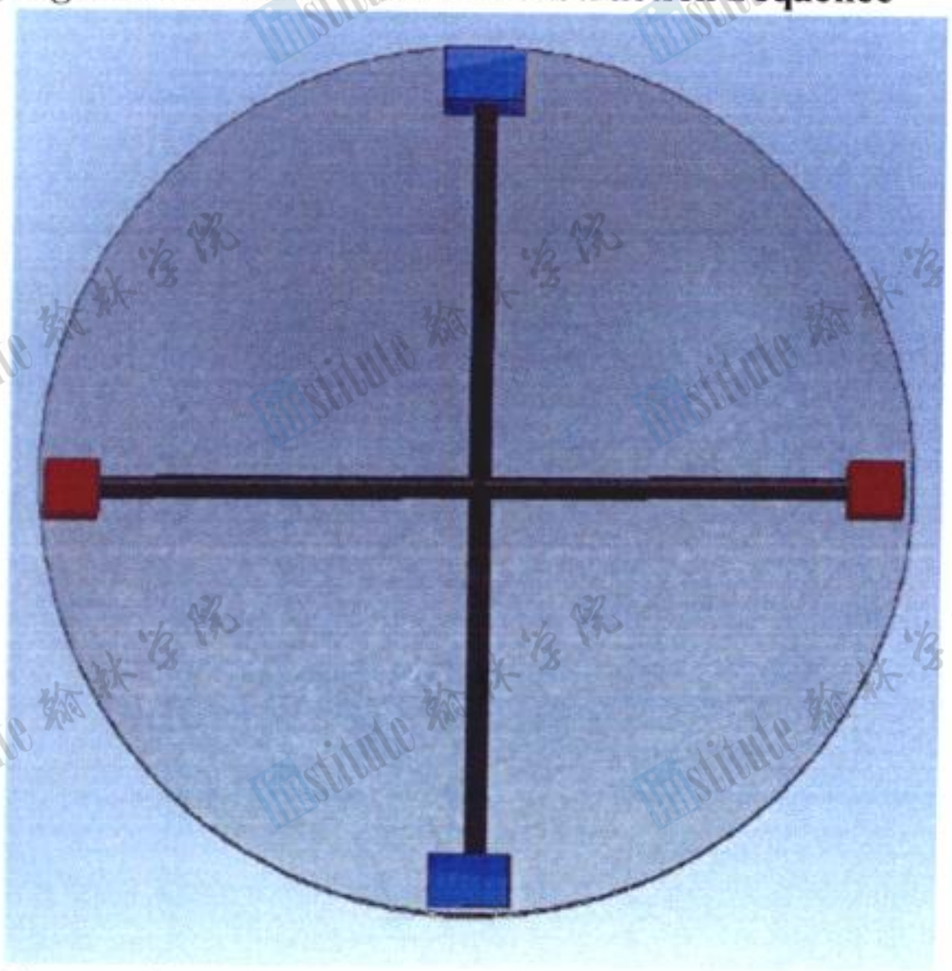


Figure 2.3.3 Phase Three of Construction Sequence

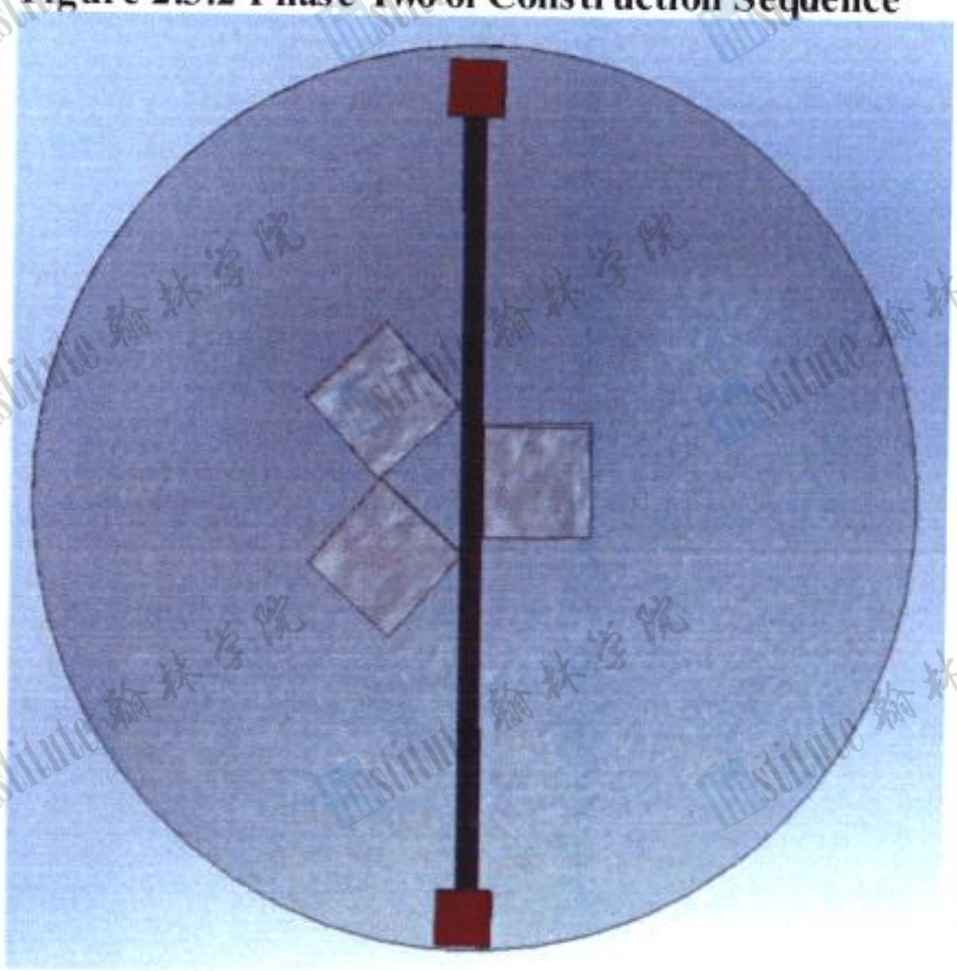


Figure 2.3.4 Phase Four of Construction Sequence

meters in diameter will be installed in 6 craters, one over each microcity's planned location, for later communication between the microcities and Earth. In addition, a solar-powered satellite will be set up to provide power for the initial phases. *See Figure 2.3.2; Note: Red boxes are ports on the equator while blue boxes are ports on the poles..*

2.3.3 Phase Three Following the installation of the satellites, automated mining systems will be set up. Daigurren Lagann robots will begin drilling from under the port toward the center of the asteroid; during the mining, materials are stored and refined in facilities for future use. The central shaft will later provide easier access to all microcities upon their completion. *See Figure 2.3.3.*

2.3.4 Phase Four The 3 industrial sectors will be created. During this phase, power generators will be activated as soon as possible to generate a reliable source of electricity. After the creation of the industrial sectors and establishment of generators, mining processes will continued toward the 6 edges of the colony. *See Figure 2.3.4.*

2.3.5 Phase Five After preparations for the residential and commercial sectors are complete, VASIMR rockets spin the asteroid at higher, constant velocity to induce an artificial gravity through centripetal acceleration. At this point, the residential and commercial sectors will be finally created. After the completion of the construction, expansion processes can till occur. *See Figure 2.3.5.*

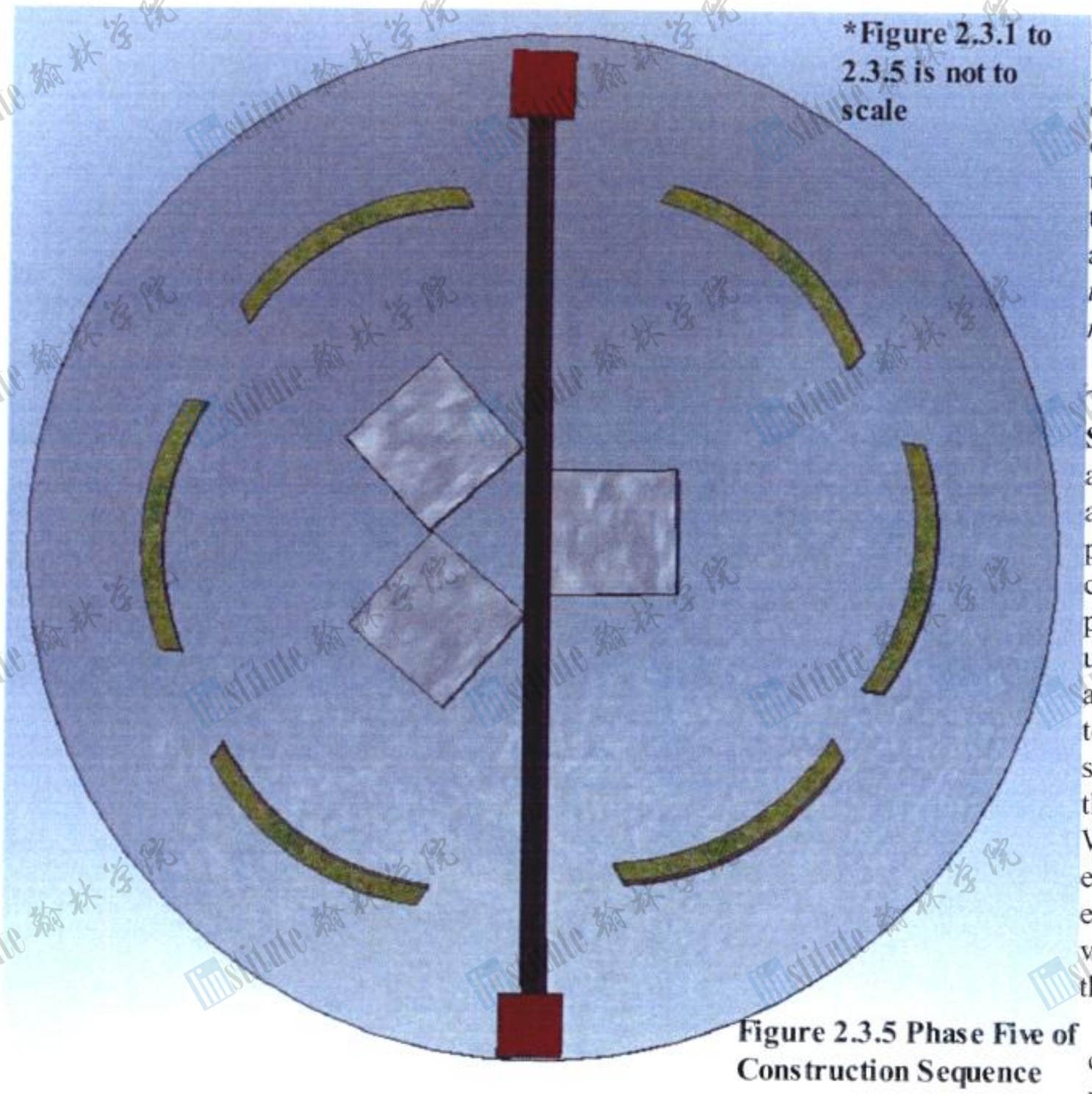


Figure 2.3.5 Phase Five of Construction Sequence

***Figure 2.3.1 to 2.3.5 is not to scale**

2.4 Structural Asteroid Attachment After the initial construction sequence is complete, the mining system used for Phases 3 to 5 will be transplanted to the target asteroid. *For more details on this exact system and process, refer to Section 5.4.*

2.4.1 Minimizing Dust Transfer in Vulnerable Settlement Areas To gain access to the interior of the asteroid from docking facilities, people are sent into an air chamber equipped with high powered air blowers, which are used to blow off as much dust as possible. Then they advance to a chamber, where they are submerged in water to remove the rest of the dust particles. With that, they are allowed to enter the colony. This process ensures the elimination of virtually all foreign matter into the colony.

2.4.1.1 Air Chamber Air chambers will be equipped with high powered air blowers located on the ceiling, on the walls, and beneath a metal grill that people stand on. After the dust is blown off, vacuums under the metal grill suck all of the dust in the air within the chamber.

2.4.1.2 Water Submersion Chamber In the water submersion chamber, people will be submerged in a 10 meter high tank of water. The top meter of water will be removed and passed through a filter to remove all dust particles that float to the top of the water. The remaining water in the tank will be drained out, leaving all the dust particles that do not float sitting on the bottom of the tank where they can be removed.

2.4.2 Locations of Ore Refining Operations Ore refining operations are located on the surface of the asteroid being mined. As noted in previous sections, the mining system calls for the establishment of a refinery on the surface to ensure a swift conversion from raw to useful.

2.5 Docking Facilities Located at the bottom of the craters on the asteroid, docking facilities will help facilitated safe docking and act as a guide to pilots for the location of ports. This particular placement of facilities ensure that passing space debris does not collect or hit the facilities and landing craft during critical stages. In addition, if a spacecraft deviates from the landing areas, none of the pressurized ares of the colony will be affected due to the long asteroid shell separating pressurized areas and ports.

2.5.1 Triple Redundancy Port Protection At the end of each poles is 1 port. 2 other ports are located along the equator, equally spaced apart. The ports located on the poles are the primary docking facilities as the near lack of gravity prevents possible interferences. In the case these ports are either disabled or occupied, the other two ports on the equator are used. Due to the distance among the ports, it is highly unlikely all the ports will be disabled as some can be used when others are in repair. In addition, since the ports at the pole are on the axis of rotation and are stationary, they will act as the launch and landing ports. On the other hand, the constant movement of the equatorial ports limits their activities to specifically launching. However, in the case of emergencies, vehicles can land in these ports.

3.0 OPERATIONS AND INFRASTRUCTURE

3.1 Location Bellevistat shall be located inside the asteroid 1866 Sisyphus at the Earth-Moon L4 orbit. The asteroid is about 8.2 km in diameter and shall be available after an initial capture into Earth's gravitational orbit. At the L4 Lagrangian point between the Earth and the Moon, the colony will be sufficiently distanced from the Earth so as to be safe from collision. The asteroid provides a shell in which the colony to be built, which can provide radiation as well as impact protection. In addition, the initial hollowing of the asteroid can provide a source of raw materials for construction.

Table 3.1 Location

Option	Pros	Cons
1866 Sisyphus	About 8.2 km in diameter; more space to work with	Larger; harder to maneuver Farther to maneuver
887 Alinda	About 4.2 km in diameter; easy to maneuver Comes closer to Earth; easier to capture	Smaller; less space Preparations for capture must be done in 4 months; very expensive
No asteroid	No need to capture an asteroid	Costs of building from scratch may be higher and more difficult

3.1.1 Sources of Materials and Equipment The materials will come primarily from the asteroid itself. Whatever cannot be manufactured on site will be imported from Earth. The asteroid shell provides impact and radiation protection for the colony so that extra construction materials for a hull are unnecessary; raw materials available on the asteroid can be employed inexpensively in absence of a need for transportation from Earth.

Table 3.1.1 Sources of Materials and Equipment

Material	Source	Transportation	Purpose
Steel	Processed on asteroid	N/A	Construction, housing
Glass	Processed on asteroid	N/A	Windows
Concrete	Processed on asteroid	N/A	Construction
Rock wool	Processed on asteroid	N/A	Insulation for housing
Ferromagnetic fluid	Earth	Willoway	Hull
Water	Processed on asteroid	N/A	Human consumption
Calcium carbonate	Processed on asteroid	N/A	Furniture and interior finishings

Equipment (refer to 5.0.2 for robots)	Source	Transportation	Purpose
DaiGurren Lagann	Earth	Willoway	External construction
Gurren Lagann	Earth	Willoway	Mining
GutsMAN	Manufactured on site	N/A	Interior construction, maintenance
ProtoMAN	Manufactured on site	N/A	Security, janitorial work
MUSCLE-T	Manufactured on site	N/A	Cargo
AgroBoy	Manufactured on site	N/A	Agriculture
RFP	Earth	Willoway	Mass production and rapid prototyping
Nanobots	Manufactured on site	N/A	Varies
Solar Power Satellite	Alexandriat	Willoway	Electrical power generation

3.1.2 Storage of Materials Upon arrival during construction, space will be set aside for storage of incoming materials and equipment next to the ports. As the time comes when the materials are ready to be utilized, MUSCLE-T shall move them out of this storage area and transport the materials to wherever it is needed.

3.2 Internal Infrastructure

3.2.1 Food Production Food production, with the exception of animal farms, will be centralized in each microcity so as to keep each self-sufficient.

3.2.1.1 Agriculture

Table 3.2.1.1 Agriculture

Aeroponic	Rice, wheat, barley, blueberry, strawberry, tomato, carrot, onion, radish, scallions, beans, soy, lotus root, potato
Soil-cultivated	Corn, apples, tangerines, mushroom, mango

3.2.1.1.1 Growth Agriculture in the colony shall be primarily grown by robotically regulated aeroponics in each microcity. Plants will be organized in stacked rows for conservation of space. OLED's will serve as an artificial sunlight for the plants in the facility. The roots of the plants are sprayed periodically and automatically with a mixture of water and nutrients to limit the amount of water and fertilizer normally needed for growing plants in soil.

Corn, apples, tangerines, mushroom, and mangoes will be specifically grown in soil from incompatibility with the aeroponic system. The soil shall be composed of crushed asteroid rock and organic compost from the wetlands. *See Section 3.2.6 for more details.*

AgroBoy shall monitor all plants once a day for health and soil condition for the soil-based plants. In the aeroponic system, the sprinklers will be checked and maintained once a week, unless a plant AgroBoy monitors appears to be dry. In this situation, the sprinkler will be checked immediately. Wetland soil shall be mixed into normal soil every two weeks to act as a fertilizer.

3.2.1.1.2 Harvest For harvest, AgroBoy will travel on rails for the aeroponic system and on wheels for soil to scan plants and cuts and collects the usable portion just before ripeness. Overripe or unusable plants are disposed of into the wetlands.

3.2.1.2 Livestock

Table 3.2.1.2 Livestock

Land mammals	Micro-breed cows, musk deer
Birds	Duck, chicken, quail
Fish	Salmon, tilapia
Produce	Chicken/Quail eggs, milk

3.2.1.2.1 Cultivation Animals will be raised exclusively in the rural microcities in the Animal Farm, away from the main population of civilians. The land mammals and birds will be kept in pens for efficient use of land and will be fed a diet of mostly corn. They will be monitored by AgroBoys, that check their health and feed them everyday. AgroBoys will assist in delivery of the young. Salmon and tilapia shall be raised in separate tanks where oxygen levels and feed are actively monitored by a computer and automatically maintained.

3.2.1.2.2 Harvest/Slaughter The slaughter of livestock shall be executed by electrocution. The electrocution will be done in two phases. First, the animals will be stunned so as to render them unconscious. After this stage, the animal shall be further shocked so as to kill them quickly with as little pain as possible. AgroBoys will then tie together the animals' legs and transport them to a processing facility where they shall be cut into more easily manageable slabs for storage and distribution.

Eggs will be collected from nests and the milk directly from the micro-breed cows. All meat products will be irradiated to kill any harmful bacteria.

3.2.1.3 Storage After processing and cleaning, meat and crops will be stored in the warehouses located in each microcity before shipment. Crops will be kept in a refrigerated environment while meat will be frozen. Here they are cataloged in a computer database that keeps a record of the food so that trends can be identified and accounted for should the rate of growth of a certain crop need to change due to demand.

3.2.1.4 Packaging, Delivery, Market Meats will be packaged normally in an environment of 0.4% carbon monoxide in small containers in plastic wraps to maintain freshness. The plastic packaging can be later broken down by nanobots. Delivery to markets and businesses shall be done by Muscle-T in the underground transportation system. From the markets, consumers can either physically purchase food or order it online for delivery to their homes via Muscle-T.

3.2.2 Power

3.2.2.1 Generation The electrical power of the colony shall be primarily produced by three PBR's (Pebble Bed Reactors), one in each of the three industrial sectors. These reactors can operate at high temperatures and thus at a high efficiency, while at the same time prevents itself from melting down by Doppler broadening. In addition, a variety of fuels may be implemented in the same design. Once the fuel is expended, it shall be put into a fusion reactor to speed its decay process.

As the initial and alternative source of power, a satellite equipped with 625,000 m^2 of solar panels made from Alexandriat will follow the colony, absorbing sunlight at an estimated efficiency of 80% and producing 500 MW of power. The solar energy absorbed will be beamed to a rectenna near the north port by microwaves where it receives the signal and converts it directly to electricity. Because the satellite does not rotate, it will almost always be exposed to sunlight.

Power not used in the night from the satellite will be stored in batteries located in each sector. GutsMAN will periodically drain the batteries completely when they are unused to maintain the longevity of the batteries. Should the unlikely situation of power failure from the PBR's occur, the solar power satellite and back-up batteries shall power the colony until the reactors are fixed.

Table 3.2.2.1 Electrical Power Generation

Type	Priority	Location	Number	Power Output	Maintenance
Pebble Bed Reactor (PBR)	Primary	Industrial sectors	3	300 MW per reactor	Monthly by GutsMAN
Solar Power Satellite	Secondary	L4 Orbit	1	500 MW	Biweekly by DaiGurren Lagann
Battery	Backup	All sectors, ports	N/A	N/A	Weekly by GutsMAN

3.2.2.2 Distribution Electricity generated from the reactors shall be routed down the elevators to the residential sectors beneath. Two reactors shall provide the power for three microcities each, while the third powers just the industrial sectors. Wires will be kept underground and linked to each home and facility.

3.2.2.3 Allocation

Table 3.2.2.3 Allocation of Power

Use	Estimated Power Requirement	Source
General public	400 MW	PBR
Industry	200 MW	PBR (industrial)
SkyTran	1 MW	PBR
Agriculture	5 MW	PBR
SCWO	5 MW	PBR
Elevators	50 MW	Solar Power Satellite, PBR
Antennae (external communication)	1 MW	PBR

3.2.3 Internal Communication Internal communication systems are all connected in an intracolonial network. *Refer to Section 5.6 for more details.*

3.2.4 External Communication External communication will be conducted through 6 antennae, 50 meters in diameter, on the exterior of the asteroid, one under each microcity. These antennae will be semi-directional and

multi-spectral to accept various wavelengths of signals. The antennae will provide a constant Internet connection with both Earth and Alexandriat.

3.2.5 Climate Control The climate will be controlled from multiple buildings, varying and regulating the temperature and humidity in the air to allow the colony to have a feel of each of the four seasons on Earth. Climates will be different depending on the season:

A special building structure, a weather park, shall be available to colonists where more varied and exotic weather patterns can be experienced. This may include rain, fog, severe wind, and thunderstorms. Natural disasters such as earthquakes will also be available. The climate in residential households can be adjusted by the residents.

Table 3.2.5 Seasonal Climates

Seasons	Spring	Summer	Fall	Winter
Scenery/Type	Mediterranean	California	Texas	Canada
Average Temp.	15°C	21°C	17.2°C	9°C
Average Humidity	35-45%	50% - 60%	30%	40%

3.2.5.1 Atmosphere High Efficiency Particulate Arresting (HEPA) filters located in the walls of the microcities are capable of cleaning up 99.97% of airborne particles that are 0.3 μm in diameter, which are considered as the most difficult particles to filter. The filters consist of arranged fibers with airspace of more than 0.3 μm between the fibers. However, particles smaller than the gap between the fibers can also be filtered, under three mechanisms: interception, impaction, and diffusion.

First, articles following a line of flow in the air stream come within one radius of a fiber and stick to it. Then larger particles that are unable to avoid fibers by following the curving edges of the air stream are forced to embed in one of them directly; this increases with diminishing fiber separation and higher air flow velocity. Enhancing mechanism is a result of the collision with gas molecules by the smallest particles, especially those below 0.1 μm in diameter, which are thereby blocked and delayed in their path through the filter. Because so many particles are attached to the fibers, the size of the gaps decreases, air purifiers and filtering sheets will be replaced with new ones frequently by GutsMAN.

The air composition and the pressure will be about the same as Earth's at sea level so that settlers will have little to adjust to.

Table 3.2.5.1 Atmospheric Composition

Gas	Percent	Volume (m^3)
N_2	78	702,000
O_2	21	189,000
CO_2	1	9,000

3.2.6 Waste Management In order to treat organic waste products, an artificial wetland would be constructed in greenhouses located in each microcity. The wetland would contain plants that will develop microorganisms to decompose the organic waste products, with a rate of 600,000 liters per hectare per day. Microorganisms are responsible for 90% of the pollutant removal and waste decomposition, while plants eliminate about 10% of pollutants by converting them to carbon to decompose the microbes. Several wetlands would be created with each of the dimensions being 1 meter deep, 82 meters long, and 7-8 meters wide.

After being treated with the artificial wetland, the remaining substances would be dealt with by using Supercritical Water Oxidation (SCWO), a method for waste recycling. In this process, the remaining substances would be placed inside a reactor with temperatures and pressure above the mixture of water and the substance's thermodynamic critical point. Under these temperatures and pressure, the substance, which is mostly solid waste, would be broken down to form sterile water, carbon dioxide, and nitrogen. These products are capable of being reused in the growth of edible biomass and recycled into the breathable atmosphere in which the settlers in.

With both process in effect, more nitrogen can be generated to help the soil, which can be used to grow plants to produce more oxygen for the settlers. This also reduces the power required for the SCWO reactor.

For industrial waste, nanobots break down parts so that the materials are easily recycled.

3.2.7 Water Management The colony's water shall initially be imported from Earth. Once imported, the water shall be transported to the water tanks for use in the colony's water line. Used water shall undergo treatment through the artificial wetlands and SCWO for reuse. Extra water will be stored in backup water tanks in each sector. As the amount of water approaches sufficiency in the colony, imports will slow down to a level where water is only imported when necessary to replenish the backup water tanks should they be required for use. A total of 6,000,000 L of water shall be imported and stored in the water tanks of each microcity.

3.2.8 Day/Night Cycles The day and night views of the sky will be simulated in a 24-hour period, which will be similar to the cycles on Earth. This allows the settlers to feel as if they are on their home planet. The day and night skies will be displayed under OLED and NCD technologies. The OLED and NCD would be stored in flexible sheets, contributing it to human factors and being easier to be stored. To light the sky, OLED shall be applied for the day, with the advantage of creating a bright display, without using much energy. When night comes, NCD will replace OLED. NCD is incapable of creating a bright display, thus it would not need much energy to operate. With an almost black night sky, the NCD would require even less energy. The moon and the stars will be simulated through lighting pixels on special sheets.

Figure 3.2.9 A view of SkyTran in operation

3.2.9 Internal Transportation The settler of the colony will have three modes of movement: walking, bicycling, and SkyTran. The SkyTran will be an intercity and intracity transport system, consisting of two-passenger cars on an elevated Maglev-style rail. These cars travel quickly and efficiently under a frictionless rail. Civilians simply walk into the unit at a station, choose their destination, and sit back as the car takes them to their chosen location. Stations exist in each microcity for repair and maintenance for damage and repair of individual cars.

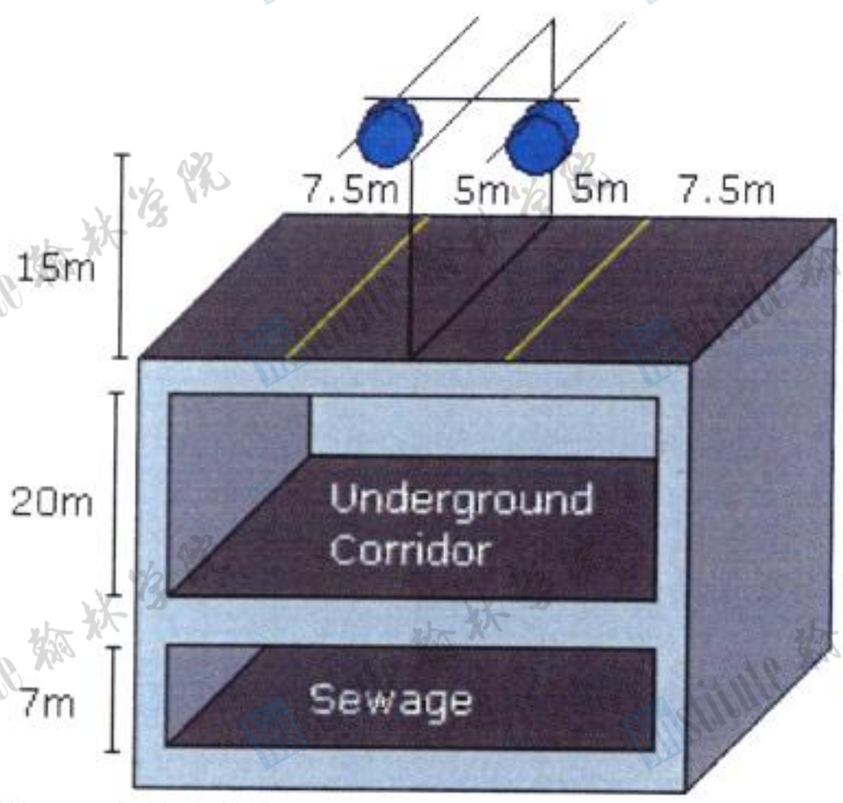


Figure 3.2.9.1 Transportation Corridors

3.2.9.1 Corridors and Means of Access Beneath the ground, an underground transportation corridor is available for robots and some space vehicles for movement throughout the colony's microcities. Elevators exist between the microcities, and are connected to the SkyTran and underground transportation networks, the industrial sectors, the central axis, and the exit ports for two of the elevators, taking loads to and from any of these different levels.

Muscle-T, the cargo robot, will have access to all facilities via the underground corridors. Tunnels to each facility and every home from underground are to be used by the robot for deliveries.

3.2.9.2 Movement of Imports/Exports The colony will contain of four ports used for import and export. The equatorial ports are in charge of export, due to the force from the spinning of the colony. The polar ports shall be in charge of importing cargo. These importing cargo will be scanned and sent into cargo containers, where they will be tagged with RFID tags. Then Muscle-T will transport them to an unloading area, where the cargo will be distributed. Basic information of individual cargo units, such as contents, storage requirements, and arrival time, will be stored in the RFID tags. A system within the commercial network

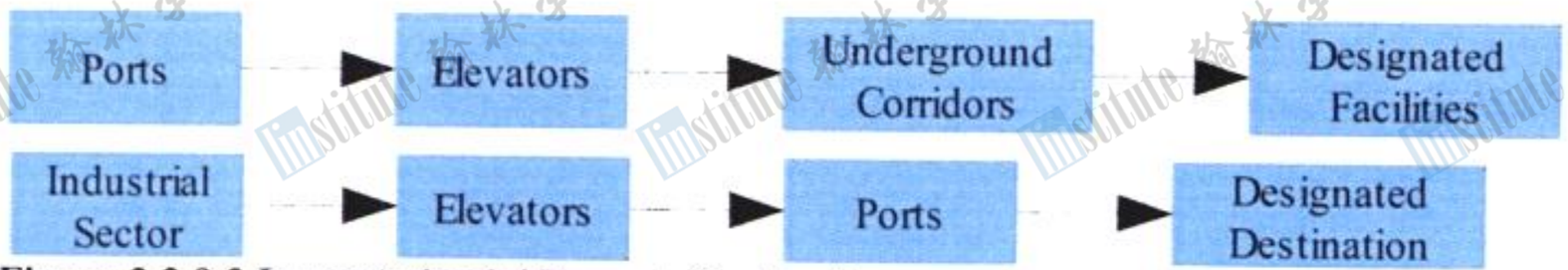


Figure 3.2.9.2 Imports (top) / Exports (bottom)

shall be implemented that will track the progress and status of cargo, directing loads of higher priority to be delivered first.

3.2.9.3 Rights of Way Robots and pedestrians shall have the rights of way over bicycles. Bicycles and the SkyTran system shall occupy the center two lanes. Pedestrians and robots will use the outer lanes, from which the SkyTran vehicles can be accessed as well. Since the SkyTran system is in the air, no further specifications of rights of way are necessary.

3.3 Space Infrastructure

Table 3.3 Space Infrastructure

Name	Location	Quantity	Purpose
Alexandriat	Earth-Moon L5 orbit	1	Space Colony
Antennae	Surface of asteroid	6	Communication
Solar Power Satellite	Earth-Moon L4 orbit	1	Electrical power generation
Rectenna	North port of asteroid	1	Electrical power generation
VASIMR's	Surface of asteroid	14	Gravitational spin and orbit maintenance

3.3.1 Space Vehicles

Table 3.3.1 Vehicle Requirements

Name	Purpose	Dimensions LxWxH (in meters)	Payload Weight (tonnes)	Payload Size (m^3)	Mission Durations	Flights / Year	Fleet sizes	Turn-around Time	Support Facilities
Arker	Civilian Transport	45×20×15	150	5700	~ 4 days	10	3-5	2 weeks	Earth, Alexandriat, Bellevistat
Willoway	Cargo	30×20×15	90	3,000	~ 3 days	50	10-14	.5 weeks	Earth, Alexandriat, Bellevistat
Anzen	Maintenance and Security	13×10×5	20	2000	varies	varies	2-3	3 days	Bellevistat
Yuki	Research	20×15×10	7	1,200	varies	varies	2-4	5 days	Bellevistat
Abunai	Emergency	20×10×15	15	1,150	varies	varies	1-3	1-2 days	Earth, Alexandriat, Bellevistat
Humko	Tourist	30×20×15	100	6,000	~ 6 days	7	2-3	3 days	Bellevistat
Spinon	One-way Re-entry	20x20x40	75	1,500	~2 days	varies	varies	none	Bellevistat, Earth

Figure 3.3.1.1 Arker

Figure 3.3.1.2 Humko

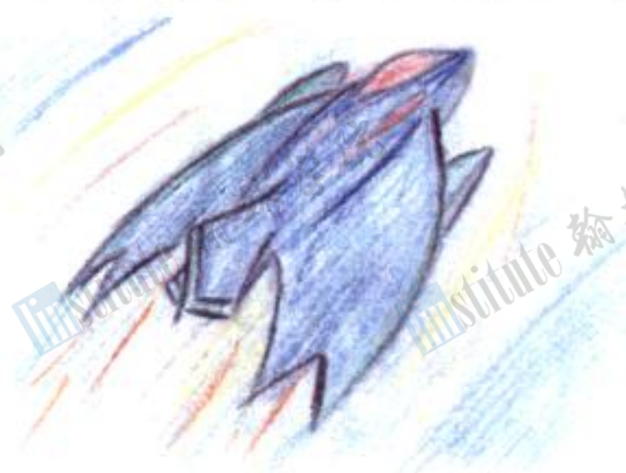


Figure 3.3.1.3 Willoway

3.4 Furniture and Interior Finishing Design Customizable furniture and interior finishings will be made by electrically stimulated ionic crystallization. Wire mesh structures shall be electrically charged and immersed in calcium carbonate solutions, where dissolved ions collect and form electrochemical bonds to cover the wire and fill the structure. This process can be used to create walls, tables, chairs, and anything else settlers may think of. In addition, this method is highly cost-effective as calcium carbonate is readily available by processing the calcium inherent in the asteroid.

4.0 HUMAN FACTORS

4.0.1 Earth Community Attributes The colony will use Earth-like community structure to ease the transition from Earth life to colony life as well as providing a soothing stress reducing environment for the colonists. The colony will be structured into microcities that will have enough facilities to make the colony and each microcity self-sufficient.

4.0.1.1 Comfortable Housing Comfortable spacious homes will be used to provide a familiar soothing environment to reduce the stresses of colony life.

4.0.1.1.1 Soothing Elements The homes will have diverse spacious Earth-like architecture to emulate an average-sized Earth home. This serves to provide a comfortable and familiar environment for colonists.

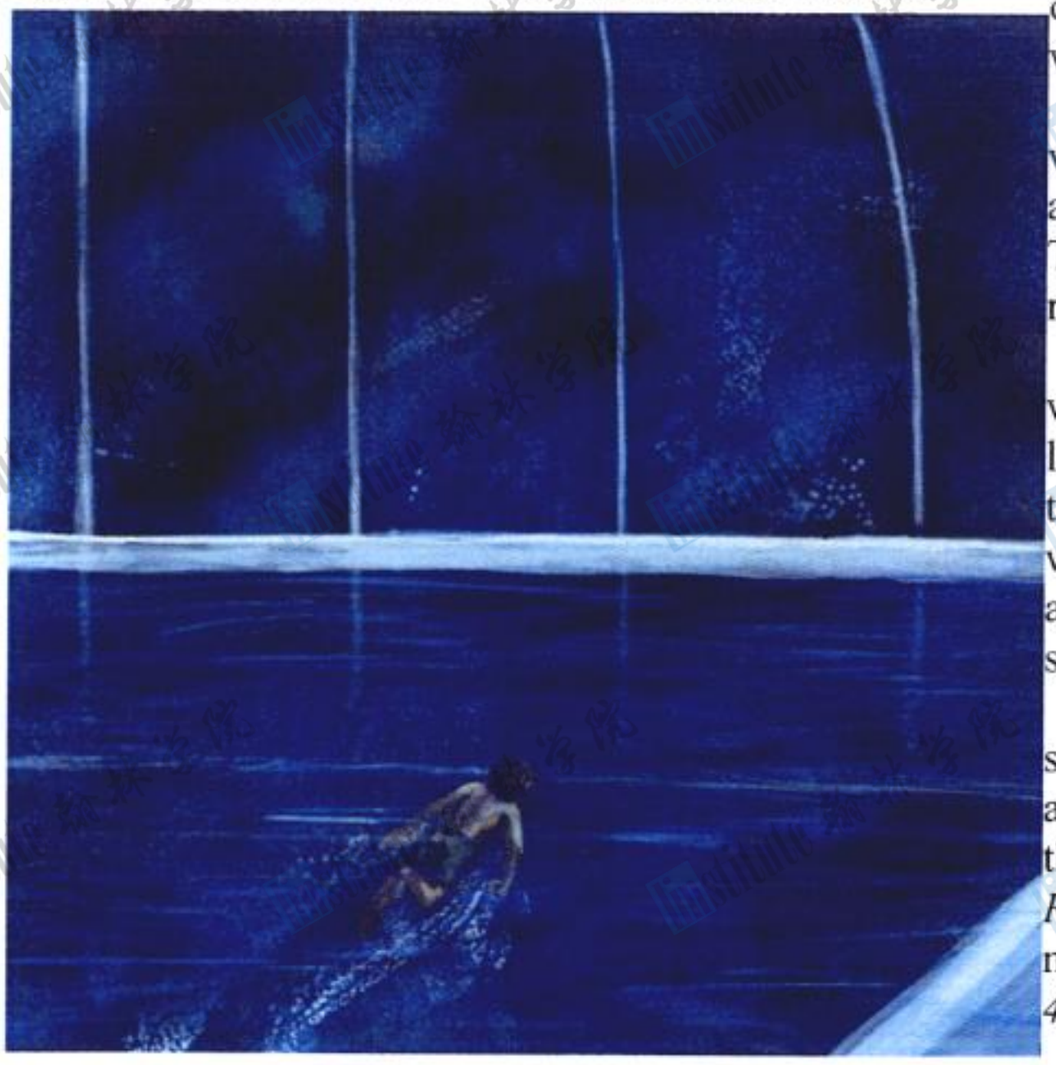
4.0.1.2 Access to Fine Food The fine food opportunities will consist of traditional Earth cuisine. However, development of a new unique Bellevistat cuisine will be encouraged as well as hybrids of different Earth cuisine.

4.0.1.2.1 Restaurants The majority of Bellevistat's restaurants will be located within the commercial center of each residential neighborhood. The rest of the restaurants will be located in the dedicated business sector in the suburban and urban microcities. These restaurants will range from fast food joints to family-dining and fine-dining serving all styles of cuisine. This serves to meet all the different food preferences that colonists have.

4.0.1.2.2 Wine Bellevistat-based vineyards will provide wine for the colonist's use and export to other colonies and Earth. Wine will be used in fine-dining restaurants and will also be made available for the colonist's personal use through the SmartHome and the underground transport system. *Refer to Section 4.1.2.2*

4.0.1.3 Access to Entertainment To eliminate the colonists boredom and homesickness and improve their morale, traditional Earth recreational and leisure opportunities will be made available to colonists within the recreational microcities. These entertainment options will help reduce stress and improve morale within the colony population. *Refer to Section 4.5*

Figure 4.0.2.2 A swimmer wades in the Pool of Stars.



4.0.2 Natural Views Bellevistat, despite being located within an asteroid, will need to have readily available access to a natural view of space outside of the colony. To achieve this goal A mirror system will be used to reflect the outside view for the colonist's viewing.

4.0.2.1 Observatory To provide colonists with a natural view, the colony will have an observatory located in each microcity that will use the mirror system to project the outside views onto its walls. The image will be reflected through a window frame to make it appear that colonists are looking through a window into space.

4.0.2.2 Pool of Stars The Pool of Stars is a swimming facility that allows colonists to swim in what appears to be a sea of stars. This effect will be achieved through use of the mirror system in the sides of the pool. *Refer to 2.0.2* This method will be the colonist's primary method of achieving natural view. *Refer to Figure 4.0.2.2.*

4.1 Community Facilities, Consumables, and Psychological Factors Bellivistat will be designed to provide the facilities and consumables colonists expect in a regular Earth community. This, combined with considerations of psychological factors, will make Bellevistat an "Earth away from Earth."

4.1.1 Community Facilities The community facilities located in the residential and commercial sectors in Bellevistat will be easily accessible for both the residents and the transient population. Bellevistat will be split up into six microcities which will be for the most part a self-sufficient city. Each microcity will have a majority of the available facilities that will allow colonists to enjoy most aspects of colony life without leaving their microcity. *Refer to Table 4.1.1.*

Table 4.1.1 Facilities

Residential Sector	Number in Colony	Area (m^2)	Total Area in Colony
Apartments	5110	64	327040
Single Story Homes	4000	100	400000
Double Story Homes	4000	120	480000
Schools	2	500	1000
Libraries	6	250	1500
Town Hall	6	5000	30000
Police/Fire Stations	12	2500	30000
Commercial Sector			
Stores	44	2500	110000
Convention Center	4	48750	195000
Offices	160	1000	160000
Residential and Commercial			
Clinics	12	2500	30000
Hospitals	6	10000	60000
Fast Food Restaurants	28	1250	35000
Family Restaurants	28	1250	35000
Fine Dining Restaurants	16	2500	4000
Nightclubs	12	2500	30000
Cafés	18	2500	45000
Movie Theaters	8	5000	40000
Agricultural Sector			
Agricultural (Large)	6	70000	420000
Agricultural (Small)	4	20000	80000
Communal Gardens and Orchards	8	Varying sizes	170000
Animal Farm	2	30000	60000
Recreational			
Parks	18	Varying sizes	341550
Simulated Wilderness	2	180000	360000
Sports Facilities/Gym	6	22500	135000
Pool of Stars	6	11250	67500
Transportation			
SkyTran Stations	42	7500	315000
Bike Rental Facility	49	2500	122500
Other			
Computer Storage	12	2500	30000
Robot Maintenance and Storage	28	2500	70000
Backup Air and Water Tanks	12	5000	60000
Warehouse	6	20000	120000
Constructed Wetland	6	11250	67500
Bellivistat U	1	167500	167500

4.1.1.1 Education Education within Bellevistat will be conducted through human teachers and Eve, a virtual teaching aid. This virtual teaching aid will be able Eve, which will be used as a substitute teacher as well as teaching assistant when the human teacher individually tutors students.

4.1.1.2 Recreation and Leisure Facilities located within the residential and commercial sectors will provide recreational and leisure venues ranging from world-class entertainment to sports and camping. *Refer to Section 4.5.*

4.1.1.3 Medical The medical facilities will be located throughout the colony to provide colonists easy access to medical attention. Staffed, by human doctors, these medical facilities will provide a full range of medical care to colonists. In addition, the colonist's HMS bracelets will monitor colonist health and provide this information to medical facilities. *Refer to Section 5.3.1.1.*

4.1.1.3.1 Hospitals Hospitals will be used to provide major medical services ranging from surgery to emergency treatments. These facilities will be primarily located within the industrial microcities to provide easy access in case of industrial accidents. Additional hospitals will be located in the residential areas in

when quarantines are required due to epidemics.

4.1.1.3.2 Clinics Clinics will be located in residential areas to provide basic medical care to residents. In cases where more advanced medical treatment is required, the colonist will be transported to the hospital via a robotic ambulance.

Table 4.1.2 Variety and Quantity of Goods

Produce	Yield (kg/m²/year)	Consumption (kg/capita/year)	Area (m²)
Starch			
Rice	7.5	11.4	27360
Wheat	7.2	73	182500
Barley	7	4.5	11571
Lotus Root	6	5	15000
Potato	52	75	25961
Sugar Beets	74	14.6	3551
Fruits/Vegetables			
Carrots	121	10	1488
Onions	50	9	3240
Garlic	45	7.5	3000
Radishes	45	9.5	3800
Lettuce/Cabbage	75	7.5	1800
Gai Lan	1.5	1	12000
Scaillions	12.5	2	2880
Beans	148	4.8	584
Mushrooms	50	2.5	900
Corn	6	8	24000
Apples	42	11	4714
Tangerines	40	10	4500
Blueberries	20	6	5400
Strawberries	25	8	5760
Grapes	23	7	5480
Tomatoes	124	41	2952
Mangoes	4	6	27000
Cucumbers	18	8	8000
Soy Beans	34	5	2647
Other			
Wine *(refer to Section 4.1.2.2)*			1250

Livestock Meat	Yield (kg/animal/year)	Consumption (kg/capita/year)	Animals Needed	Area (m²)
Beef	190	30	2842	4240
Chicken	5	32	115200	3500
Duck	6	4	12000	390
Tilapia	2	2	18000	24000
Salmon	25	3	2160	2650
Musk Deer	15	12	14400	21800
Produce				
Eggs (Quail)	5	10	36000	1150
Eggs (Chicken)	20	20	18000	550

4.1.1.4 Business Business will be conducted on Bellevistat in offices. These offices will be rented out to companies for use as a division office. These facilities will make up the core of the commercial sector.

4.1.1.5 Public Facilities Public facilities will provide colonists with a place to spend time interacting with each other to promote a sense of community.

4.1.1.5.1 Parks and Simulated Wilderness Several parks will be located within each microcity. This will give colonists a location where they are not walled in.

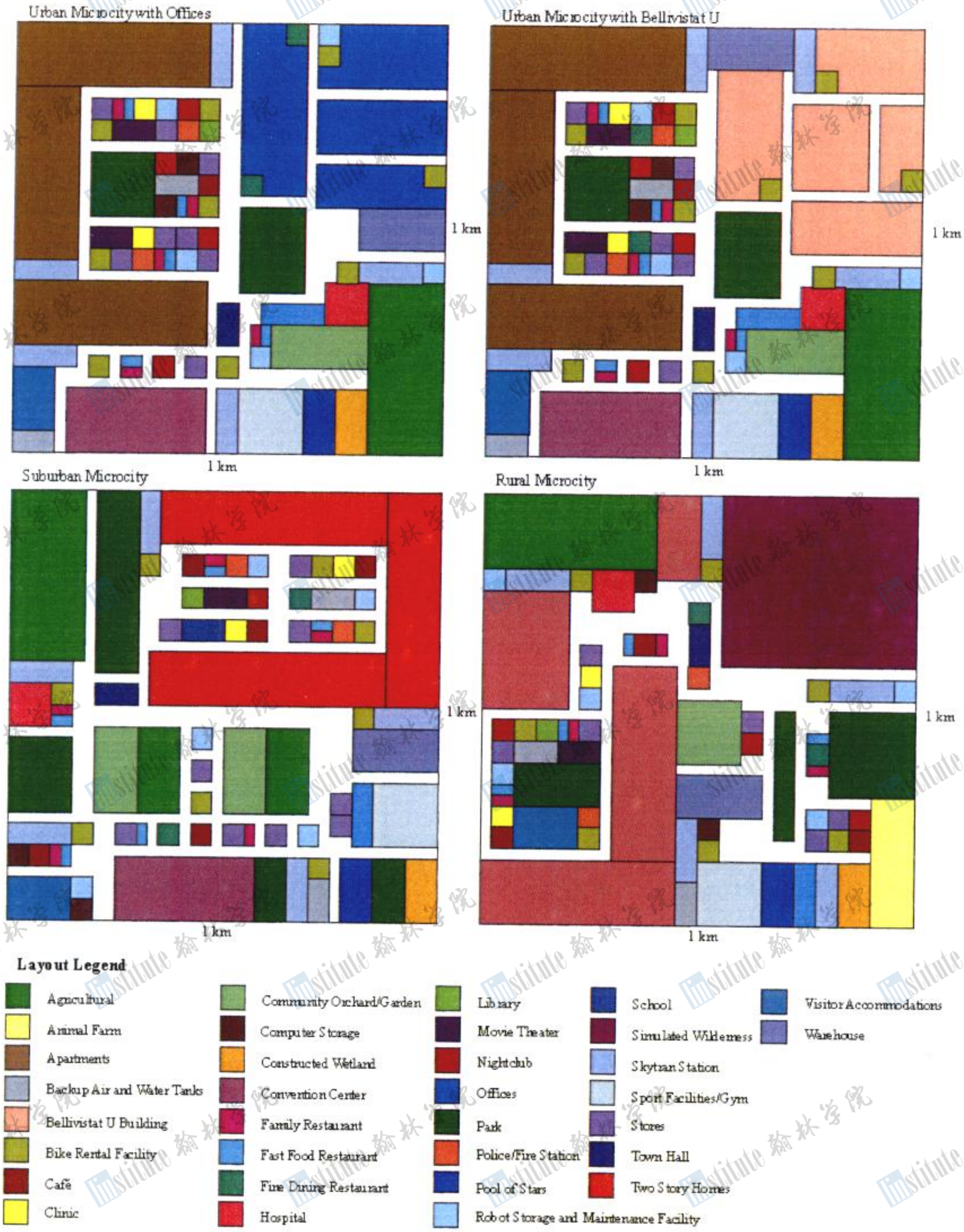
4.1.1.5.2 Community Orchards and Gardens The orchards and gardens will provide colonists with an open area where they can grow their own foods to supplement their diet. This fosters a sense of community between colonists in a microcity.

4.1.1.5.3 Town Center A town center will be available in all microcities. The town center is a social and commercial area that has restaurants, theaters and stores so that the main commercial sector can be dedicated to business and offices. The purpose is to provide easy access to basic supplies and entertainment without leaving the microcity.

4.1.1.6 Visitor Accommodations Visitor accommodations facilities will be located in the closest microcities to the ports. Each of these facilities will have a hotel to provide temporary lodging. In addition, these facilities will allow visitors to borrow bikes and preloaded HGs for their convenience.

4.1.1.7 Other Facilities Minor facilities such as convention centers, nightclubs, libraries and the Simulated Wilderness will supplement the quality of life within Bellevistat by providing additional lifestyle opportunities.

Figure 4.1.1.8 Microcity Layout



4.1.1.8 Microcity Layout The microcities will be a combination of both residential and commercial facilities to create a almost self sufficient system. Each microcity is designed with a specific population demographic in mind. *Refer to Section 4.4.* Most facilities will be within easy access of the colonist's homes. This results in a blending of the residential and commercial sectors within each microcity. However, each group of buildings was placed to serve a specific purpose based on location and surrounding facilities.

4.1.2 Variety, Quantity and Distribution of Consumables and Supplies Bellevistat's agricultural sector will grow a variety of food needed to support the colonists through methods. Nutrition and efficiency is emphasized due to the space constraints of a space colony. *Refer to Table 4.1.2.*

4.1.2.1 Microbreed Cattle Microbreed cows are several times more economical than regular cows for several reasons. These cows, despite being smaller in size than regular cows, produce about the same amount of milk as a regular cow. Also microbreeds does not require as much care as regular cows as they could survive in harsher environments, making them suitable for use on Bellevistat. Microbreed cattle have the additional advantage of having leaner meat which will be healthier for colonists.

4.1.2.2 Wine Bellevistat will have vineyards to produce wine for both the colonist's use and export. Wine has numerous health benefits when taken occasionally and will also complement the menu of the fine dining restaurants on Bellevistat. Colonists can order wine through the SmartHome system which would have the wine bottles delivered to the colonist's residence from the warehouse through the underground transportation system.

4.1.2.3 Vitamin D Because colonists will not have natural sunlight, they will develop a vitamin D deficiency. Because of this, Bellevistat will grow mushrooms and cultivate salmon, which are both high natural sources of vitamin D. Milk and grain products will be fortified with vitamin D to further encourage consumption.

4.1.2.4 Distribution of Food and Consumables Food and consumables will primarily be delivered through the SmartHome system via the underground transport corridor system. *Refer to Section 5.3.3.1.* Colonists will use this to receive food and consumables directly from the warehouse by ordering online. However, there will still be stores to allow colonists to buy items not available through the SmartHome system.

4.1.3 Psychological Factors Due to the nature of a frontier space colony, colonists will experience various psychological problems (homesickness, security, claustrophobia). Bellevistat will reduce occurrences of these issues by removing factors that will most likely trigger psychological problems.

4.1.3.1 Earth Isolation With Bellevistat being physically separated from the majority of mankind on Earth, feelings of isolation will undoubtedly occur. To compensate, numerous factors of colony life will be similar or identical to Earth life. This serves to make colonists feel as if they were on Earth.

4.1.3.1.1 Recreation and Leisure The colonist's recreational opportunities will consist of a full range of activities that they would expect on Earth. *Refer to Section 4.5.* In addition to movies and sports, activities such as hiking and camping will be available. These opportunities serve a double purpose as they will also ease feelings of confinement.

4.1.3.1.2 Communication Colonists will have the opportunity to communicate directly with people on Earth. Television, podcasts, VoIP,and the Internet will be accessible on Bellevistat. This effectively bridges the distance between the colonists on Bellevistat and friends and family on Earth. In addition, colonists can choose to leave voice or video messages to people on Earth and other colonists.

4.1.3.2 Confinement Since Bellevistat is located inside an asteroid, colonists will eventually feel enclosed, To counteract this feeling, the microcities will be spacious and will provide diverse environments. Also, the Pool of Stars will simulate swimming amongst the stars in space. *Refer to Section 4.0.2.*

4.1.3.2.1 Simulated Wilderness The Simulated Wilderness will serve as a wilderness area that allows colonists to engage in activities such as hiking and camping. This provides an entirely different environment for colonists when they feel confined within Bellevistat. *Refer to Section 4.5.1.*

4.1.3.2.2 OLED Sky The ceiling of the microcolony is a 150 meters above the ground and will act like a natural sky through use of OLED panels. *Refer to Section 4.1.3.4.1* At such a height, the colonists will get the impression that the ceiling is actually a natural sky, making the microcities and the colony more spacious than it really is.

4.1.3.2.3 Rooftop Gardens The rooftop gardens on the houses will help to relieve feelings of confinement. Because these gardens are on the roof of the residential buildings, they will be readily available if colonists are suddenly struck with feelings of confinement.

4.1.3.3 Security The colonists will be protected at all times between the security robots and the human security officers. These robots and officers will respond to emergencies as well as patrol Bellevistat to

Figure 4.2.1 Apartment Design

Figure 4.2.2 Single Story House Design

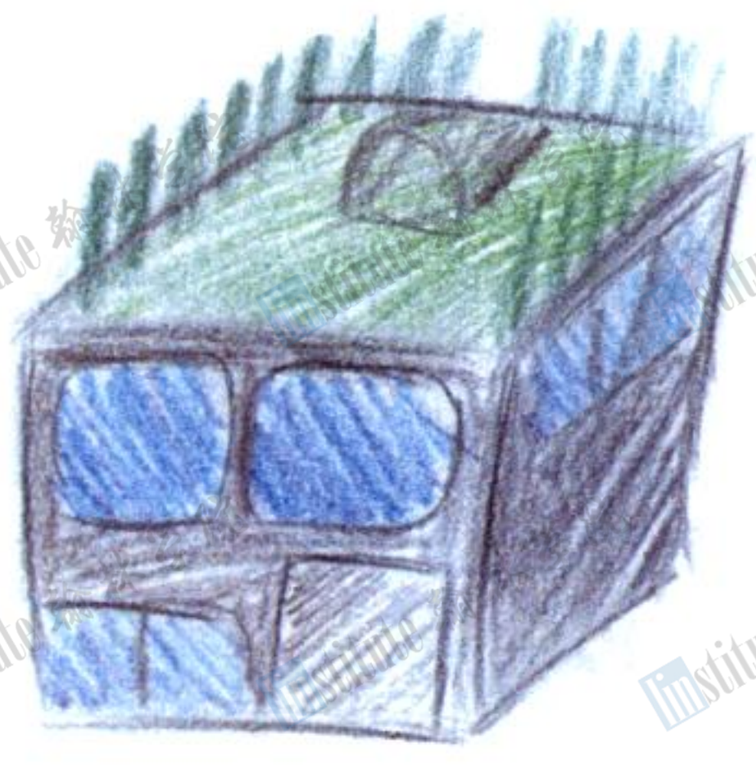
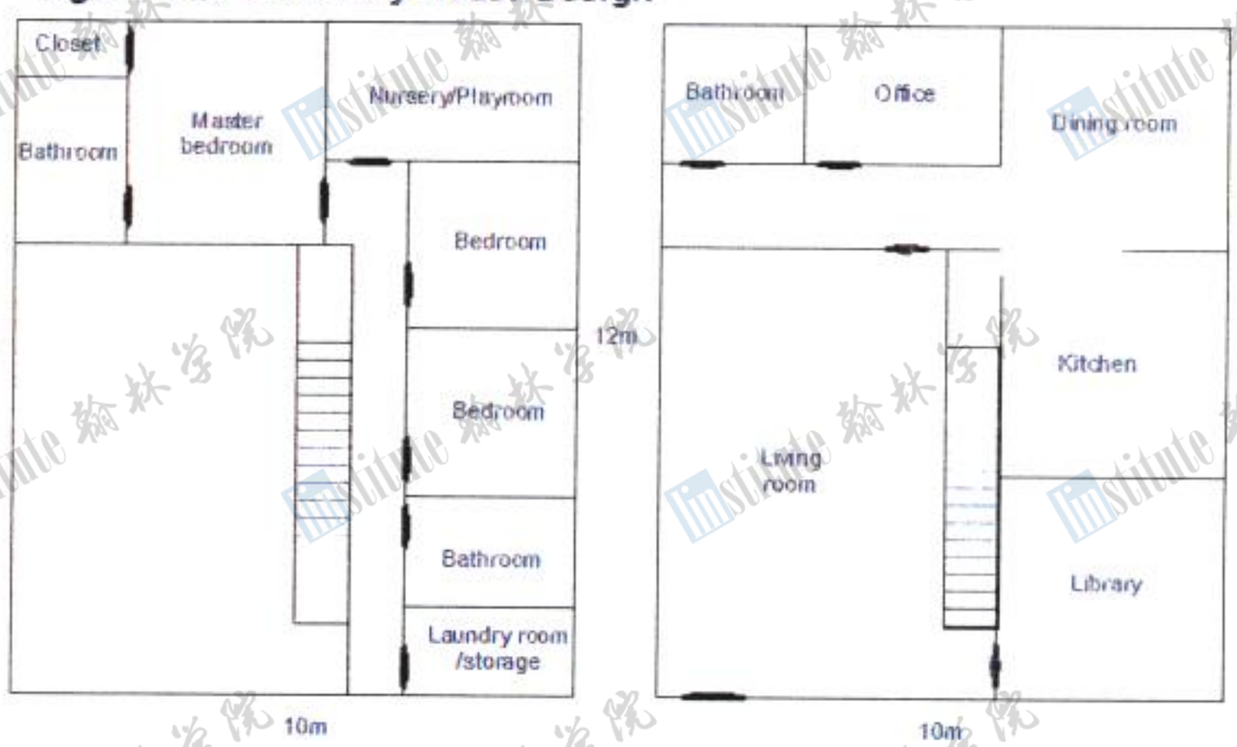


Figure 4.2.4 Exterior Housing Design

Figure 4.2.3 Two Story House Design



provide security to the colony and the colonists.

4.1.3.4 Environmental Factors Bellevistat will imitate the environment of Earth to help colonists to feel comfortable in Bellevistat. This also helps new colonists adjust to Bellevistat and relieve their homesickness.

4.1.3.4.1 Day/Night Cycle Bellevistat will use a 24 hour day night cycle maintained by the OLED lighting system. A sun will be simulated by having a circular patch of brighter OLEDs that moves across the ceiling of the microcity. A similar method will be used to emulate the moon and stars during the night time hours. The day to night ratio will change throughout the year in phase with the seasons on Earth.

4.1.3.4.2 Climate and Atmosphere The climate and atmosphere will be consistent with the climate of Earth as it rotates through the seasons. The approximate makeup (in parts per million by volume) will be 78% N2, 21% O2, 1% CO2 and trace gases. Humidity will be maintained at approximately 35%. *Refer to Section 3.2.5.*

4.2 Residential Housing Designs The residences will consist of three different types: apartments, single-story houses and two story houses. These types will be used to meet the needs of different residents. Apartments will accommodate single adults, single-story houses married adults, and two story houses married adults who have or plan to have children. *Refer to Figures 4.2.1 through 4.2.4*

4.3 Human Productivity Enhancement Colonists will have access to various systems, devices and transportation systems to assist them in their day to day life. *Refer to Table 4.3*

4.3.1 Systems On Bellevistat Colonists will have access to numerous systems that will increase their productivity. These systems will assist humans in their day to day life

4.3.1.1 Health Monitoring System The Health Monitoring System (HMS) will monitor the colonist's state of health and will alert colonists when they need to go to seek medical attention. This will also help doctors to diagnosis colonists by providing them with a medical record as well as medical information. *Refer to Section*

Table 4.3 Work Categories and Tools Required	
Work category	**Tools Required**
Commercial	Furniture (desks and chairs), Computers, Cashiers
Business	Furniture (desks and chairs), Computers
Dining	Furniture (desks and chairs), Cashiers, Kitchen appliances
Entertainment	Furniture (desks and chairs), Computers, Cashiers
Education	Furniture (desks and chairs), Computers, EVE teaching assistant, Lab equipment (beakers, test tubes, centrifuges, etc.)
Medical	Furniture (desks, beds and chairs), Computers, Diagnostic equipment (stethoscopes, syringes)
Research	Furniture (desks and chairs), Computers, Lab equipment (beakers, test tubes, etc.)
Industry (Low-G)	Computers, Forklift
Maintenance	Spacesuit, Interior and Exterior maintenance robots
Security	Tasers, Security Robot

5.3.1.1.1.

4.3.1.2 SmartHome The SmartHome is an automated system that is used to manage the devices within each house and apartment to fit the resident's preferences. It will also be used to order and receive food and consumables from the warehouse via the underground transportation corridor.

4.3.1.3 EVE EVE is a virtual teaching assistant that will be used in all educational facilities on Bellevistat. Loaded with face recognition software, Eve is able to determine whether or not students understand the material and adjust the lesson plan accordingly. The same software will be used to determine if students are properly paying attention and during test, to catch cheating. *Refer to Figure 4.3.1.3*

4.3.2 Devices Colonists will have access to devices that will assist them in controlling the automation systems on Bellevistat. *Refer to Figure 5.0.1.1.*

4.3.3 Transportation Colonists in Bellevistat will use the SkyTran system for transportation. *Refer to Section 3.2.9.* Transportation within a microcity however can also be conducted by the bike which offers personal transportation.

4.3.3.1 Bike Because each individual micro city has a size of several square kilometers, bikes will be made available for transportation at the SkyTran stations, visitor accommodations facilities, and bike facilities. These bike facilities will keep an electronic inventory through RFID tags to ensure that there are enough bikes at each facility. As a form of collateral, each bike will require plugging in the mobile device, HG, in order to unlock the bike for use.

4.3.4 Safety and Maneuverability in Low-G Environments Within the low-g and/or unpressurized environments, all colonists are required to wear a spacesuit, which would provide propulsion and/or mechanical counter pressure to allow work to be done within these environments.

4.3.4.1 Spacesuit When colonists need to travel through or within either unpressurized or low-g environments, they will be provided with spacesuits that will utilize mechanical counter pressure instead of a gas pressurization technique. Spacesuits will consist of several sprayed-on layers that will be easy to don and doff. Within these individual layers, there will be a layer of paper batteries that will be generated energy through sweat. In addition, the spacesuit will also provide slight resistance to both generate additional energy and exercise. These energy generation methods will be used to reduce the need for large batteries on the spacesuit. Propulsion in low-g is achieved by means of several small air thrusters fuel by efficient air compressors.

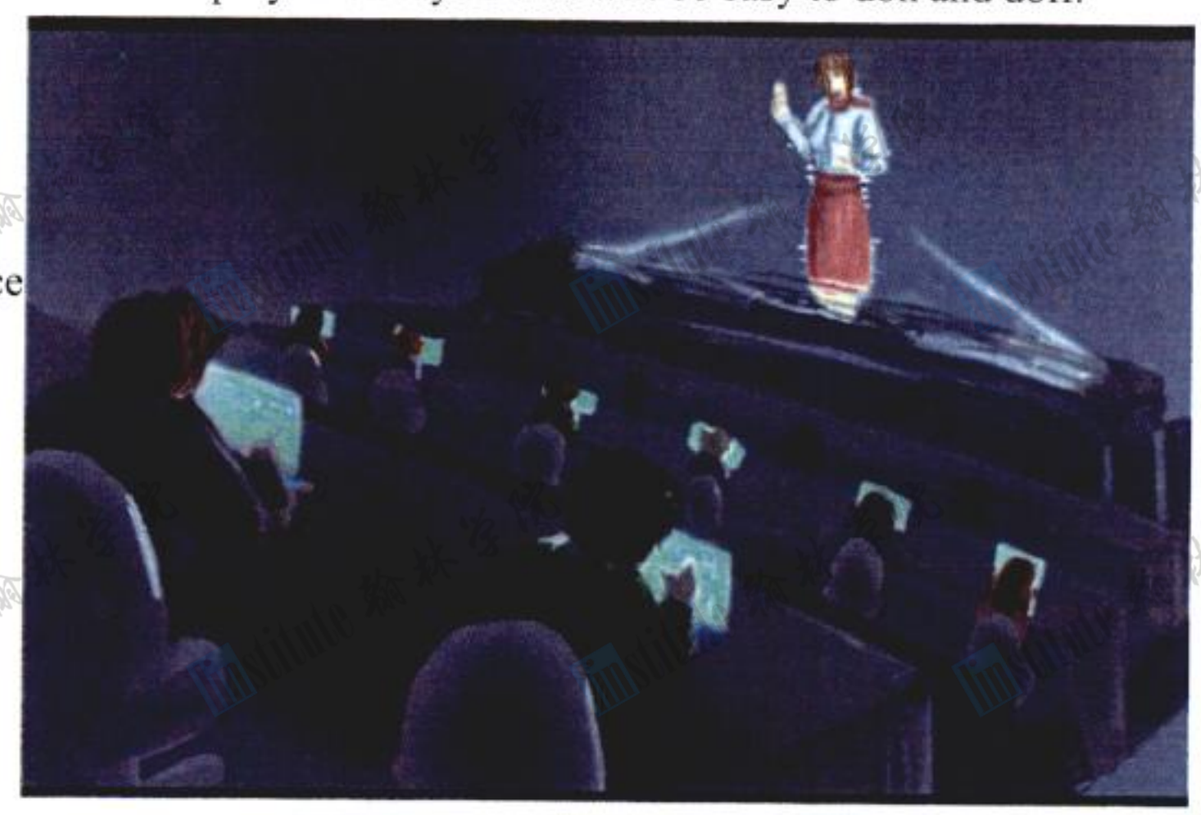


Figure 4.3.1.3 EVE

4.4 Divergent Neighborhood Designs To have divergent residential neighborhoods, Bellevistat will have three different neighborhood types for the six microcities. These designs will give the colonists diverse lifestyle options as well as provide each demographic with the required

Figure 4.3.1.4 Spacesuit Design

living space and needs. Also each microcity will also have a commercial sector that will provide most of the jobs for colonists within that particular microcity.

4.4.1 Urban The urban neighborhoods will be slated for the single adult population as this demographic will not require a large living space per unit. Housing will be be provided by apartment complexes. To further generate an urban feel, most facilities will be within walking distance of the residences. Bikes will be provided for long distance transportation within the microcity. The urban neighborhoods will also have numerous cafés, nightclubs and bars to accommodate the social needs of the single adult population. A large park will be located near the center of each urban microcity to provide colonists with a "Central Park". This park will have a communal orchard and garden that colonists can use to cultivate their own fruits and vegetables to supplement their diets.

4.4.1.1 Bellevistat U One of the two urban microcities will serve an additional purpose. A modified microcity layout will be used to make this particular microcity a college town. This microcity will have the university's facilities where the business sector will be in the other microcity. The university will provide higher education to the young adult population as well as the facilities for the research being conducted in the agricultural and industrial sector.

4.4.1.2 Business Sector The other urban microcity will house the colony's business center. As a business center, this sector will be mainly composed of office buildings but there will also be fine dining restaurants to allow businessmen and women to easily meet with each other and their clients. This sector will enhance the urban feel of the microcity as it will cause some businessmen and women to "commute" to their office from their homes.

4.4.2 Suburban The suburban neighborhoods will be designed to accommodate the married adult and children population in addition to part of the single adult demographic. The suburban neighborhoods will provide spacious homes that will provide the adult colonists additional living space for their children. Each home will have a plot of soil located on the roof to serve as a yard or a garden. The commercial portion of the neighborhoods will consist of town centers that will provide a social area for teenage students as well as single adults. *Refer to Section 4.1.1.5.2* As a community designed to accommodate children, there will be schools and various social opportunities made available.

4.4.3 Rural The rural microcities will be designed to accommodate a small but significant portion of the agriculture being conducted on Bellevistat in addition to providing residential neighborhoods. The residences will be single story houses that will be used as homes for the older married adult population. Each home will be have a yard in addition to a rooftop garden. Also there will be a large communal orchards and vineyards that will help provide the rural feel to these microcities. In addition to agriculture, the rural microcities will also house a majority the recreational facilities, including the Simulated Wilderness. *Refer to Section 4.5.1* The commercial sector will provide the supplies for people who wishes to enjoy the opportunities the recreational facilities have to offer.

4.5 Lifestyle Bellevistat will serve as an "Earth away from Earth" as colonists will be experience a lifestyle that will be very similar to those people on Earth have. However, the lifestyle will also be noticeably different due to space constraints which requires the need of new technology.

4.5.1 Recreational Activities In terms of recreation, colonists will have access to numerous opportunities that will encourage physical activity. These activities will be Earth-like but will take advantage of technology to enhanced the colonist's experience.

4.5.1.1 Sports Team sports will be encouraged over working out at gyms because sports will create long lasting social connections between colonists in addition to promoting physical fitness. However, individual sports such as golf will still be available as they foster a sense of community between colonists. Due to the confined nature of a space colony, some sports will use virtual reality to create virtual matches. This also allows colonists in different microcities to play together.

4.5.1.1.1 Zero Gravity Sports and Activities Located in the zero gravity industrial center of the colony, colonists can play sports in a zero gravity environment. Separate facilities will be provided for these sports to keep these recreational areas and the people in them safe from the nearby manufacturing.

4.5.1.2 Simulated Wilderness The Simulated Wilderness is a sector put aside in the rural microcities that will allow colonists to engage in recreational activities such as camping and hiking. The Simulated

Wilderness may not accurately provide the full camping experience but it will still provide colonists with a completely new environment when regular colony life becomes too much.

4.5.2 Leisure Colonists on Bellevistat will have access to both traditional Earth modes of leisure as well as an unique Bellevistat take on leisure.

4.5.2.1 Entertainment Colonists will be able to enjoy traditional entertainment such as movies and roller coasters but they will also have the option to experience these activities in a new way with the aid of simulators. Colonists can use virtual reality to place themselves into a movie or use simulators to ride roller coasters that the colonists have created.

4.5.2.2 Social Interaction The social needs of the colonists will be met with conventional social interaction. Cafés, nightclubs and other public areas will allow colonists to interact with each other as well as encourage face to face interaction.

5.0 AUTOMATION DESIGNS AND SERVICES

5.0.1 Computer Specifications

5.0.1.1 Hardware Specifications

Figure 5.0.1.1 Hardware Specifications

*Note: ABP – Asynchronous Based Processor; APU – Auxiliary Processing Unit; FPGA – Field Programmable Gate Array; MBA – Mesh-Based Architecture (Each MBA core runs at 0.5 ghz)

5.0.1.1.1 HG and MG Details and Integration Compared to other mobile devices, the HG is unique in its appearance. Unextended, its appearance is similar to a stack of Post-Its. Extended, an elegant OLED-based e-paper, supported by "rubber" metal, slides out. Users can just simply touch the paper and interact through MultiTouch. In addition, the HG boasts an Environment Adjustment System, which utilizes infrared sensors, cameras, and other sensors to acclimate the HG's screen to the environment. At the same time, its built-in RFID reader enables colonists to access conveniences described in later sections.

The MG primarily acts as a home computer. It differs from traditional system by offering a heliodisplay, a 2D projected screen on air. Users are free to simply touch the heliodisplay and interact in a new, refreshing method. Besides a heliodisplay, the MG is unique due to its Intelligent Adaptation (Refer to Section 5.0.1.2.1 for more details).

To achieve seamless integration between the two common units that colonists will use, the HG acts as a simple extension of the MG in terms of storage. Saved files and accessed files on the HG are physically stored in the MG; the HG's storage acts as a temporary cache for files and programs. As a result, colonists can access any files they have at any given time. In addition, to provide a familiar environment on both, colonists have the option of sharing desktops between both MG and HG. At the same time, each shares a common interface: MultiTouch. Through MultiTouch, colonists can intuitively and easily interact with computers while being able to easily switch devices. *Refer to Section 5.0.1.2.1 for additional details on the use of the MG's and the HG's use of FPGAs.*

5.0.1.2 Software Specifications *Refer to Figure 5.0.1.2.*

5.0.1.2.1 Intelligent Adaptation and Interaction To speed program execution and lower overall

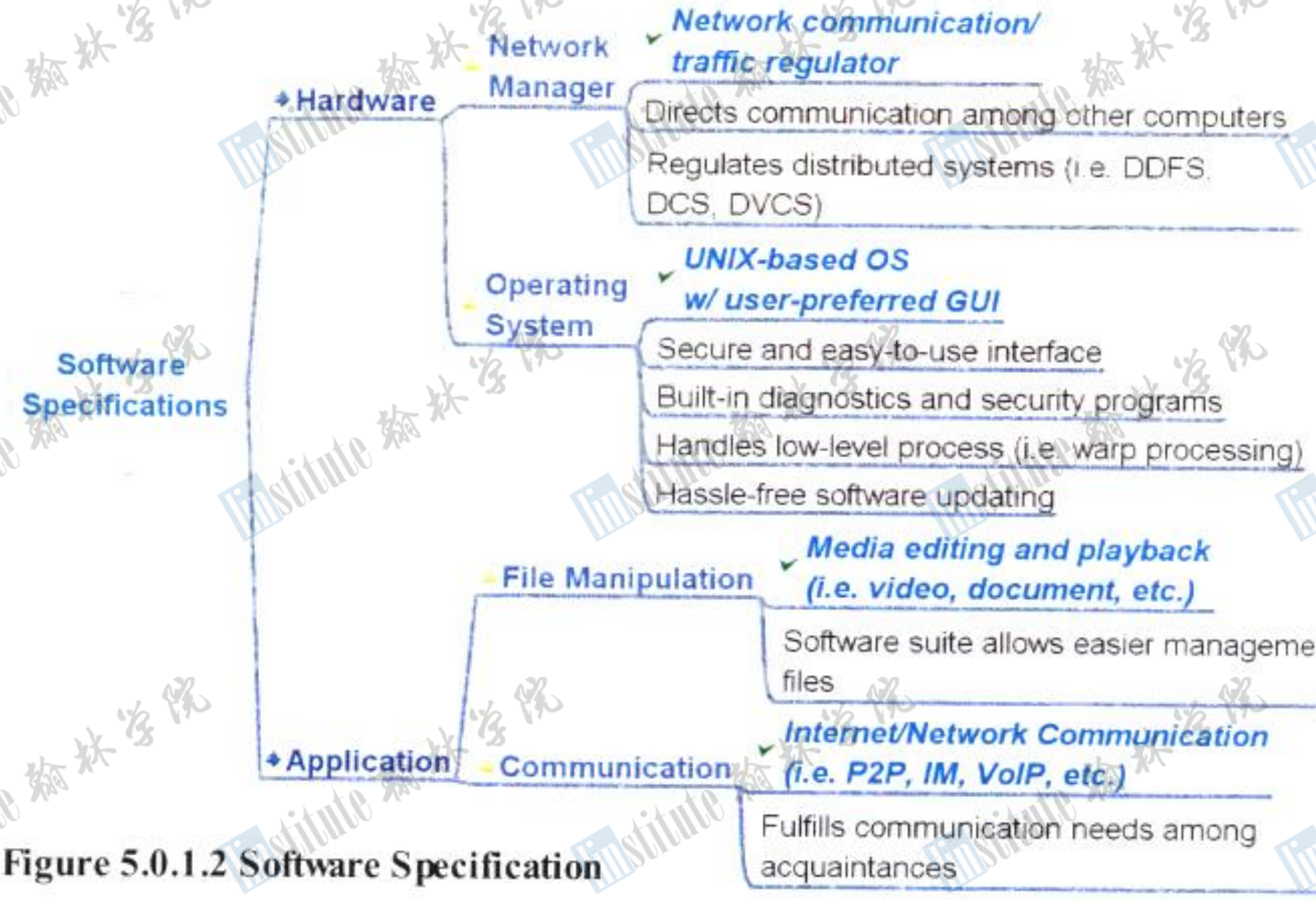


Figure 5.0.1.2 Software Specification

processing load, programs will be compiled to bytecode and run on top of a low-level virtual machine. The bytecode will be iteratively and dynamically compiled at runtime through JITC (Just In Time Compiling) to a combination of software instructions (executed via CPU) and hardware logic (executed via FPGA). In this combination, FPGA units are reconfigured into frequently accessed portions of the code while CPU units process the other portions of the code. The virtual machine will track frequently used portions of the code as the program runs; accordingly, the machine changes the FPGA units from the data of the program run. Porting programs written in high-level languages to such a platform would require only a simple recompilation of the program source code. Hence, software and hardware will work together to intelligently adapt to different software environments accordingly.

In addition to adaptation, software can interact intelligently with users through a combination of face recognition and cameras. By recognizing different facial expressions from cameras, the computer is capable of 'reading' the emotional state of the user. Depending on the user's mood, the Operating System can suggest different actions, such as taking a break, or working on something else. Through this interaction, users can remain productive with their time.

5.0.2 Robot Specifications

Table 5.0.2 Robot Specifications

Name	Dimensions (LxWxH in meters)	Features	Amount
Lagann base -DaiGurren Lagann (external construction) -Gurren Lagann (mining)	Lagann: 2.0x2.0x1.0 DaiGurren Lagann: 3.0x3.0x2.0 Gurren Lagann: 3.0x3.0x2.0	Lagann: gecko feet, plasma-magnetic propulsion DaiGurren: laser cutter and welder, bolter, claws Gurren: ultrasonic drill, pick, scoop, cargo bay	500
MAN base -GutsMAN (interior construction) -ProtoMAN (security, janitorial)	MAN: 0.5x0.4x0.75 GutsMAN: 0.5x0.4x2.0 ProtoMAN: 0.5x0.4x1.5	MAN: arm/claw, spray nozzle, tweel Guts: laser cutter and welder, bolter, nozzle cargo (paint, cement, nanobots, etc.) Proto: taser, vacuum, mops, cargo bay (one regular, another with nanobots), nozzle cargo (fire retardant foam, tear gas, nanobots)	400
Miscellaney Utility Storage/Cargo Land Exchanger - Transport aka MUSCLE-T (cargo)	5.0x5.0x3.0	Cargo bay	200
AgroBoy (agriculture)	0.5x0.6x0.8	Baskets, ethylene sensors, scythe	300
Prowl (pet robot)	0.25x0.40x0.30	3D laser scanner (human gesture tracking),	

		cameras, claws, emotion sensing capabilities, foot vacuum, taser, voice recognition	
Rapid Formation Prototyper aka RFP (mass production and rapid prototyping)	5.0x5.0x7.5	3D printer, selective laser sinister, fused deposition modeling, stereolithography apparatus, electronic beam melter	100
Nanobot	varies	varies	varies

Figure 5.0.2.1 Prowl

Figure 5.0.2.2 ProtoMAN

5.0.2.1 Specialized Robotic Designs An unique feature of all robots is the composition of the shell and hull. The external shell is created from NiTi, or nickel titanium alloys (easy recovery from deformation by heating due to its memory shape nature) and coated with carbon nanotubes (projectile reflection due to its elasticity). Below this shell lie various layers of monomer-filled microcapule embedded epoxy (self-repairing), carbon nanotube (damage pinpoint), Demron (radiation), and Aerogel (cushioning).

Instead of conventional battery sources, robots obtain power from tritium batteries. Tritium batteries work by converting the decay of tritium to electricity through photovoltaic processes; as a result of tritium's half life and subsequent lowered output, batteries will be replaced every two decades. Through tritium batteries, robots will be powered for a long period at a low cost.

To conserve resources and accommodate changes, certain robots will have modularity functions through a bayonet grip mechanism. The mechanism requires a simple attach, twist, and pull sequence for connection. Due to the heavy nature of attachments, external machines will facilitate the changing process.

Figure 5.0.2.3 GutsMAN

Figure 5.0.2.4 AgroBoy

5.0.3 Facility Automations A majority of facility tasks are accomplished by robots. Transportation of goods throughout the colonies are fulfilled by MUSCLE-T. Agricultural manual labor, such as planting and harvesting, is accomplished through AgroBoy. As for industrial work, the RFP is capable of rapidly both manufacturing goods in mass quantity and producing prototypes. Security of the colony is handled by presence of ProtoMAN.

5.0.4 Community Automations To facilitate the community, a combination of robots and computers will alleviate community of work. ProtoMAN robots doubly fulfill security needs and janitorial needs while MUSCLE-T units travel the colony, depositing packages to homes. In addition to robots, HG units provide convenience to the community through its mobile computing capability, interaction with the colony (i.e. RFID tags and businesses), and interaction with the user (i.e. messages of colonial news); it provides access to SMART home functions. Through the ER units, an universal Health Monitoring System is capable of tracking the community's health status. *For more information, refer to Sections 5.3.1.1, 5.3.3, 5.3.3.1, 5.3.4.*

5.0.5 Business Automations To ease store management, all goods are tagged with powder RFID tags, containing price, type, and other data. Through its inherent RFID reader, HG units are capable of creating a real-time inventory map for consumers to use and find items. In addition, upon walking out with items, they can read and adjust the tags while transacting the tag's amount from the user's account; simply put, transaction made easy. At the same time, the real-time inventory map can be used by owners to keep track of their stores' inventory, or track stolen objects. In addition to store management, business owners can telepresently communicate via the Cee or MG; thus,

they can be 'present' for important business on Earth or in colony.

5.0.6 Network Planning *Refer to Section 5.6 and Figure 5.0.6.*

5.0.6.1 User Access to Network To access the network, the ER unit is required. *For more details on different access levels and accounts, refer to Section 5.2.4.*

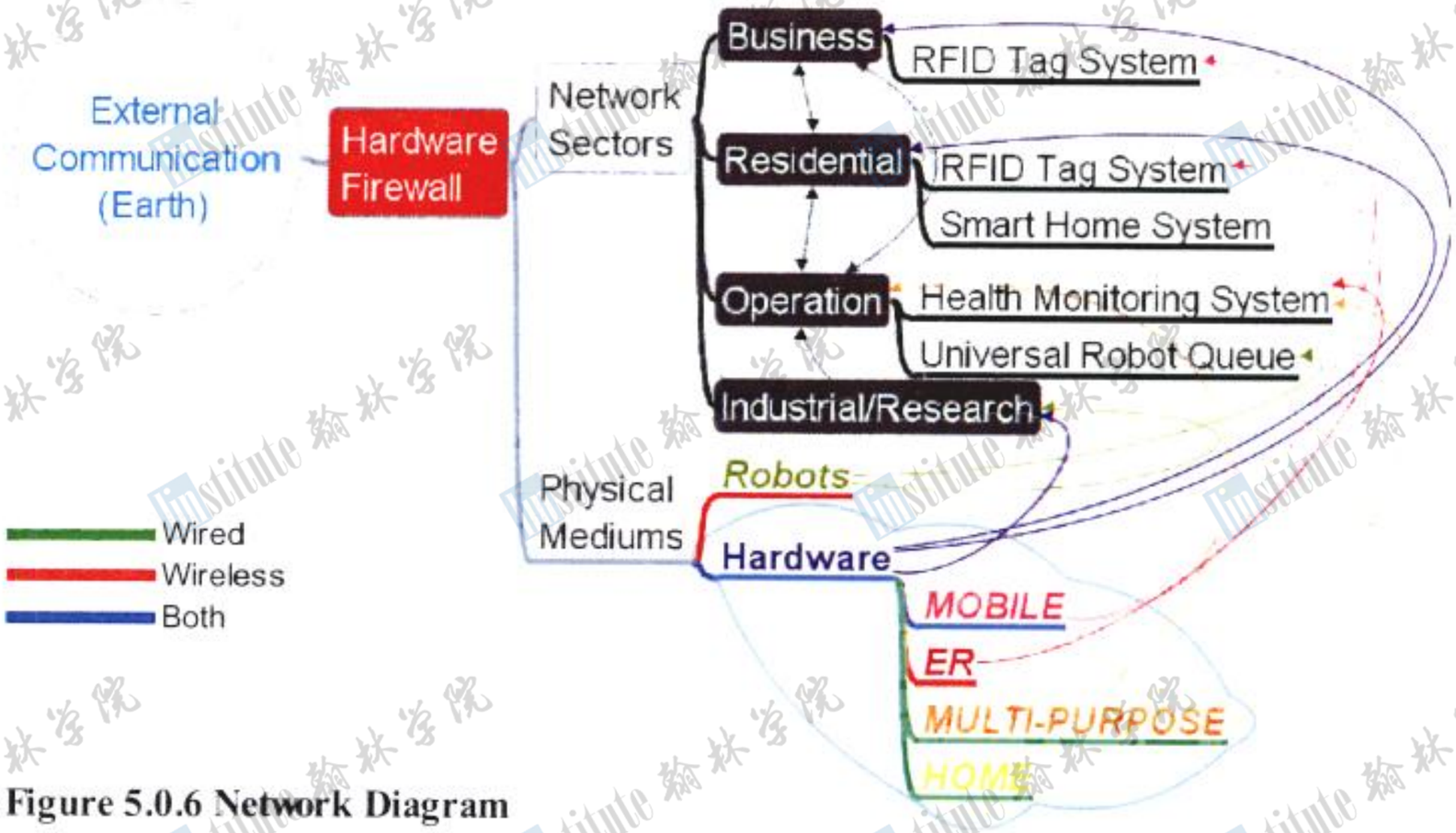


Figure 5.0.6 Network Diagram

5.0.7 Data Storage and Distribution *Refer to Section 5.6.2.1.*

5.0.8 Locations and Sizes of Critical Facilities

5.0.8.1 Repair and Maintenance Facilities To provide immediate deployment and wide coverage, each microcity is home to three repair and maintenance facilities, each measuring 50 x 50 meters, each catering primarily to the maintenance of robots. Robots are to periodically report back for every 24 hour of operation or in the case of critical damage; specialized GutsMAN units will be in charge of repair. In the case of highly critical or unrecognizable damages, human technicians will be on site to render a final verdict. *Refer to Figure 4.1.1.8.*

5.0.8.2 Storage Facilities For the storage of other automation devices, specifically computers, there are at least two 50 x 50 meter storage warehouses in each microcity. As devices are prone to failure in unfavorable environments, the environment within each warehouse is specifically maintained at a certain humidity level and temperature through an automated system using a combination of sensors, air conditioners, and other devices; in the case of possible exigencies, such as a fire, there is not only a Sapphire-based sprinkler system but also a staff of both ProtoMAN and human technicians. *Refer to Figure 4.1.1.8 for locations.*

5.0.8.3 Transportation Corridors The underground transportation corridor enables robots to rapidly move throughout the colony. As the appearance of robots can be psychologically terrifying or disturbing to colonists, the corridor allows robots to travel to different areas without being seen. In addition, this helps reduce traffic flow; all robots using the corridor are tracked through a RFID tag system. All robots are able to travel through the corridor as it is 50 meters in length and 20 meters in height, which are significantly larger than the dimensions of the tallest and widest robot. *Refer to Figure 3.2.9.1.*

5.1 Automations for Settlement Construction

5.1.1 Transportation and Delivery As packages are imported into the colony, each are tagged with a RFID tag, containing appropriate data describing its exact content. From this tag, MUSCLE-T units delivers the cargo to the correct destination. As items are delivered, an automated system keeps track of the contents of each MUSCLE-T while transmitting the most effective path for each to follow. During the settlement construction, this process will be ongoing; after construction, other deliveries will be added onto the cargo delivery, such as residential package deliveries. When these types of deliveries are added, MUSCLE-T units interact with each residential home to send and receive packages.

5.1.2 Settlement Assembly

5.1.2.1 Exterior Construction The exterior construction sequence is divided into two parts. First, mining is accomplished through a mining system led by Gurren Lagann robots; *refer to Section 5.5 for more details on this process*. After mining parts of the asteroid, actual construction begins with the DaiGurren Lagann robots welding pre-fabricated parts for a port; for more details into the construction process, *refer to Section 2.4.*

5.1.2.2 Interior Finishing To swiftly finish the interior of most buildings and colony structures, GutsMAN robots are the primary units used. *Refer to Section 5.4 for more details on the exact process and time for GutsMAN to accomplish interior finishing.*

Table 5.2 Construction Robot Tables		
Assembly Devices	**Description**	**Purpose**
Gurren Lagann	Using ultrasonic drills, Gurren Lagann units are capable of mining through any surface. It is used throughout all the construction sequence.	Mines the asteroid for both materials and construction
DaiGurren Lagann	DaiGurren Lagann complete the construction of the domes by welding together pre-manufactured dome parts. After construction, they monitor and repair the integrity of the dome.	Constructs and repairs the dome
MUSCLE-T	MUSCLE-T obtain cargo from the ports and accordingly deliver materials to sites of construction. After construction, it is used for colonial purposes.	Transports materials throughout the colony
RFP	Through a variety of rapid manufacturing techniques and devices, the RFP is capable of constructing any necessary material needed for constructing, such as furniture.	Mass manufactures or produces items needed
GutsMAN	GutsMAN are smaller robots, intended for interior finishing. It is able to spray materials to quickly paint or glue parts and homes. Later, it is used to maintain the colony.	Finishes interior of homes; maintains colony

5.2 Automations for Settlement Maintenance, Repair, and Safety Functions

5.2.1 Settlement Functions

5.2.1.1 Settlement Maintenance and Repair Periodic maintenance of the settlement will be achieved through the DaiGurren Lagann and MAN-based units; these units are capable of detecting and fixing minor or major problems within the colony, such as cleaning, wiring damage, or plumbing. In addition, various sensors, such as internal hull sensors and power monitors, will provide data on specific utilities and areas, which is constantly analyzed to provide possible maintenance and repair sites for robots to visit. Maintenance routines and repairs will be tracked and logged by an automated computer system to ensure an efficient distribution and timing of robots; when necessary, human technicians can be summoned to access possible complications.

5.2.1.2 Settlement Safety Due to their capabilities of withstanding harsh environments and being expendable, robots will be used to execute most, if not all, the contingency plans; in addition, their "set-and-go" nature ensures that tasks will be completed, irregardless of interruptions. Along with robots, an automated system will send out a clear message to all citizens through the MG, HG, Cee, and ER units about the possible exigencies occurring in the colony.

5.2.1.2.1 Backup Systems *Refer to Section 5.6.2.1.*

5.2.1.2.2 Contingency Plans

Table 5.2.1.2.2 Contingency Plans			
Contingency	**First Response**	**Second Response**	**Initial Response Completion Time**
Foreign Object Collisions	Obtain data from external hull sensors to analyze extent of damage. If critical, initiate second response.	Deploy DaiGurren Lagann and GutsMAN at site of damage.	~20 seconds
Hull Breach	Activate electromagnet upon breach; ferromagnetic fluid will seal breach temporarily.	Evacuate citizens accordingly. If sealed successfully, proceed repair through robots. If unsuccessful, immediately lockdown area.	~40 seconds
Fire	Warn citizens via robots, ER, and HG. Send out GutsMAN.	Analyze situation. Deploy more GutsMAN while evacuating citizens	~3 minutes

		accordingly.	
External Communication Failure	Find out source of failure, and attempt to repair. Continue communication attempts.	If unfixable, send out a mission to inform authorities while continuing repair attempts.	~20 minutes
Attempted Cyber Breach	Stop all non-vital communication. Attempt to locate the attacker by analyzing address from router while blocking specific address range.	Analyze method of breach; take countermeasures to prevent similar attacks. Repair possible damage, and resume communication.	~5 minutes
Attempted Security Breach	Immediate deployment of ProtoMAN and security personnel to apprehend intruder(s). If resistant, disable intruder(s). If necessary, lockdown area.	If intruder(s) have escaped, search area with people for abnormalities.	~15 minutes
Chemical Leak	Alert affected area via robots, ER, and HG. If necessary, lockdown area and evacuate.	Send out medical personnel for immediate treatment. Cleanse area with GutsMAN guided by humans. Assess damage and act accordingly to prevent future leaks.	~7.5 minutes
Biological Infection	Send patient(s) to hospital for immediate diagnosis. If serious, quarantine patients and contacted people while locking affected area.	Disseminate warnings via HG and ER. Keep alert for outbreaks.	~2 hours
Solar Flare	*Refer to Section 5.2.2*		

5.2.2 Solar Flare

Contingencies During a solar flare, robots enter a "solar flare" mode where all non-vital and non-critical robots are sent inside the colony, or external shelters. Within the colony, the storage and repair facilities are a shelter against the solar flare due to its radiation shielding. Critical and vital processes are continued during the solar flare. After the solar flare, repair robots are sent throughout as an expedient to possible damages.

5.2.2.1 Robot Specifications for Solar Flare Counter

As a precaution, robot materials are equipped with specific solar flare countermeasures. To

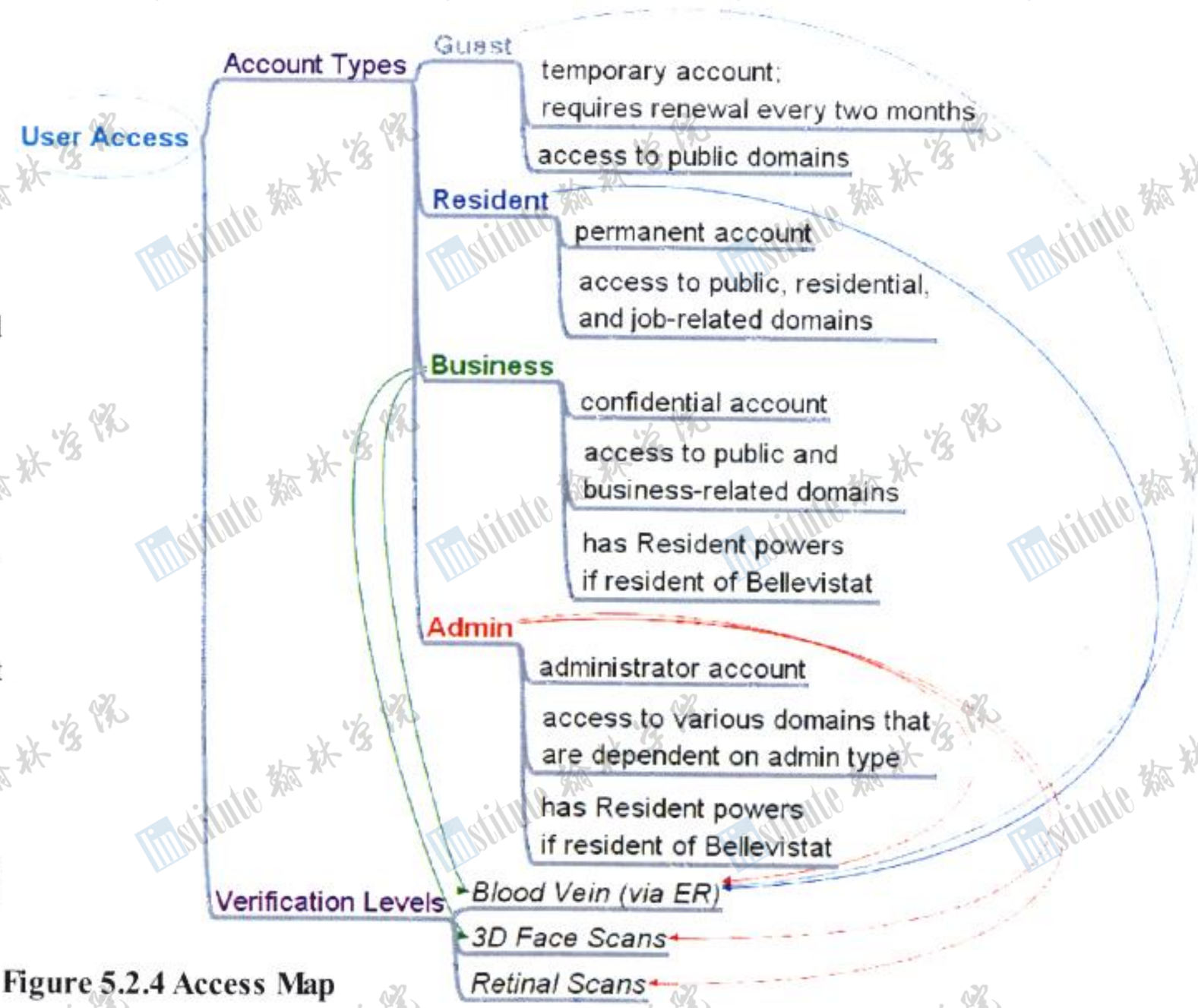


Figure 5.2.4 Access Map

ensure operation, VMRAM (Vertical Magnetoresistive Random Access Memory) is installed in all robots as it is non-volatile and resistant to radiation damage; at the same time, other robot hardware is radiation-hardened. Despite imminent failure, components will continue to function and operate. In addition, robots come with a physical layer of Demron as a barrier against radiation.

5.2.3 Locations of Automations for Critical Functions *Refer to Section 5.0.8.*

5.2.4 Access to Critical Data and Automation Systems *Refer to Figure 5.2.4.*

5.2.4.1 Security Measures For constant identity verification, ER units constantly scan blood vein vessels in the wrist; the individual nature of blood veins ensure that the user is the actual user in the colony. Every time an ER unit is detached, it will rescan when attached to an user to ensure the correct account is accessed. In addition to blood vein biometrics, certain sensitive domains will only be accessible with addition verification (e.g. 3D face, or retinal scans). As for physical security, it will be physically evident through ProtoMAN and strategically placed multispectral cameras. Along with this, each area in the colony will have special sensors and cameras that are capable of 'probing' the general area for potentially dangerous chemicals or concealed weapons.

5.3 Automations for Community

5.3.1 Community Livability Enhancements *Refer to Sections 5.0.3, 5.0.4, 5.0.5, and 5.2.4.1.*

5.3.1.1 Health Monitoring System The Health Monitoring System (HMS) monitors the health of the colonists through a combination of ER units and appliances. Through the ER units' infrared, temperature, and pulse sensors, medical data, such as glucose levels, heart rates, and body temperature, is constantly read and stored. As new uses for sensors, notably infrared, are developed, ER units can be accordingly updated. They are powered by thermoelectric generators that derive energy from the individual's body heat. Alongside the ER units, weight scales and toilets in the individual's home track body weight and analyze excrete for possible abnormalities; this data is emitted to and stored by ER. Subsequently, the ER unit data is used to compile a 3D medical avatar for doctors to use during diagnosis. Finally, in the case of aberrations, the ER units will notify the users to see their doctors.

5.3.2 Productivity Enhancements in Work Environments Through the HG and MG units, workers are capable of working on tasks while being mobile or at home. The data integration between both units (where the data is stored on the MG units) allows HG units to access and store potential work files to work on later. In addition, the HG units' MultiTouch and voice-command capabilities enable full interaction between the user, allowing users to simply voice out commands or manipulate through touch. In addition, the intelligent adaptation by both computers speeds the processing of applications while encouraging productivity. *Refer to Section 5.0.1.2 for more details on this process.*

5.3.3 Residential Convenience Enhancements Similar to business owners, powder RFID tags -altered slightly to prevent confusion with commercial tags- are offered to residents for them to tag belongings. Through the HG units, residents can easily locate their belongings in case of loss or theft. To prevent encroachment of privacy, tags can be appropriately labeled private or public.

5.3.3.1 Smart Home Integration Inherent in residential areas, the Smart Home is a system where users can control built-in home electronics (i.e. air conditioners, lights, etc.), designate robot-based services, and overview food distribution. Other services Smart Homes provide are an automated recycling and trash sorter, in-home delivery and shipment, and efficient energy distribution processes (e.g. deactivation of certain devices during sleep, etc.). To achieve convenient access to this system, a web-based interface enables users to control all commands at their preference via their HG or MG units. *Refer to Section 5.3.7.2 and 4.1.2.4 for additional details on robot distribution and food distribution.*

5.3.4 Community Maintenance and Routines To ensure the integrity of the community, robots, specifically repair and construction based, will monitor community structures, such as the hull, public areas, and utilities. Certain structures, such as the communal orchard and pool of stars, will be constantly monitored and maintained by respectively-needed robots (e.g. AgroBoy for orchard, GutsMAN for pool of stars). *Refer to 5.3.3.1 and 5.3.7.2 for more details.*

5.3.5 Privacy of Personal Data *Refer to Section 5.6.2.1.1*

5.3.6 Control of Private Systems *Refer to Section 5.3.3.1 and 5.6.2.1.1.*

5.3.7 Access to Community Services Community services can be accessed by HG, MG, and public computers. Refer to the subsections for more details.

5.3.7.1 Community Computing Grid *Refer to Section 5.6.2.2*

5.3.7.2 Robot Resources Through the Smart Home system, residents have access to robot

services. Their requests, in turn, is added to the universal robot queue in the automated computer system for robots, which keeps track of all requested and necessary robot functions. Each portion of its queue is fulfilled based on the location, importance, and estimated amount of time spent. To provide better coverage and fulfillment of services, the system will spread robots throughout all sectors.

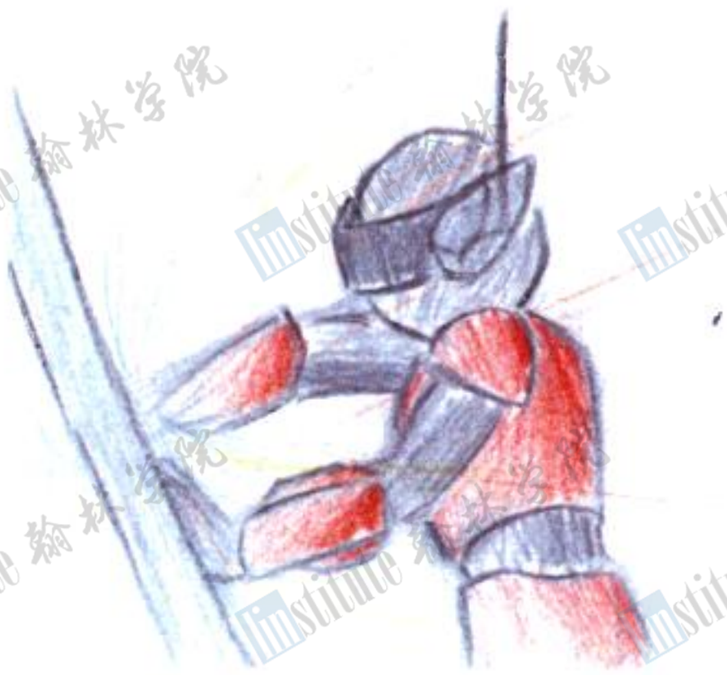


Figure 5.4 GutsMAN beginning to weld together the wires necessary for the calcium carbonate walls.

5.4 Automations for Interior Finishing GutsMAN will use a variety of tools to finish the interior of the colony and remove the need for human construction workers. All interior finishing will follow a "bottom up" sequence of construction because the GutsMAN will be suspended from the ceiling for the majority of the interior construction time.

5.4.1 Interior Finishing of Residential To finish the interior of residences, the GutsMAN robots will put flooring on the floor while suspended from the ceiling of the room. Then, the robots will install all electrical wiring and plumbing. Robots will then and begin paint the walls using their spray nozzle attachment and grow the furniture through automated electrically stimulated ionic crystallization. *Refer to Section 3.4* . While waiting for the paint to dry and furniture to grow, the GutsMAN robots will install lighting. The furniture will be grown in approximately four hours, making the total time of interior finishing approximately one to one and a half hours per room with an additional three hours for furniture. At this time, the room will be completely furnished and ready for use.

5.4.2 Interior Finishing of Buildings For non residential buildings, the process will be similar. The main difference is that the room and the required furniture is on a larger scale and thus takes a longer amount of time. The approximate time will be six hours due to this.

5.5 Automations for Asteroid Mining A majority of the mining process is automated. However, in the case of errors and malfunctions, a horde of technicians will keep a constant overview of the system.

5.5.1 Asteroid Mining After arriving on an asteroid, mining begins with the establishment of refining facilities, conveyer belts, and bucket wells. At this point, mining operation commences with the Gurren Lagann units beginning to drill beneath the surface. As they mine, the mining content is scooped into the bucket wells (see Figure 5.5.1). When the bucket is full, it ascends to the surface, drops its content onto the conveyer belt, and descends down (see Figure 5.5.2); during this time, the Gurren Lagann stores the mined content into its temporary storage compartments, which will then be dumped into the bucket upon its descent.

5.5.2 Material Transportation The transportation of the mined materials is accomplished through the bucket wells and conveyer belts. As noted in the previous section, bucket wells, when filled, are hoisted up to the service. It then promptly drops its content onto a conveyer belt that leads into the refining facilities. See Figure 5.5.3 for an overall view.

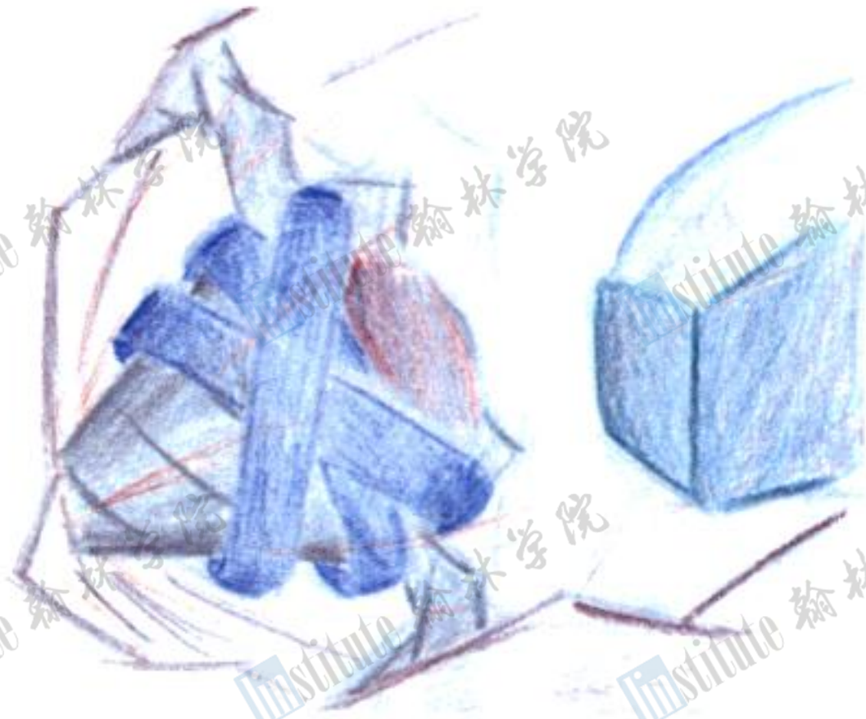


Figure 5.5.1 Gurren Lagann is drilling into the asteroid in the mining phase while dumping its collection into the bucket behind it.

5.5.3 Material Refinement Refining facilities will basically employ a crush and heat procedure. After crushing the ore, the ore is then heated and consequently melted. The melted ore cools down into refined materials. In the case of materials not compliant to this method, the facilities have the option of using magnets to separate materials or break the elusive materials by dissolving some of the materials.

Figure 5.5.2 After receiving the ore, the bucket is hoisted up to the surface for the next phase.

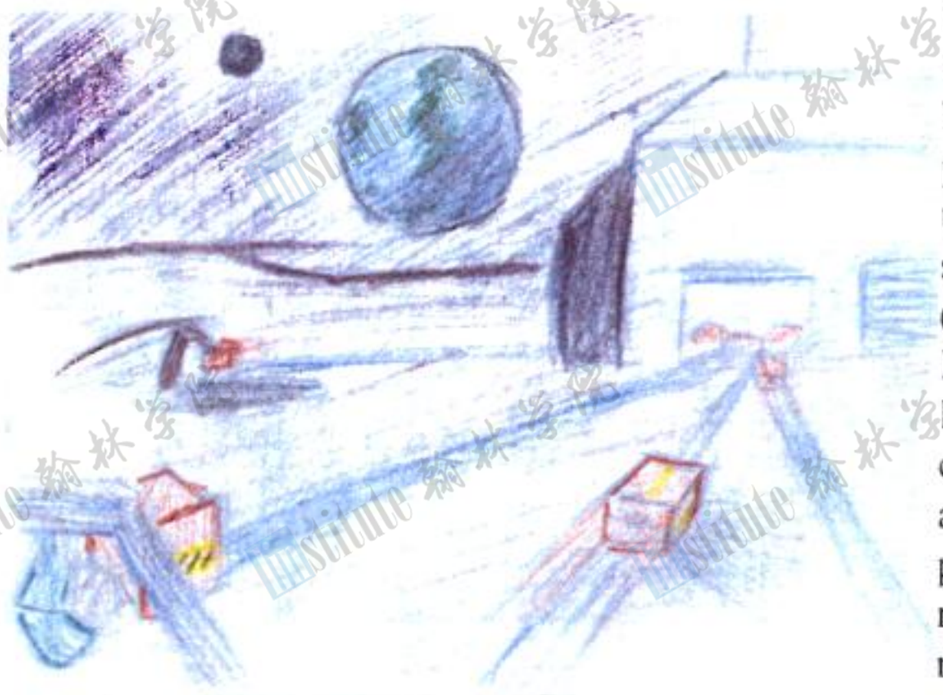


Figure 5.5.3 The bucket unloads its content onto a conveyer belt that leads into the refineries.

5.6 Automations for Networking

5.6.1 Network Hardware Specifications Bellevistat's internal network mediums are terabit wired (wired Ethernet) and one hundred gigabit wireless (gigabit 802.EE compliant network operating in the high frequency range of the electromagnetic spectrum). To ensure privacy and security, all connections' activities will be logged and securely encrypted. Hardware-based firewalls, or firewall-oriented Cee units will protect the internal network against potential attacks from external connections to Earth. External communication with Earth is achieved through a satellite dish, signaling over a broad spectrum for lower power consumption, increased bandwidth, and higher transmission success.

5.6.2 Network Infrastructure Specifications The colony's network infrastructure revolves around certain key structures (specified in the later subsections). The base of it lies in the use of IPv6 and FAST TCP (Fast AQM Scalable TCP). IPv6 is the preferred network layer due to the fast population growth of addresses; FAST TCP acts as an efficient transport layer as it moderates the amount of packets being sent among computer by monitoring the difference in the RTT (Round Trip Time) and a base RTT. At the same time, static Internet pages will be cached and accessed to and from the DDFS to preserve bandwidth; on the other hand, a constant connection will be kept for dynamic contents (i.e. news). In addition, as noted in the Figure 5.7, all computers are polarized into different sectors. However, all computers are networked together in terms of data, processing, and hard networking. In terms of access to functions, this is subject to the various security measures as noted in Figure 5.8.

5.6.2.1 Distributed Data Filing System Under the Distributed Data Filing System (DDFS), storage units in all computers collaborate together. Every file in each computer is constantly replicated and proliferated on different computers; the amount of replication is determined by the frequency of file access. To accomplish this feat, storage units on each computer contain two partitions: one local to hold 'local' files and one private to hold the 'backup' files from the DDFS. To keep track of all circulated files, each computer holds an index of all physically stored files along with an index of pointers to its backed-up files.

Along with the DDFS, a Distributed Version Control System (DVCS) will be used to keep track of possible changes and deletions to a file. When a file changes, the change will be accordingly branched from the original and subjected to the DDFS. In the case that it remains unchanged for a certain length, the DVCS will signal the DDFS to merge the original and change as one. As for deletion, the DVCS flags the file for deletion, which is then deleted in the DDFS.

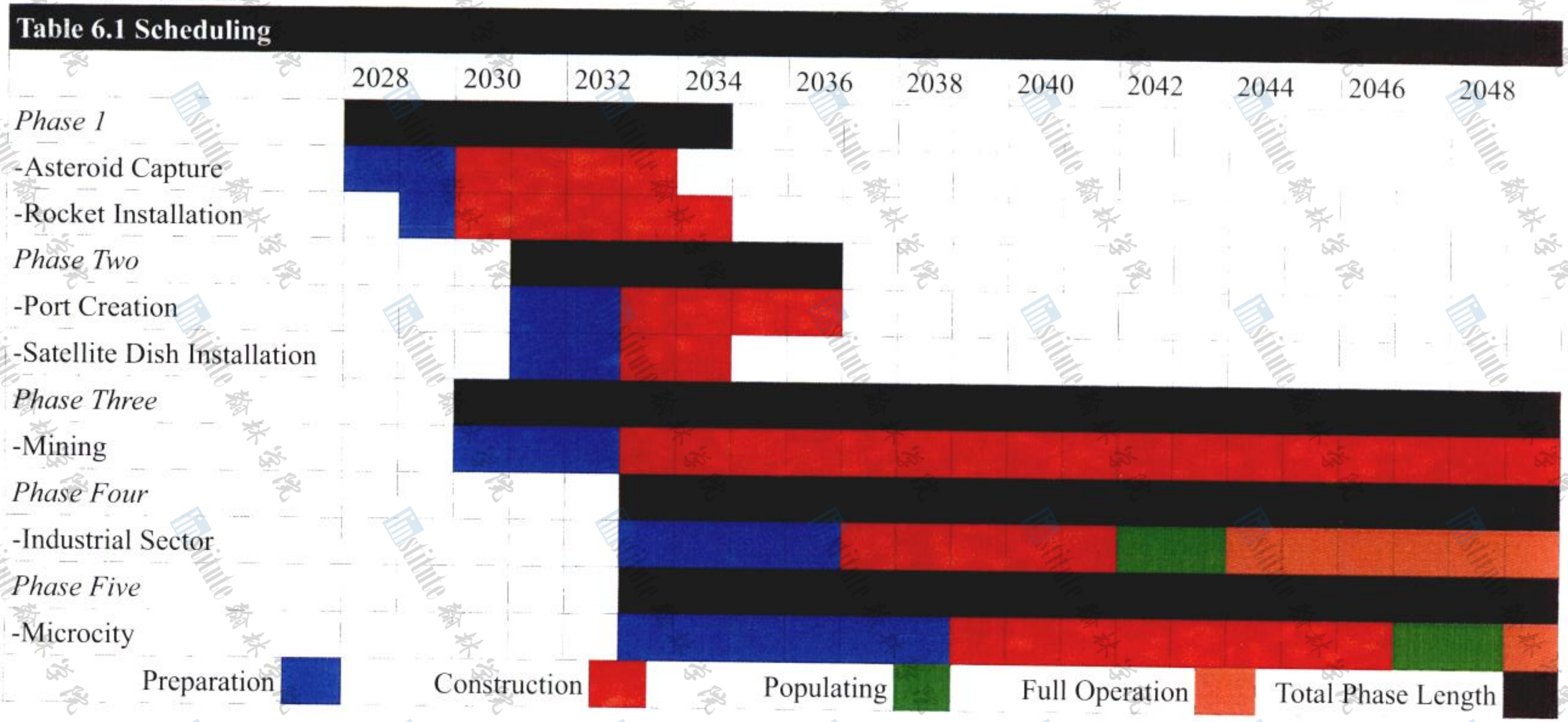
5.6.2.1.1 Data Encryption To provide data confidentiality, files can be encrypted by various means. Colonists have the option of encrypting their personal files with either biometric encryption via ER units, or software-based encryption. For critical files, such as business or research data, quantum encryption, physical encryption (i.e. use of physical mediums), biometric encryption (i.e. retinal or face recognition), or a combination will be provided.

5.6.2.2 Distributed Processing System Similar to the DDFS, under the Distributed Processing System (DPS), primary processing units in all computers are linked together in a network-wide processing grid. Each individual computer sends, or receives processing powers through a mixture of network requests and data upload. Through the DPS, each computer can send requests for power in order to both efficiently utilize other computer's idle times and finish applications more quickly.

6.0 SCHEDULE AND COSTS

6.1 Schedule

Table 6.1 Scheduling



6.2 Costs

6.2.1 Total Costs

6.2.1.1 Construction Expenses

Table 6.2.1.1 Construction Expense	
Construction Expense	**Cost**
Construction Costs	
- Costs of Total Construction Sequence (including assembly and transportation)	$340 BILLION
- Raw Materials	$164.825 BILLION
TOTAL:	**$504.825 BILLION**
Commercial Costs	
- Automation Costs	$0.2305 BILLION
- Personnel Costs	$19.6 BILLION
- Space Vehicle Costs	$145 BILLION
TOTAL:	**$164.8305 BILLION**

TOTAL CONSTRUCTION COST (20 years): $669.6555 BILLION

6.2.1.2 Revenue

Table 6.2.1.2 Revenue	
Profits of Revenue	**Cost**
Services	
- Fuel Station	$150 MILLION
- Maintenance and Docking Bay	$250 MILLION
- Lodging	$250 MILLION
- Tourism	$250 MILLION
Industrial	
- Manufacturing	$5 BILLION
- Mining	$30 BILLION
- Storage	$100 MILLION
- Research	$15 BILLION

ANNUAL REVENUE MADE: $51 BILLION
TOTAL REVENUE MADE (20 years): $1,020 BILLION

6.2.2 Cost Breakdown

6.2.2.1 Raw Materials

Table 6.2.2.1 Raw Material Costs

Material	Unit Cost (price/m^3)	Amount needed (m^3)	Total Cost
Materials derived from 1886-Sisyphus			
Calcium Carbonate	$500	5,000,000	$2.5 BILLION
Concrete	$750	3,000,000	$2.25 BILLION
Glass	$1,000	1,000,000	$1 BILLION
Steel	$4,000	20,000,000	$80 BILLION
Water	$2,150	500,000	$1.075 BILLION
Materials imported from Earth			
Uranium-235	$1,000,000	18,000	$18 BILLION
Ferromagnetic fluid	$100,000	100,000	$10 BILLION
Miscellaneous Costs	----------	----------	$50 BILLION

SUBTOTAL: $164.825 BILLION

6.2.2.2 Automation Costs

Table 6.2.2.2 Automation Costs

Automation Devices	Assembly Cost	Number	Total Cost
Robots			
AgroBoy	$75,000	300	$22.5 MILLION
DaiGurren Lagann	$100,000	250	$25 MILLION
Gurren Lagann	$100,000	250	$25 MILLION
GutsMAN	$85,000	200	$17 MILLION
MUSCLE-T	$30,000	200	$6 MILLION
ProtoMAN	$85,000	200	$17 MILLION
RFP	$200,000	100	$20 MILLION
Devices			
Cee	$3,000	10,000	$30 MILLION
ER	$200	20,000	$2 MILLION
HG	$1,500	20,000	$30 MILLION
MG	$2,000	18,000	$36 MILLION

SUBTOTAL: $0.2305 BILLION

6.2.2.3 Personnel Costs (20 Years)

Table 6.2.2.3 Personnel Costs

Jobs	Annual Salary	Amount	Total Cost
Architects	$160,000 - $180,000	125	$0.45 BILLION
Asteroid Procurement Specialists	$180,000 - $200,000	50	$0.20 BILLION
Businessmen	$150,000 - $175,000	300	$1.05 BILLION
Engineers (all types)	$200,000 - $250,000	500	$2.5 BILLION
Electricians	$175,000 - $200,000	150	$0.6 BILLION
Pilots	$180,000 - $200,000	300	$1.2 BILLION
Scientist	$200,000 - $300,000	400	$2.4 BILLION
Technicians/Supervisors	$180,000 - $200,000	300	$1.2 BILLION
Miscellaneous	----------	----------	$10 BILLION

SUBTOTAL: $19.6 BILLION

6.2.2.4 Space Vehicle Costs

Table 6.2.2.4 Space Vehicle Costs

Vehicles	Assembly Cost	Number	Total Cost
Abunai	$1 BILLION	10	$10 BILLION
Anzen	$1 BILLION	5	$5 BILLION
Arker	$3 BILLION	5	$15 BILLION
Humko	$1 BILLION	5	$5 BILLION
Spinon	$100 MILLION	----------	$25 BILLION
Willoway	$5 BILLION	15	$75 BILLION
Yuki	$2 BILLION	5	$10 BILLION

SUBTOTAL: $145 BILLION

6.2.2.5 Construction Sequence Costs

Table 6.2.2.5 Construction Sequence Cost (Assembly and Transportation Cost Included)

Phase	Cost
Phase One: Capture of Asteroid	$45 BILLION
Phase Two: Ports and Satellite Dish Installation	$25 BILLION
Phase Three: Mining	$15 BILLION
Phase Four: Industrial Sector	$55 BILLION
Phase Five: Microcities	$200 BILLION

SUBTOTAL: $340 BILLION

7.0 BUSINESS

7.0.1 Variety of Commercial and Industrial Ventures The asteroid 1866-Sisyphus is one of the biggest of the NEOs (Near Earth Objects). This allows many activities to be located within the asteroid. The large volume also removes the need to suspend or discontinue previous activities to make room for new activities.

7.0.2 Flexibility of Commercial Areas The enormous size of the asteroid allows for large degree expansion. Since the colony is subdivided into many sectors within each microcity, each sector will have a basic common style. Similar facilities are located together in sectors. This allows new businesses to be placed within an appropriate sector.

7.1 Extraterrestrial Mining, Refining and Delivery Bellevistat will have an asteroid captured and brought near the colony so that material for buildings and other purposes can be mined from the asteroid and shipped back to Bellevistat for use. This provides more raw materials for Bellevistat without compromising the structural integrity of 1866-Sisyphus.

7.1.1 Ore Mining and Refining Ore harvesting will be accomplished through Gurren Lagann units and an automated mining system. Harvest ore will be sent to local mining facilities, established on the asteroid, for processing. The processed ore materials are subsequently shipped to Bellevistat for uses in construction, industrial, or business.

7.1.2 One Way Reentry Vehicle After the ore is mined, processed, and refined on a captured asteroid, the materials will be sent back via the Spinon, an one-way reentry vehicle created from steel obtained in the captured asteroid. Spinon boasts a recyclable body content with re-usable rockets and a recyclable steel body -via melting processes and molding. It has the capability of traveling from a captured asteroid to Bellevistat and from Bellevistat to Earth. Built with a strong chassis, it lands on Bellevistat through a specialized landing system whereas it lands on Earth through a coordinated effort with parachutes and rockets.

7.2 Space Manufacturing Space manufacturing will primarily occur in the industrial sector of the colony, protected from radiation and floating objects in space by the thick asteroid shell. Manufacturing facilities will be located in the center of the asteroid within the industrial to protect the residents from any adverse effects. Because the industrial sector is separated from the residential cities by more than 3 kilometers in the asteroid, colonists will not be directly affected by the industrial sector if the whole sector completely fails.

7.2.1 Spacecraft Manufacturing With the facilities for spacecraft manufacturing located in the industrial sector, the near zero gravity is fully taken advantage of as it less force and power is required to assemble spacecrafts. Construction robots utilize both recycled and fresh material from the asteroid in creating a spacecraft. After the completion of a spacecraft, it is directly shipped to the ports for immediate use.

7.2.2 Manufacturing for Large Scale Projects The industrial sector has ample space to support the construction of components for future space construction and to store manufactured goods. In the case that more space is needed, the industrial sector can be easily expanded. The location of the industrial sector provides a chance to glimpse at the advantages of low-G large scale manufacturing; at the same time, a constant flow of raw materials provides enough stock for large scale manufacturing processes. In addition, RFP units on the colony enable companies to rapidly prototype one copy before confirming a large scale creation of the product.

7.2.3 Manufacturing for Space and Lunar Construction For both lunar and space construction equipments, they are fabricated in the industrial sector. Considering Bellevistat's location, equipment can be quickly shipped to any location within space; in addition, all equipment can be manufactured in less time and less power used through innovative low-G mass manufacturing processes. In addition, through the RFP, a variety of different equipment can be created on a mass scale at the same time.

7.3 Tourism Tourism is a major source of revenue on the colony. Tourists pay $600,000 for an one-way ticket to the settlement, which include transportation of 250 pounds that includes the weight of the tourist and his or her belongings. The anticipated number of transients, at any given time, is to number 1,000. To accommodate for the influx of visitors, there are numerous hotels located throughout each microcity except the industrial sector; various tourist attractions are available to attract and occupy tourists.

7.3.1 Bellevistat as Vacation Destination To attract tourists to Bellevistat, commercials will be aired on Earth, portraying Bellevistat as the "vision of beauty." It will eloquently display certain cites of attraction, such as the "pool of stars" and the "wilderness simulation"; views of various activities will be shown, such as low-G sports.

In addition, ads will specifically stress to possible tourists that Bellevistat is a chance to live and experience space. *Refer to Figure 4.0.2.2 for an example of a tourist attraction.*

7.3.2 Tourist Accommodations and Amenities In order to attract more tourists, many amenities will be offered and provided to tourists. With each microcity offering a different neighborhood, travelers have the choice to lodge in familiar or "new" areas. Hotels are designed to specifically attract the tourists to the natural beauty of Bellevistat by displaying the genuine hospitality of its occupants while offering specific information on activities or sites of attraction; each hotel offers the same services, equivalent of a five star hotel on Earth. As seen from Figure Figure 4.1.18, tourists can easily find a wide variety of places to eat, shop, or explore.

7.3.3 View of Mining, Refining, and Manufacturing Facilities There are daily guided tours within mining and refining facilities or manufacturing facilities to allow visitors to catch a glimpse of the wonders of low-G manufacturing and asteroid mining. From these tours, it allows possible businessmen to understand the advantages, efficiency, and speed of low-G manufacturing.

7.3.4 Low-G Activities As the asteroid is spinning, certain segments of the asteroid experience low-gravity. In these segments, Bellevistat offers certain activities to appeal to civilians of Earth. Most notable of these activities is "zero-G sports". As sports are highly popular on Earth, it attracts the attention of many people while offering the chance at experiencing a highly different aspect of the traditional Earth sports, such as football. For instance, imagine "zero-G paint balling". Instead of being held on a grounded two-dimensional environment, players can now experiment with interacting in a 3D-environment, opening up countless of new possibilities in strategies. *For more information to this exciting process, refer to section 4.5.1.1.1.*

7.3.5 Visitor Access to Bellevistat Systems and Resources Transients to the colony are provided with a HG and an ER unit. To ensure that access is limited, ER units verify the identity of the transients before providing or denying access to parts of the colony. HG units enhance the tourists' experience of Bellevistat by immersing them in the technological lifestyle of Bellevistat; however, full functionality of the HG will be limited for security issues. *Refer to Section 5.2.4.*

8.0 COMPLIANCE MATRIX

	Requirements	Fulfillment	Justification	Page
1.0	**Executive Summary**			**1**
2.0	**Structural Design**	**The colony of Bellevistat is located in the interior of an asteroid, providing it with ample space and protection from space debris and radiation.**		**2-6**
2.0.1	Population Growth	Residential and commercial sectors can be continually expanded as the asteroid is mined, accommodating for population growth.	As resources are mined from the interior of the asteroid, more space will be available to be used as living quarters. With the mined resources, we can build extra living space for an expanding population.	2
2.0.2	Natural View	Thick glass with water will allow residents a safe view of space.	Glass will allow for a clear view, and water blocks out most of the radiation.	2-3
2.1	**Exterior View of Asteroid**	**Refer to Figure 2.1.**		**3**
2.1.1	Construction Material	Concrete, ferromagnetic fluid, glass, rock wool, steel	Steel and concrete are easily obtained from the asteroid, and there is plenty of the building material. Glass will also be used since there will be windows, and it is also the main material for the construction of the pool of stars.	3
2.1.2	Areas of Induced Gravity	VASIMR rockets spin the asteroid, and keep it spinning at a set rate.	VASIMR rockets are high powered nuclear rockets that allow for quick changes in direction or velocity of the asteroid.	4
2.1.3	Regions of Low and Zero Gravity, Pressurized and Unpressurized Environments	Mining facilities will be maintained in low gravity. Ports will be maintained in zero gravity. All areas will be pressurized except for the ports, which are unpressurized.	Mining facilities will maintain low gravity in order to put less stress on the machinery and allow dust and other particles to settle onto the floor. Ports will be maintained in zero gravity in order to allow incoming spacecraft to maneuver more freely.	4
2.1.4	Radiation and Debris Protection	The colony will be protected from radiation and debris by the 100-200 meter thick asteroid shell that encases the colony.	100-200 meters of asteroid rock acting as the hull of the colony is enough to absorb all of the radiation and debris that hits it, since it is so thick.	4
MR	**Overall exterior view of settlement, showing rotating and non-**	**Refer to Figure 2.2**		**4**

	Requirements	Fulfillment	Justification	Page
	rotating sections, and indicating functions inside each volume—e.g., port, residential areas, and agriculture			
2.2	Allocation of Interior "Down "Surfaces"	Refer to Section 4.1.1		4, 16
MR	Overall map or layout or interior land areas, showing the total area of the "down surfaces" inside the artificial gravity volumes, and use of these areas	Refer to Figure 4.1.1.8		16
2.3	Assembly Sequence	The first phase is the capture and stabilization of the asteroid. Following that is the installation of ports. From the ports, mining will begin towards the center. At the center, the industrial micro-cities will be established. After the industrial area is established, mining towards the 2 micro-city areas for commercial and residential areas will occur.	The capture and stabilization of the asteroid is the first priority, so that subsequent trips to the asteroid would be easier. Ports will be built first after stabilization, so that spacecraft with prefabricated materials and machines will be able to be unloaded on the asteroid. The mining and manufacturing facilities will be built next to start creating space for the construction of the residential and commercial sectors and to start manufacturing what will be needed by the colony as people begin to arrive and populate.	4-6
MR	Drawings showing several intermediate steps of settlement assembly	Refer to Figures 2.3.1-2.3.5		5-6
2.4	Structural Asteroid Attachment			6
2.4.1	Minimizing Dust Transfer in Vulnerable Settlement Areas	All spacecrafts getting into settlement colony will necessitate the passing through of an air chamber, where multiple air streams inside will separate dust particles from the items passing through. A second chamber will be used to submerge the items in water to further remove dust.	Air chambers that blow air streams will blow off dust particles accumulated on items and people while they are traveling. After dust is removed through the preliminary treatment, the subject is submerged in a water chamber to further remove any space dust that was missed in the air chamber. This is necessary to keep the colony from being contaminated by space dust.	6

	Requirements	Fulfillment	Justification	Page
2.4.2	Locations of Ore Refining Operations	Ore refining operations will be conducted on the surface of the asteroid.	The interior of the asteroid will be mined for ores to use in the building of the residential, commercial, and other areas for the people of the settlement. While the insides of the asteroid are mined, refining operations occur on the surface, ensuring constant operation	6
MR	**Captured asteroid incorporated in overall settlement design**	**Mining package will be set to nearby asteroid to start mining on there. Refer to section 5.4 for more details.**	**When the materials on the original asteroid run out, another asteroid will have to be captured for additional resources.**	**6**
2.5	**Docking Facilities**	**Docking port facilities will be located at the bottom of craters on the surface of the asteroid to facilitate safe docking and to act as a guide for the pilot as to where the docking port is located.**	**As the asteroid travels through space, small debris throughout space will fly by. In the most critical stage of docking, when the spacecraft is landing on the asteroid, the pilot does not need to be distracted by incoming particles that may affect where the spacecraft lands. Locating the ports at the bottom of craters, the spacecraft will be protected from objects flying across the surface of the asteroid.**	**6**
2.5.1	Triple Redundancy Port Protection	One port will be located at each pole of the asteroid, and 2 more will be located equally spaced around the equator of the Asteroid.	With ports located at both the top and bottom, and also at 2 widely spaced points at the equator, if one port fails, there are still 3 more ports far from the dysfunctional port. By spacing out the ports, if one port is made useless by an object in space impacting the port, it will most likely not destroy another port.	6
MR	**Include multiple docking port facilities in exterior design**	**Refer to Figure 2.3.2 to 2.3.5.**		**5-6**
3.0	**Operations**			**7-13**
3.1	**Location**	**Bellevistat will be located inside the asteroid 1866 Sisyphus at the Earth-Moon L4 orbit.**	**The colony will be far enough from the Earth to be safe from collision. The asteroid is very large and provides a shell in which the colony to be built, providing radiation and impact protection, and a source of materials.**	**7**

	Requirements	Fulfillment	Justification	Page
3.1.1	Sources of Materials and Equipment	Materials and equipment will primarily be processed or manufactured in the colony. Whatever cannot be made on site will be imported from Earth.	The asteroid shell provides impact and radiation protection for the colony, and the raw materials available on the asteroid are inexpensive to use.	7
3.1.2	Storage of Materials	Materials shall be stored in a separated area upon arrival near the ports before they are ready to be used.	This area is necessary to keep materials in a stable location prior to the materials' implementation.	8
MR	**Chart or table identifying materials and equipment required for the settlement construction process, and from where and how those materials and equipment are shipped.**	**Refer to Figure 3.1.1**	**Refer to Figure 3.1.1**	**7**
3.2	**Internal Infrastructure**	**Food production, electrical power, communication systems, atmosphere and climate control, waste and water management, day and night cycles, and transportation systems shall be provided with careful consideration of safety and efficiency.**	**These basic provisions are essential to the survivability of the colony.**	**8**
3.2.1	Food Production	Crops will be grown in all microcities. Animals will be raised in the rural areas only, in separate facilities.	This will provide self-sufficiency to all the microcities.	8
3.2.1.1	Growth	Aeroponics and soil shall be used for the growth of crops. All animals and plants shall be under the care of AgroBoy robots	Aeroponics provides an efficient system of irrigation for plants, and the plants unable to handle the process can be in soil, with fertilizer from the wetlands.	8
3.2.1.1.2	Harvest	Harvest is done by AgroBoy by cutting and collecting the useful portions of plants, and electrocuting animals.	Electrocution of animals will ensure that pain is minimal, for the humane concerns of the colonists.	8
3.2.1.3	Storage	Warehouses shall be available in each microcity for storage of food before shipment.	These warehouses provide a suitable environment to keep food fresh if the food is not shipped immediately.	8
3.2.1.4	Packaging, Delivery, and Market	Muscle-T robots shall handle delivery of food to the markets.	Muscle-T usually handles deliveries to homes, markets, businesses, facilities, etc.	9
3.2.2	Power	Electrical power shall be provided for the public safely and efficiently so as to reduce danger	Cost effectiveness and public safety are of utmost importance when dealing with power	9

	Requirements	Fulfillment	Justification	Page
		and cost.	generation.	
3.2.2.1	Generation	The power of the colony shall be produced primarily by PBR's in each of the three industrial sectors. Secondary and backup power shall come from a solar power satellite and batteries.	The PBR's are efficient and inherently safe from meltdown. Supplementary power from the satellite will put less strain on the main power grid.	9
3.2.2.2	Distribution	Electricity shall be routed from the industrial sectors to the microcities underneath by elevator.	This is the most practical method of distribution to the public.	9
3.2.2.3	Allocation	Refer to Figure 3.2.2.3.	Refer to Figure 3.2.2.3.	9
3.2.3	Internal Communication	Refer to Section 5.6.	Refer to Section 5.6.	9
3.2.4	External Communication	There will be 6 antennas covering the surface of the asteroid, semi-proportional toward Earth.	The antennae shall provide Internet connections for both Earth and Alexandriat.	9-10
3.2.5	Climate Control	Climate will be regulated from specialized buildings located in each sector to simulate seasons on Earth.	This will further increase the resemblance of the colony's conditions to those of Earth.	10
3.2.5.1	Atmosphere	Air quality will be regulated by HEPA filters located in the buildings.	These filters are capable of cleaning up 99.97% of airborne particles that are 0.3 μm in diameter.	10
3.2.6	Waste Management	Natural waste products shall be treated by using artificial wetlands, then passing the leftover substances to be treated under the SCWO process.	By using artificial wetlands, most of the toxic substances would be removed, but the wetland can only hold so much at a given time. Thus not all of the toxin can be removed. The leftovers will undergo the SCWO process, in which the substances shall be recycled and reused.	10
3.2.7	Water Management	Water will be initially imported from Earth. It shall be processed with the wetlands and SCWO after use.	Earth will be the closest available source of water, and once the colony has imported enough, shipments can stop, as the colony is self-sufficient.	11
3.2.8	Day/Night Cycles	OLED and NCD shall be planted and used on the sector ceilings to simulate day and night skies.	These technologies can realistically emulate Earth skies and require little power to operate.	11
3.2.9	Internal Transportation	Internal transportation within microcities shall include walking, bicycles, and a SkyTran system.	The SkyTran system provides a fast and efficient form of transportation	11
3.2.9.1	Corridors and Means of Access	An underground transportation corridor and elevator between microcities shall be available for	This interconnected transportation network ensures connectivity and accessibility to	11

	Requirements	Fulfillment	Justification	Page
		movement throughout the colony.	all areas of the colony.	
3.2.9.2	Movement of Imports/Exports	Cargoes shall be transferred in and out of the colony through the Bellevistat's ports. These cargoes shall be placed in the RFID tags.	These RFID tags can be read by from several meters away; therefore searching for a certain cargo should be more efficient.	11-12
3.2.9.3	Rights of Way	Pedestrians shall have the right of way over bicycles except in the bicycle lanes.	The bicycle lane should provide a pathway for bicycles to move quickly and efficiently without much interruption.	12
MR	**Dimensioned drawings showing systems which provide required infrastructure, and, as appropriate, their configurations.**	**Refer to Figure 3.2.9.1.**	**Refer to Figure 3.2.9.1.**	**11**
3.3	**Space Infrastructure**	**Refer to Table 3.3.**	**Refer to Table 3.3.**	**12**
3.3.1	Vehicles	Refer to Table 3.3.1.	Refer to Table 3.3.1.	12
MR	**Chart or table describing space-based infrastructure and vehicles required for settlement operations, including notation of which will be included in this contract and which will be developed commercially without Foundation Society investment.**	**Refer to Table 3.3 and Table 3.3.1.**	**Refer to Table 3.3 and Table 3.3.1.**	**12**
3.4	**Residential and Commercial Plant Growth**	**Refer to 3.2.1.**	**Refer to 3.2.1.**	**8**
MR	**In agriculture description, account separately for production of feed and facilities for animals in drawings and tables.**	**Refer to 3.2.1.**	**Refer to 3.2.1.**	**8**
3.5	**Furniture and Interior Finishing design**	**Furniture and interior finishings will be produced by electrically stimulated ionic crystallization of calcium carbonate.**	**Calcium is readily available on the asteroid for processing into calcium carbonate.**	**13**
MR	**In chart or table of materials sources, separately account for materials needed for residential interiors and amenities.**	**Refer to Table 3.1.1.**	**Refer to Table 3.1.1.**	**7**

	Requirements	Fulfillment	Justification	Page
4.0	**Human Factors**			**13-21**
4.0.1	Earth Community Attributes	The colony will emulate Earth-like environments to help colonists adjust to their new home.	By using a familiar community structure, the colony will not come as a huge shock to its new citizens.	13
4.0.1.1	Comfortable Housing	The colonists will live in comfortable and spacious housing to provide a relaxing living space.	Having a relaxing living space will help relieve the stresses of adjusting to colony life.	13
4.0.1.1.1	Soothing Elements	The homes will have diverse designs but all of these designs will be reminiscent of Earth homes.	The spacious and well lit homes will provide a relaxing environment that colonists can retreat to	13
4.0.1.2	Access to Fine Food	The colonists will have access to all kinds of fine cuisine. Traditional Earth foods will be made available in fine dining facilities. In addition, wine will be provided by Bellevistat-based vineyards.	The fine dining restaurants will be located within the commercial center to allow businessmen and visitors convenient access to fine dining. Bellivistat wine will provide these restaurants traditional fine dining.	13
4.0.1.2.1	Restaurants	Restaurants will be located in the neighborhood's commercial center which will allow colonists to easily access to numerous different cuisines.	Restaurants will range from fast food to fine dining. Family restaurants will serve numerous different cuisines to satisfy the colonist's varied tastes.	13
4.0.1.2.2	Wine	Refer to Section 4.1.2.2.		13, 17
4.0.1.3	Access to Entertainment	Refer to Section 4.5.2.1.		13, 21
4.0.2	Natural Views	The colonists will be able to use mirrors (disguised as windows) to see space outside the colony.	The mirrors will be seamlessly reflect the space outside to give colonists an unobstructed natural view.	13
4.0.2.1	Observatory	An observatory will be located in every colony to provide colonists with a place where they can see the space outside through windows.	The observatory will provide colonists with natural view which helps to relieve feelings of confinement.	13
4.0.2.2	Pool of Stars	The Pool of Stars also uses the mirror system to reflect the view of space onto its sides to give the impression that colonists swimming in it are swimming amongst the stars.	The purpose of the Pool of Stars is to provide a method that colonists can use to have a natural view of space. It also is a unique sensation to swim in what appears to be space.	13
4.1	**Community Facilities, Consumables, and Psychological Factors**			**14-18**
4.1.1	Community Facilities	The communities on Bellivistat will have all the facilities of those on Earth. Each microcity will have one set of essential facilities which makes them self sufficient.	The community facilities will be reminiscent of those of Earth. This is used to allow microcities to be self sufficient for an extended period of time in case of failure of the SkyTran system.	14
4.1.1.1	Education	The colonists will be educated through a holographic teacher interface.	A virtual teacher will be able to interact with students just like a real teacher.	14
4.1.1.2	Recreation and Leisure	Various facilities will be provided to allow a variety of world-class entertainment to be made available	Colonists will have access to entertainment from Earth along with recreational activities. This	14

	Requirements	Fulfillment	Justification	Page
		for the colonists.	prevents feelings of homesickness and isolation, relieves boredom and improves morale.	
4.1.1.3	Medical	The colony will be staffed with human doctors operating in various medical facilities.	Colonists will be more responsive to a human doctor compared to a medical robot.	14
4.1.1.3.1	Hospital	A single hospital will be available in each microcity to deal with emergency medical situations amongst colonists.	Hospitals will handle all major medical situations such as surgery, rehabilitation and long term care.	14-15
4.1.1.3.2	Clinics	Clinics will be accessible to colonists to deal with minor medical situations and checkups.	The clinics will handle minor medical cases and checkups, which leaves the major cases for the hospital.	15
4.1.1.4	Business	Offices will be made available for businessmen to conduct corporate work with clients on Bellevistat.	Offices will allow business to be conducted on Bellivistat without the delay caused by communication with Earth. The Bellevistat office will act like a division of the company.	15
4.1.1.5	Public Facilities	Public facilities will provide a social meeting place for colonists as well as recreational and leisure opportunities.	Public Facilities will help promote social interaction between colonists. Recreation and leisure are also promoted through "outdoor" areas .	15
4.1.1.5.1	Parks and Simulated Wilderness	Parks and the Simulated Wilderness provide an open air area that will promote general relaxation.	These facilities will provide an area that colonists can relax in. The Simulated Wilderness will also promotes camping and hiking amongst colonists.	15
4.1.1.5.2	Community Orchards and Gardens	Community orchards and gardens will provide colonists with an outside source of food and will foster a sense of community.	Community orchards and gardens is located in each microcity that allows each colonist to grow their own food in a public area if they chose to.	15
4.1.1.5.3	Town Center	The town center is a group of restaurants, stores, movie theaters and other facilities that will provide basic supplies and entertainment within a microcity.	The town center allows colonists to easily access basic stores and facilities without walking an extended distance or leave the microcity.	15
4.1.1.6	Visitor Accommodations	Visitor accommodations facilities will provide temporary lodging, a preloaded HG (personal device) with map/colony info and rented bikes.	The visitor accommodations facilities offer numerous services to visitors by providing the Bellevistat experience through a loaned personal device.	15
4.1.1.7	Other Facilities	Other facilities will supplement the colonist's life on Bellivistat by providing opportunities for lifestyle.	Other facilities will enhance the colonist's lifestyle by giving colonists additional lifestyle options.	15
4.1.1.8	Microcity Layout	The colony will be divided into six microcities that will be diverse to suit the preferences of a specific demographic.	By suiting different demographics, Bellevistat's microcities will meet the different preferences of the colonist population.	16-17
4.1.2	Variety and Quantity of	Consumables and supplies will be	To achieve diversity of cuisine,	17

	Requirements	Fulfillment	Justification	Page
	Consumables and Supplies	varied to allow colonists to experience several different cuisines.	agricultural facilities will grow a diverse range of food.	
4.1.2.1	Microbreed Cows	Microbreed cows will be used as they are efficient livestock in terms of intake and output.	Microbreed cows are effective livestock as they are small and produce exactly the same amount of milk as regular cows.	17
4.1.2.2	Wine	Wine will be produced on Bellivistat for fine dining, sale, and export purposes.	Wine will be produced to supply colonists with an old fashioned staple of fine dining.	17
4.1.2.3	Vitamin D	Bellivistat will encourage the consumption of Vitamin D in the form of salmon and mushrooms.	Being inside an asteroid, colonists will require a natural source of Vitamin D as the skin can not produce it without natural sunlight.	17
4.1.2.4	Distribution of Food and Consumables	Refer to Section 4.3.1.2.		17, 19
4.1.3	Psychological Factors	Bellivistat will provide activities that will keep the transition from Earth to colony painless.	The numerous methods to reduce the colonist's stress will keep them happy.	17
4.1.3.1	Earth Isolation	Because Bellivistat is separated from Earth, feelings of isolation will be combated with facilities and activities that colonists will normally find on Earth.	By providing activities and facilities that colonists will normally find on Earth, the feelings of isolation from Earth will be reduced.	17
4.1.3.1.1	Recreation and Leisure	Refer to Section 4.5.2.1		17, 21
4.1.3.1.2	Communication	Humans will be able to directly communicate with people on Earth, thus eliminating feelings of isolation.	Communication with Earth will always be available to reduce feelings that Bellivistat is separated from Earth.	17
4.1.3.2	Confinement	To lessen the feelings of confinement, various features will be used to make the colony look more spacious.	By making the colony look more spacious, the feeling of confinement will be reduced.	17
4.1.3.2.1	Simulated Wilderness	Refer to Section 4.5.1.2.		17, 20
4.1.3.2.2	OLED Sky	The OLED sky accurately simulates the sky of Earth.	The OLED sky imitates the Earth sky to make it feel more natural to the colonists.	17
4.1.3.2.3	Rooftop Garden	The rooftop garden will provide colonists with a readily accessible place to relieve feelings of confinement.	The rooftop garden will give colonists a place to relax when they feel confined.	17
4.1.3.3	Security	Human police officers and firefighters, with the assistance of security robots, will be employed to protect the colonists and their belongings.	Human officers and security robots will address safety concerns by conducting patrols throughout the colony.	17-18
4.1.3.4	Environmental Factors	The environment on Bellevistat will mimic Earth's environment.	By providing environmental conditions nearly identical to those of Earth, colonists will not develop homesickness or disrupt their internal clock.	18
4.1.3.4.1	Day/Night Cycle	The colonists will experience a simulated 24 hour day/night cycle through the OLED sky. Night	A regular day/night cycle will help keep the colonist's internal clock regular.	18

	Requirements	Fulfillment	Justification	Page
		hours will be simulated by dimmed OLED lights. The day/night cycle will also change according to the seasons.		
4.1.3.4.2	Climate and Atmosphere	Bellevistat will use atmospheric conditions nearly identical to the atmosphere of Earth. Refer to 3.2.5	A simulated natural climate and atmosphere will prevent feelings of homesickness.	18
MR	**Map(s) and/or illustration(s) depicting community design and locations of amenities, with a distance scale; identify percentage of land area allocated to roads and paths.**	**Refer to Figure 4.1.1.8.**	**Refer to Figure 4.1.1.8.**	**16**
4.2	**Residential Designs**			**18**
4.2.1	Housing Designs	Houses will be designed with a specific population demographic in mind.	The colonists' different architectural preferences and needs of residences will be met by providing.	18
MR	**External drawing and interior floor plan of at least one home design, the area (preferably in square feet) for each residence design, and the number required of each design.**	**Refer to Figure 4.2.1 to Figure 4.2.4.**	**Refer to Figure 4.2.1 to Figure 4.2.4.**	**18**
4.3	**Human Productivity Enhancement Methods**			**18-19**
4.3.1	Systems on Bellevistat	Colonists can control various Bellivistat systems to help them in their day to day lives.	The devices will be the main method of communication between colonists and computer systems.	18
4.3.1.1	Health Monitoring System	The Health Monitoring System will keep a record of a colonist's health.	The Health Monitoring System assists doctors in diagnosing their patients.	18
4.3.1.2	SmartHome	Food, consumables and minor supplies will be delivered to homes via the SmartHome system. Everything else will be sold in stores. The SmartHome will handle the mundane tasks of taking care of a household.	The SmartHome system will allow colonists to order essential consumables and supplies. This removes the need for tedious grocery shopping at supermarkets.	18-19
4.3.1.3	EVE	The EVE teaching assistant will assist human teachers in managing a class.	EVE is able to simultaneously and passively evaluate every student for understanding. This helps teachers create lesson plans.	19
4.3.2	Devices	Refer to Section 5.1		19, 21
4.3.3	Transportation	For transportation, a combination of SkyTran and bikes will be used.	The SkyTran will deliver colonists to the general area. Then colonists will take bikes or walk to their destination.	19
4.3.3.1	Bike	Bikes will have a battery charger that will take energy from the pedaling.	The battery charger will charge a battery that will feed the energy generated into the colony's power	19

	Requirements	Fulfillment	Justification	Page
			grid.	
4.3.4	Safety and Maneuverability in Low-G Environments	Colonists will have to use spacesuits in low-g situations.	Spacesuits will require the compressed air thrusters on the spacesuit to get around.	19
4.3.4.1	Spacesuit	The spacesuit is designed to get the most energy out of the colonists wearing to suit to allow the spacesuit to be worn longer. The spacesuit is sprayed on skintight to provide mechanical counter-pressure.	The paper battery can be charged from sweat. This method significantly reduces the need for conventional batteries. The spraying method ensures that the spacesuit is skin tight and that it can also serve as a pressure suit.	19
MR	**Chart or table identifying major categories of work people will do in and around the settlement, and listing tools they will need to do these tasks (e.g., warehouse – forklift, delivery – handcart, low-g manufacturing – handholds and tethers, exterior maintenance -spacesuit)**	**Refer to Table 4.3.**	**Refer to Table 4.3.**	**19**
4.4	**Divergent Neighborhood Designs**			**19-20**
4.4.1	Urban	The urban microcity will be slated for the young single adult population. Urban microcities will consist of apartments and other facilities placed close together to create the feeling of an urban environment.	The multistory apartment complexes will induce feelings of an urban environment by being similar to a city full of skyscrapers. Apartments are adequate for the needs of the single adult population.	20
4.4.1.1	Bellivistat U	Bellivistat U is a university that will provide higher education to colonists.	Bellivistat U will remove the need for colonists to go to Earth for higher education.	20
4.4.1.2	Business Sector	Business will be conducted in the urban microcity because it adds to the urban feel.	Offices will be easily accessible to encourage businessmen and women to commute, which adds to the urban feel.	20
4.4.2	Suburban	The suburban neighborhoods will be slated for married adults and their children. The facilities will be spaced out to provide colonists with a suburban feel.	The additional space provided by the larger residential unit will allow married couples to raise children. The neighborhood itself is designed with the purpose of providing a social environment for teenagers.	20
4.4.3	Rural	The rural neighborhoods will be designed for the married adults without children. To provide a rural feel, gardens, community orchards and agricultural areas will be available and easily visible to all colonists.	The rural residential sectors will provide residences for married couples without children. The rural feel and recreational facilities will provide a relaxing environment. The gardens and orchards will also provide residents to grow their own fruits and vegetables.	20

	Requirements	Fulfillment	Justification	Page
MR	**On interior map(s), identify locations and sizes of different neighborhoods.**	**Refer to Figure 4.1.1.8.**	**Refer to Figure 4.1.1.8.**	**16**
4.5	**Lifestyle**			**20-21**
4.5.1	Recreational Activities	Recreation on Bellivistat will be conducted through activities such as hiking and sports.	Recreation is achieved through activities offered at the appropriate facilities.	20
4.5.1.1	Sports	Sports on Bellivistat will be located primarily in the sports facilities but there will be some located in the zero-g portion of the colony.	Sports will be provided in sports facilities to encourage exercise and a sense of community.	20
4.5.1.1.1	Zero Gravity Sports and Activities	Facilities located in the industrial sector of Bellevistat allow colonists to experience zero gravity activities.	Zero gravity activities will provide a new adaptation to common Earth sports and pastimes.	20
4.5.1.2	Simulated Wilderness	The Simulated Wilderness will provide a place where colonists can enjoy the outdoors.	The Simulated Wilderness will allow colonists to hike and camp, thus giving the colony a realistic outdoor area.	20-21
4.5.2	Leisure	Leisure opportunities on Bellivistat allow colonists to relax and enjoy themselves by meeting their entertainment and social needs.	To meet entertainment and social needs, Bellivistat will have to provide leisure opportunities through its facilities.	21
4.5.2.1	Entertainment	The colonists will have ready access to a variety of traditional Earth entertainment.	By providing several different types of traditional entertainment, the colonists will alleviate homesickness as well as boredom.	21
4.5.2.2	Social interaction	Colonists will have access to various public areas to interact with each other.	The social needs of colonists are met by public areas designed to encourage social interaction.	21
MR	**Show and/or describe examples of pastimes available for residents**	**Refer to Section 4.5.**	**Refer to Section 4.5.**	**20-21**
5.0	**Automation Designs and Services**			**21-29**
5.0.1	Computer Specifications	Hardware and Software Specifications	Computer systems enable easier completion of tasks; less resources, such as paper, used	21
5.0.1.1	Hardware Specifications	Refer to Figure 5.0.1.1.	Storage delays eliminated with consolidation of memory and hard drive; mesh-based architecture unlock full potential of processors	21
5.0.1.1.1	HG and MG Details and Integration	HG, MG, FPGA, cameras, etc.	Full interaction between humans and computers; convenience through shared storage and desktops	21
5.0.1.2	Software Specifications	Refer to Figure 5.0.1.2.	User preferred GUI for easier interaction; constant software updating mechanisms to ensure security; hassle free maintenance and monitoring	22
5.0.1.2.1	Intelligent Adaptation and	Cameras, FPGA , JITC, virtual	Faster application load times;	21-22

	Requirements	Fulfillment	Justification	Page
	Interaction	machine	intelligent help and interaction	
5.0.2	Robot Specifications	Refer to Table 5.0.2.	Specialized robots to reduce manual labor and complete certain tasks swiftly	22-23
5.0.2.1	Specialized Designs	NiTi, carbon nanotube, monomer-filled microcapule embedded epoxy, carbon nanotube, Demron, Aerogel, tritium battery, modular bayonet	Long operation time of robots due to strong external shell; reduction of costs through less parts manufactured; future customization of robots	23
5.0.3	Facility Automations	AgroBoy, MUSCLE-T, ProtoMAN, RFP	Labor finished by robots; focus by humans on important tasks	23
5.0.4	Community Automations	ER, HG, HMS, MUSCLE-T, ProtoMAN, Smart Home	Stress relief; constant overview of colony's health; convenience through ability to track and find items	23
5.0.5	Business Automations	Cee, HG, RFID tags, telepresence	Painless management of finances and inventory; realistic communication	23
5.0.6	Network Planning	Refer to Section 5.6 and Figure 5.0.6.	Redundant data storage backup; efficient usage of all resources	24
5.0.6.1	User Access to Network	ER; Refer to Section 5.2.4.	Constant verification of identity	24
5.0.7	Data Storage and Distribution	Refer to Section 5.6.2.1.	Prevention of data loss through DDFS	24
5.0.8	Locations and Sizes of Critical Facilities	Repair and Maintenance, Storage, and Transportation Corridors	Swift and convenient access to facilities for immediate robot maintenance	24
5.0.8.1	Repair and Maintenance Facilities	3 50x50m facilities in each microcity	Immediate checkup of all robots; swift access to maintenance	24
5.0.8.2	Storage Facilities	2 50x50m facilities in each microcity	Proliferated distribution for convenient locations	24
5.0.8.3	Transportation Corridors	Underground transport corridor	Less traffic; preventative measures against psychological scarring	24
5.1	**Automations for Settlement Construction**			**24-25**
5.1.1	Transportation and Delivery	MUSCLE-T, RFID	Effective and efficient delivery	24
5.1.2	Settlement Assembly	Exterior Construction and Interior Finishing	Minimization of human damages and casualties through automated assembly	24
5.1.2.1	Exterior Construction	DaiGurren Lagann	Painless and efficient construction of external dome	24
5.1.2.2	Interior Finishing	Refer to Section 5.4.	Swift and precise finishing	24
MR	**Chart or table describing automated construction and assembly devices, and the purpose(s) of each**	**Refer to Table 5.2.**	**Quick colonial construction through proliferation of tasks to multi-purpose robots**	**25**
5.2	**Automations for Settlement Maintenance, Repair, and Safety Functions**			**25-27**
5.2.1	Settlement Functions	Maintenance and Repair, Safety	Swift notification of danger to all colonists; defined response systems in case of emergencies	25
5.2.1.1	Settlement Maintenance	DaiGurren Lagann, MAN units	24/7 monitoring of dome; constant	25

	Requirements	Fulfillment	Justification	Page
	and Repair		maintenance	
5.2.1.2	Settlement Safety	All robots and devices	Rapid response to exigencies	25
5.2.1.2.1	Backup Systems	Refer to Section 5.6.2.1.	Redundant backup system	25
5.2.1.2.2	Contingency Plans	Refer to Table 5.2.1.2.2.	Predefined response plans to swiftly respond to possible emergencies	25-26
5.2.2	Solar Flare Contingencies	Solar flare mode, storage and repair facilities, repair-based robots	Insurance of minimal damages to all automation systems in the case of a solar flare	26
5.2.2.1	Robotic Specifications for Solar Flare Counter	VMRAM, Demron	Ensures minimum or full functionality of robots	26-27
5.2.3	Locations of Automations for Critical Functions	Refer to Section 5.0.8.	Proliferation of facilities for quick response to contingencies	27
5.2.4	Access to Critical Data and Automation Systems	Refer to Figure 5.2.4.	Prevention of forbidden access; levels of security through verification	26
5.2.4.1	Security Measures	ER, face scanners, retinal scanners, ProtoMAN, cameras, sensors	Correct identification of all users; constant verification	27
MR	**Chart or table listing anticipated automation requirements for operation of the settlement, and identifying particular computers and robots to meet each automation need.**	**Refer to Figure 5.0.1.1 and Table 5.0.2.**	**Use of robots and devices for fast completion of tasks while reducing human labor to a minimum**	**21-23**
5.3	**Automations for Community**			**27-28**
5.3.1	Community Livability Enhancements	Refer to Section 5.0.3, 5.0.4, 5.0.5, and 5.2.4.1.	Stress relief through convenient devices and robots	27
5.3.1.1	Health Monitoring System	ER, home appliances	Constant check on health status; easier to diagnose patients	27
5.3.2	Productivity Enhancements in Work Environments	HG, MG	Easy manipulation of devices for faster work and productive gains	27
5.3.3	Residential Convenience Enhancements	RFID tags, HG	Easy detection of items; easy buying for users	27
5.3.3.1	Smart Home Integration	All robots, all devices, Smart Home functions	Easier home management	27
5.3.4	Community Maintenance and Routines	All robots	Reduction of manual labor; constant check-up on community	27
5.3.5	Privacy of Personal Data	Refer to Section 5.6.2.1.1.	Secure prevention of data theft and access	27
5.3.6	Control of Private Systems	Refer to Section 5.3.3.1 and 5.6.2.1.1.	Convenient access through HG	27
5.3.7	Access to Community Services	Cee, HG, MG	Computer access to all colonists	27
5.3.7.1	Community Computing Grid	Refer to Section 5.6.2.2	Efficient distribution and usage of total computing power in colony	27
5.3.7.2	Robot Resources	Robot management system, all robots	Distribution of robots and easy access to robots for labor	27-28
MR	**Drawings of robots and computers that people will encounter during**	**Refer to Figure 5.0.1.1, Figure 5.0.2.1 to 5.0.2.4.**	**Aesthetically pleasing robots and computers to lessen psychological impact; highly**	**21, 23**

	Requirements	Fulfillment	Justification	Page
	their everyday lives in Bellevistat, and diagram(s) of network(s) and bandwidth requirements to enable computer connectivity.		**efficient network design**	
5.4	**Automations for Interior Finishing**			**28**
5.4.1	Interior Finishing of Residential	GutsMAN	Automated finishing of homes to ensure swift completion without constant monitoring	28
5.4.2	Interior Finishing of Buildings	GutsMAN	Reduction of manual labor	28
MR	**Drawing(s) of interior finishing system(s) in operation, with estimated time to complete interior of typical building(s).**	**Refer to Figure 5.4.**	**Use of robots to reduce the amount of human damage and casualties**	**28**
5.5	**Automations for Asteroid Mining**			**28-29**
5.5.1	Asteroid Mining	Gurren Lagann, mining system	Automated system to alleviate humans of menial labor; faster completion of construction	28
5.5.2	Material Transportation	Bucket wells and conveyer belts	Swift delivery of materials	28
5.5.3	Material Refinement	Refineries	On-spot refinement of ores to quickly produce and deliver needed materials for construction	28
MR	**Drawing(s) of mining system(s) in operation, with description of how many human controllers are required.**	**Refer to Figure 5.10 to 5.12**	**Reduction of cost; reduction of manual labor**	**28-29**
5.6	**Automations for Networking**			**29**
5.6.1	Network Hardware Specification	Terabit wired Ethernet, one hundred gigabit wireless, Cee firewalls, satellite dish	Reliable and fast bandwidth; constant communication; protection from external cyber attacks	29
5.6.2	Network Infrastructure Specification	FAST TCP, Internet cache	Effective protocols to reduce bandwidth	29
5.6.2.1	Distributed Data Filing System	All devices	Hassle-free backup; data redundancy; prevention of total data loss in the case of exigencies	29
5.6.2.1.1	Data Encryption	Biometric (e.g. Veins, Fingerprint, etc.), physical key, software encryption (quantum)	Prevention of data access through plethora of identification processes	29
5.6.2.2	Distributing Processing System	All devices	Utilizes full processing power; speedier applications	29
6.0	**Schedule and Costs**			**30-33**
6.0.1	Schedule for completion and occupation of settlement	Gradual construction sequence; gradual population.	Gradual growth to prevent immediate usage of resources	30
6.0.2	Costs for design and construction phase of	Refer to Table 6.2.1.1.	Refer to Table 6.2.1.1.	31

	Requirements	Fulfillment	Justification	Page
	schedule			
6.1.1	Schedule describing contractor tasks from contract award to when customer assume responsibility	Refer to Table 6.1.	Spread out growth phases to ensure safe and eventual construction of colony	30
6.1.2	Schedule dates when members may begin moving in	2042 (industrial) and 2047 (microcity)	Insurance of safety of colonists before arrival on colony with secure construction	30
6.1.3	Dates when entire original population established in community	2049	Full operation of colony ensures full original population operating at maximum productivity	30
MR	**Durations and completion dates of major design, construction, and occupation tasks in list/chart/drawing**	**Refer to Table 6.1.**	**Multiple construction operations ensure completion of whole colony in one deadline instead of several deadlines**	**30**
6.2.1	Costs of design through construction of settlement in U.S. dollars w/o inflation	Refer to Table 6.2.1.1.	Refer to Table 6.2.1.1.	31
6.2.2	Estimates of numbers of employees associated with each phase of design and construction	Refer to Table 6.2.2.3.	Larger than average salary to entice and commit personnel to colony	33
6.2.3	Justify contact costs to design and build settlement	Refer to Table 6.2.1.2.	Constant influx of revenue through various services and industrial offers ensure profitability of the colony	31
MR	**Charts/Tables listing separate costs associated with different phases of construction**	**Refer to Table 6.2.2.1 to 6.2.2.5.**	**Allocation of costs to primarily construction sequence, raw materials, and transport vehicles**	**30-33**
	Total cost billed to FS	**$669.6555 BILLION**		**31**
7.0	**Business**			**34-35**
7.0.1	Variety of Commercial and Industrial Ventures	Expansion of colony to keep up with commercial and industrial demands	Entices industries to colony for profits due to large space for ventures	34
7.0.2	Flexibility of Commercial Area	There is sufficient room in all 6 micro-cities and 3 matrix for the expansion of businesses	Due to the vast volume of the asteroid, there is a lot of space for expansion	34
7.1	**Exterior Mining, Refining and Delivery**	**Materials collected from the asteroid shall be transferred to Earth through cargo vehicles or commercial vehicles**	**Robots on the asteroid harvest and send back materials through one way vehicles, to save from brining materials from earth**	**34**
7.1.1	Ore Mining and Refining	Mining sites and equipments shall be established on the surface of the asteroid	The separate mining site will allow for more materials for the colony, and will also not damage the infrastructure of the asteroid.	34
7.1.2	One Way Reentry Vehicle	Vehicles shall consist mostly from materials from the asteroid, with the package in the center of the vehicle; vehicles shall be designed to be aerodynamic	Aerodynamic vehicles shall reduce air friction in Earth's atmosphere to prevent the vehicle from destruction and reduce the amount of the surface from being burnt up.	34
7.2	**Space Manufacturing**	**All manufacturing sites shall be**	**Being inside the colony, the**	**34**

	Requirements	Fulfillment	Justification	Page
		located inside the colony	**manufacturing sites are protected from any damage from outside objects; gives easy access of the sectors to people if they need to perform maintenance**	
7.2.1	Spacecraft Manufacture	Spacecrafts shall be built in the industrial area inside the colony	In the industrial sector, the near zero gravity conditions, along with the pressurized environment allows for easier spacecraft assembly	34
7.2.2	Manufacturing for Large Scale Projects	Construction of projects shall be constructed in manufacturing facilities located in a certain area in the industrial area	Manufacturing in the colony shall reduce the number of flights between Earth and the colony, reducing the amount of fuel required	34
7.2.3	Manufacturing for Space and Lunar Construction	Manufacturing of space projects will take place in the colony; machines will be able to be sent to the asteroid's surface through cargo vehicles	By manufacturing on the asteroid, the sources for equipment will be closer to space and lunar construction projects as Earth is farther away	34
7.3	**Tourism**	**Tourisms would be available at $600,000 per one way trip by traveling in a tourist spacecraft**	**The trip is inexpensive, and includes a 250lb. allowance for personal items, allowing people an affordable vacation out of this world**	**34-35**
7.3.1	Bellevistat as Vacation Destination	Commercials would be played on Earth to advertise the different attractions that can only be found on the asteroid	Television advertisements will appeal to people because of the unique experience offered	34-35
7.3.2	Tourist Activities and Amenities	Hotels are located in each of the micro-cities, near SkyTran stations	There is easy access to the different activities in the cities through the SkyTran system, and housing for visitors are near the stations	35
7.3.3	View of Mining, Refining and Manufacturing Facilities	Daily guided tours of the industrial areas will be conducted	Allowing the visitors into the industrial sector will give them a first hand view of the workings of the industrial sector	35
7.3.4	Low-G Activities	ZeroG Paintball, ZeroG Sports	Many activities that are not possible, or are hard to do, are easy to do in zero gravity	35
7.3.5	Visitors Access to Bellevistat Systems and Resources	Residents of the colony will be provided personal devices that grant limited access to different areas	Different levels of access to technology will give each person in the colony the access, according to the users allowed usage	35