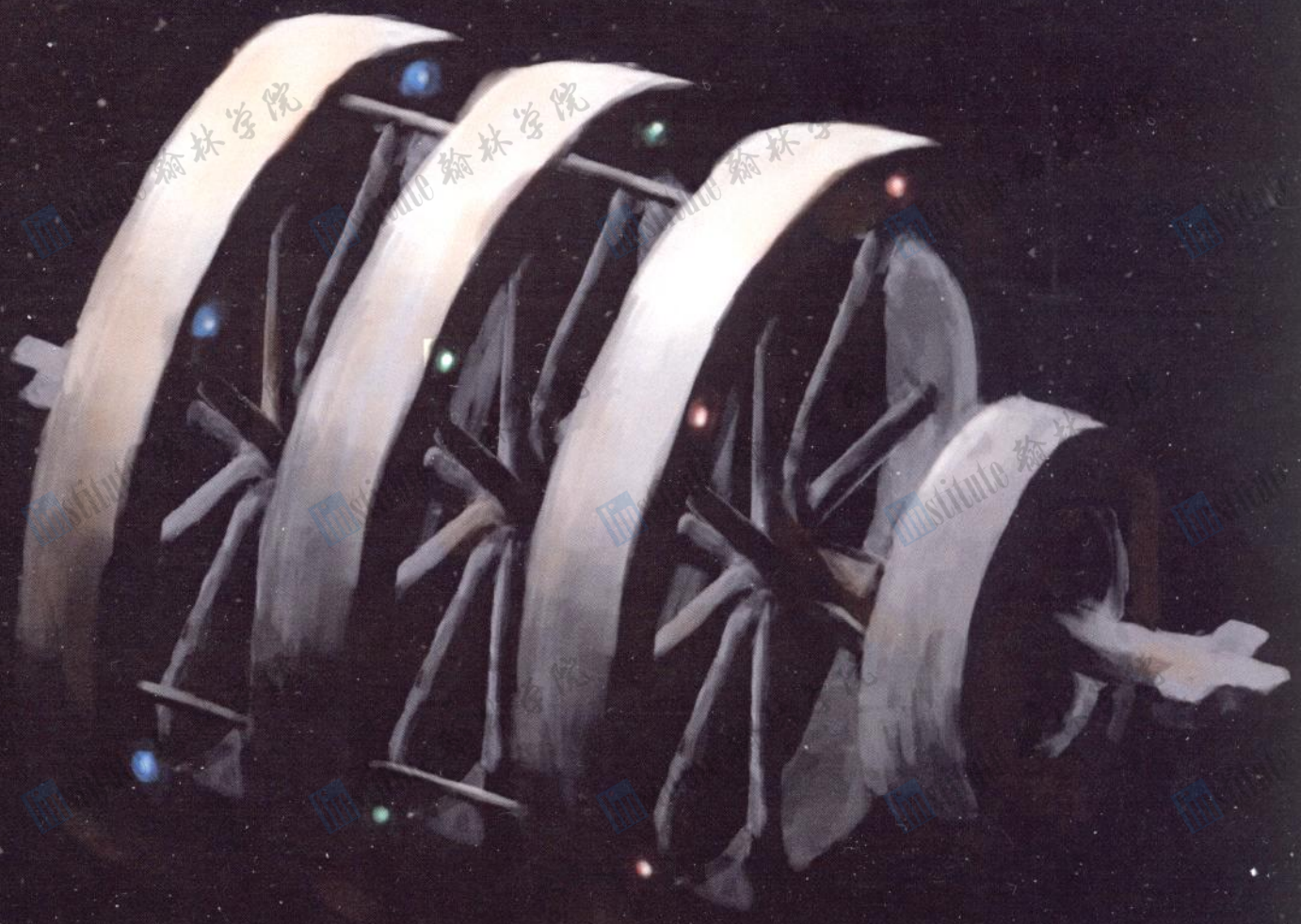
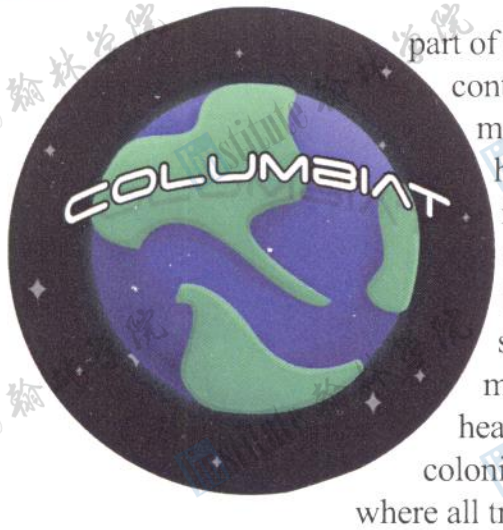
Columbiat



PHOENIX Q

Team Phoenix Quintessential
Located at Cerritos, California, USA

1.0 Executive Summary



Throughout the history of mankind, trade and commerce have been an essential part of every successful civilization, big or small. Through the ages, humans have been content to live within the bounds of Earth. Humanity has slowly but surely developed more and more advanced technologies to simplify the lives of humankind. Much has changed, but one thing remains unchanged, the role of commerce in driving innovation forwards. For thousands of years, humans have looked towards the sky, unable to conquer this frontier, even with the continuing invention of newer and better machines. With the creation of Bellevistat, humans have finally been able to start establishing permanent living quarters in space, the frontier which is intrigued many for a very long time. Bellevistat is a mainly industrial colony, specializing in heavy industry. It is is also a stepping stone to future future colonies. One such proposed colonies is Columbiat, the trade Mecca of the sky. Columbiat is planned to be the hub where all traders meet to exchange goods, information, and ideas, and destination for tourists.

With the continued degradation of the earth's atmosphere, the true effects of global warming have been realized. However, what has been done has been too little too late. Prevention rather than repairing damages is the primary motive for the overall design of the settlement. Therefore, this proposed settlement aims to reduce energy consumption, thereby reducing the pollution within the colony so that a more ambient living environment can be provided, even in an area with many people and a large volume of trade. One significant part of this plan of cutting down on waste production within this settlement is the "green towers", buildings that take wasted organic materials and process them and reuse them to grow more crops, reducing waste materials that would otherwise accumulate.

This settlement plans to keep the sunlight and the radiation at a level that is comfortable for all residents of the settlement, as well as providing a safe environment for travelers to enjoy the many wonders within the city in the stars. The hull of the floating metropolis will be composed of sturdy material that can withstand the shock of most objects that strike it. The walls of the hull are made of transparent nano-layered plastics: steel strength plastics that are as strong as steel but flexible. These plastic panes provide a clear view of space outside, and also are coated with lead oxide to prevent radiation exposure beyond that experienced on Earth. The port design is also streamlined so that each port can efficiently serve the rings nearest to them, preventing unnecessary congestion in space. In terms of energy use, most mechanical parts, like the interfaces between non-moving and moving parts of the settlement, are non-electromagnet based to conserve energy.

Robots are commonly seen as the primary consumer of electricity. However, the robots planned on this settlement will be numerous. In exchange for the bigger size of robot workforce, each robot can be more specialized in a task, meaning it can be designed for more efficient operation, reducing the energy consumption. Robots also help reduce energy in places like the docks, where an always on electromagnet to keep ships docked in the bay would consume a huge amount of power.

Beyond just productivity and efficiency, the settlement also features a wide variety of housing options falling mainly under two broad categories: apartment and house. Another aim of the settlement is to provide as interesting an experience as possible to the residents of the settlement, not just bland living environments. Houses and apartments will be constructed and decorated in a variety of formats, like New England style houses or New York style loft apartments. For an even greater experience within the space settlement, holorooms will be located in communal facilities. Within the walls of these holorooms, patrons can be jumped to another location virtually, yet experience the feeling within the environment. This opens up a whole other dimension of activities like hunting, fishing, flying airplanes, or any number of other activities that can't be achieved normally.

Columbiat promises to be an excellent settlement. Although the materials and cost of creating the settlement will not be cheap, the residents can expect the settlement to fulfill their wildest dreams. With a combination of comfort, security, and easy access to all of the sectors and the activities within, this settlement will be the marketplace for both the businessman and the family looking to experience what people before have never experienced before: living among the bright stars in the dark night sky.

2.0 Structural Design

Columbiat will be the home of approximately 22,000 full time residents and a population of 1,500 to 2,500 transients. The settlement's design aims to create as real a living environment as would be experienced living on earth, but at the same time putting safety of the inhabitants as the top priority. Columbiat will provide a place for commerce and trade in space, along with a place for short term stay. There are also accommodations for long term travelers or visitors who may want to stay more than just a few days. Long term ship repairs can also be handled on the settlement's long term ship repair bays.

The settlement is designed to be stable as well as functional and safe. Located at the Earth-Moon L2 point, the settlement revolves around the Earth at the same rate as the moon. When construction is completed, the settlement will have an axle with 4 tori revolving around the axle. At either ends of the axle will be docking ports for multiple ships, as well as two ports in the center of the axle. The overall structure will resemble a crude bullet shape, with 3 big rings and a smaller ring in that order on the axle. The orientation of the colony will be with the smaller end of the colony pointing out towards the outer solar system, while the bigger end will be point towards the moon.

One of the main focuses of the colony construction is streamlining the movement of goods, materials, and people throughout the colony. Movement between the three big rings are a set of 4 "walkways" between each set of tori, commercial and residential and residential and residential/agricultural. These walkways provide a path from each sector to the next sector without the gravity changing, so humans will not feel a change of gravity from 1G to 0G and back to 1G in a short span of time. It also eliminates special packaging for items that might cause problems if left floating around, since on the walkway, gravity is maintained.

One major component that improves the safety of the colony is the design of the spoke, The spoke is securely attached to the axle and the ring when in use, but if there is a threat of an object hitting the spoke, the spoke can be detached from the axle and the ring end, so that the settlement overall wont be affected very much by the impact of the flying object hitting the spoke.

2.0.1 Expansion and Population Growth

Population growth is expected on Columbiat, since the colony will handle a large portion of space commerce, and will only grow. The initial design of the settlement provides for ample room for expansion in the event of a big population increase. Each torus, at time of completion, will have more than double the minimum space required to support a population of 22,000 full time residents along with 1,500 to 2,500 temporary residents. This extra space can be used initially for purposes to boost the productivity of the settlement, and then be converted to living environments in the residential ring or more office space for the commercial tori.

Additionally, the central axle can be extended beyond its current dimensions if the need arises that another ring needs to be added. The 4 will be able to handle the incoming and outgoing traffic to and from the settlement on completion of the colony since the large number of ports will be able to dock multiple ships, so ships should have no problems finding a spot to set down. If the population grows, the transportation system will not be greatly affected due to the large number of docking areas for ships, so the transportation system will not be significantly affected. Furthermore, at most the ship movement in and out of the ports would be increased slightly.

2.0.2 Environment

There are 4 rings, commercial, residential, residential and agricultural, and low gravity and industrial, in that order starting from the side of the axle closest to the moon. The first three tori will be kept at normal gravity to imitate the gravity felt on Earth. This will allow the inhabitants in this area to go about their business in a familiar environment. The low gravity torus will be at half the gravity of Earth. The decreased gravity will be used by the industrial sector to reduce the amount of energy expended and facilitate tasks. The half gravity will also serve to provide comfortable accommodations for any traveler who is not ready to make the transition from virtually 0 gravity to 1 G in one of the three larger rings.

The tori are separated by function to aid in the flow of people within the settlement. The high traffic areas, namely the commercial sector and the industrial and low gravity sectors, are located near the large port areas so that travelers can have direct access to the service that is most pertinent to them. The two ports in the center of the axle between the residential and the residential/commercial rings will be used exclusively for

passenger transport, so ships are not expected to stay for very long. By limiting the port to only passengers, people can quickly get to their houses within the residential sectors. The two central tori will be residential and residential/agricultural. The residential tori will be closer to the commercial tori so that people can travel to and fro quicker. The residential/agricultural area is next to the residential area so food produced and be easily transfered to the residential tori. Also, any crops that are shipped out of the colony can utilize the port near the industrial area, which will not experience as much traffic as the commercial ring side port.

An added benefit resulting from the separation of the settlement into sections is for increased safety. In case of a problem with any one of the sectors, that sector can be quarantined, and closed off from the rest of the colony to prevent the problem from spreading.

2.0.3 Living Quarters

The colony offers 2 different types of living spaces: apartments and houses. Furthermore, the environment can either be in the agricultural setting, or the commercial setting of the ring next to the commercial sector. Apartments will be only a few stories high at max, since at higher altitudes relative to the ground, the gravity would change. The majority of the buildings in the residential/agricultural sector will be houses, more suited for long term residents. The buildings in the residential sector will be a balance of houses and apartments, since the ring caters to both the traveling businessman who is not home for periods of time so a house would be unnecessary, and the family and long term residents, who would find a house more comfortable to live in.

The housing offered in the half gravity ring will predominantly be apartments, since most of the population there is temporary, and will move on to the normal gravity rings after a few days of adjusting to the gravity.

2.0.4 Working Environment

The working environment is greatly varied. In the commercial sector, the ring is kept in 1G to emulate the working environment on Earth so that doing business on the settlement will be as similar to doing business on Earth. The layout of the commercial sector will be similar to that of a typical commercial area on Earth.

The working environment for the industrial sector, however, will only have 0.5G, to facilitate manufacturing and other processes. However, since industry is not a big part of the colony, less space is allocated to it, and thus it has to share its ring with the low gravity housing.

2.0.5 Natural View

Natural view for the colony is a very important aspect of the design of the colony. Although it is not necessary, humans feel safer when they can see Earth all the time. Not seeing Earth creates a kind of isolation for the humans living on the settlement. Since the settlement is in the Earth-Moon L-2 point, getting a natural view of Earth would be exceedingly hard. Some options are blasting a hole through the moon, which is not a feasible idea since the moon is so big and I do not think anybody would want to destroy the center of the moon. The second option would be destroying the moon completely. Again, this would not be a good idea, especially since with the moon gone, there would be a loss of pull from the moon on the settlement. What this would mean that the settlement would move off from its course around the Earth, and would then cause the colony to destabilize and veer off course.

Therefore, the natural view for the colony will be supplied by strategically placed cameras on the side of the moon facing Earth, streaming a live video capture of earth. The images of Earth will be broadcast through the windows on the sides of the colonies facing the Earth if the moon was not in the way. The images will be rendered on "invisible" displays mounted on the sides of the colony. This will display an image of Earth identical to what a person standing on the surface of the moon would see. The image of Earth will be adjusted on the walls of the colony to reflect where the Earth would be if the moon was not in the way.

2.1 Exterior Design

Refer to Figure 2.1.

2.1.1 Uses

The 4 rings will be used for 5 different purposes. The first ring that is closest to the moon will be used for commercial purposes. All business will be conducted in the commercial ring. The ring following that ring will be a residential ring. It will be purely residential with services offered for the enjoyment of the people. The 3rd ring from the moon end will be a shared agricultural and residential ring, providing most of the food for the people in the colony. The farthest ring from the moon will be a shared industrial and low gravity residential ring. It will have half the size of all of the other rings to keep the rotation constant while providing half of the gravity off the other rings, to be used for low gravity industrial purposes, as well as for people to adjust to the gravity on the settlement.

2.1.2 Major Structural Components *Refer to Figure 2.1.*

2.1.3 Construction Materials of Hull

The settlement aims to utilize as much material as possible which is readily accessible, rather than having everything shipped from Earth. However, even with that design, a portion of the colony is still made from material that is imported from Earth. The hull uses steel as a shell on the outside bottom of the ring, as it is relatively shock absorbent so it can take the impact of small objects in space. Within the steel shell is ferromagnetic fluid, which serves two purposes: to absorb more shock that comes from an object that strikes the hull. Above that is a ring of fiber reinforced concrete created with materials mined off the surface of the moon. This will be the biggest part of the hull composition, providing protection from objects if they were to break through the steel shell, and also creating a surface for people to walk on.

The "top" of each ring will have approximately the same composition except the concrete layer will be thinner because direct impact with the "top" of the ring is more unlikely when compared to the bottom, which faces out towards space.

The walls of each tori will be composed of 3 layers of nano-layered plastic which is similar in strength to steel. Since it is plastic, it is also flexible, meaning it will be able to ward off most flying objects. The walkways between the tori are also composed of the same materials as the walls of the colony, so that people can see through to the outside.

The rest of the colony will be made of steel, which is strong and able to absorb shock from objects. *Refer to Figure 2.1.3 for details.*

2.1.4 Volumes of Artificial Gravity

Artificial gravity will be supplied too most of the settlement through rotation of the colony along the axle. The axle rotates along with the rest of the settlement. The only places that don't rotate are the two port platforms at either end of settlement. The gravity on the settlement will provide a suitable environment for the people to work

Figure 2.1 Design Dimensions

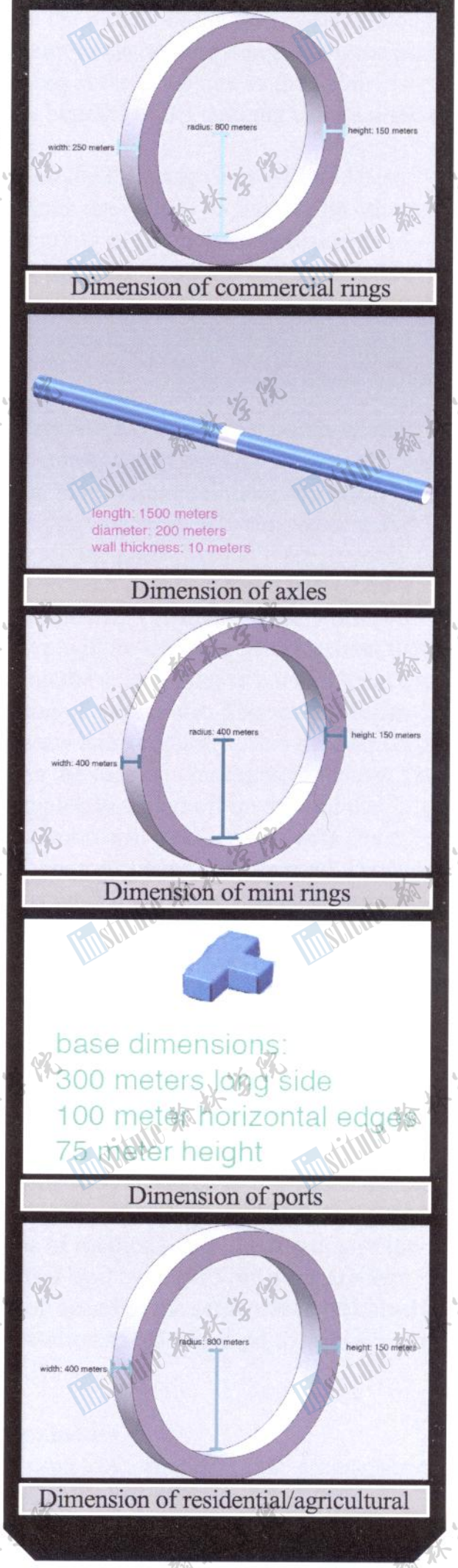
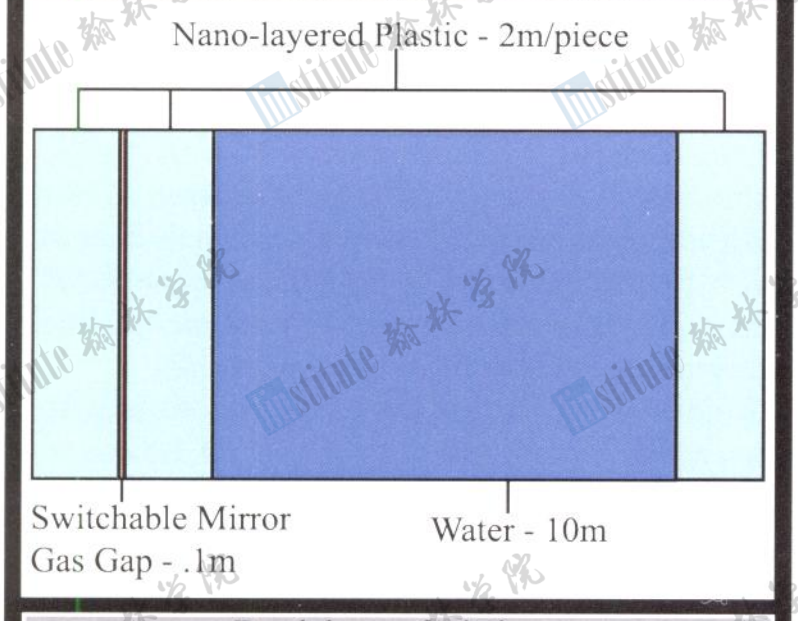


Figure 2.1.3 Hull Layers



and live. On the other hand, the two ports at the end of the colony will be kept stationary in relation to the rest of the colony so that ships will have an easier time docking on the port. The two ports in the middle of the settlement, although connected to the spinning axle, will be designed so the ports will be counter spinning at the same rate as the colony is spinning, so the same benefits of 0G docking can be offered to these two ports.

The gravity on the three big rings will be 1G so that each ring will mimic the gravity on Earth. The 4th mini ring will be half the gravity of Earth for new residents to adjust to gravity after traveling in 0G space for extensive amounts of time.

2.1.4.1 Structural Interfaces between Rotating and Non-Rotating Sections

The settlement will have very few points where there are rotating and non-rotating sections connected, to make the settlement more stable, reliable, and safe. The only points that have interfaces between rotating and non-rotating sections are the ports. In total there are only 4 points of change, 1 on each of the axle end ports, and 2 for the two ports in the center. The interface between the points of disconnection will be simply a wheel system that is between the port and the axle similar to a bearing except wheels are used instead of metal balls. The simple design is used to energy efficiency and simplicity. Also maintenance is greatly simplified in the case of a mechanical failure. The "bearing" will be completely sealed off on the end that is in contact with space, but it will have a removable cover on the inside side in case a part has to be replaced. During maintenance, the ports on that port area will be asked to leave the port for a short time as the port is connected with the axle so that the bearing area can be stationary and worked on. For the center port, the same concept applies except there are two bearings, one on each side of the two ports.

2.1.4.2 Rationale for Rotation Speed and Magnitude

The rotational speed of 0.95 rotations per minute will be applied to the main axle, which is connected to the tori. However, the ports are not connected to the rest of the colony in terms of rotation, since the rotation of the settlement will be offset by a system so the ports are kept stationary. The rotation speed of the settlement is relatively slow compared to the large radius of the settlement. This large radius low rotation speed was used to minimize any side effects that may result from the rotation of the settlement in a circle.

2.1.5 All Volumes Maintained in Pressurized and Unpressurized Environments

All tori will be pressurized to 1 atmosphere at the ground level of each tori., mimicking the atmospheric pressure of Earth at sea level. The connecting walkways between the tori will also be pressurized, but they will also have multiple airlocks along the walkway in the case of an emergency where one section has to be partitioned off. The ports will not be pressurized, since there is no need to pressurize the port areas. The central axle and the spokes connecting the axle to each of the rings will be unpressurized. However, at the ends of each of these rods,

there is an airlock. Therefore, specific spokes and the axle can be pressurized separately from the others, allowing only what is necessary to be pressurized.

2.1.5.1 Airlocks

Airlocks will be used in almost all of the areas of the colony where there will be movement of people and objects. At each junction, there will be an airlock. For example, between the ring and spoke junction, an airlock will be installed to move an object from a pressurized to unpressurized environment. Multiple airlocks will be located along the walkway between each of the rings as a safeguard in the event of a breach of the walkway wall, the damaged section can be quickly closed off, significantly decreasing the chance of injury. Furthermore, the airlocks can serve to depressurize people if they need to travel outside of the walkway to fix a breach.

Since the spokes of the colony are very sturdy, unlikely to be breached by small to medium sized extraterrestrial objects, and are only used mainly to transport objects, rather that people, not as many airlocks will be needed. Of the 8 total spokes for each of the tori, 4 out of the 8 spokes will have multiple airlocks spaced out along the spoke to prevent entrance of foreign matter from space if there was a breach of the spoke. At the ends of every spoke, there is a airlock to completely cut off the spoke if it has to be fixed. An airlock will also be installed on the ring side of the connection to prevent foreign contamination in the case that a spoke gets cut off from the rest of the ring by an object striking it with enough force to dislocate the spoke.

2.1.6 Debris Protection

In space, there are a lot of small particles floating around. The colony's hull is designed to deflect and absorb the shock from small to moderate sized objects. Most of the colony, excluding the tori, are constructed of steel in the shape of a cylinder for a greater chance of deflecting objects and absorbing shock.

The floor of each tori is made up of a steel outer shell to protect against objects that fly at the outer side of the tori. he steel will deflect objects and absorb most of the shock from these strikes. Within the shell, there will be an area filled with ferromagnetic fluid which can be solidified with an electric charge if a hull breach occurred to patch up the hole. Within that there will be a big ring of fiber reinforced concrete as the last line of defense. This layer of concrete will absorb any shock from flying objects if in the rare chance that a flying object penetrated the steel shell and the ferromagnetic fluid. At that point, the think layer of concrete will totally stop the debris.

The walls of the colony will be protected from flying debris by 3 layers of nano-layered plastic, which is comparable in strength to steel. The plastic is strong and flexible, so it will be able to withstand a big amount of shock and deflect the object. *Refer to 2.1.3 for thickness of materials*

2.1.7 Radiation Protection

Radiation from the sun is a big issue, since the humans want to be able to see space, but at the same time don't want to be burned by the suns rays. To minimize radiation, the walls of each torus are designed to reduce as much radiation as possible. The walls have 3 layers of nano-layered plastic with a lead oxide coating on both sides of each layer to block of the sun's radiation while still keeping the opacity of normal glass. Between the outer two layers of nano-layered plastic, there will be a gap for a gas mixture that changes from opaque reflective to translucent depending on the gas content within the gap. The opacity can be changed by addition of hydrogen or oxygen gas. This will be helpful in blocking out the sun if needed. Between the two interior nano-layered plastic panes, pure water will fill the gap so that any radiation not caught by the lead oxide films will be absorbed, giving people a clear view of space while protecting them from solar and other sources of radiation.

2.2 Interior Down Surfaces

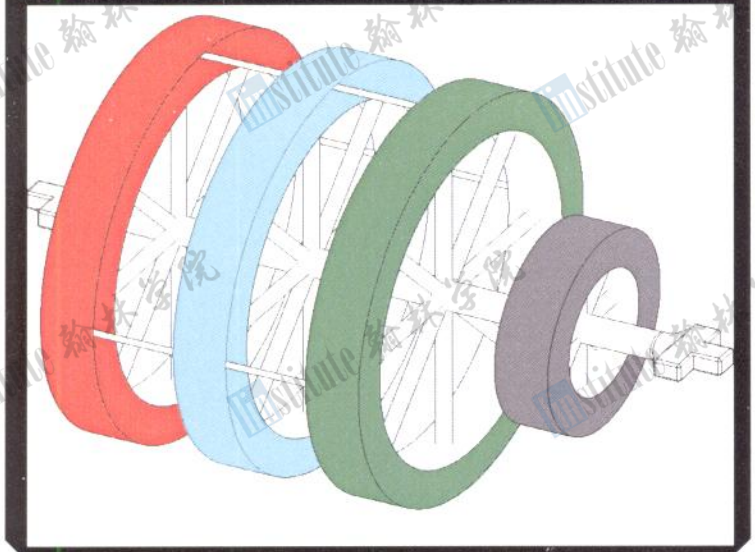
Refer to Figure 2.2.

2.2.1 Volumes of Areas *Refer to Figure 2.2.1.*

2.2.2 Micro-gravity and Unpressurized Area Use

The areas that will be in micro-gravity and unpressurized are the ports, the axle, an the spokes of the rings There is no need to supply gravity to the ports because landing will be easier if there was no gravity The

Figure 2.2 Allocation of Interior Down Surfaces

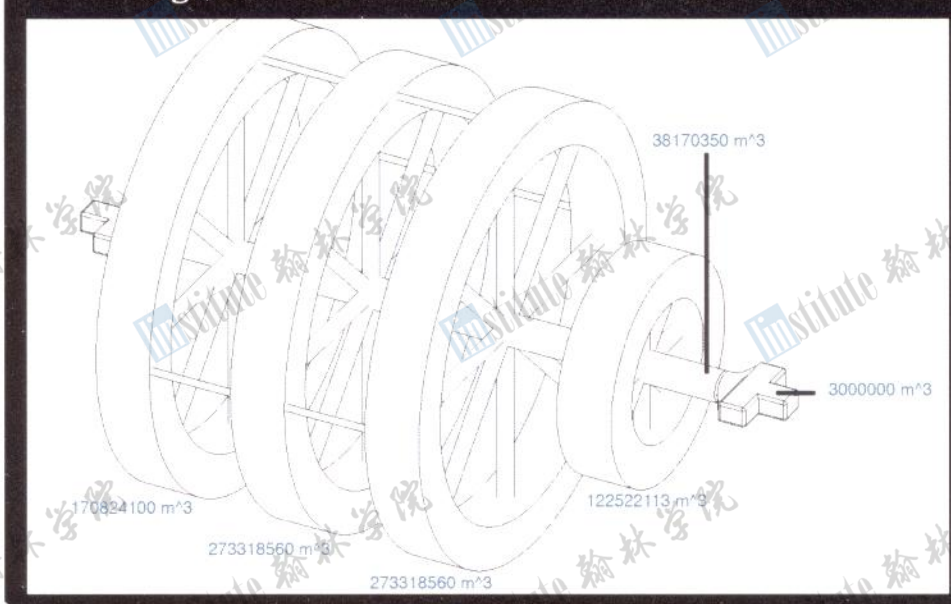


ports will also not need pressurized facilities, because people and goods will say in an enclosed containers for a lot of the time. The axle will also not need to be pressurized and will have micro-gravity because mostly only goods will be transported through the axle. Humans will only have to go through once to get to there rings because once they arrive at a ring, people can travel between rings through the walkway, which is pressurized and is 1 G, which is more agreeable with people. The spokes of the ring, similar to the axle, do not need to be pressurized, and will also be low gravity because the objects traveling through the spokes will not have to be kept in a pressurized environment, including goods like clothing, and anything that needs to travel through the spokes, like humans, will be in a vessel that will take people across the spokes. If there are a lot of people, an alternate method can be applied.

2.2.3 Orientation of Area

The settlement's central axle will be perpendicular to its path of travel. The commercial end is closer to the moon and will be tilted 45 degrees towards the moon, and the low gravity and industrial end will be pointed away from the moon. The tori will all be parallel to each other, so that the rotation speed of the rings can be kept rotating at the same rate. This is necessary because there are connecting walkways between the 4 rings to facilitate movement between each torus without having to undergo a rapid gravity change adjustment.

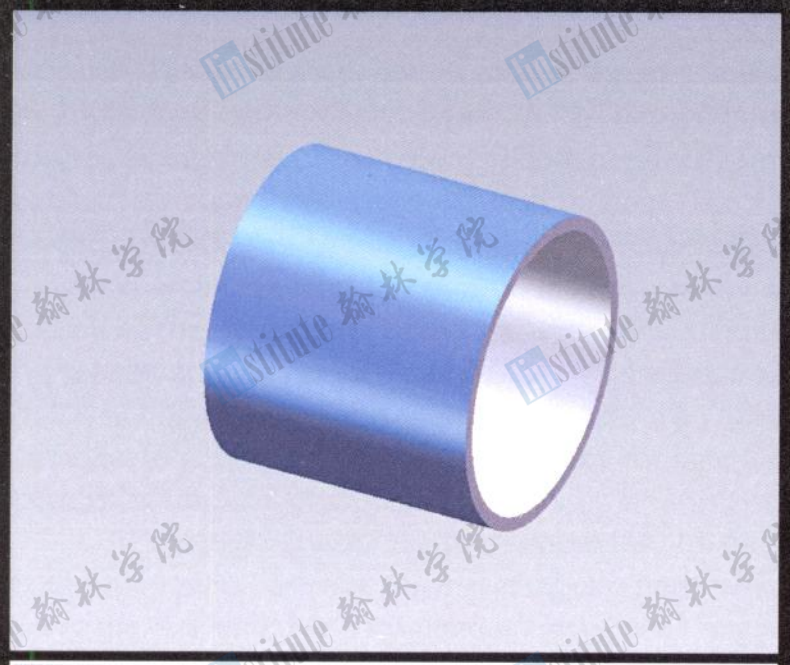
Figure 2.2.1 Volume of Interior Down Surfaces



2.3 Construction Sequence

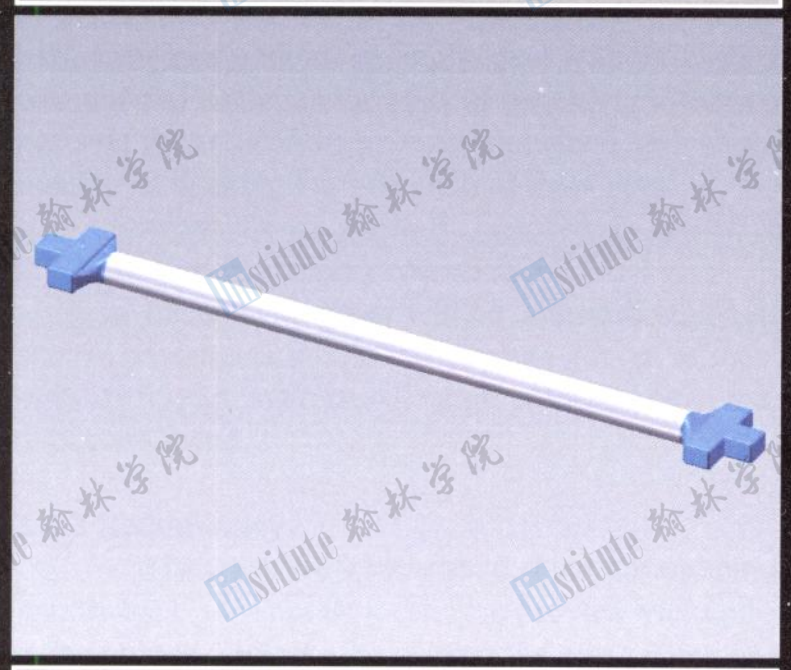
The settlement will be constructed in order of utility, and each part of the colony builds upon what is available, reducing costs. First, the central connection piece is placed in place at the moon-Earth L2 point. Next, the two prefabricated pieces making up the central axle are to be attached to the connection piece. The prefabricated ports are then connected to either ends of the colony to provide places for ships carrying materials to dock. From that point, smaller bits of the spokes are sent to the docking areas to be connected to the central axle. After the spokes are created, lunar material is shipped to the docks on either side of the axle. The lunar material is then used to create the fiber reinforced concrete, which is then used to make the tori. Work will be done from both ends, so that the settlement can be built faster. After the rings are built, the walkways between the rings will be built, completing the settlement construction. Located within the rings are rockets, which will fire, thereby rotating the rings to the desired rotation rate. *Refer to Figure 2.3 for more details.*

Figure 2.3 Construction Sequence

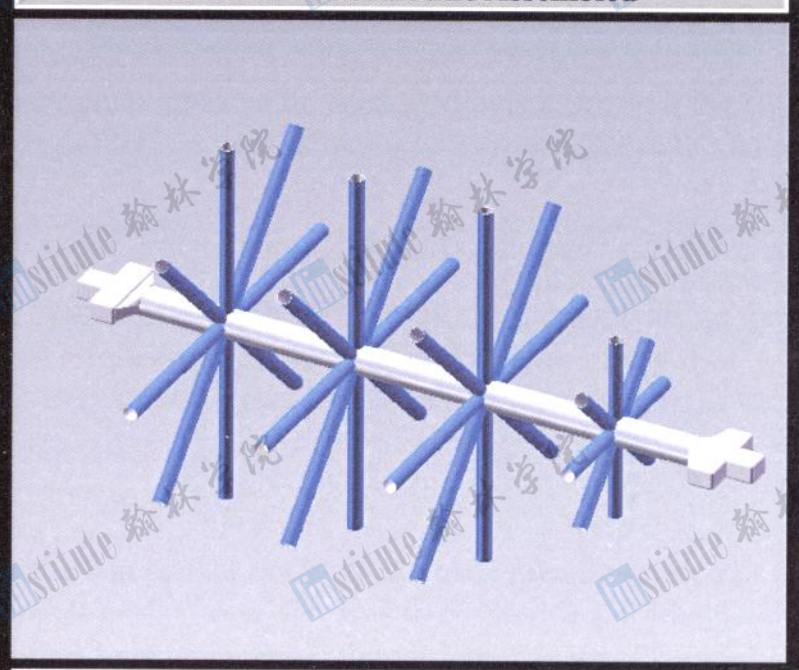


Phase I - Central Connection Piece

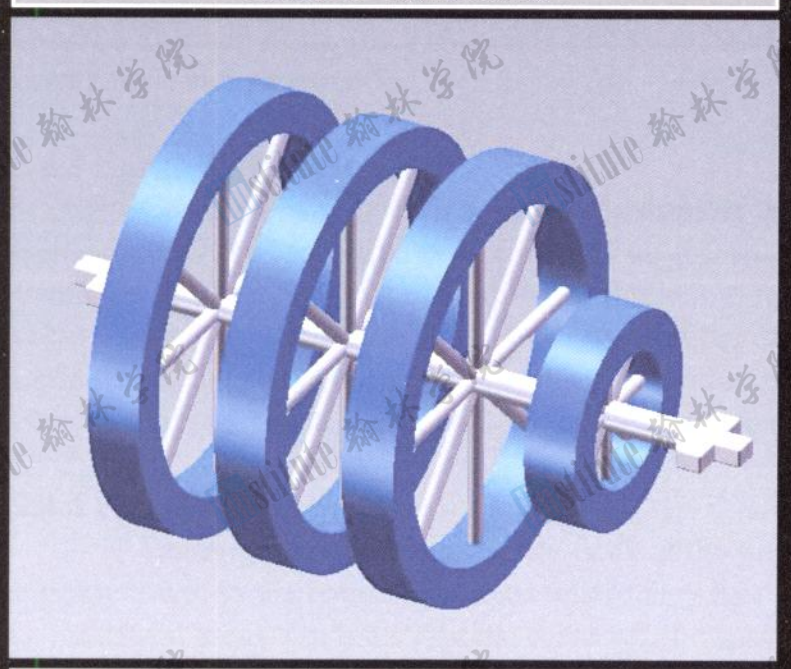
Phase II - Central Axle Assembled



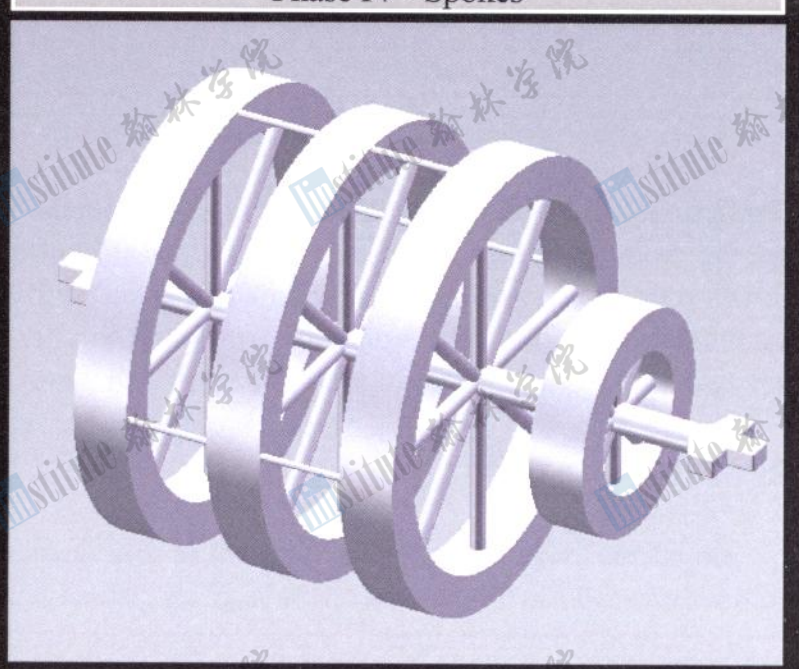
Phase III - Axial Ports



Phase IV - Spokes



Phase V - Rings



Phase VI - Walkways

2.4 Ports

The colony will have a total of 4 ports, with multiple docking bays at each port. A "T" shaped port is located at each end of the colony. These ports will almost exclusively support the rings adjacent to them. The port on the ring side will handle all of the incoming traffic for commercial matters. The port on the low gravity and industrial ring will handle ship long term ship docking for repairs on the extended part of the "T", and also all industrial items and new residents or people who need to adjust to gravity after traveling in space for extended periods of time.

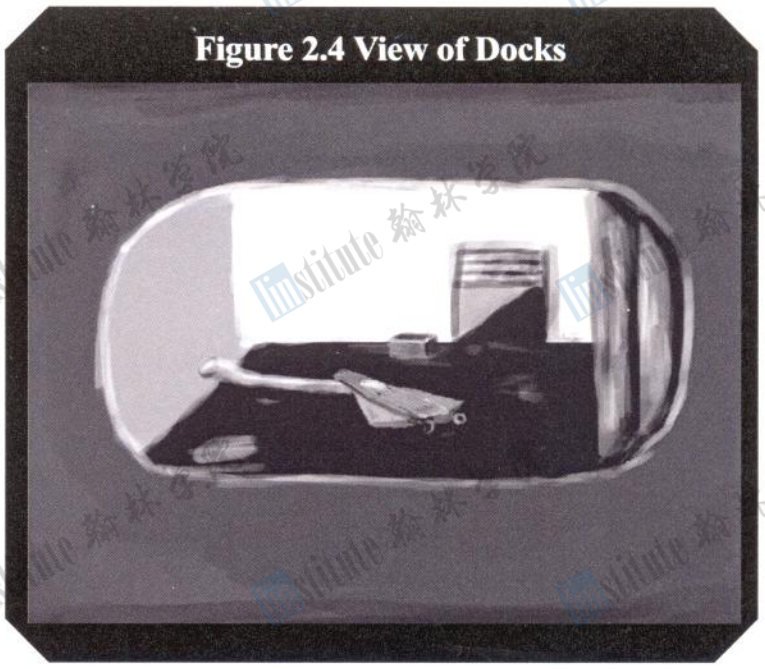


Figure 2.4 View of Docks

Located between the two central tori, on the central connection piece, are two other rectangular ports which serve the residential and residential/agricultural rings. These two ports will handle all of the traffic going into and out of the residential areas, so residents can more quickly go to their houses without having to deal with the commercial or industrial traffic on the ends of the axle. Furthermore, these ports also can be used to alleviate traffic if the two ports on the ends of the axle get inundated with ships, although that is a very unlikely occurrence due to the large number of docking bays on each of the 4 ports.

2.4.1 Foreign Material Protection

Each docking bay will be equipped with a flexible "pathway" which will connect to the doorway of the ship so passengers within the ship can get out of the ship and into the settlement without bringing in any dust or other foreign matters. All cargo unloaded from the ship will to go to a processing center within the port to be decontaminated.

2.4.2 Redundancy

The ports are widely spaced out throughout the settlement so that not only can each area be serviced mainly by 1 port, but they can also provide backup for the other ports if one port was to be disabled. Redundancy is the primary concern for placing the ports. The ports are placed strategically so the settlement cannot be crippled by the destruction of 1 port. Furthermore, if upgrades were to be made to the axle, and the axle was to be extended to add additional rings, the 3 available ports can handle the traffic as the 4th one is taken off the axle so that the central axle can be extended.

2.4.3 Cargo Ship Ports

Cargo ships will dock at the protrusions of the "T" shaped ports at the ports at the end of the central axle. Since most of the cargo that is dropped off on the settlement will most likely be picked up and shipped away, the items are best left at either ends of the settlement to reduce the chance of damage to the colony in the high traffic areas in case of an accident. Also, since most of the cargo will not go to the two central residential and residential/agricultural rings except for food, clothes, and other basic items, it is more efficient to drop off the cargo near the commercial or industrial areas where the items can be processed and shipped more quickly.

2.4.4 Passenger Vessel Ports

Passenger vessels will mainly dock at the ports in the center of the axle, so the passengers can more quickly travel to the residential areas where they live without having to fight with the traffic from the commercial or industrial areas. On both T-ports, there will be space to dock passenger vessels if needed, since for example, businessmen need to travel to the commercial areas more quickly. The docks at the end near the commercial ring can help them get to the commercial ring more quickly.

2.4.5 Long Term Repair

Long term repair for ships will be conducted on the extension of the T-port parallel to the central axle. Since the industrial sector is the closest to that port, the ship will be able to be serviced by the industrial ring more easily. Furthermore, if parts are needed, the industrial sector is nearby and can be used to quickly fabricate missing parts. If a whole piece of a ship has to be repaired, the piece can be moved easily from the port to the within the industrial ring to be fixed.

2.5 Low Gravity Accomodations

2.5 Low Gravity Accommodations

Since some people coming to the colony will not be able to instantly adjust to the gravity on the settlement which will be the same as on Earth, a half gravity ring will be provided to house these people for a short duration before they become accustomed to the gravity. The low gravity ring is right next to the residential/ agricultural ring, so residents can immediately move next door to 1 G accommodations once they are ready.

3.0 & 3.1 Operations & Construction Materials

3.1 Construction Materials Sources Materials shall be acquired from the Alaskol when possible, because of its close proximity to the settlement site. Equipment unable to be made on site will be manufactured at Bellevistat. All other materials shall be shipped from Earth.

Table 3.1.1 Sources of Materials and Equipment

Material	Source	Transportation	Amount (construction)	Purpose
Steel	Earth	Jyk	23,995,312 m^3	Hull reinforcement, housing
Nano-layered plastic	Earth	Jyk	28,274,333 m^3	Settlement walls, windows
Fiber-reinforced lunar concrete	Alaskol	Bor	89,170,180 m^3	Hull
Ferromagnetic fluid	Earth	Jyk	8,196,140 m^3	Hull
Water	Earth	Jyk	26,000,000 L	Human consumption, biological necessity, radiation protection
Air	Earth	Jyk	840,000,000 m^3	Biological necessity, atmospheric pressure
Equipment (refer to 5.0.2 for robots)	**Source**	**Transportation**	**Amount (construction)**	**Purpose**
Shodo-nou	Manufactured on site	N/A	250	Agriculture robot
Shodo-ko	Manufactured on site	N/A	100	Livestock care robot
DaiGurren-Lagann	Bellevistat	Bor	350	Construction robot
Gurren-Lagann	Manufactured on site	N/A	200	Maintenance robot
RFP	Bellevistat	Jyk	100	Mass production / rapid prototyping robot
RFP-E	Bellevistat	Jyk	100	Internal construction robot
Ten-gu	Manufactured on site	N/A	200	Security robot
Ten-chi	Manufactured on site	N/A	200	Janitorial robot
G	Manufactured on site	N/A	100	Port robot
HD	Manufactured on site	N/A	100	Cargo robot
TWR	Bellevistat	Jyk	5	Nuclear reactor
VASIMR	Bellevistat	Bor	16	Rockets for propulsion

3.1.1 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, robots (HD and G) shall move them out of this storage area and transport the materials to wherever they are needed.

3.2 Community Infrastructure

3.2.1 Atmosphere/Weather/Climate Control The climate and weather will be controlled from select 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 as seen in Table 3.2.1.

Table 3.2.1 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%

3.2.1.1 Atmospheric Composition High Efficiency Particulate Arresting (HEPA) filters located in the walls of the rings 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 Gurren Lagann.

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 3.2.1.1 Atmospheric Composition

Gas	Percent	Volume (m^3)	Mass (tonnes)
N_2	78	655,200,000	749.8
O_2	21	176,400,000	18.9
CO_2	1	84,000,000	12.4

3.2.2 Food Production

Food production, with the exception of animal farms, will be accomplished through vertical farming towers distributed through each ring, so to provide for more efficient distribution of foodstuffs

3.2.2.1 Agriculture Traditionally, most designs for self-contained environments have relied on hydroponics and fish farms for food production, methods that produce high yields, but are also high-maintenance. Hydroponic systems, for example, tend to require frequent nutrient replenishment, just as fish tanks need constant flushing of fouled water. But these issues can be mitigated by combining hydroponics and aquaculture into "aquapoincs", with fish waste becoming plant fertilizer, and the plants clean the dirty water.

3.2.2.1.1 Vertical Farm Food in the colony will be produced through automated aquaponic systems in the vertical farming towers, using OLEDs to produce the light for photosynthesis. The use of towers saves space and leads to a more efficient water/waste grid, eliminating the need for high concentrations of water and power to be diverted to a separate "Agricultural Area."

On each floor of the towers, aquaponic tanks are organized in concentric circles around the inner core, organized for conservation of space. In these tanks, a slow current floats trays of plants past nutrient dispensers, while ceiling-mounted systems monitor and control humidity, temperature, and nutrient distribution. Below the plants swim tilapia and salmon, their ammonia-laden waste sinking to a gravel bed, where bacteria convert it to nitrates, which are filtered by the system and routed

Figure 3.2.2.1.1
Vertical Farm Tower

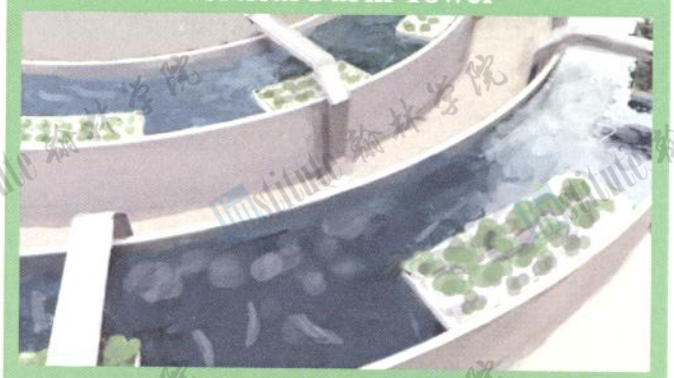


Table 3.2.2.1 Crop Growth Method Breakdown

Aquaponics	Rice, wheat, barley, sugar beets, blueberry, strawberry, tomato, carrot, onion, radish, scallions, beans, soy, lotus root, potatoes, lettuce, cabbage
Soil-cultivated	Corn, apples, tangerines, mushroom, mango

to the nutrient dispensers, thereby fertilizing the plants and returning clean water to the fish.

However, some plants (Corn, apples, tangerines, mushroom, and mangoes) do not respond well to hydroponic methods, and so will be grown in soil. This soil will be composed of crushed lunar regolith blended with organic compost and enriched with nitrates.

The agricultural robot, Shodo-nou shall monitor all plants once a day for health and soil condition for the soil-based plants. In the aquaponic system, the sprinklers will be checked and maintained once a week, unless a plant monitors appears to be dry. In this situation, the sprinkler will be checked immediately. Compost shall be mixed into normal soil every two weeks to act as a fertilizer. *Refer to Figure 3.2.2.1.1*

Table 3.2.2.2 Livestock

Land mammals	Micro-breed cows, Mutton
Birds	Chicken
Fish	Salmon, tilapia

3.2.2.1.2 Harvest For harvest, Shodo-nou will travel on rails for the aeroponic system and on wheels for soil to scan plants for the presence of specific alcohols—a more precise judge of ripeness than color or firmness—cutting and collecting the usable portion just before ripeness. Overripe or unusable plants are disposed of into the wetlands.

3.2.2.2 Livestock *Refer to Table 3.2.2.2*

3.2.2.2.1 Cultivation For efficiency, most meat products will be cultivated in the lab from chicken, sheep or cow stem cells raised on a diet of water, glucose and natural proteins. To approximate the texture of meat, they will "exercise" the muscle with electrical pulses. Granted, this will not be sufficient to replicate the fatty texture of a porterhouse steak, but for most needs, such as ground or processed meats, this will be enough. However, for more expensive cuts of meat and produce, a small population of animals will also be raised.

These animals will be raised exclusively in the special Vertical Tower Farms 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 and alfalfa. They will be monitored by Shodo-kos that check their health and feed them every day. Shodo-kos will assist in delivery of the young. As mentioned, salmon and tilapia shall be raised with the plants in the aquaponic system, with oxygen levels and feed actively monitored by a computer and automatically maintained.

3.2.2.2.2 Harvest/Slaughter The slaughter of livestock shall be conducted through 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. Shodo-nous 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.

3.2.2.3 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.

3.2.2.4 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 HD.

3.2.3 Electrical Power

3.2.3.1 Generation The electrical power of the colony shall be primarily produced by four TWR's (Traveling-Wave Reactors), one in each of the four rotating rings and one more at a port to power the ports and the central rod. These reactors use unenriched uranium fuel packed inside hexagonal pillars and work by converting the otherwise useless U-238 into fissile P-239. Conversion and fission occur together in a slow wave that moves through the core at about a centimeter per year. The reactors only need a thin layer of enriched uranium to begin the reaction and, because of the slow movement of the wave, can last for a few decades, minimizing the need for fuel replenishment.

Table 3.2.3 Electrical Power Generation

Type	Priority	Location	Number	Power Output	Maintenance
Traveling-Wave Reactor (TWR)	Primary	Individual Rings	4	300 MW per reactor	Monthly by Gurren Lagann
Battery	Backup	All sectors, ports	N/A	N/A	Weekly by Gurren Lagann

For a backup source of power, batteries will be charged by some unused voltage from the TWR's. If any of the reactors were to fail, the batteries would be utilized to power the electricity grid until the reactor is fully repaired and functional. Gurren Lagann will periodically drain the batteries when they are unused to maintain the longevity of the batteries.

3.2.3.2 Distribution
Power will be routed from the reactors underground to necessary facilities and households.

3.2.3.3 Allocation *Refer to Table 3.2.3.3*

Table 3.2.3.3 Allocation of Power

Use	Estimated Power Requirement
General public	20 MW
Commercial	20 MW
Industry	200 MW
SkyTran	1 MW
Agriculture	5 MW
Air Filters	1 MW
SCWO	5 MW
Elevators	50 MW
VASIMR rockets	32 MW

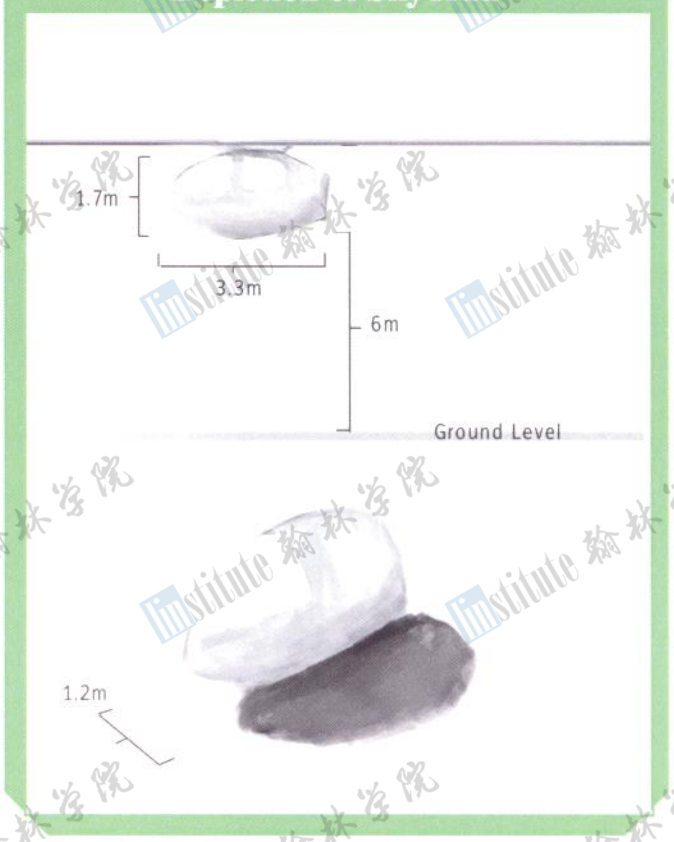
3.2.4 Water Management Initially be imported from Earth, water shall be transported to water tanks for use in the colony's water line. Used water shall undergo treatment through the SuperCritical Water Oxidizer (SCWO) for reuse. Extra water will be stored in backup water tanks in each ring. As the amount 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 26,000,000 L of water shall be imported and distributed evenly to the water tanks of each ring. Once in circulation, water management will be handled inside the colony's farming towers so that it can either be reused for agricultural needs, or recirculated for civilian needs.

3.2.5 Waste Management Household waste management will also take place in the farming towers, first being scanned for traces of heavy metals, and then processed in the SCWO. Sludge is put into a chamber with temperature and pressure above water's thermodynamic critical point. Under these temperatures and pressures the 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 in the farm tower and recycled into the breathable atmosphere in which the settlers in.

3.2.6 Internal Communication Inside the colony, each civilian will carry a mobile device called the Fuki, which allows them to stay connected with each other, the colony, and Earth news, too, with Internet access, while serving as a personal computer at the same time (refer to table 5.0.1 for more details).

3.2.7 External Communication Exocolonial communication requires effective long-distance communication that allows for data transfer without a continuous direct line of sight. To achieve this, store-and-forward methods shall be implemented, meaning information will be routed through hosts that hold on to it until a link is established. Columbiat will be in a space network consisting of the other existing colonies, spacecraft, Earth satellites, the Earth itself, and potentially future settlements and spacecraft. Communication with Earth will be an indirect connection relayed through either Alexandriat or Bellevistat and

Figure 3.2.8
Depiction of SkyTran



Earth satellites due to the fact that the moon stands in between the colony and Earth at all times.

3.2.8 Internal Transportation Internal civilian transportation will consist of a combination of SkyTran maglev railways and collapsible public bicycles. The SkyTran will be an intra-ring transport system, consisting of a large fleet of two-passenger cars under a Maglev-style rail elevated 6 meters from the ground. The small carrying capacity of the cars provide a more personal public transportation experience, allowing the rider to choose his or her own destination and following the shortest possible path, rather than being limited to single routes for individual cars that would require transferring to different rails and waiting for the next car to arrive. *Refer to Figure 3.2.8.*

Figure 3.2.9
Bicycles

Alternatively, civilians can rent public bicycles if they wish to travel on the ground but do not want to walk. Bicycles will be size-customizable to compensate for all body types and sizes and equipped with optional electric motor assistance for tired or disabled individuals. They will be available for check-out at SkyTran stations (though not all stops) and at major public areas. *Refer to Figure 3.2.9.*

Underneath the roads will be a 10m by 10 m underground transportation corridor for robots, cargo, and other large vehicles to travel without interference from people.

Between rings will be corridors for inter-ring transportation. The bottom half of the corridor will be an extension of the underground transportation corridors within the rings, and above it will be a road for bicycles and walkways at the sides. The SkyTran systems will be separately maintained for each ring and therefore will not travel ring to ring.

Transportation from ring to central rod will be achieved with the use of high-power elevators within the spokes. As this method of transportation is very costly to run, it will only operate a few times a day, and loads will be optimized to use as few elevators as possible at a time.

In the central rod, the lack of artificial gravity render wheels useless. Therefore, maglev rails will be installed for robots to be able to move. SkyTran units will also be deployed in the central rod for safe human transport.

3.2.9 Day/Night Cycles Day and night cycles on the colony shall emulate the 24-hour cycles of the Earth so that settlers have a natural feel for time passing. To achieve this, OLED and NCD lights would be stored in flexible sheets and lined in the ceilings of the colony and activate according to a set schedule. 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 display that only needs electricity to change colors and requires no energy for keeping color. This would be useful in the night, when the sky is dark and does not need alternating colors. The moon and the stars will be simulated through lighting certain pixels on the sheets.

3.3 Space Infrastructure

Table 3.3 Space Infrastructure

Name	Location	Quantity	Purpose
Alexandriat	Earth-Moon L5 orbit	1	Space Colony
Bellevistat	Earth-Moon L4 orbit	1	Space Colony, low-G heavy manufacturing
Alaskol	Moon	1	Space Colony, lunar materials source
VASIMR's	Outer surface of rings	16	Gravitational spin and orbit maintenance

3.3.1 Space Vehicles *Refer to Table 3.3.1*

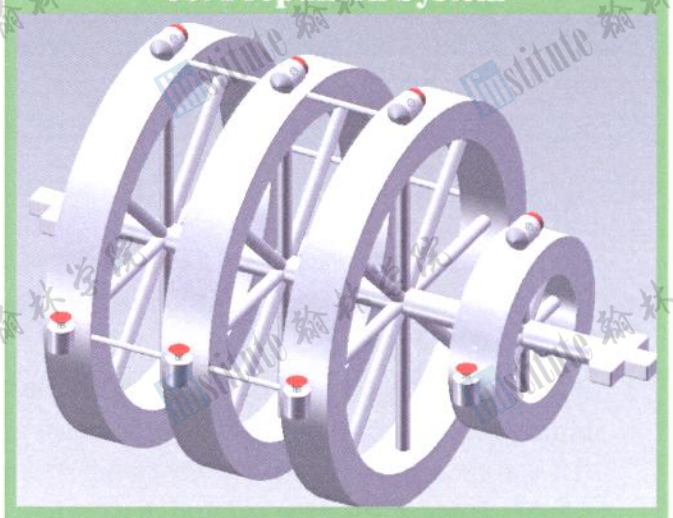
Table 3.3.1 Vehicle Requirements

Name	Purpose	Dimensions (m)	Payload Weight (tonnes)	Payload Size (m^3)	Foundation Funded	Support Facilities
Mare	Civilian Transport	30×20×15	90	3,000	Yes	Earth, Alexandriat, Bellevistat, Columbiat, Alaskol
Jyk	Cargo	45×20×15	150	5,700	Yes	Earth, Alexandriat, Bellevistat, Columbiat, Alaskol
Bor	Heavy Cargo	65×35×25	700	24,000	Yes	Earth, Bellevistat, Columbiat, Alaskol
Rifter	Maintenance/ Security	13×10×5	20	2,000	Yes	Columbiat
Magus	Research	20×15×10	7	1,200	No	Columbiat, Alaskol
Kynes	Emergency	20×10×15	15	1,150	Yes	Earth, Alexandriat, Bellevistat, Columbiat, Alaskol

3.4 Propulsion System

Rotation for artificial gravity will be initiated and maintained by VASIMR rockets stationed under the outer surfaces of the rotating rings. Each ring will have four rockets, positioned around the ring so as to cover the rings at the points near the inter-ring corridors. For rotation, doors will open and the rockets shall be extended to protrude from the ring while pointing tangent to the direction of desired rotation. Calculations shall be made by a management center located in the industrial ring that coordinates all the rockets' power, activation timing, and activation duration to achieve the correct spin rate (.1106 rad/s) for the desired artificial gravity of 1G. For station-keeping at the L2 libration point and other potential translational movement, a fleet of Jyks, Bors, and Rifters shall be deployed to tug the colony to the correct position. When not in use, the VASIMR rockets will be pulled back into the ring where it can be maintained or repaired from the inside of the colony. Propellant will consist of nitrogen gas, stored in warehouses at each ring and power supply shall come from a direct line from the TWR's in each rocket's respective ring. Thrust capabilities for each rocket will range from 50 to 1,000 N depending on the amount of power supplied.

Figure 3.4
Jet Propulsion System



3.5 Vehicle Provisioning and Maintenance

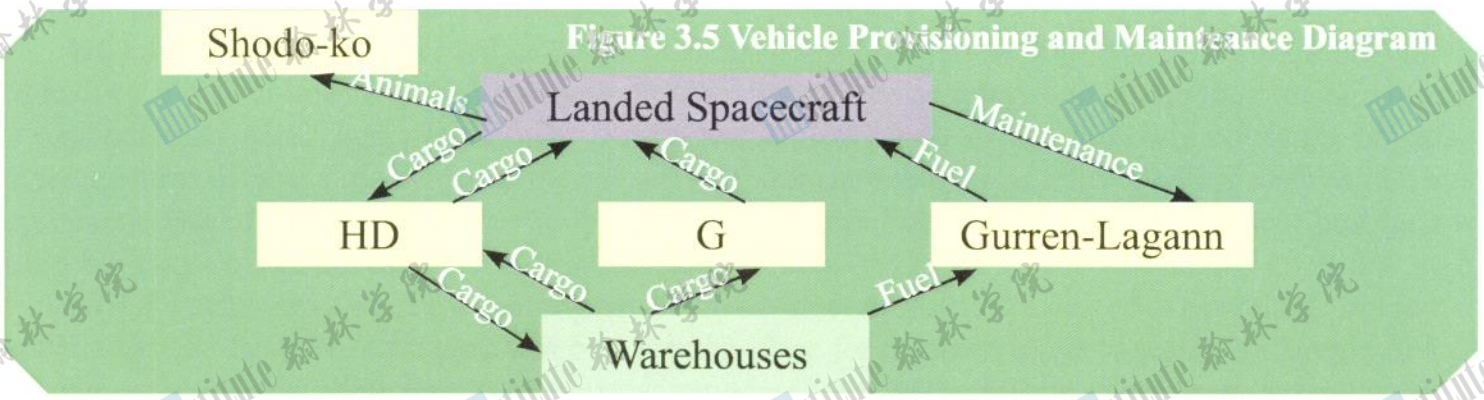


Figure 3.5 Vehicle Provisioning and Maintenance Diagram

4.0 Human Factors

4.0.1 Quality of Life To promote a healthy quality of life, the colonists' living experience will Earth-like. This will provide colonists a familiar environment so that they can adjust easily to life on Columbiat.

4.0.1.1 Community Attributes The entire colony is split in the traditional Earth community structure. This reduces adjustment time. Each ring will serve a specific purpose: residential, commercial, industrial and agricultural.

4.0.1.2 Comfortable Homes Each home will utilize all available space in an efficiency manner so that colonists will have a comfortable residence to return to when they feel stressed.

4.0.1.3 Access to Fine Food Fine food restaurants will be located throughout Columbiat so that colonists will have access to luxury dining that they expect in a fully developed area. In order to support the nonstop action of Colmbiat, all restaurants will be open at all hours.

4.0.1.3.1 Restaurants Restaurants will range from fast food to fine dining in order to meet the varied tastes of all colonists. All restaurant types will be available everywhere but certain areas will have a higher concentration to better serve the colonists who frequent that area. For example, fast food joints will be located near the ports and residential areas to serve port workers and the younger population respectively.

4.0.1.3.2 Wine Wine making facilities will be located within the agricultural sector for the production of all kinds of wine from the assortment of fruit grown in Columbiat to create a new wine of glass. This wine will be supplied to fine dining restaurants and colonists with a small amount of export.

4.0.1.4 Natural View For natural views of space, sun, moon and Earth, a series of options are available to colonists. First, for general view of space, the moon, and the sun, colonists will have access to observatories located in the residential areas. For natural view including the Earth, special Holo-Rooms located within the Low-G ring will be available for colonist's use. Also, Proj-Windows will allow colonists to view space outside the colony from within the comfort of their own homes.

4.1 Community Design

Columbiat will be designed so that each colonist can find their own lifestyle out of the many opportunities provided by community. Most facilities a colonist would expect in a developed city on Earth will have an adapted version available within Columbiat. *Refer to Figure 4.1*

4.1.1 Services Columbiat will provide all the expected traditional community services as well as several unique to the colony in order to provide colonists with a familiar yet interesting community. The use of technology in all aspects of daily life will help colonists live a techno-lifestyle fitting for a "Singapore in Space". *Refer to Table 4.1.1*

4.1.1.1 Housing Housing on Columbiat will fall under two categories, houses and apartments. The distribution of such housing types within the colony will depend on the neighborhood type. Rural neighborhoods will have more houses and urban areas will have many of apartments. Suburban neighborhoods will have approximately equal amounts of both housing types.

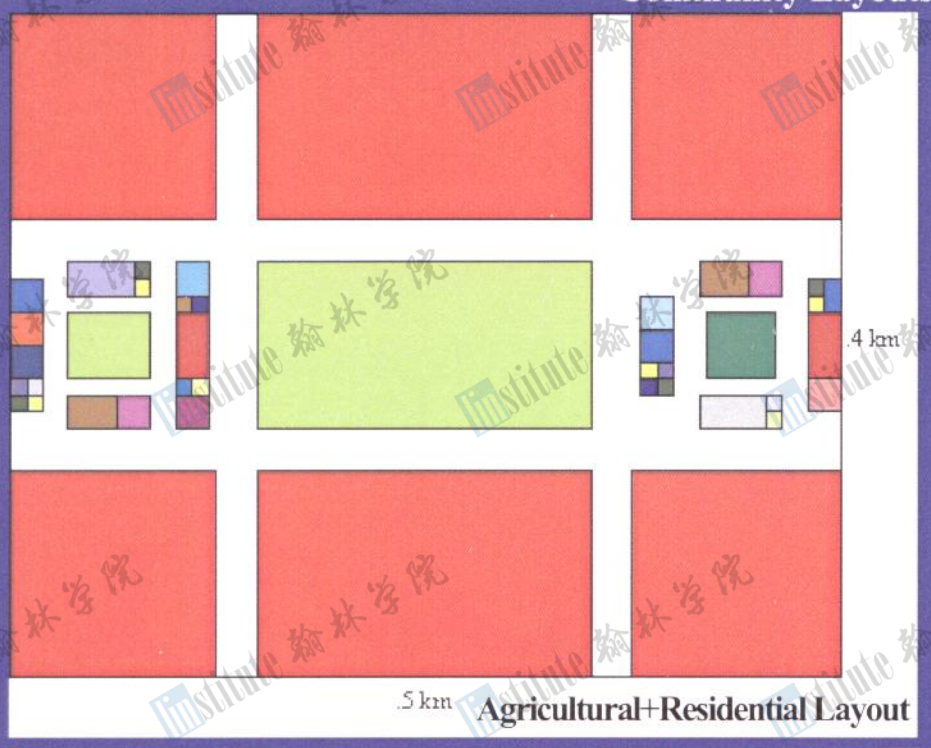
4.1.1.2 Education Education will be done primarily through a holographic teaching avatar called EVE. EVE will be projected from holographic projectors mounted on a robotic base unit or on individual student's desks. From these positions, EVE can teach and evaluate students in groups or individually. *Refer to Figure 4.1.1.2*

4.1.1.3 Entertainment Entertainment will be provided on Columbiat through recreational and leisure activities, world-class shows, movies, theme parks, conventions, and sporting events. Each ring will have the rudimentary facilities to support each of these entertainment venues.

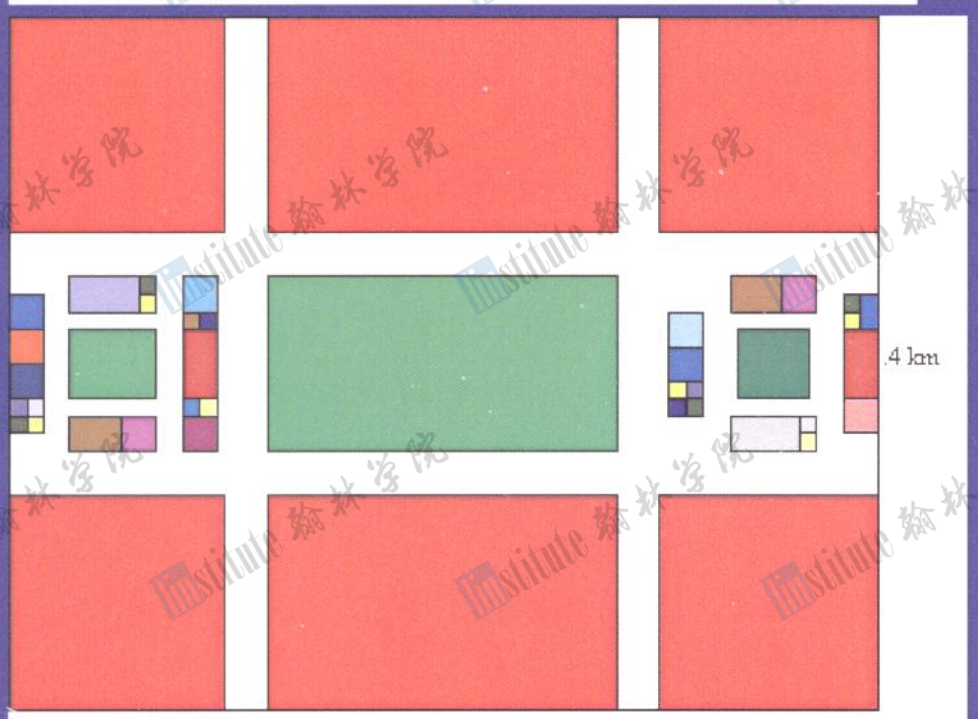
4.1.1.4 Medical Services Medical assistance on Columbiat will be done mainly through the Fuki wearable devices that colonists wear. This worn portable device has an integrated health monitoring system tracks each colonist's vital signs periodically. If it detects something abnormal, Fuki will notify the colonist and search the medical database to determine the cause. Also, human doctors and other medical staff will be available at hospitals in cases of importance where simple monitoring from Fuki would not suffice. These hospitals will provide a full range of medical service to colonists. *Refer to Section 5.3.1.1*

4.1.1.5 Parks Parks will be a central social area for all communities. Located in the middle of most residential areas and facilities, each park will be a popular place for colonists to get together. By having parks as an integral part of the colonist's life, the park's open air nature will negate the feeling of being walled in by the colony.

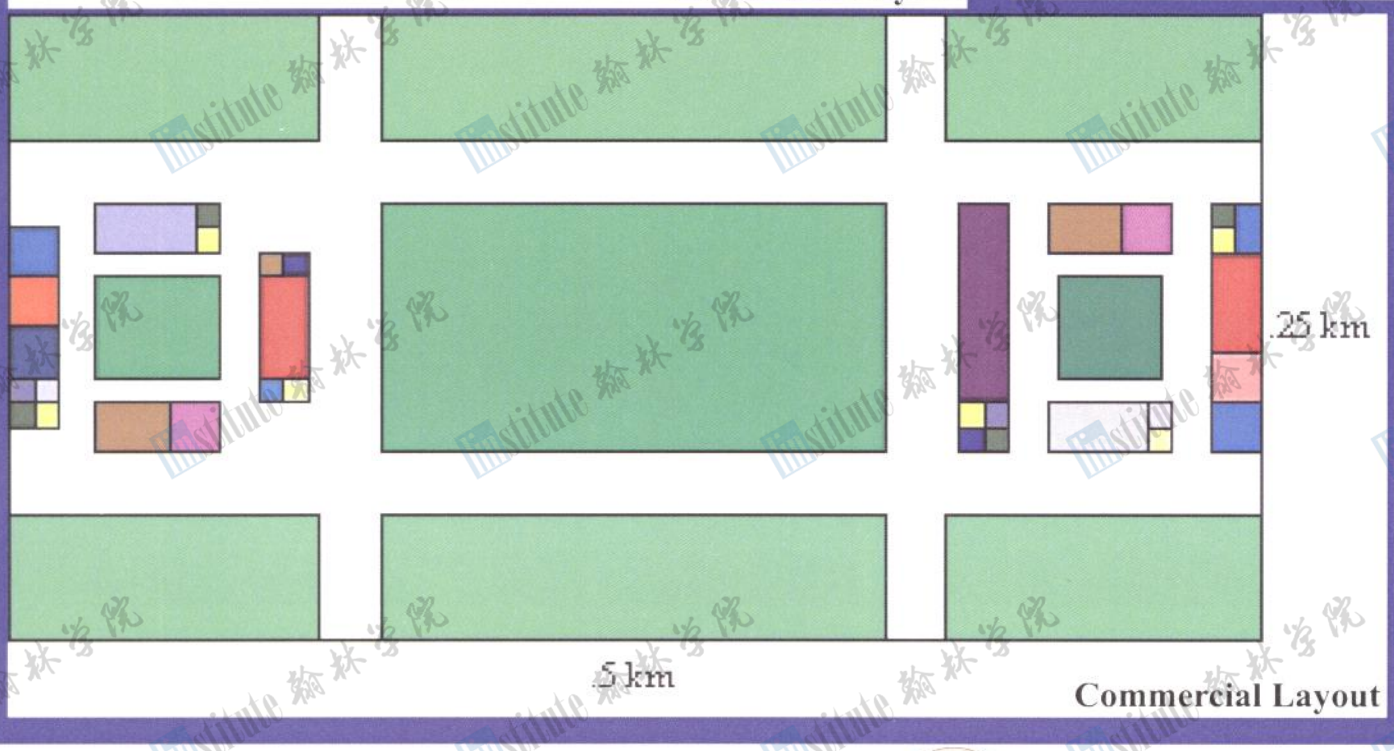
Figure 4.1
Community Layouts



Agricultural+Residential Layout



Residential Layout



Commercial Layout

Road and Path Land Use

Ring	Road and Path Area (m^2)	% Land Use
Residen-tial	48125	24.06%
Residen-tial-Agri-cultural	48125	24.06%
Commer-cial	21250	21.25%

Table 4.1.1 Facilities

Residential Sector	Number in Colony	Area (m^2)	Total Area in Colony	Color in Figure 4.1
Apartments	6250	100	625000	
Houses	8750	150	1312500	
Schools	20	400	8000	
Libraries	20	400	8000	
Town Halls	20	400	8000	
Commercial Sector				
Convention Centers	10	1600	16000	
Offices	225	1000	225000	
Residential and Commercial				
Police/Fire Stations	60	400	24000	
Clinics	60	100	6000	
Hospitals	30	800	24000	
Restaurants	120	100	12000	
Nightclubs	60	400	24000	
Movie Theaters	30	800	24000	
Cafés	60	100	6000	
Stores	120	100	12000	
Observatory	30	800	24000	
Agricultural				
Green Tower	30	1600	48000	
Community Gardens and Orchards	20	Varying sizes	220000	
Recreational				
Parks	20	Varying sizes	220000	
Sports Facilities/Gym	60	400	24000	
Transportation				
SkyTran Stations	60	100	6000	
Bike Rental Facility	60	100	6000	
Other				
Computer Storage	30	400	12000	
Robot Maintenance and Storage	30	400	12000	
Backup Air and Water Tanks	60	100	6000	
Warehouse	60	800	48000	

4.1.1.6 Recreation Recreation and leisure activities will be provided for through a series of parks, community centers and sports facilities as well as the availability of entertainment. Individual activities and sports are also supported with the inclusion of buildings such as libraries and gyms.

4.1.2 Supplies and Consumables All supplies and consumables will be availability in the type and quantity per capita that a developed city on Earth would have. *Refer to Table 4.1.2*

4.1.2.1 Variety All supplies and consumables would be available in terms of variety as one would expect from a developed city on Earth. Popular luxury items will be available in small amounts and sold in specialty stores. Clothes of all types will be available and different clothing lines would be sold to colonists in stores owned by the manufacturer or by online ordering.

4.1.2.2 Quantity Each consumable will be stocked at approximately 110% of the expected monthly consumption. This slight oversupply will ensure that all

colonists will have access to all supplies they require.

4.1.2.3 Resupply and Replenish Colonists will have access to consumables comparable to the level others would expect from a developed city on Earth. To do this, colonies will produce supplies at a rate to maintain the slight surplus. For imported goods, these supplies will be replenished once the current level drops below a certain point.

4.1.2.3.1 Sources Most foods and other consumables will be produced on Columbiat in the agricultural and industrial sectors. The only time something is imported from outside the colony is for special goods that the colony can produce or or when the momentary demand of a certain good exceeds the production capability of Columbiat.

4.1.2.3.2 Distribution Supplies and consumables will be distributed to colonists through two methods. The first is the traditional store where colonists physically enter the store and chose the items they want to buy. The second is a computer catalog where colonists can have the items delivered to their door by robots. With the second method, a regular delivery schedule can be devised for the colonist's convenience.

4.1.3 Psychological Factors Since the colony is separated from rest of civilization, a series of design elements are used

Table 4.1.2 Supplies and Consumables

Produce	Yield (kg/m²/year)	Consumption (kg/capita/year)	Area (m²)
Rice	7.5	11.4	357212.16
Wheat	7.2	73	2382720
Barley	7	4.5	151076.571429
Lotus Root	6	5	195840
Potato	52	75	338953.846154
Sugar Beets	74	14.6	46366.443243
Fruits/Vegetables			
Carrots	121	10	19422.148760
Onions	50	9	42301.44
Peppers	15	5	78336
Radishes	45	9.5	49612.8
Lettuce/Cabbage	75	7.5	23500.8
Gai Lan	1.5	2	313344
Scaillions	12.5	2	37601.28
Beans	148	4.8	7621.881081
Mushrooms	50	2.5	11750.4
Corn	6	8	313344
Apples	42	11	61549.714286
Goji Berries	13	7	126542.769231
Blueberries	20	6	70502.4
Strawberries	25	8	75202.56
Grapes	23	7	71524.173913
Tomatoes	124	41	77704.258065
Mangoes	4	6	352512
Cucumbers	18	8	104448
Soy Beans	34	5	34560
Alfalfa	1.5	N/a	
Other			
Wine	N/a	N/a	1250
Synsepalum dulcificum	N/a	N/a	1250

Livestock	Yield (kg/animal/year)	Consumption (kg/capita/year)	Animals Needed	Area (m²)
Meat				
Beef (microcow)	190	15	1855	2500
Beef (genetic)	220	15	1602	2125
Chicken	5	32	1540400	46204
Tilapia	2	2	23500	31250
Salmon	25	3	2820	3400
Mutton	120	5	980	1500

Table 4.1.2 Supplies and Consumables (Continued)				
Produce				
Eggs (Chicken)	20	20	23500	705
Milk (Cow)	4500	120	700	950
Cheese	450	20	1050	1425
Clothes	**Number per Colonist**		**Number Needed**	
Tops				
Shirts	8		188000	
Blouses	5		117500	
Bottoms				
Pants	8		188000	
Skirts	5		117500	
Other				
Socks	12		282000 pairs	
Shoes	3		70500 pairs	
Undergarments	12		282000	

within Columbiat to ease the feeling of separation from those outside the colony and to relieve the feeling of being enclosed inside the colony.

4.1.3.1 Long Lines of Sight By providing long lines of sight within the colony, the curvature of the ring will give the perception of a horizon. This psychologically suggests an open area to the colonists which will reduce the feeling of being enclosed.

4.1.3.2 High Ceiling The ceiling will be 150 meters high which will emulate a simulated sky. OLEDs on the ceiling can be used to create a realistic day-night cycle with weather patterns. This illusion will help reduce the feeling of being enclosed within Columbiat.

4.1.3.2.1 Day/Night Cycle Colonists will experience 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 each ring. 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. Also, the/day night cycles of each ring will be different from each other to produce the effect of different "time zones."

4.1.3.2.2 Weather Patterns Colonists will experience an assortment of weather patterns based on the current season. These weather patterns will be used to provide colonists a variety of weather that will break the monotonous nature of an enclosed colony. *Refer to Section 3.2.1*

4.1.3.3 Holo-Room Holo-Room facilities will provide colonists access to a room that will use holographic systems to simulate any environment and will use a colonist's motions as input. Colonists can use this room to experience the outdoors which will help relieve their feeling of being enclosed in. Also, the Holo-Room can be used as an entertainment device through the holographic immersion of a movie or game.

4.1.3.4 Agriculture/Residential Communities One ring of the colony will be zoned for residential and agricultural use. This will provide residential communities in this ring a rural feel. In addition to parks, orchards and other farmland located in the agricultural sector will provide the rural feel and the long lines of sight.

4.1.3.5 Natural View Natural view provided by observatories and the Proj-Windows allow colonists to see outer space via a live camera feed. Being able to see outside the colony on a regular basis allows for increased resistance to feelings of claustrophobia. *Refer to Section 2.0.5*

Architecturally, Columbiat will use space efficient buildings to make up its homes and communities. Buildings are placed closer together to save space. Proj-Windows are utilized to display a view of the colonist choice despite the fact that the closeness of the buildings would normally block any view.

4.2 Architectural Design

4.2.1 Home Design Homes will fall under two categories, houses and apartments. Houses are designed to fit the needs of married adults and their children. Apartments, on the other hand, are more suited for single adults. And apartments and houses will be appropriately designed to meet the needs of these anticipated occupants. *Refer to Figures 4.2.1 through 4.2.4*

4.2.2 Neighborhood Design Neighborhoods are structured with different lifestyles and tastes in mind. As a result, colonists will have a choice of real estate that is suitable for the colonists.

4.2.2.1 Variety A variety of neighborhood choices will be available to colonists so that they can chose the community that best fits their lifestyle.

4.2.2.1.1 Urban The urban neighborhoods on Columbiat will mainly consist of apartments and other multiple story buildings. Despite this, the use of parks and long lines of sight will reduce the feeling of being enclosed by the tall buildings.

4.2.2.1.2 Suburban For suburban neighborhoods, colonists will have additional parks and houses than an urban environment but most buildings will still be multistory. Also, distance between buildings is slightly larger so that the community will experience slightly more roomy to colonists.

4.2.2.1.3 Rural A rural neighborhood will consist entirely of homes. Theses houses will be built with enough space for a yard around each house for personal use. Rural neighborhoods will also have community gardens and orchards where they can grow additional foodstuffs for their own use.

4.2.2.1.4 Low-G For transients and colonists moving from Low-G environments, a special Low-G neighborhood will be built in the Low-G sector. Transients and colonists will reside here until they are acclimated to the gravity of the rest of Columbiat. As a result of Low-G, all buildings here will have high padded ceilings.

4.2.2.2 Locations Each neighborhood type will be spread out across the two residential rings of the colony. The urban and suburban neighborhoods will be located in the pure residential ring while rural neighborhoods will be in the dual-purpose residential-agricultural ring. And the Low-G neighborhood will be placed in the Low-G ring.

4.2.3 Furniture All furniture are designed to be minimalistic so that each room will appear more spacious that it actually is. Despite being minimalistic however, the use of materials will make each piece of furniture comfortable. This combination of a spacious room and comfortable furniture will provide a relaxing environment for colonists.

4.2.3.1 Variety Furniture will be chosen by the colonists so that each home and apartment fits the occupant's needs. Colonists can chose from a wide variety of chairs, sofas, and beds. Instead of traditional tables however, will be completely modular, with each attachment for this Mod-able providing colonists a variety of combinations that can fit any role.

4.2.3.1.1 Mod-able The Mod-able is a table with the ability to switch out attachments and the table surface with the assistance of a pair of roof mounted robotic arm and an attachment storage compartment.

4.2.3.1.2 Proj-Window Due to the cramped nature of a space colony, most windows

Figure 4.2.1
1st Floor of Homes

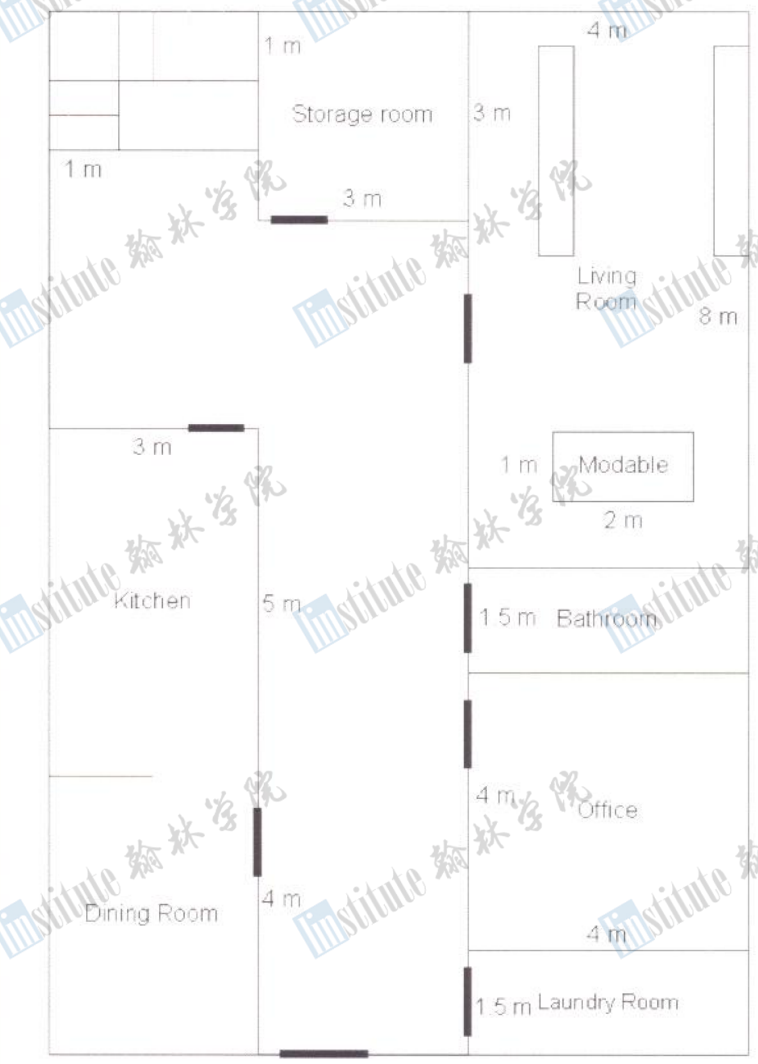


Figure 4.2.1
Apartment Floors

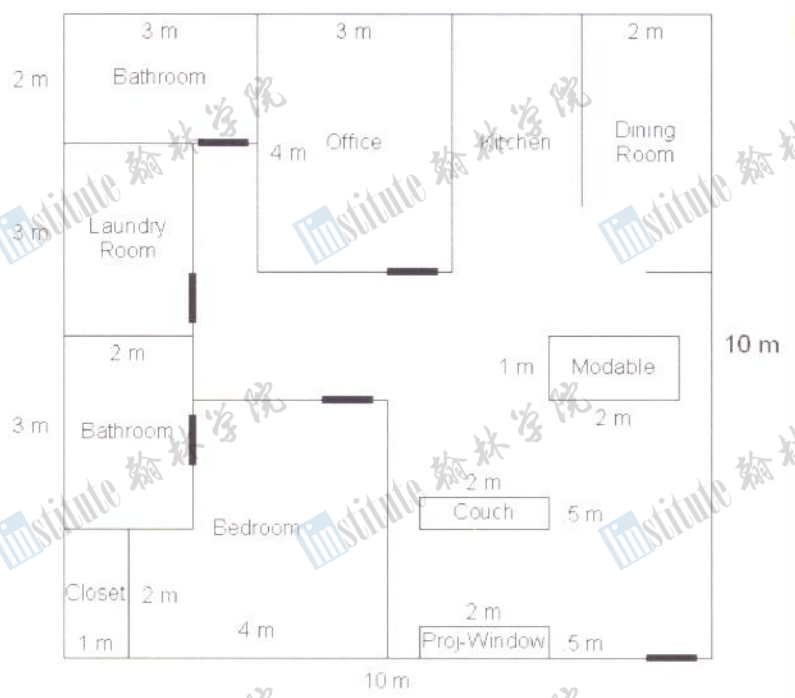


Figure 4.2.2
2nd Floor of Homes

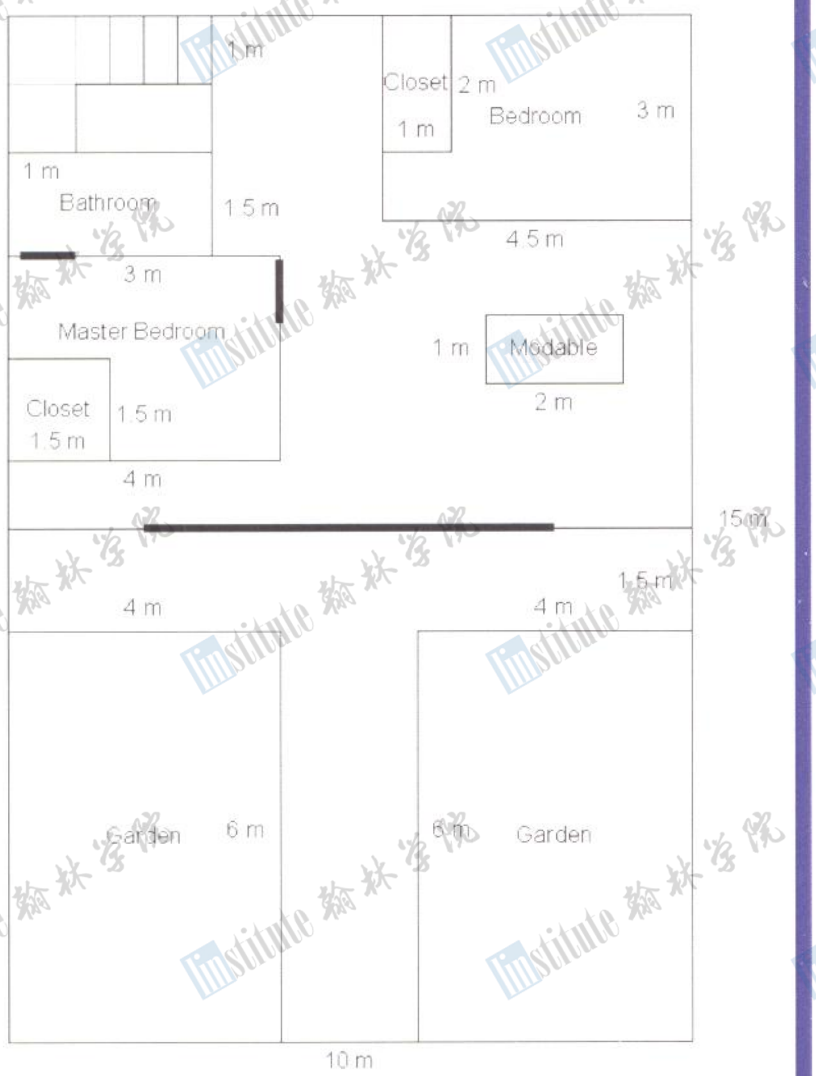


Figure 4.2.4
House Design

cannot provide colonists with a view worth looking at. However, by making these windows televisions fitted inside a window frame, colonists can chose from a series of views to look at in addition to television channels.

4.2.3.2 Sources All furniture will be assembled on Columbiat. In addition, most parts will be constructed within Columbiat's industrial sector with only the technologically complex parts coming from Earth and Bellevistat. Furniture will either be assembled in the industrial sector and brought to the home or built on site with a 3-d printer, depending on complexity of the furniture.

Access to Low-G will be achieved through the passage through an airlock located between regular living space and Low-G areas. Colonists who are adjusting in the Low-G residential areas will not be required to wear the full spacesuits but only the applicable layers for Low-G areas.

4.3 Safe Access to Low-G Environments

4.3.1 Safety Measures The primary safety measure in Low-G areas will be the spacesuit. This spacesuit will have several features that will protect colonists from possible mishaps in Low-G areas.

4.3.1.1 Systems When in Low-G areas, colonists will have their vital signs checked by the spacesuits. If an abnormal reading is obtained, tethers guns on an nearby wall will fire to bring the colonist to safety for a more through health inspection.

4.3.1.2 Devices A special pack will be worn by colonists when in Low-G areas. This pack will hold tethers and a pair of small tether guns which will provide a quick way of securing colonists to a surface while still maintaining use of their hands. Also, the gecko feet can be activated in the boots via a small electrical charge. *Refer to Figure 4.3.1.2*

4.3.1.3 Vehicles In terms of vehicles, a SkyTran train system separate from the one used in the main residential and commercial rings will run provide rapid transport of both colonists and cargo around the Low-G areas. *Refer to Section 3.2.8*

4.3.2 Access to Low-G, Interior of Hull, and Exterior of Hull The safety of colonists are assured through the use of various systems and devices designed to keep them safe while not over-encumbering them.

4.3.2.1 Low-G To access Low-G areas, colonists will have to go through an airlock where they will don spacesuits that will protect the them from possible mishaps and accidents. They will use the devices built

Figure 4.3.1.2 Tether Gun

into the spacesuit to to get around and work with their hands free. *Refer to Section 4.4*

4.3.2.2 Interior of Hull For travel within the interior of the hull, colonists can walk, ride a bike or the skytran. To travel between rings, colonists will use a corridor connecting the rings so that they can either walk or bike to another ring.

4.3.2.3 Exterior of Hull When accessing the outside hull surface, colonists will go through service airlocks. They will climb out of the airlock and use a combination of tethers and other low-g devices built into the spacesuit to get around and to attach themselves to the hull. To protect colonists while they are working outside settlement volumes, colonists will be required to use airlocks to exit the main settlement volumes. Inside these airlocks, they are required to don a spacesuit that will provide the counterpressure in unpressurized areas and the safety systems in Low-G areas.

Figure 4.4.1
Depiction of Spacesuit

4.4 Spacesuit and Airlock

4.4.1 Spacesuit Spacesuits will consist of layers of materials that will be sprayed on a full body base layer. Air tanks and other life support systems will be woven into the spacesuit layers. *Refer to Figure 4.4.1*

4.4.1.1 Storage Spacesuit layers will be stored in canisters. This provides an easy medium for the spraying system to use. These canisters will be stored in a storage space next to each airlock.

4.4.1.2 Use Spacesuits will be required every single time a colonist enters a low-G or unpressurized area. Spacesuits and the use of Low-G safety devices will protect colonists from potential danger.

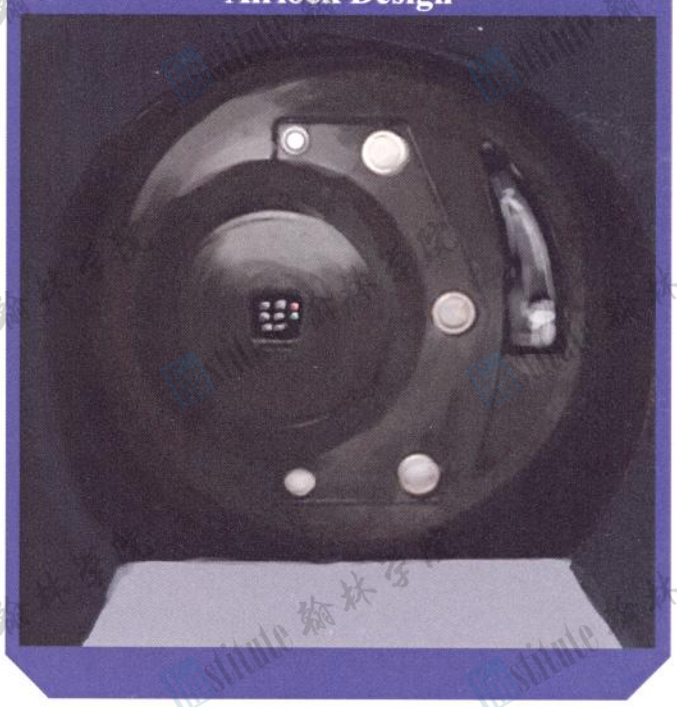
4.4.1.2.1 Donning To don a spacesuit, the base layer will be put on by the colonists. Then each layer of the spacesuit will be sprayed on by a spraying system.

4.4.1.2.2 Doffing To doff a spacesuit, an electric charge will loosen the first sprayed-on layer while air is injected to separate it from the base. This allows all the layers save the fully body base layer to be quickly removed.

4.4.1.2.3 Recycling To recycle the spacesuit, the doffed layers will be melted down and filtered back into its base parts which will be used to replenish the canisters that each layer will be stored in.

4.4.2 Airlock Design Airlocks will be located between all pressurized and unpressurized areas to facilitate access. Also, airlocks will be placed in major points of intersection with the colony so that each section can be sealed quickly with the closing of the airlocks. Another feature is that each airlock will be used in tandem with another nearby airlock. This allows passage in both directions with minimal waiting time. *Refer to Figure 4.4.2*

Figure 4.4.2
Airlock Design



4.4.2.1 Operation Most airlocks will be kept pressurized and open. However the pairs of airlocks that will be used for any travel between pressurized and unpressurized areas will have one of the two kept pressurized and the other unpressurized at opposite points in the operation cycle.

4.4.2.2 Reducing Air Loss Air loss will be reduced by having air from one airlock being recycled to the paired airlock. This cycling will prevent unnecessary air loss from individual air cycles. To protect the colony from outside space dust and other debris, a filtering system will be used to clear the air in during each cycle.

To ensure the wellbeing of the population, all colonists will be taken of, including transients. Security will also be provided so that all colonists will be safe while on Columbiat.

4.5 Visitor Accommodations and Security

4.5.1 Hotels Each hotel will serve both the transient population as well as visiting businesspeople. As a result, hotels will be designed to serve their needs.

4.5.1.1 Location Hotels will be located in both the commercial and Low-G sectors. The commercial sector hotels will serve businesspeople and transients who are used to an environment with gravity. For transients who are from Low-G environments, they will stay in Low-G hotels until they acclimate or leave.

4.5.1.2 Design Hotels will be architecturally structured like the surrounding buildings. However, they will have the same comfort level of a standard home on Columbiat through the use of the same furniture and other design elements used in the houses and apartments.

4.5.2 Security Security within Columbiat will mainly be done via automated systems and robots. Human security forces will be impractical for the population size. The main purpose of security is to ensure that everyone gets along, especially between transients and permanent residents.

4.5.2.1 Unobtrusive Surveillance The main method of surveillance is through cameras and microphones. These items will be hidden in both the walls and security robots who will be stationed in popular areas for transients.

4.5.2.2 No Interference to Residents Cameras will be hidden from colonists by having them embedded in the walls and ceiling. Also all security robots and systems will have a low profile and only openly engage when necessary to stop a fight.

4.5.3 Medical Quarantine Medical quarantine will be required when an unknown disease is detected through the constant tracking of colonist health by the Fuki which has a health monitoring component. Another case where a quarantine is required when the signs of an infectious disease known to cause a pandemic appear in a colonist.

4.5.3.1 Operation To quarantine any effected colonists, affected sectors will be sealed and the air filtered while doctors attempt to identify and/or treat the disease. During this time, colonists will be constantly monitored for any changes in their vital signs. The quarantine will end when doctors give the all clear. However, all individuals involved will be kept under close observation through their Fuki in case of emergencies. *Refer to Table 4.5.3*

Table 4.5.3 Medical Quarantine Procedure

Action	Time From Start Of Quarantine
Seal airlocks	1 second
Eleveate air filtration systemspeed to maximum	10 seconds
Identify and locate affected individuals	1 minute
Isolate affected individuals and those they were with into two groups	3 minutes
Begin through monitoring of all individuals	3 minutes
Insert spacesuit-clad doctors via airlock	10 minutes
Attempt diagnosis of disease	15 minutes
Identify unaffected individuals	25 minutes
Begin best treatment option	25 minutes
Escort unaffected individuals to secondary quarantine	30 minutes
Release unaffected individuals if no health problem arises	45 minutes
Release individuals who have been in contact with affected individuals if no health problem arises	50 minutes
Escort remaining individuals to a hospital quarantine ward.	1 hour
Reopen sealed areas	4 hours
Return air filtration system to regular speed	12 hours

5.0 Automation Design and Services

5.0.1 Computer Specifications

Refer to Table 5.0.1.

5.0.1.1 FPGA Intelligent Adaptation In conjunction with the DPS, FPGA blocks complement each computer's main processor for speedy program execution with lower processing loads. As every application repeat certain segments of code frequently, FPGA blocks accordingly reconfigure to reflect these portions, allowing CPUs or the DPS to handle other code segments while instantaneously executing those functions. On the start of familiar applications, this intelligent adaption activates; as for new applications, the OS tracks which portions are commonly used, compiles a FPGA profile for it, and updates surrounding computers with the information. Hence, both software and hardware work in conjunction to adapt to different software environments.

Table 5.0.1 Computer Specifications

Name	Quantity	Dimensions (LxWxH in meters)	Specifications
Fuki	25,000	Dependent on wearer	1,024 core MBA CPU, $4.0x10^8$ logic blocks FPGA APU, 16GB flash, heliodisplay; wireless, infrared, laser, electrodes, and temperature sensors; powered by thermoelectric and solar generators w/ gas-turbine engine; used for mobile computing, identity verification, and HMS; worn on arms
Hien	15,000	0.2x0.2x0.1m	4,096 core MBA CPU, $4.0x10^{10}$ logic blocks FPGA APU, 10PB NRAM; used in homes *(Refer to Section 4.2.3 for details)*
Rippou	10,000	0.5x0.5x1.0m	1024 thz quantum-based CPU, 328 PB holographic storage; used for general purpose activities

*Note: ABP – Asynchronous Based Processor; APU – Auxiliary Processing Unit; FPGA – Field Programmable Gate Array; MBA – Mesh-Based Architecture (Each MBA core runs at 1 ghz)

5.0.1.2 Software Specifications To provide users with customized preferences, each computer is loaded with an UNIX-based Web Operating System and a plethora of open-source application suites (ex. communication, file manipulation, media editing, office, etc.). On start-up, after verifying the user's identity through Fuki's blood-vein detection, the OS accesses the user's virtual account and loads his or her software configurations (ex. GUI system and input system) and previous session; on each log-off, the OS accordingly updates the virtual account. In addition, it's low-level integrated network layer interfaces with the Distributed System to not only ensure efficient distribution of software and processing but also quick access and process of data. Applications are loaded locally instead of over the network to conserve bandwidth. *(Refer to Section 5.0.2 for more information on online accounts and Section 5.0.3.3 for Distributed Systems)*

5.0.2 User Accounts Upon arrival to Columbiat, each inhabitant, including guests, is provided with a virtual account, which tracks online currency, user location, automation systems access levels, and other data. More importantly, these accounts also store personal computer files, system preferences, and data sessions to provide conveniences and familiarity whenever a person logs on a computer. Through the DDFS and hardware-key-based encryption, account data is securely stored all over the colony's computers. All this data is safely stored in Upon arrival to Columbiat, each inhabitant, including guests, is provided with a virtual account, which tracks online currency, user location, and other relevant data along with access levels to automation systems. Most importantly, these accounts also store personal computer files, system preferences, and data sessions that provides certain conveniences as any person can log in to their individual setups on any colonial computer. The data within these accounts are stored in various computers through the use of the DDFS. *(Refer to Table 5.0.2 for User Account Hieararchy and Identification Security Measures)*

5.0.2.1.1 Identification Security Measures Since each person's blood vessels are exclusive to himself or herself, it is used as a secure verification method in Columbiat. Through the Fuki's infrared sensor, every user's

arm veins are scanned, which ensures their identity at every given moment without any cost of convenience; in the case an user attempts to 'steal' an identity by obtaining someone else's Fuki, the Fuki has a built-in mechanism that automatically rescans the wearers veins and accordingly switch back to that person's account. However, for higher echelon accounts, 3D face scans and retinal scans are implemented to ensure absolute verification.

5.0.2.1.2 Privacy and Security of Account Data By storing data into the DDFS, security measures are already taken since files are spread throughout the colony, making it nearly impossible to track down files. Keeping in mind unforeseen events, data are additionally encrypted by biometric means, particularly the user's blood veins; thus, privacy of account data is ensured as the user's Fuki must correspond with the data's biometric encryption code. For highly critical files, such as business or administration, software-based encryption, quantum encryption, or a combination is offered to provide the highest level of security possible.

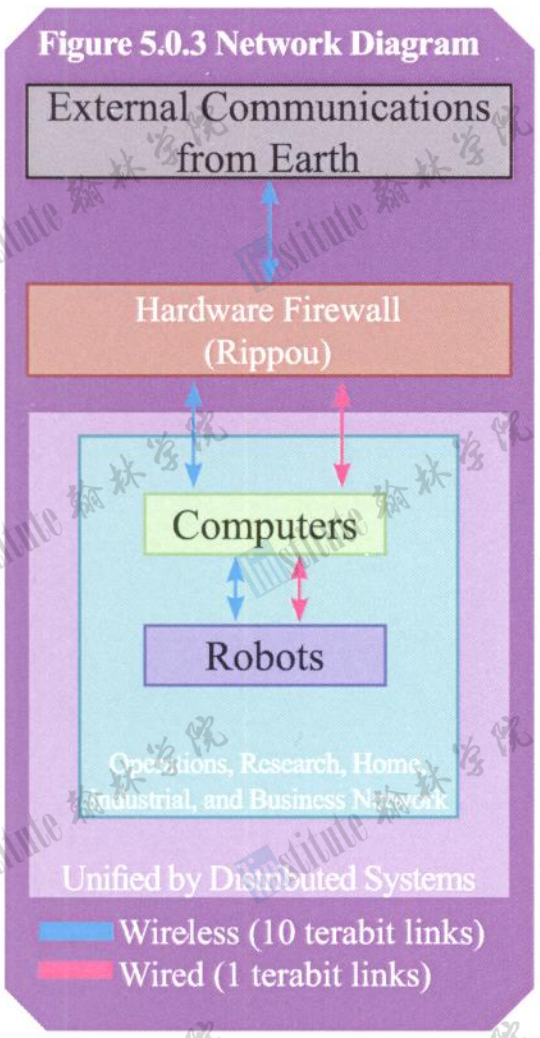
Table 5.0.2 User Account Hierarchy

Account Type	Privileges	Verification
Guest	Temporary account that requires renewal every month; access to public domains	Fuki
Resident	Permanent account; access to public, residential, and job-related domains	Fuki
Business	Confidential account; access to public and business-related domains (access to residential if resident of Columbiat)	Fuki, 3D Face Scans
Admin	Administrator account; access to different domains, dependent on admin type (access to residential if resident of Columbiat)	Fuki, 3D Face Scans, Retinal Scans

5.0.3 Network Specifications *Refer to Figure 5.0.3*

5.0.3.1 Hardware Specifications Due to the heavy bandwidth usage from the Distributed Systems, Columbiat's network is powered by ten-terabit wired Ethernet networks and 802.EE compliant terabit wireless networks operating in the high-frequency range of the electromagnetic spectrum. For security reasons, several Rippous are allocated to the sole task of acting as firewalls while logging and encrypting all network activities.

Figure 5.0.3 Network Diagram



5.0.3.2 Infrastructure Specifications

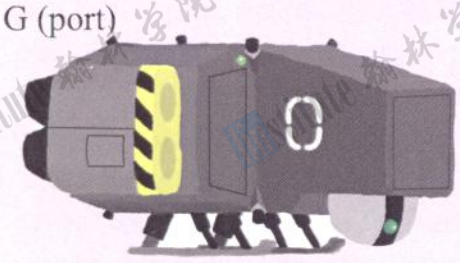
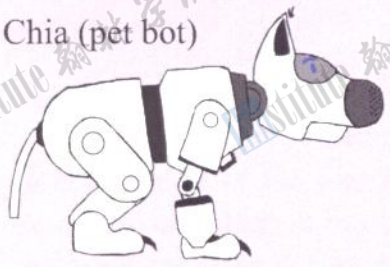
5.0.3.2.1 Distributed Data Filing System (DDFS) To power an online-based computing system while providing backup, data in the colony is disseminated throughout all storage units in the colony. Each individual file is constantly replicated and proliferated on various computers, minimum of three; the amount of duplication and range of spread is determined by the frequency of file access and quantity of users with the same files. In addition, every virtual account stores an index of pointers to aid the OS in quickly scouring the network for the correct physical unit to access and obtain files; in the case of possible deletion of this index, each storage unit is complete with a customized boot sector that contains an index of its stored data, which can be used to rebuild account indexes.

5.0.3.2.1.1 Distributed Version Control System (DVCS) In the case of file changes or deletions, the DVCS accordingly updates the DDFS. When a file is altered, the new file is appropriately branched off from the original and marked as a subset of it within the DDFS; if the original file is no longer accessed, the DVCS signals the DDFS to delete all the original files. In the case a file is deleted, the DVCS first checks to see if the same file is existent in other user's accounts; if not, it is then marked for deletion in the DDFS.

5.0.3.2.2 Distributed Processing System (DPS) For efficient utilization and spread of processing power, a network-wide grid-computing system aka DPS is implemented. When computers are charged with tasks requiring immense computing powers for a speedy execution, the OS immediately determines the estimated time of completion without DPS and with DPS and a relative index number, ranging from 1 to 5 with the highest number representing the biggest impact the task has on user productivity. If the time of completion is at least 40% lower with DPS and the index number is above a 3, the computer sends out processing requests to other computers

Table 5.0.4 Robot Specifications

Name		Quantity	Dimensions (LxWxH in meters)	Features
Shodo base 	Shodo-nou (agricultural) 	Shodo: 400 Shodo-nou: 250 Shodo-ko: 100	Shodo: 0.5x0.8x0.3m Shodo-nou: 0.5x0.8x0.6m Shodo-ko: 0.5x0.8x0.5m	Shodo-nou: baskets, scythes, ethylene sensors, wheel-to-raft converter Shodo-ko: claw-based arms, lights, tasers
	Shodo-ko (livestock) 			
Gurren base 	DaiGurren-Lagann (construction) 	Gurren: 600 DaiGurren-Lagann: 350 Gurren-Lagann: 200	Gurren: 2.0x2.0x3.0m DaiGurren-Lagann: 2.0x2.0x3.5m Gurren-Lagann: 2.0x2.0x3.0m	Gurren: gecko feet, welder, visual sensors DaiGurren-Lagann: laser cutter, bolter, claws, plasma-magnetic propulsion thrusters, drill Gurren-Lagann: Multimeter, arm attachment integrated with pincers, grippers, claws, and repair tools
	Gurren-Lagann (maintenance) 			
RFP [Rapid Formation Prototyper] (mass production and rapid prototyping)		100		3D printer, selective laser sinister, fused deposition modeling, stereolithography apparatus, electronic beam melter, spray nozzle
RFP-E [Rapid Formation Prototyper-Extended] (internal construction)		100		3D printer, selective laser sinister, fused deposition modeling, stereolithography apparatus, electronic beam melter, spray nozzle, wheels

Ten base  Ten-gu (security)  Ten-chi (janitorial) 	Ten: 450 Ten-gu: 200 Ten-chi: 200	Ten: 0.5x0.6x0.8m Ten-gu: 0.5x0.6x0.9m Ten-chi: 0.5x0.8x0.8m	Ten: Nozzle w/ internal nozzle cargo, tweels Ten-gu: Nozzle cargo filled with fire-retardant foam and tear gas, DNA sequencer to aid in virtually reconstructing possible suspect faces, tasers, speakers Ten-chi: Nozzle cargo filled with fire-retardant foam and nanobots, vacuum wheels, mops
G (port) 	100	3.0x8.0x5.0m	Thrusters, auto-pilot link w/ oncoming ships, maglev links
HD [Heavy Duty] (cargo) 	100	6.0x6.0x6.0m	Forklift-based claws, cameras, RFID tag reader, high-traction treads, cargo bay, maglev links
Chia (pet bot) 	10,000	0.3x0.4x0.3m	3D laser scanner (human gesture tracking), cameras, claws, emotion sensing capabilities, foot vacuum, taser, voice recognition
EVE (education) 	50	0.5m radius x 0.2m height	3D laser scanner (human gesture tracking), cameras emotion sensing capabilities, holographic imager
MedEx (medical) 	100	0.5x0.7x1.0m	Photothermal optical coherence tomography for in-depth human tissue visual, defibrillator, appendages w/ microneedles connected to kit with painkillers, antiseptics, artifical blood, and spray on skin

in the network; the distribution of requests is dependent on the proximity of computers and processing power usage of computers. After computers receive and process the data, it is re-uploaded to the original requester.

5.0.3.2.3 Distributed Sensory Grid (DSG) With the omnipresence of sensors in homes, robots, and other automations, certain automations can access these sensors through the DSG. By obtaining real-time information, systems can accordingly adjust and accommodate for present situations. As an example, consider a possible outbreak of fire. Through the DSG, Ten-Gu in the proximities are alerted of the fire, immediately reacting and putting out the flames. Thanks to the DSG, every automations is capable of being aware of real-time changes.

5.0.4 Robot Specifications *Refer to Table 5.0.4*

5.0.4.1 Robot Features and Designs All robots have a uniform shell composition, energy source, and modularity functions. The shell of each robot is first cast in a polymer-coated nickel titanium shell, which offers the benefits of a self-repairing coating and fast deformation recovery by heating, thanks to memory metal properties. Underneath this shell lies layers of monomer-filled microcapule embedded epoxy for instant self-repair, carbon nanotubes that helps pinpoint damage, Demron for radiation protection, and Aerogel that provides cushioning. To lower costs, robots are powered by tritium batteries that provide high levels of electricity through the conversion of the decay of tritium; due to subsequent lowered output, they are replaced every twenty years. At the same time, certain robots have bayonet grip mechanisms for part modularity; through easy attach-twist-pull movements, robots can easily obtain new functions while conserving resources. Finally, as a precaution against solar flare induced malfunctions, radiation-resistant VMRAM and radiation-hardened hardware is installed in all robots, allowing functionality in times of danger.

5.0.5 Locations and Sizes of Facilities Each ring of the colony is home to at least ten strategically placed 30x30m repair and maintenance facilities and ten 30x30m storage warehouses. Facilities function as a headquarter for nearby robots to check-in every 24 hours for maintenance and repair while also acting as a launching pad for robots in times of emergencies. Warehouses are kept at optimum levels of humidity and temperature through automated systems. Within the warehouse, Sapphire-based sprinkler systems and Ten-gu robots are active to extinguish exigencies. During times of solar flare, it acts as a haven for automations due to its Demron internal layering. In addition, the underground transportation corridor allows robots to move throughout the colony unintrusively while reducing traffic flow; through a RFID tag system, robots are easily tracked.

5.1 Automation of Construction Processes

5.1.1 Transportation and Delivery of Materials As ships arrive to the building site with the aid of G robots, cargo is offloaded into temporary warehouses located in the ports and axles; these items are subjected to the same process described in Section 5.4.1. A temporary system built for the construction sequence tracks flow of materials to and from different building sites, automatically signalling nearby HD robots to deliver needed materials from warehouses. This automated system ensures constant productivity and quick assembly of the colony.

5.1.2 Settlement Assembly For the majority of the construction phase, DaiGurren-Lagann robots provide the labor in welding together pre-fabricated parts and mining the moon for resources while RFP robots create construction materials from mined objects. *Refer to Section 2.4 for more details on the construction process.*

5.1.3 Interior Finishing Instead of part-based construction, the interior structures are created through a large-scale version of 3D printing. Essentially, RFP-E units 'print' out the foundations of buildings layer by layer from the materials provided. After completion, Gurren-Lagann robots add the finishing touches by installing electrical wiring, plumbing, furnitures, and other appliances.

5.2 Facility Automation

5.2.1 Settlement Maintenance and Repair The physical bulk of the maintenance and repair routines are handled by the Gurren-Lagann (handles all repair functions) and Ten-Chi (handles all cleaning and inspection duties). Through the DSG, a computer system is constantly informed of data, such as pressure, load levels, and etc., on vital utilities and areas. It analyzes the information to determine whether or not some areas need maintenance, or to quickly deploy robots to prevent current or future exigencies. In addition, the system tracks and logs these operations to ensure efficient distribution and timing of robots in areas. When absolutely necessary, technicians

are summoned to solve complications.

5.2.2 Settlement Safety In times of contingencies or dangerous situations, robots are the primary forces of strength due to their autonomy, extendability, and ruggedness. At the same time, colonists are constantly informed of present and future threats through their Fuki or Hien units by messages or surrounding robots by speakers.

5.2.2.1 Backup Systems Vital automation systems are directly wired to emergency generators to ensure full functionality in the case of any exigencies. At the same time, robots are capable of individual operation due to battery-powered energy; in the case of robot, or hardware losses and breakdowns, new replacements are readily deployable from surround warehouses. In regards to data backup, the DDFS duplicates and proliferates copies of files to other computers, automatically ensuring redundancy and prevention of loss of one file with less financial burden.

5.2.2.2 Contingency Plans *Refer to Table 5.2.2.2*

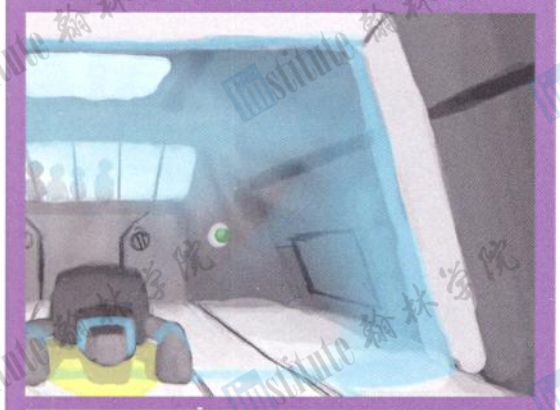
5.2.2.3 Physical Security Measures In addition to the physical force provided by Ten-gu units, wide-angle multispectral cameras with embedded multiple lens (numbering 300) are placed in strategic locations throughout the colony. Due to the sheer number of lens in cameras, a high-resolution aerial and internal view of the colony are available at all times, providing security relatively-easy and wide surveillance.

5.2.2.4 Solar Flare Contingencies In times of

Table 5.2.2.2 Contingency Plans

Contingency	First Response	Second Response	Initial Response Completion Time
Foreign Object Collisions	Analyze data from DSG to calculate extent of damage. If critical, move on to second response.	Deploy Dai-gurren and Gurren-lagann to fix.	~10 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	Alert colonists through robots and computers. Deploy Ten-gu and Ten-chi.	Analyze situation, and send out more robots if necessary.	~2 minutes
External Communication Failure	Probe for source of failure and repair. Keep communication attempts alive.	If repairable, inform authorities while experimenting with different solutions.	~10 minutes
Attempted Cyber Breach	Halt all unnecessary communication. Locate attacker(s) by tracing and blocking address ranges on routers.	After analysis of breach, implement appropriate countermeasures to prevent new attacks. Resume communication.	~1 minutes
Attempted Security Breach	Direct Ten-Gu and human personal to apprehend intruder(s). If resistant, disable attacker(s).	If intruder(s) have escaped, initiate lockdown and scour area for hinting abnormalities.	~10 minutes
Chemical Leak	Alert affected vicinity through robots and computers If necessary, lock down area and evacuate.	Deploy medical personnel and MedEx for immediate treatment. Clean areas with human-directed Ten-chi. Assess damage and act accordingly to prevent future leaks.	~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 computers. Keep alert for outbreaks.	~3 hours
Solar Flare	*Refer to Section 5.2.2.4*		

Figure 5.2.4.2
Electrostatic Dust-Removal



To combat space dust, external vehicles and robots are sent to maintenance facilities equipped with electrically-charged walls. Seen in the picture above, the walls exert a controlled electrostatic field (light-blue field) that attracts all of the charged dust particles. To ensure complete cleaning, automations are subjected to the field multiple times.

solar flares, all robots enter a special "solar flare" mode in which non-vital robots rush toward storage and maintenance facilities; these facilities act as a shelter against solar flares due to multiple levels of radiation shielding materials. Critical and necessary processes continued throughou the solar flare. Immediately after, in conjunction with the DSG, robots are sent throughout the colony to expedite repairs and damage assessment.

5.2.3 Access to Critical Functions Only admins are allowed to access critical functions. *Refer to Table 5.0.2 for details on verification.*

5.2.4 External and Foreign Robot Maintenance *Refer to subsections below.*

5.2.4.1 Maintenance and Repair Robots from visiting ships are transferred to nearby maintenance facilities for quick dust-offs and tune-ups. After loading specifications and blueprints of foreign robots, Gurren-lagann units immediately assess robots for possible chassis or internal damage and attempt to fix arising problems. In the case of unrepairable damage, replacement robots are provided. With the completion of a check-up, robots are stored in facilities then transferred back to ships right before take-off.

5.2.4.2 Dust Control *Refer to Figure 5.2.4.2.*

5.3 Habitability and Community Automation

5.3.1 Community Livability Enhancements Necessary community livability tasks are automated by a diversity of robots. Through the Shodo-nou and Shodo-ko, plants and animals are cultivated without the need of human labor, allowing the colonists to focus on important tasks. For the industrial sector, RFP units provide instant prototyping and immediate mass production that allows the community to become self-sustainable. Other robots offer other services, such as education (EVE), medical (MedEx), security (Ten-gu), and janitorial (Ten-chi). In addition, automated systems overlook and maintain these robots to maintain high living standards.

5.3.1.1 Health Monitoring System (HMS) Through an aggregate of Fukis and bathrooms, the HMS overlooks the physical conditions of every colonist. Fuki's integrated sensors, consisting of electrodes, infrared, laser, and temperature, provide importantly medical data, particularly heart rate, oxygen saturation, respiratory rate, blood pressure, and body temperature. Bathroom appliances, such as weight scales and toilets, provide measurements of weight changes and analyze excretions for possible abnormalities. These data are actively stored in Fuki and backed up to the user's virtual accounts. From this data, specific 3D-medical avatars are created for doctors to use during diagnosis. In addition, constant monitoring for drastic changes in data prompts notification to users for doctor visits to prevent possible diseases.

5.3.2 Productivity Enhancements By implementing a Web-based account system, citizens have the convenience of easily switching to their familiar work environments by simply logging onto any computer. At the same time, all their files are accessible, allowing them to complete tasks anywhere and at any time. In addition, the ability to voice or gesture commands leave users with a feeling of activity and satisfaction. The widespread usage of robots for manual labor also allows workers to focus only on their productivity.

5.3.3 Residential Convenience *Refer to Section 5.3.3.1.*

5.3.3.1 Smart Home System With houses coming complete with a plethora of electronic equipment, residents have the ability to control appliances or customize their preferences and functions through the Smart Home System. In addition, the system allows users to schedule robot-based services, such as cleaning or neighborhood surveillance. Other services provided include automatic delivery and shipment of goods, easy recycling and trashing, automatic shut-off of non-used devices, and more. These options are all accessible from each resident's web account.

5.3.4 Control and Access of Systems Each system is specifically designated to certain accounts, particularly administrators. Only common and public systems, such as Smart Home, are accessible to the public. *Refer to Table 5.0.2 for more details*

5.4 Business Automation

5.4.1 Cargo Handling Systems

Refer to Figure 5.4.1

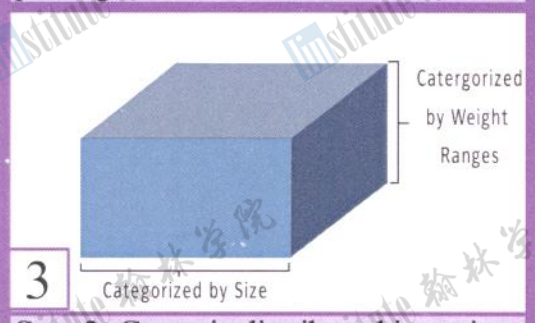
5.4.1.1 Inventory Management After every 3D scan, the scanned object's image and physical profile are stored into both an automated database and RFID tags that are attached onto each of the same object. With each warehouse embedded with RFID sensors, a live-inventory system is in effect, constantly updating the database with the location and quantity of items. Thus, it is simple a matter of looking up an object in the database to quickly know its position, specification, and quantity.

5.4.2. Transfer of Materials between Foreign and Native Vehicles Materials between foreign and native vehicles are transferred in an easy fashion. On arrival, HD robots simply arrive and unload transfer items onto its cargo bay through their appendages. It moves on to Columbiat vehicles and dispense the items into the vehicles. For transfer between native and foreign vehicles, the same process is repeated except in a backward manner.

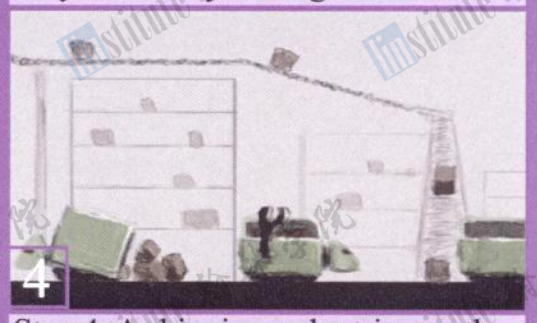
Figure 5.4.1 Cargo Handling

Step 1: After loading cargo from ports through claws and traveling on maglev rales, HD robots tip out their packages at the nearest warehouse.

Step 2: Cargo is 3D-scanned to determine physical specifications and then tagged by RFID tags for easy inventory management.



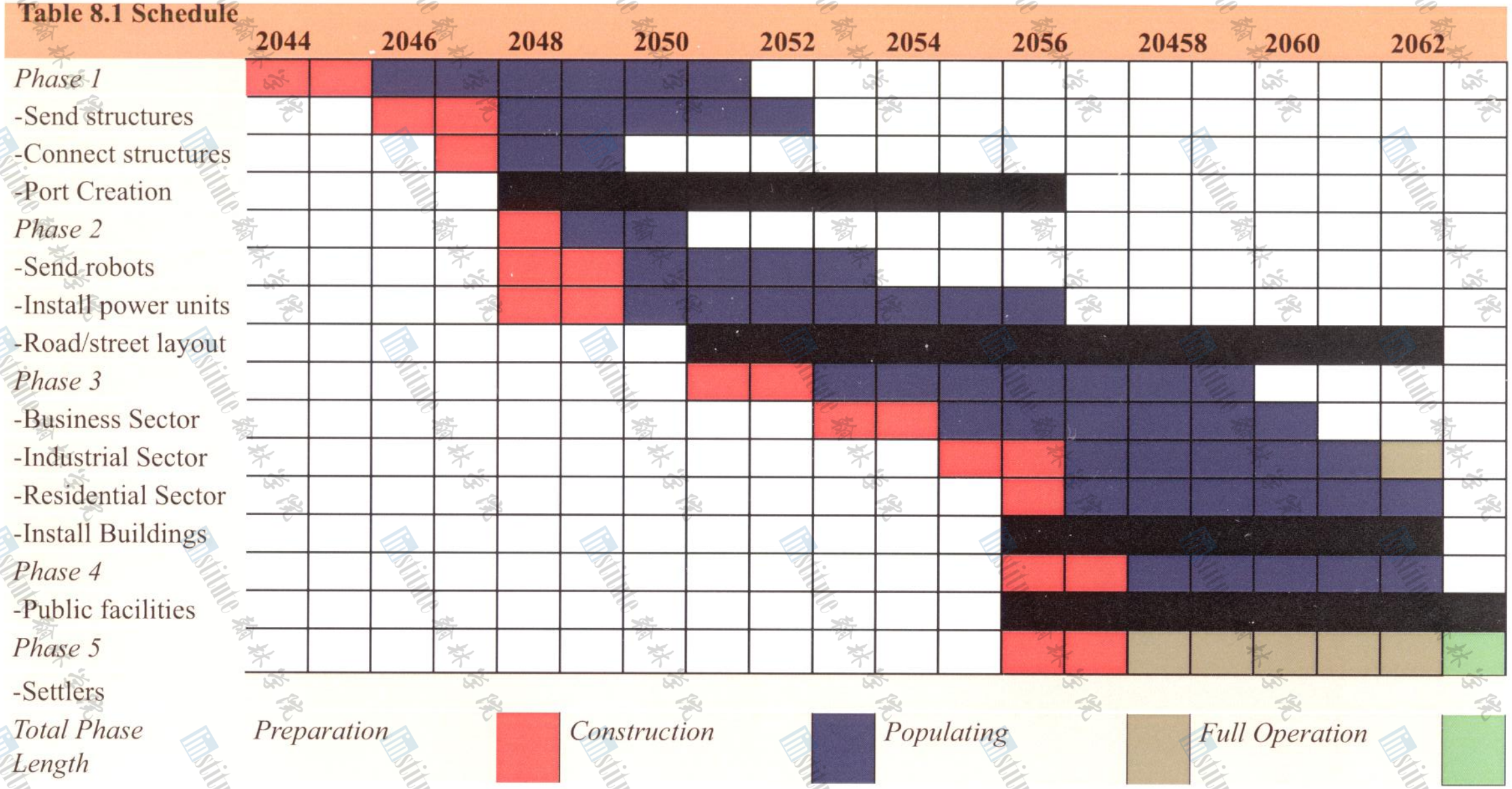
Step 3: Cargo is distributed into either temporary or permanent storage, where they are further sorted by size and weight. As seen above, similar sizes stay in one set of racks, which is divided further by weight.



Step 4: A shipping order triggers the warehouse system to eject requested items from their respective racks down a series of rollers. All of the order eventually trickle down to waiting HD robots. After HD robots confirm the presence of all items in the order through RFID readers, it immediately drives off to drop off the order at the designated location.

6.1 Scheduling

Table 8.1 Schedule



6.2 Costs

6.2.1 Total Costs

6.2.1.1 Construction Expenses

Table 6.2.1.1 Construction Expenses

Construction Expense	Cost
Construction Costs	
- Costs of Total Construction Sequence (including assembly and transportation)	$400 BILLION
- Raw Materials	$160.5 BILLION
TOTAL:	***$560.5 BILLION***
Commercial Costs	
- Automation Costs	$25 MILLION
- Personnel Costs	$10 BILLION
-Space Vehicle Costs	$200 BILLION
TOTAL:	***$235 BILLION***

TOTAL CONSTRUCTION COST (18 Years): $795.5 BILLION

6.2.1.2 Revenue

Table 6.2.1.2 Revenue

Profits of Revenue	Cost
Services	
-Fuel Station	$200 MILLION
-Maintenance and Docking Bay	$225 MILLION
-Lodging	$200 MILLION
-Tourism	$250 MILLION
Industrial	
-Manufacturing	$10 BILLION
-Mining	$25 BILLION
-Storage	$90 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
Steel	$5,000.00	16548491.46	$120,000,000,000.00
Water	$2,000.00	36000000	$100,000,000,000.00
Ferromagnetic Liquid	$15,000.00	5,652,510.583	$120,000,000,000.00
Cement	$7,000.00	61,496,676.23	$620,000,000,000.00
Nanolayered plastic	$10,000.00	28,274,333.88	$410,000,000,000.00

SUBTOTAL: $1,370 BILLION

6.2.2.2 Automation Costs

Table 6.2.2.2 Automation Costs

Automation Devices	Assembly Cost	Number	Total Cost
Robots			
Chia (pet bot)	$90,000.00	10000	$900,000,000.00
EVE (Education)	$100,000.00	50	$5,000,000.00
G (Port)	$600,000.00	100	$60,000,000.00
Gurren Base	$600,000.00	350	$210,000,000.00
Gurren Base	$300,000.00	200	$60,000,000.00
Dai Gurren-Lagann (construction)			
Gurren Base	$300,000.00	200	$60,000,000.00
Gurren-Lagann (maintenance)			
HD [Heavy Duty] (cargo)	$200,500.00	100	$200,500,000.00
MedEx (medical)	$700,000.00	100	$70,000,000.00
RFP	$600,250.00	100	$60,025,000.00
RFP-E	$600,700.00	100	$60,070,000.00
Shodo Base	$50,000.00	400	$20,000,000.00
Shodo-nou (agricultural)	$20,000.00	250	$5,000,000.00
Shodo-ko (livestock)	$20,000.00	100	$2,000,000.00
Ten Base	$100,000.00	450	$45,000,000.00
Ten-gu (security)	$120,000.00	200	$24,000,000.00
Ten-chi (janitorial)	$120,000.00	200	$24,000,000.00

SUBTOTAL: $1,805,595,000

6.2.2.3 Personnel Costs (18 Years)

Table 6.2.2.3 Personnel Costs

Jobs	Annual Salary	Number	Total Cost
Architects	$180,000 - $200,000	200	$38 MILLION
Businessmen	$130,000 - $150,000	400	$56 MILLION
Engineers (all types)	$250,000 - $300,000	360	$97.2 MILLION
Electricians	$220,000 - $240,000	400	$92 MILLION
Pilots	$200,000 - $220,000	250	$52.5 MILLION
Scientist	$230,000 - $270,000	450	$112.5 MILLION
Technicians/Supervisors	$180,000 - $210,000	400	$38 MILLION
Miscellaneous	----------	----------	$7 MILLION

SUBTOTAL: $493.2 MILLION

6.2.2.4 Space Vehicle Costs

Table 8.2.2.4 Space Vehicle Costs

Vehicles	Assembly Cost	Number	Total Cost
Bor	$1 BILLION	20	$20 BILLION
Kynes	$3 BILLION	30	$90 BILLION
Magus	$2 BILLION	10	$20 BILLION
Mare	$5 BILLION	30	$150 BILLION
Rifter	$4 BILLION	20	$80 BILLION

SUBTOTAL: $360 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 - Send structures	$30 BILLION
- Connect Structures	$20 BILLION
- Port Creation	$20 BILLION
Phase Two - Send robots	$2 BILLION
- Install power units	$10 BILLION
- Road/street layout	$25 BILLION
Phase Three - Business Sector	$35 BILLION
- Industrial Sector	$27 BILLION
- Residential Sector	$25 BILLION
Phase Four - Public Facilities	$40 BILLION
Phase Five - Settlers	$80 BILLION

SUBTOTAL: $314 BILLION

7.0 Business Development

Acting as a second home for many settlers, Columbiat would provide all of the equipments necessary for building an environment similar to that of Earth. To further accommodate the people's everyday lifestyles, cargo ships, medicine and office facilities, banks, fueling services, and tourist attractions would be built for the people. Through this, the Foundation Society can be assured that the settlers would not feel any sense of homesickness, nor treat it as a work place, but to live in it as if it is their home on Earth. This would also help in increasing the number of tourists coming each year to stay for a longer period of time. The cost for a one-way ticket would be approximately $500,000, in addition to the cost for hotels and food.

7.0.1 Commercial and Industrial Venture Designs Because of its vast size, Columbiat has the opportunity to create numerous sectors throughout the colony for business and commercial purposes. This allows similar business types to be built next to one another. New technology would be used to illuminate the buildings, all the while maintaining a unique structural design that is similar to that of Earth.

7.1 Transportation and Node

The transportation types of vehicles depend mostly on what it carries. Everyday cargoes would be controlled and handled by robots, unless the cargoes are marked as "fragile;" in the case of that, human workers would handle the cargoes. Tour buses shall also be driven by robots, allowing visitors to experience the feeling of everyday life in the colony by cooperating with robots. Ships that travel to and from Earth would be piloted by humans with robots taking control of the ship when the humans rest, which is similar to today's autopilot system aboard planes.

7.1.0.0 Docking Docking areas are typically separated by the types of vehicles that are to be docked. Therefore, passenger ships would be led to one docking area, while cargo ships are led to another. This system would allow traffic flow into and out of the colony to be faster.

7.1.0.1 Warehousing Warehouses would hold supplies involving repair or cleaning. Therefore, warehouses should be built near areas, such as fueling stations, where refueling and repairs are made. This should be convenient for the settlers, since fueling stations are installed throughout the colony.

7.1.0.2 Cargo-handling Robots shall handle the loading and unloading of the cargoes. Through calculations, they would be able to calculate where to place the cargoes in the ships or vehicles in order to reduce the amount of space wasted. After the unloading process is over, they would place the cargoes onto cargo vehicles that are driven by other robots, who will drive the cargoes to the assigned destination.

7.1.1 Terminal Facilities Robots would handle cargoes by unloading, loading, and sending them to their destination, while human workers would assist settlers and visitors with registering their names and checking in their names to have a record of every visitor currently in the colony. This system would allow the visitors to not worry about their baggages throughout the journey and allowing more time enjoying the colony and what it shall offer them.

7.1.2 Activities Recreation, resorts, restaurants, theaters, cinemas, and amusement parks shall be established for the settlers and visitors to enjoy life in the colony without thinking about life back at Earth. Activities shall be designed in a fashion that resembles those on Earth, but with a different feel. The Low-Gravity effect shall be available in the buildings.

7.1.2.0 Rest Resting quarters shall be constructed near ports and working areas, where pilots may rest. It is essential that they be built as close to their ship as possible. The journey between Columbiat and Earth may cause the pilots to experience fatigue, which would endanger the journey. Resting quarters shall also be placed near working sites, fueling stations, and agricultural fields for the workers.

7.1.2.1 Recreation Electric tour buses are available every thirty minutes for visitors as well as current settlers who wish to learn more about the colony and view new designs and decorations around the colony. They may experience the changing colors of the walls above them that represent the changing of the time of the day. Cyber cafes are also available to encourage settlers to continue communicating with people on Earth and publicize the colony. Libraries, shopping centers, and parks shall also be set up for the settlers.

7.1.2.2 Resorts Resorts and hotels are built in the two outer rings, with the distance between the hotel and the origin of the ring being the same as the distance between the hotel and the wall of the ring that borders the outer space. Hotels would include swimming pools, balconies, and the option to disengage gravity in the hotel room.

7.1.2.3 Restaurants Restaurants will serve food that taste similar to those on Earth. However, their appeal shall be different. Each restaurant shall be sectioned into rooms, so that customers may experience a low gravity feeling while dining. This unique feature shall contribute in drawing many more visitors. Along the walls

of the restaurants shall be the designs of a space environment.

7.1.2.4 Theaters In cinemas and theaters, movies from Earth shall be shown. Singers and artists shall be invited to perform in the colony, as people would not miss any of their most favorite celebrities' pieces of work. In Columbiat, it is also possible to shoot movies in angles that aren't possible on Earth. Therefore, many people may carry their work to Columbiat and began an entertainment business in Columbiat.

7.1.2.5 Amusement Parks Two amusement parks shall be constructed, in which roller coaster rides, arcade rooms, a food court, and a reserved section for children who do not meet the requirements to participate in the rides. Another section shall be built that includes an anti-gravity complex, where people may form into teams to play games, such as war games.

7.1.3 Medical Quarantine Centers At least one medical facility is constructed in each of the rings of the colony. This is essential in that working and fixing parts in space pose as a severe danger to the people. Therefore, the need of at least one medical facility in each ring is crucial. Medical quarantines must always be pressurized with the gravitational system enabled at all times. A backup gravitational system would be enabled if the primary gravitational system malfunctions. Medical facilities shall be as similar to those on Earth. A food court also exists in each of the medical facilities.

Commerce and Financial Centers are built according to their usages and the companies that support them. Most of the centers would hold numerous offices depending on their uses. These centers form companies, which shall in turn form offices. Frequent communication shall be present between Earth and Columbiat.

7.2 Commercial and Financial Centers

7.2.0.0 Office Facilities The construction of office facilities depend on the number of companies that support the construction of it. Bigger companies would be able to finance more offices without the need of help from several companies. Offices include 150-Person Offices, 100-Person Offices, 30-Person Offices, and 5-Person field Offices. Each office would handle different level tasks.

7.2.0.1 150-Person Offices Four companies would construct 150-person offices, with each office handling work regarding management, financing, and control of the budget of the colony as a whole. Most of the communication with Earth shall occur here.

7.2.0.2 100-Person Offices Eight companies would construct 100-person offices. Each would deal with the number of ships entering the colony. These offices shall control the incoming and out-coming of traffic of the colony.

7.2.0.3 30-Person Offices Fifteen companies would build 30 person offices. Real estate offices are constructed to assist visitors who need a home, because they wish to either work or stay at the colony for an extended period of time. Real estate agents would often travel around the colony, with the customer, to search for a home. Prices may range between $1,000,000 to $2,000,000 depending on the size and technology the house has.

7.2.0.4 5-Person Field Offices Thirty companies would build 5 person offices, in which the sole purpose of these offices would be to be in charge of small companies opened by the settlers themselves. These offices would monitor the private companies and profit from the private companies.

7.2.1.0 Banks Banks are established for both the settlers and the companies. Heavy security systems are enabled to prevent theft; therefore, it is best for settlers to deposit their money into the banks, where surveillance cameras and computerized password codes and locks are always enabled. Banks are controlled directly by the Foundation Society.

7.2.1.1 Space-Based Companies These companies are mostly companies developed by the settlers. They shall give parts of their profit to the Foundation Society, which shall apply the money to fund projects to expand or upgrade the colony. It may also apply the money in improve conditions inside the colony such as improving parks and waste collection.

7.2.1.2 Space Settlement Residents Columbiat shall have the appeal similar to that of Earth, in order for the settlers, especially new settlers, to become quickly accustomed to life in Columbiat without the need to change their lifestyles, since Columbiat is designed to be closely similar to Earth, yet maintain its uniqueness.

7.2.1.3 Ships' Crews Ships' crews and pilots shall receive free service and housing in the colony during the time in between flights that return to Earth. Therefore, a special hotel is reserved for these crew and pilots and shall be situated near the docking areas where the ship that returns home is parked.

7.2.2.0 Foundation Society Headquarters The Foundation Society Headquarters overlooks and controls every robot, company, and events that occur within the colony. They are responsible for the safety of the settlers, along with control of the offices that the companies control. Therefore, many companies are departments of the Foundation Society that governs the colony.

7.2.2.1 Business and Investment Empire The Business and Investment Empire is controlled by the four companies that are in charge of building the 150-person offices. Therefore they are obliged to hold numerous meetings with Earth and members of the 150-person offices. *Refer to 7.2.0.1.*

7.2.2.2 New Settlement Opportunities Incoming settlers shall visit the real estate centers to search for housing in the colony. During the time of searching for housing, real estate agencies must provide temporary housing for the settlers for free. The maximum number of days to reside in the temporary homes shall be ten days. If the settlers do not find a house during those days, they shall be sent back to Earth.

7.2.2.3 Settlement Services Settlement services is controlled by the fifteen companies that form the thirty offices. Daily waste collection from houses is encouraged. If settlers find a problem in any aspect of their house, they shall contact their real estate agency, who handles housing services as well.

7.2.3.0 Computer Networking Due to security reasons, there exists three levels of computer networks. The Base of the colony shall have control of all three of the computer networks, while the other two networks are restricted in accessing the other networks. The second level type of computer network would be for workers and companies. The third level of network shall be reserved for the residents at their homes.

Robots are responsible for checking and maintaining spacecrafts entering and leaving the docking area. Any form of damage would endanger the colony and the flow of visitors would decrease. Therefore they must exit the colony to fix the spacecraft before it enters. Robots must also ascertain that there shall have no malfunctions on the computers.

7.3 Provisioning and Maintenance Base for Visiting Spacecraft

7.3.0 Fueling Fueling stations are built throughout the colony for the people's convenience. Many fueling stations are established ameliorate daily traffic. To reduce the amount of time spent at refueling the vehicles, robots are designed to refuel the vehicles, while the driver of the vehicle pays for the fuel.

7.3.0.1 Fuel Storage Facilities Fuel storage facilities would include the storage of hydrazine, nitrogen, titroxide, helium-3, and deuterium. Each fueling station shall include all five of these fuel for the convenience of the settlers.

7.3.1.0 Maintenance The maintenance crew shall be available in every port and fueling facilities. These maintenance crew shall be dispatched immediately if they detect that there is a malfunction in a vehicle. They would be deployed to fix the problem before the vehicles enter the colony or before the vehicles leave the colony. The crew would also be found at fueling stations for the same reason as the ones near the ports.

7.3.1.1 Cleaning The cleaning crew should be near fueling stations, since fueling stations are located throughout the colony. The cleaning crew consists of robots and would be dispatched as soon as they are acknowledged of any problems that may disturb or pose as a danger to traffic. They also make sure that there aren't any waste on the street.

7.3.1.2 Waste Collection The crew would be deployed every four hours. This would reduce the possibility of the spread of an outbreak throughout the colony. Keeping a sanitary colony would increase the population. After the crew accumulates the waste, they would be dumped at special areas in the colony.

7.3.1.3 Ships Repair Ships pose as a risk to the structures within the colony if they are sent inside. Therefore, ships are repaired near the ports, where many of the required supplies are also located. Many required supplies are also located there. After the repair, vehicles may be refueled at the nearby fuel station.

7.3.2.0 Excess production A portion of excess production of food would continue to be sold on the market until the date before expiration. Therefore, the food packaging must be checked every day in the morning. Expired food would be treated by the waste collection crew.

7.3.2.1 Agriculture Food and crops are grown at the fields in the colony, instead of having to be sent from Earth. This would help reduce the expenditure of the colony. The food and crops would also be more fresh and healthy, without having to be shipped.

7.3.2.2 Supplies Storage Supply rooms would be near ports and near fueling stations. This would allow other parts of the colony to appear more sanitized and organized. They shall be near the cleaning crew; therefore settlers would be able to easily access supplies without traveling around the colony. This would reduce the amount of fuel used.

7.3.2.3 Processing Capability Processing of the food would be handled by the robots. Robots would harvest the crops and send them to food processing buildings where they are washed and packaged to be sent to markets.

7.3.2.4 Food Crisis At times of food crisis, the people may turn to the usage of excess production of food. These food from excess production have been placed aside and saved for times such as food crisis. Therefore, the supplies and food would not be wasted.

8.0 Compliance Matrix

	Requirements	Fulfillment	Justification	Page
1.0	**Executive Summary**			**1**
2.0	**Structural Design**	**Central axle with four tori and multiple ports on either ends of the axle, and 2 in between the 2 center tori**	**The four tori are evenly spaced out to balance the overall structure of the colony. Ports are located at either ends of the axle to serve as docks for incoming spaceships, and the two in the center to allow easier access to the residential sectors.**	**2-3**
2.0.1	Expansion	Each tori has approximately twice the amount of space needed to support the initial population	To maintain a healthy population, each torus can not be spun at a very fast rate. Therefore, the radius has to be sufficiently big enough to provide sufficient force to simulate gravity, but still keep the citizens from getting sick from the movement. The radius allows for a lot of down-space to be created, therefore providing extra space for future expansion.	2
2.0.2	Environment	4 tori to accommodate residential, industrial, and commercial. There is one commercial torus, 1 residential torus, 1 residential and commercial torus, and 1 industrial/low gravity torus	The tori are all separated by functions, so as to streamline the flow of people, eliminating unnecessary travel between two tori. Furthermore, separation of space by function allows for quarantine of specific sectors in case of emergency.	2
2.0.3	Living	Houses and apartments in residential part of tori	Settlement will feature houses and short apartment buildings, since the artificial gravity changes the higher one goes in a building.	3
2.0.4	Working	1 shared industrial torus	Since industry will not be the major component of the economy of the settlement, it does not need as much space, so it shares the ring with the half G sector, allowing industrial products to be manufactured at half the artificial gravity on any other ring.	3

	Requirements	Fulfillment	Justification	Page
2.0.5	Natural View	Multiple cameras mounted on the surface of the moon. Images are displayed on the interior walls of the settlement facing the direction of the moon with transparent displays built into the walls of the colony.	Since the colony is at the Earth-Moon L2 point, there is no effective way to allow a natural view of earth without either punching a hole through the moon or using a mirror to reflect an image, but either way is ineffective because stabilizing a big glass mirror suspended by itself is very challenging, and cutting a hole through the center of the moon is just irrational.	3
2.1	**Exterior**	**4 tori connected to a central rod with 8 spokes connecting each torus to the axle. Between each tori there are 4 connections to allow for transportation of small objects and travel of humans.**	**Each torus is connected to the central axle with 8 spokes to open up 8 routes for transportation, while keeping the tori strongly connected to the axle. By having connections between each torus, humans and small objects can travel from one torus to another in the shortest distance, without changing gravity at any point.**	**4-6**
2.1.1	Uses	There will be 4 tori, with the two center tori used for a dual purpose commercial and residential area. The two outer rings will be used for commercial and industrial/ low gravity purposes	The commercial and the low gravity industrial sectors will be at the two ends of the axle since these two areas will experience the greatest flow of traffic. The two central tori will be used for residential, and it will be farther from where all of the major traffic.	4
2.1.2	Major Structural Components Dimensions	Refer to Figure 2.1		4
2.1.3	Construction Materials of Hull	Construction material for the hull will be mainly from the moon, along with some materials that are exclusive to Earth. The hull will use the lunar soil on the moon to manufacture concrete. The concrete will be fiber reinforced and there will be a layer of steel around the concrete.	The settlement is very close to the moon, so the moon will be mined to make the concrete that will be used for the rings. Also, it cuts down on the shipping costs. The concrete will be fiber reinforced so that cracking will not be a problem. Around the concrete ring will be a layer of steel to provide a buffer layer so that if an object were to strike the colony, the metal would give some so that the concrete would not be damaged.	4

	Requirements	Fulfillment	Justification	Page
2.1.4	Volumes of Artificial Gravity	Artificial gravity will be simulated in the commercial, industrial, and agricultural sectors at to match the gravity on Earth. The gravity in the low gravity area will be half of Earth's gravity.	To maintain an agreeable work and living environment for the inhabitants of the settlement, the gravity will be made to match Earth's gravity, so daily business can be conducted as it would be on Earth. However, to help people adjust from 0G in space to 1G on the settlement, a half gravity intermediate ring will be used so that people can slowly acclimate to the 1G rings from 0 gravity	4-5
2.1.4.1	Structural Interfaces Between Rotating and Non-Rotating Sections	The whole settlement revolves along the axle axis, but the ports will be stationary. In the interface between the axle and the ports, there will be a non-rotating decontamination room connected to the ports. It will also serve as a pressurization and depressurization airlock.	Most of the settlement will be connected and rotating at the same rate. There are only a few parts where there are non rotating parts. This reduces the chances for malfunction.	5
2.1.4.2	Rationale For Rotation Speed and Magnitude	0.95 rotations per minute	The rotation speed of 0.95 rpm is a generally acceptable rate of rotation at which people will generally not feel too much of a side effect.	5
2.1.5	Volumes Maintained in Pressurized and Unpressurized Environments	All tori will be pressurized, while the axle and ports will be unpressurized.	Pressure will only be required within the tori since in every other place objects will be transported within vessels between pressurized environments.	5-6
2.1.5.1	Airlocks	Airlocks will be built at the junctions between all pressurized and unpressurized areas.	Airlocks will allow different sections of the settlement to be quarantined or kept from unpressurized areas in case of a malfunction parts of the colony, or if there was damage causing depressurization.	6

	Requirements	Fulfillment	Justification	Page
2.1.6	Debris Protection	The colony will be protected by a steel shell on all parts of the colony other than the tori. For the tori, for the outer part of the ring, a steel shell will be used in conjunction with a fiber reinforced concrete. Between these two layers there will be ferromagnetic fluids. The ceiling will be made of similar material to the ground except in different proportions. The walls of the tori are made of 3 layers of nano-layered plastics.	Most of the colony will be uninhabited by humans and is therefore unpressurized. Although the hulls are sufficiently protected from flying objects by steel shells, if an object was to break through, there would be no effect because there is no pressure loss so the hole can easily be patched. Within the torus, the floor of the torus will be made of a steel-ferromagnetic fluid-fiber reinforced concrete combination to protect against flying objects and deflect them (steel), to repair holes (ferromagnetic fluid), and to protect against any breach of the interior of the tori (concrete).	6
2.1.7	Radiation Protection	Protection from radiation will be provided by lead oxide. The walls of the rings will be made of 3 pieces of nano-layered plastic, with a coating of lead oxide on the outside and on the inside of the plastic. There will be a small gap between the outer two layers of steel for gas to create a switchable mirror using gas content to reflect or let in light to the colony. Between the inner 2 layers of glass, there will be water to protect people from radiation too.	The lead oxide layer applied on the two sides of the outer layer of plastic will be able to absorb the radiation generated by the sun. The water will eliminate most of the remaining radiation that is not blocked by the lead oxide. This configuration will also prevent from solar flares, which release more radiation than usual.	6
MR	**Exterior View of Settlement Showing Major Features, Dimensions, Rotation, and Pressurization**	**Refer to Figure 2.3**		**8**
2.2	**Allocation of Interior Down Surfaces**	**Refer to Figure 2.1.1**		**6-7**
2.2.1	Volumes of Areas	Refer to Figure 2.2.1		7
2.2.2	Micro-gravity and Unpressurized Facility Use	Microgravity will be available at the ports and throughout the axle, where items will be transported through. The ports, axle, and spokes of the wheels are unpressurized.	Micro-gravity will help ships dock at the bays. It will also facilitate transport of objects throughout the axle to its destination spoke. The ports, axle, and spokes will be	6-7

	Requirements	Fulfillment	Justification	Page
2.2.3	Orientation of Areas	4 tori will be oriented parallel to each other with a center rod running through the 4 tori. The settlement overall will be positioned at a 45 degree angle to the line between the Earth and moon, and it will be parallel to the path of orbit for the moon.	The tori are parallel to each other so that the rotation rate can be kept the same and there can be walkways between the rings. The central rod is perpendicular to the rings as an axis of rotation and also 45 degrees to the line between the Earth and moon so that people in the colony can see the moon and the "Earth".	7
MR	**Layout and Usage of Interior Land**	**Refer to Figure 2.2**		**7**
2.3	**Construction Sequence**	**All major components of the settlement will be prefabricated and shipped in pieces to be assembled. First, the connection between the 2 parts of the main axle will be placed in position. Then the two axle parts will be attached to the connector. Third, the ports will be installed on the to ends of the axle. Following that, the spokes for all four rings will be attached to the central axle. Next, the rings will be built around the spokes. Finally, the connecting walkways will be installed between the rings.**	**The construction sequence builds up the colony block by block. The central axle will be prefabricated and shipped and assembled in space. After, the ports will be attached so that ships can dock. After ships are able to dock, materials and smaller chunks of prefabricated items can be shipped and processed on the ports, so no big bulky items have to be shipped, and instead can be directly assembled on the colony. The pokes are then built from the central axle and outwards. All of the mined materials from the moon to create the concrete to make the rings will be processed on the ports and then moved through the spokes so from there the ring can be fabricated without shipping tons of materials from Earth. Finally, connections between the rings will be created, finishing the settlement.**	**7-8**
MR	**Settlement Assembly Drawings**	**Refer to Figure 2.3**		**8**
2.4	**Ports**	**There will be a total of 8 ports. 3 ports on the cross shaped ends of the central rod, and 2 ports on 2 extensions located between the two central tori.**	**The multiple number of ports on the colony helps to keep the docks free of traffic congestion. Furthermore, the ports are spaced out so that one flying object can not cripple all of the means by which ships land.**	**9-10**

	Requirements	Fulfillment	Justification	Page
2.4.1	Cargo Ship Ports	The two protrusions of the crosses at either end of the central rod will be used for cargo ship docking.	The docking areas for cargo ships will be at the two ends because most of the items unloaded will not get the the central residential rings, but rather will stay in the outer 2 rings. Therefore, unloaded cargo can be more easily moved to the outer 2 rings and processed.	9
2.4.2	Passenger Vessel Ports	The port parallel to the central rod and next to the commercial torus will be used for passenger vessels. Also, the two ports on the extensions in the middle of the rod between the residential and agricultural/residential tori will be used for passenger vessels.	The two ports between the 2 residential tori provides a way for passengers to get to the residential areas faster. This diverts traffic from the commercial and industrial ports. It also gives humans a more direct and quicker way to get to the residential areas.	9
2.4.3	Long Term Repair	The dock parallel to the central rod and next to the industrial ring will be used for long term repair.	By positioning the long term repair near the industrial tori, ships can be more easily serviced by robots within the industrial ring. If there are some repairs that require the fabrication of a new part, the industrial sector right next to the repair bay can supply all of the parts.	10
MR	**Port Location and Drawings off a Typical Docking Bay**	**Refer to Figure 2.4**		**9**
2.5	**Low G Accommodation**	**Low G accommodations will be provided by the half gravity ring.**	**The low G tori will provide half the space of the normal residential ring, but it will have the same rotation rate as the other rings so that once people get adjusted to the gravity on the settlement, they can move into the 1 G environment.**	**10**
MR	**Lower G Sections with Rotation Rate**	**Refer to Figure 2.2**		**7**
3.0	**Operations and Infrastructure**			

	Requirements	Fulfillment	Justification	Page
3.1	**Construction Materials Sources**	**Materials obtained from Alaskol when possible. Other resources arrive from Bellivistat and Earth.**	**Location of colony is not suitable for self-sustenance due to lack of resources from Moon, thus reliance on other colonies until establishment and exploration ventures begin.**	**11**
3.1.1	Storage of Materials	Temporary storage warehouses	Materials must be kept from colonists to prevent theft and ensure safety from possible misuse of items	11
3.1.2	Transportation of Materials	Refer to Section 5.4.2	Use of robots automate transportation process, ensuring safe storage and security of goods from external harm	
MR	**Chart or table identifying types and amounts of the various materials and equipment required for the settlement construction process, and from where and how those materials and equipment are shipped.**	**Refer to Table 3.1.1**	**Initial construction requires large amounts of resources, which can only be obtained from nearby colonies**	**11**
3.2	**Community 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.**	**Listed provisions are the base necessity for the survival of the colony as a whole.**	**12**
3.2.1	Atmosphere/ Climate/ Weather Control	Refer to Table 3.2.1	Stimulation of varied seasons necessary to slowly adapt possible settlers or guests to colonial life while comforting colonists with the slight resemblance to Earth	12
3.2.1.1	Air Composition	HEPA filters; refer to Table 3.2.1.1	Resemblance of air composition to Earth's and quality of air is necessary for longevity of colonists in foreign environments	12
3.2.2	Food Production	Food production will be located in vertical farms located in the residential, commercial, and residential-agricultural rings.	A decentralized system allows each ring to be self sufficient in case of emergency. Also all colonists will have easy access to a vertical farm for food.	12

	Requirements	Fulfillment	Justification	Page
3.2.2.1	Agriculture	Most of agriculture will be grown in an aquaponic system of automated floating trays of plants in ring-shaped pools of water.	This allows fish to replenish the nitrogen required for the plants while the plants clear the water for the fish, reducing waste.	12
3.2.2.1.1	Vertical Farms	Vertical farms will combine several forms of cultivation of both meat and vegetables.	Vertical farms will recycle waste products of the food into growing more food.	12
3.2.2.1.2	Harvest	Robots will harvest the foodstuffs using an alcohol sensor to determine ripeness.	Alcohol is a more accurate indicator of ripeness.	13
3.2.2.2	Livestock	Refer to Table 3.2.2.2		13
3.2.2.2.1	Cultivation	Animals will be raised in the Vertical Farms which provides all the facilities to properly exercise the meat for proper firmness.	The Vertical Farm's animal cultivation method can replicate the effects of an animal's natural living without the required space.	13
3.2.2.2.2	Harvest/Slaughter	Electrocution will be used to kill animals for consumption.	A high volt electrocution will instantly kill providing a humane death.	13
3.2.2.3	Storage	All foodstuffs will be kept in warehouses that will preserve both ripeness and freshness.	By preserving both the ripeness and freshness of the foodstuffs, any change in demand of a certain foodstuff can be met with food preserved for freshness.	13
3.2.2.4	Packaging, Delivery, Market	All foods will be stored, packaged and delivered in a manner that preserves freshness.	By preserving freshness, foods will not spoil by the time they reach the shelf.	13
3.2.3	Electrical Power	Electrical power will be done via traveling wave generators and batteries for back up power.	Traveling wave reactors are the most efficient kind that meets the requirements of power. Batteries will store extra electricity for future use.	13
3.2.3.1	Generation	Power will be created through traveling wave reactor which convert the energy of waves into usable power.	The startup procedure of a traveling wave reactor is minimal allowing for a way to quickly turn on and off the reactor.	13
3.2.3.2	Distribution	Power will be distributed in a manner that meets the demand adequately.	Power output will always be greater than usage. Therefore at any given point, each user of electricity will receive enough	14
3.2.3.3	Allocation	Refer to Table 3.2.3.3		14
3.2.4	Water Management	Water will initially be from Earth. From there, all water will be constantly used, reclaimed and reused.	Water will be required to be imported from Earth as it is the closest readily available source.	14

	Requirements	Fulfillment	Justification	Page
3.2.4.1	Quantity	26,000,000L of water will be initially imported from Earth and stored evenly over the storage containers in the rings of the colony.	This amount of water is enough to have enough water on hand for consumption while having an equal amount being reclaimed.	14
3.2.4.2	Storage	Water will be held in water storage containers located within each ring.	Having water near the residents will reduce the energy requirements to provide water to the colony.	14
3.2.5	Waste Management	All waste will be heated and pressed into its base components for recycling in the colony or proper disposal.	By removing all the recyclable materials first, only a minimum of waste is generated.	14
3.2.6	Internal Communication	Fuki will provide all internal communications between colonists.	Each colonist will have a personal Fuki that they use for day to day life on Columbiat. As a result, it is the perfect medium for communications.	14
3.2.7	External Communication	External communications will be done with a store and forward method where data is held until a connection is establish	Because of the location of the colony, constant communication is impossible. Therefore, only the store and forward method will be required.	14
3.2.8	Internal Transportation	Internal transportation will be achieved by the SkyTran, bikes and underground transportation corridors.	To travel within the colony, colonists have the choice of the subway-style SkyTran, a personal bike and transportation corridors.	15
3.2.8.1	Personal	Bicycles will provide colonists a secondary mode of transportation besides the SkyTran system.	Bikes will allow colonists to travel directly to their desired location.	15
3.2.9	Day/Night Cycles	Day/night cycles will be created via OLED and NCD in the ceiling of the colony. By using these lights to create the sky, sun and moon, a day/night cycle is created.	The use of OLEDs and NCDs result in almost no power consumption. NCDs in particular does not require power to stay lit.	15
MR	**Dimensioned drawing(s) showing systems which provide required infrastructure, and, as appropriate, their configurations (e.g., show routings of utilities services).**	**Refer to Figure 3.2.2.1.1, Refer to 3.2.8 and 3.2.9**		**15**
3.3	**Space Infrastructure**			**15**
3.3.1	Existing Infrastructure	Refer to Table 3.3		15

	Requirements	Fulfillment	Justification	Page
3.3.2	Vehicles	Refer to Table 3.3.1		15
MR	**Chart or table describing space-based infrastructure and vehicles required for settlement operations, including notations 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**		**16**
3.4	**Propulsion Systems**	**Rotational propulsion of the colony will be done via retractable VASIMR rockets. Linear propulsion will be done by cargo vehicles and vehicles stationed at Columbiat to pull the colony into place.**	**The VASIMR rockets will fire in a tangential direction to provide the torque required to achieve the wanted rotation speed. Linear propulsion through the tugging of colony is most practical as mounted rockets will cause an unwanted torque.**	**16**
MR	**Show drawing(s) of propulsion system(s), locations and interface(s) with the structure, propellant type(s), propellant storage, and identify thrust produced by each type.**	**Refer to Table 3.4**		**16**
3.5	**Vehicle Provisioning and Maintenance**	**Refer to Table 3.5**		**16**
MR	**Chart, table, and/or drawing(s) showing provisioning and maintenance services, including warehousing and loading systems.**	**Refer to Table 3.5**		**16**
4.0	**Human Factors**			**17**
4.0.1	Quality of Life	The quality of life will be similar for the most part to the level of comfort expected on Earth.	A good quality of life will help colonists adjust to life on Columbiat.	17
4.0.1.1	Community Attributes	Communities will be structured traditionally with separated residential, commercial and industrial areas.	A familiar community structure drastically reduces the time of adjustment of colonists.	17

	Requirements	Fulfillment	Justification	Page
4.0.1.2	Comfortable Homes	Homes will utilize all available space to appear more spacious than it actually is.	A comfortable home will provide a sanctuary for colonists when they are stressed.	17
4.0.1.3	Access Fine Food	Traditional fine dining will be available but an unique culinary style will be promoted.	Fine dining will help Columbiat serve both its residents and the transient businesspeople.	17
4.0.1.3.1	Restaurants	From fine dining to fast food restaurants and cafés, restaurants will be distributed within Columbiat in a manner to best serve the population.	To best serve the population, certain areas will have large amounts of certain restaurants to accommodate the unique tastes of the population.	17
4.0.1.3.2	Wine	Wine will be provided in Columbia to supplement the fine dining experience of the colonists. This wine can be made from the array of fruits grown on Columbiat.	Wine is a luxury normally only enjoyed in culturally developed areas on Earth. By using different fruits besides grapes, a new class of wine can be created.	17
4.0.1.4	Natural View	Natural view will be done via observatories and Low-G holorooms along through live feeds through Proj-Windows.	Due to the location of the colony, holographic technology and live video feeds will be used to provide colonists with images of the space outside the colony.	17
4.1	**Community Design**			**17-21**
4.1.1	Services	The infrastructure of the colony are to be modeled on the infrastructure of Earth cities. However several communities services will be completely new to make Columbiat both innovative and unique place to live.	This emulation will allow colonists to transition easily from Earth to Columbiat. The innovative elements will give the colony an unique feel.	17
4.1.1.1	Housing	Housing in Columbiat will consist of both apartments and traditional houses. The urban neighborhoods will have a higher concentration or apartments while the rural and suburban areas will have more houses.	By having both apartments and homes for housing, colonists can choose the housing option that meets their needs.	17
4.1.1.2	Education	Classrooms will have "teachers" composed of robotic units using holographic projectors and "tutors" individually projected from each student's desk.	An automated education system will be able to teach students and determine their understanding better than a human teacher.	17

	Requirements	Fulfillment	Justification	Page
4.1.1.3	Entertainment	The majority of the entertainment will mix traditional Earth elements with elements unique to Columbiat. However some entertainment will be of complete Earth origin for visitors to the colony.	Entertainment will provide colonists a way to alleviate the problems of boredom and homesickness for traditional Earth amenities.	17
4.1.1.4	Medical Services	Medical service will be provided through the hospitals and clinics located on the colony and the medical staff and robots who are stationed there. The Fuki portable computer will also have a medical monitoring system with which the colonist's vital signs can be checked.	By providing medical service from both humans and robots at hospitals and clinics, colonists will receive the best medical care. The Fuki computer is the best medium to track a colonist's vital signs because the computer is worn on the colonist's forearm.	17
4.1.1.5	Parks	Parks will serve primarily to provide colonists with an open space that colonists can meet and interact in. Parks will become an open air town center.	Parks will be a central and integral part of all communities. They will also relieve the sense of being enclosed within Columbiat.	17
4.1.1.6	Recreation	Recreation will consist of both entertainment and sports held in the parks. Recreational facilities will also be built to allow greater access.	Recreational facilities hosting both recreational sports and entertainment will help relieve boredom and improve morale.	19
4.1.2.	Supplies and Consumables	Supplies and consumables will be available on Columbiat in adequate amounts so that colonists can have ready access to supplies without waiting for imports from outside the colony.	Supplies and consumables are an integral part of the operation of the colony and of colonist's lives. As a result, these items must be available and easily accessed.	19
4.1.2.1	Variety	A wide variety of supplies will be made available to colonists so that most of the colonist's needs can be meet easily.	The variety of supplies and consumables will provide colonists with choices. This extends to having lifestyle choices.	19
4.1.2.2	Quantity	To ensure all colonists have enough consumables to go through their life, 110% of expected consumption will be on hand at any given time.	By having a slight surplus of supplies and consumables, all colonists will be guaranteed access to them.	19-20

	Requirements	Fulfillment	Justification	Page
4.1.2.3	Resupply and Replenish	Resupply of the colony's stores of supplies and consumables will be done via the colony's production capabilities and a small amount through import.	To maintain the small surplus required to assure access and availability of supplies, the colony will produce and export at the same rate it is consuming.	20
4.1.2.3.1	Sources	Most supplies and consumables will be produced within Columbiat. Only the more complex items outside the production capabilities of Columbiat will be imported.	Due to the nature of Columbiat, resupply by trade with places outside of Columbiat can be interrupted. Therefore, Columbiat will attempt to produce everything it needs to be self sufficient.	20
4.1.2.3.2	Distribution	To distribute the goods, two methods will be employed. The first is a physical store that colonists go to. The second is an online store where ordered items are shipped to the colonist's home.	By providing a physical and electronic way to obtain supplies, colonists can chose the method that is most convenient for them and their lifestyle.	20
4.1.3	Psychological Factors	To prevent psychological problems from the enclosed nature of the colony, the colonists will be exposed to open areas to relieve these anxieties.	Being enclosed within a space colony like Columbiat will cause psychological problems dealing with confinement. To alleviate this, the colony will be made as roomy and open as possible.	20-21
4.1.3.1	Long Lines of Sight	To give the illusion of the outdoors within the colony's rings, roads traveling tangent to the ring will naturally form a horizon with the curvature of the ring.	By having roads long enough that colonists can perceive a horizon, the psychological feeling of confinement is reduced drastically.	21
4.1.3.2	High Ceiling	The high ceiling will be coated with OLEDs to simulate a natural looking sky. A day night cycle and weather patterns will be used to make this simulation more realistic.	An high OLED ceiling will provide the basis of two visual illusions designed to make the outdoors of the colony feel like the actual outdoors.	21
4.1.3.2.1	Day/Night Cycle	A simulated sun will be created using the OLEDs embedded into the ceiling. By having this sun move across the sky, a day/night cycle can be created. By having each ring on a different cycle, different time zones and seasons can be created.	A day/night cycle will produce a realistic initiation to the outdoors. Also, due to the arrival of ships from different time zones, each ring will operate on their own time zone so that visitors can adjust easily.	21

	Requirements	Fulfillment	Justification	Page
4.1.3.2.2	Weather Patterns	Weather patterns will be simulated in Columbiat in accordance to the simulated seasons.	By simulating weather with the OLEDs embedded in the ceiling, the OLED sky illusion is further enforced.	21
4.1.3.3	Holo-Room	A holographic projector system located in a room will be able to create any virtual environment for both recreational and educational purposes. The room will also be able to create virtual open spaces so that people can experience the outdoors without traveling outside the colony.	Holo-Rooms are rooms that can create any virtual environment. This allows colonists to "visit" places outside of the colony without the dangers of actually donning a spacesuit and exiting the colony.	21
4.1.3.4	Agriculture/Residential Communities	One of the two residential areas will share its ring with the agricultural sector. This combined with a rural community design will allow for a rural feel.	A rural environment will be more open than an urban neighborhood. Allowing residents to live in such environment will lower the effect of being enclosed.	21
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**		**18**
4.2	**Architectural Design**			**21-23**
4.2.1	Home Design	Homes will be structured like homes on Earth but all space will be utilized efficiently to create a feeling of roominess.	Efficient use of space will allow more houses and apartments to be built. The feeling of roominess is created from making the room seem bigger than it actually is.	21
4.2.2	Neighborhood Design	Neighborhoods will be structured to conserve space. The level this minimalistic attitude will be applied will depend on the neighborhood type.	With the efficient use of down area, communities will be more compact which will allow for more community amenities.	21
4.2.2.1	Variety	Neighborhoods will fall within three different categories, the urban, suburban and the rural.	Having more than one neighborhood design will provide colonists the choice to choose the house or apartment that fits their needs.	22

	Requirements	Fulfillment	Justification	Page
4.2.2.1.1	Urban	Urban environments will be created by the compacting of multistory buildings. Despite the crowded nature, the long lines of sight and high ceiling will counteract any effects.	For those who enjoy the close community of an urban lifestyle, the urban neighborhoods will provide the close knit feeling and feel physically spacious at the same time.	22
4.2.2.1.2	Suburban	Suburban environments will be like the urban environment by having multistory buildings but these will be placed farther apart. Along with more houses, these neighborhoods will resemble suburbia.	For a more family-centered neighborhood, the suburbia feel of the suburban neighborhoods will provide the proper environment for raising children.	22
4.2.2.1.3	Rural	The rustic rural environment would be achieved by the integration of the residential areas with the agricultural sector. Through the use of community gardens and orchards, these neighborhoods will have an agrarian feel to them.	Rural neighborhoods are designed with the free spirits and independent people in mind. With plenty of open space, the rural areas will have the closest approximation of the true outdoors.	22
4.2.3	Furniture	Furniture will be space efficient by having multiple uses for the same piece of furniture.	Efficient use of furniture will be the main element that gives the feeling of roominess to the houses and apartments.	22
4.2.3.1	Variety	This modular furniture encompass all the furniture types citizens expect.	The use of modular furniture allows colonists to utilize the same piece of furniture for different purposes.	22
4.2.3.1.1	Mod-Table	A Mod-Table will use allow colonists to use the table as both a table and a holographic entertainment center.	The Mod-Table will replace many different types of furniture within homes. As a result, extra space will be available for colonist's use.	22
4.2.3.1.2	Proj-Window	The Proj-Window can serve as a television, a computer interface and a live feed to a view outside the colony.	By combining the television and the computer into the window, the colonist's home will appear more spacious than homes of similar size.	22-23
4.2.3.2	Sources	Furniture will be manufactured on Columbiat, either in the industrial sector or on-site with a three dimensional printer.	Prefabrication and on-site manufacturing and installation will allow for a quick and easy way to furnish homes.	23

	Requirements	Fulfillment	Justification	Page
MR	**External drawing and interior floor plan of at least four home designs, the area (preferably in square feet) for each residence design, and the number required of each design.**	**Refer to Figure 4.2.1-4.2.4**		**23**
4.3	**Safe Access to Low-G Environments**	**To enter a low-G area, residents must be in a space-suit and go through several safety checks.**	**Security and safety are strictly enforced to prevent potentially dangerous accidents to both colonists and to the colony's structure.**	**23-24**
4.3.1	Safety Measures	In case a colonist loses all momentum and is stuck without a nearby wall or object to hold on to, various safety measures will be available to bring him to safety.	By bringing colonists to a wall, the safety systems will ensure that the colonist can get to safety without posing a hazard to others.	23
4.3.1.1	Systems	A tether rope that will be launched towards the stranded colonist from mountings on the walls. The colonist can then use the tether to pull himself or herself safety.	This system can be easily reloaded for repeated use.	23
4.3.1.2	Devices	Gecko-gloves and boots will provide the necessary maneuverability on surfaces in the low-G areas. A tether gun will be available to allow colonists to grab onto objects and surfaces further away.	Being able to grip surfaces will allow colonists to hold on in case of depressurization as well as the ability to walk. The tether gun will allow colonists to pull themselves towards a wall or an object towards them.	23
4.3.1.3	Vehicles	The SkyTran system will be used to allow colonists to safely travel long distances in the Low-G sector.	Compared to using tethers and gecko-boots, the SkyTran system is a faster and safer means of travel within the Low-G ring.	23
4.3.2	Access to Low-G, Interior of Hull, Exterior of Hull	Colonists will have access to devices that will allow them to access to unrestricted areas within the colony.	Colonists will have the means and freedom to enter unrestricted parts of the colony.	23
4.3.2.1	Low-G	To access Low-G, colonists will have to go through an airlock where they have to don a spacesuit to protect themselves.	To protect colonists in Low-G, colonists will have to wear space-suits and the protective mechanism that come with it.	23-24

	Requirements	Fulfillment	Justification	Page
4.3.2.2	Interior of Hull	To access the interior of the hull, colonists can use bikes, walk or the SkyTran to travel within the hull.	Colonists will be safe in the livings areas of the colony. All other areas within the interior of the hull will follow the Low-G procedures.	24
4.3.2.3	Exterior of Hull	To access the exterior of the hull, colonists will exit the colony through airlocks located in the hull. Gecko feet and tethers will allow colonists to secure themselves in this environment.	The exterior of the hull is much more dangerous than the Low-G sector but the same devices and systems will be capable enough to keep the colonists safe.	24
MR	**Drawings showing examples of handrails, tethers, cages, and/or other systems enabling safe human access to any location on or in low-g settlement areas.**	**Refer to Figure 4.3.1.2**		**24**
4.4	**Spacesuit and Airlock Design**			**24**
4.4.1	Spacesuit	The spacesuit will consist of multiple layers starting with a base layer that will be worn. This base layer will be a full body on top of regular clothes. Additional layers will be sprayed on to keep internal pressure and heat and supply air to the colonist.	The spacesuit will be protect colonists from incidents that can happen in potentially dangerous areas.	24
4.4.1.1	Storage	The layers of the spacesuit that will be sprayed on will be stored in the canisters they will be sprayed from.	Canisters are easy to store and are used as part of the donning	24
4.4.1.2	Use	The spacesuit will be required in both unpressurized and low-G areas for safety reasons.	The spacesuit will allow colonists to get around low-G areas and survive in unpressurized areas.	24
4.4.1.2.1	Donning	Donning the spacesuit requires a worn base layer that the rest of the spacesuit will be sprayed on.	The spray method increases flexibility of the colonist while in the spacesuit.	24
4.4.1.2.2	Doffing	To doff the spacesuit, a small electric charge and pressure will be injected between the worn layer and the first sprayed on layer so that the outer layers will detach from the base layer and can be removed.	A quick doffing method will allow colonists to reduce contact time with possible contamination on the spacesuit.	24

	Requirements	Fulfillment	Justification	Page
4.4.1.2.3	Recycling	The doffed spacesuit can be separated back into layers which can be cleaned and recycled for future use.	Spacesuits can be used multiple times to conserve resources.	24
4.4.2	Airlock Design	Airlocks will be used at all major points of intersection within the colony to seal parts of the colony, including between pressurized and unpressurized areas. Each airlock will be paired with another one to allow passage in both directions.	Airlocks will be integrated into key points so that depressurization from hull breaches can be contained.	24
4.4.2.1	Operation	Each airlock will be kept pressurized and open so that colonists can pass through. Each cycle of an airlock will be opposite of the airlock it is paired for the purpose of allowing passage in opposite directions.	This use of airlocks will allow for quick access of all areas of the colony. Also, if the need arises, the locks can be closed to seal areas of the colony.	24
4.4.2.2	Reducing Air Loss	Air loss is reduced through recycling of the air taken from the depressurization of air lock. This air will be filtered and will be later used to pressurize the airlock.	Having a filtering procedure in the middle of the recycling process will reduce contaminants from the air.	24
MR	**Drawing(s) showing spacesuit and airlock operations, with estimates of air volume lost during each cycle (i.e., on/off or in/out) of these systems.**	**Refer to Figure 4.4.1 and 4.4.2**		**24**
4.5	**Visitor Accommodations and Security**			**25**
4.5.1	Hotels	Hotels will serve to house transient population in a manner that places them out of the way of the permanent population.	This reduces the impact of the transient population on the colonists.	25
4.5.1.1	Location	Hotels will be located within the commercial sectors of the colony.	Hotels will cater mainly with visiting businesspeople and this location will provide the most convenience.	25

	Requirements	Fulfillment	Justification	Page
4.5.1.2	Design	The exteriors of the hotel will be architecturally the same as the surrounding commercial buildings but the interior will be furnished like the residential homes.	Hotels will make use of all available space the same way residential homes will while looking in place with all the offices.	25
4.5.2	Security	Security will mainly be conducted through automated robots and security systems to prevent unauthorized access to sensitive areas.	The unique security systems will prevent electronic attacks on the colony infrastructure as well as provide privacy and security to colonists.	25
4.5.2.1	Unobtrusive surveillance	Surveillance will be maintained through hidden cameras and microphones in the walls and ceiling. Security robots will be stationed to monitor transient activity in popular areas.	By hiding cameras and microphones and having security robots stationed in popular areas, any conflict between colonists and transients can be quickly averted or dealt with.	25
4.5.2.2	No Interference to Residents	Security will not interfere with colonist everyday life as all monitoring measures will be hidden out of the colonist's view or placed in low-profile locations.	Residents will not be disturbed by the use of monitoring if they do not notice its presence.	25
4.5.3	Medical Quarantine	Medical quarantines will seal off an entire sector of the colony when an unknown disease is detected.	The use of quarantine will halt the extent of the infection of the unknown disease.	25
4.5.3.1	Operation	Colonists who have shown signs of infection will be quickly isolated. Then the others in quarantine will be throughly checked and monitored for some time before they are deemed safe to exit quarantine.	The use of quarantine procedures will keep the colonists safe from infection at all times during the quarantine. Air scrubbers will be turned on to maximum power to clean the air so that the affected area can be cleared of any airborne bacteria.	25
MR	**Chart(s) or table(s) listing anticipated security issues/situations and security response(s) to each situation; description of process(es) to respond to unanticipated security issues.**	**Refer to Table 5.2.2.2**		**31**
5.0	**Automation Designs and Services**	**Refer to 5.0.**		**26-30**
5.0.1	Computer Specifications	Refer to Table 5.0.1	Computer systems enable easier completion of tasks; less resources, such as paper, used	26

	Requirements	Fulfillment	Justification	Page
5.0.1.1	Numbers and Types	Refer to Table 5.0.1	Quantity supplied reaches optimal balance between surplus and shortage, providing instant replacements at low cost	26
5.0.2	Server Specifications	Refer to Table 5.0.1, Rippou	Quantum computing necessary to handle intensive tasks, particularly research data crunching	26
5.0.2.1	Numbers and Types	Refer to Table 5.0.1	Surplus of servers necessary to provide reserve power for DPS or quick replacements	26
5.0.3	Software Specifications	UNIX-based Web Operating System, open-source application suites	Web interface provides constant updating mechanisms, instant access to familiar computing environments; suites offer tools for work productivity	26
5.0.3.1	Numbers and Types	Software in all computer's memory	OS can instantly load and access applications instead of consuming bandwidth through Web-based applications	26
5.0.4	Network Devices Specifications	Ten-terabit wired networks, terabit wireless networks, and Rippou	Reliable, fast bandwidth and connection; dedicated firewalls to protect against possible cyber attacks	27
5.0.4.1	Numbers and Types	Provided for all computers in use	Huge focus on web OS requires all active computers to be linked together; ensures verification of computers being active and alive	27
5.0.5	Robot Specifications	Refer to Table 5.0.4	Specialized robots to reduce manual labor and complete certain tasks swiftly	28-29
5.0.5.1	Numbers and Types	Refer to Table 5.0.4	Quantity of robots is at optimal equilibrium between amount needed for immediate backup provision and amount needed for constant functionality of needed robots	28-29
5.0.6	Data Storage	Refer to Table 5.0.1	Varied storage types to suit different applications and needs	26
5.0.6.1	Types and Capacities	Flash, NRAM, and holographic	Flash storage for low costs and energy consumption; NRAM for long lifetimes, minimal energy consumption, and decent amount of storage for average residents; holographic primarily to store large amounts of data	26
5.0.7	Data Collection	DDFS	Easy tracking of data for easy accountability	27

	Requirements	Fulfillment	Justification	Page
5.0.8	Data Distribution	DDFS	Prevention of data loss through redundant backups	27
5.0.9	User Access to Computer Networks	Fuki	Verification of identity ensures only allowed individuals are accessing network	26
5.0.10	Robot Designs	Refer to Table 5.0.4 and Section 5.0.4.1	Longer operation of robots due to durable shell and tritium battery; reduction of costs and provision of customization through modularity	28-30
5.1	**Automation for Construction**	**Refer to Section 5.1**		**30**
5.1.1	Transportation and Delivery of Materials and Equipments	G and HD	Efficient and constant delivery of materials for fast construction	30
5.1.2	Settlement Assembly	DaiGurren-Lagann and RFP	Painless automated assembly of colony without necessary danger to human life	30
5.1.3	Interior Finishing	RFP-E	3D printing method to precisely manufacture buildings without measurement issues or other hassles	30
MR	**Chart or table describing automated construction and assembly devices – both for exterior and interior applications (e.g., homes) – and the purpose(s) of each.**	**Refer to Table 5.0.4**	**Proliferation of tasks to multiple robots by automated system results in fast building times**	**28-29**
5.2	**Automations for Settlement**	**Refer to Section 5.2**		**30-32**
5.2.1	Settlement Maintenance and Repair	Gurren-Lagann, Ten-chi, and DSG	Constant monitoring of colony status; offloads stress from possibilities of spontaneous damages through 24/7 maintenance	30-31
5.2.2	Settlement Safety	All robots and computers	Swift response to exigencies while alerting all colonists of danger and countermeasure plans	31
5.2.2.1	Backup Systems	Emergency generators and DDFS	Redundant data backup system; continuity of vital systems in case of power failure	27, 31
5.2.2.2	Contingency Plans	Refer to Table 5.2.2.2	Predefined response strategies for quick response to emergencies	31
5.2.3	Physical Locations of Computers and Robots for Critical Functions	30x30m repair and maintenance facilities, 30x30m warehouses, and underground transportation corridor	Widespread presence of facilities for immediate deployment of robots to scene of danger	31

	Requirements	Fulfillment	Justification	Page
5.2.4	Robot Safeguards against Solar Flare	VMRAM and Demron; Refer to Section 5.2.2.4	Minimum or full functionality of robot during solar flares, ensuring continuity of colonial tasks	30-32
5.2.5	Access to Critical Data, Computer Systems, Robot Systems, and Security Measures	Refer to Table 5.0.2	Implementation of different account types and verification hierarchy to restrict access to only the ones allowed	27, 32
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 Tables 5.0.1 and 5.0.4**	**Utilization of robots and various devices reduce human labor to a minimum while providing means of quickly completing tasks and increasing productivity**	**26, 28-29**
5.3	**Automations for Community**	**Refer to Section 5.3**		**32**
5.3.1	Enhancement	Refer to Sections 5.3.1, 5.3.2, and 5.3.3	Relief of stress through provided devices and robots	32
5.3.1.1	Livability in Community	All robots	Offload of manual labor jobs yields focus on work and hobbies, advancing colony in many ways	32
5.3.1.2	Productivity in Work Environments	Web OS and all computers	Access to user data at any given place; loading of familiar environments results in faster turnout times for work	26-27, 32
5.3.1.3	Convenience in Residences	Smart Home System	Easy-to-use home management	32
5.3.2	Maintenance and Routine Task Automations	All robots and computers	Use of automated robot and computer systems provides conveniences and hassle-free preservation of facilities	28-29, 32
5.3.3	Reduction of Manual Labor	All robots and computers	Allows colonists to focus on matters on hand instead of fretting over small issues	28-29, 32
5.3.4	Privacy of Personal Data	Biometric, quantum, and software encryption	Combination of identity-based keys and software keys secures files from theft and random access	32
5.3.5	Control and Access of Private Systems	Refer to Table 5.0.2 and Section 5.3.4	Prevention of illegal access to systems through different identification methods	27, 32
5.3.5.1	Community Computing	DPS	Efficient distribution and full utilization of available processing power	27
5.3.5.2	Robot Resources	Smart Home System	Gives users feeling of ease and convenience due to complete control of robot tasks through simple web interfaces	32

	Requirements	Fulfillment	Justification	Page
MR	**Drawings of robots and computers that people will encounter in Columbiat, and diagram(s) of network(s) and bandwidth requirements to enable computer connectivity.**	**Refer to Table 5.0.1 and 5.0.4 and Figure 5.0.3**	**Aesthetically pleasing robots and computers to lessen psychological impact of fear; highly efficient network, designed to utilize and distribute bandwidth and power effectively**	**27-29**
5.4	**Automations for Cargo Handling**	**Refer to Section 5.4**		**33**
5.4.1	Automated Cargo Handling System	HD	Compared to other intricate methods, simple claw and unload design remains most reliable and effective;	33
5.4.2	Inventory Management	RFID tags on packages and RFID readers in warehouses	Ongoing tracking of items enable real-time locating and itemizing of goods	33
5.4.3	Material Transfer Between Vehicles	HD	Though slow, transfer of goods through HD acts as a safety measure from possible theft due to its size	33
MR	**Illustration, chart, or matrix showing inventory management system; and illustration of automated unloading/loading system(s).**	**Refer to Figure 5.4.1 and Section 5.4.1.1.**	**Live inventory system to inform owners quickly of missing products; reliability of system due to straight-forward design requiring minimum movements; quick distribution of goods through automated systems**	**33**
5.5	**Automations for Foreign Automations**	**Refer to Section 5.2.4**		**32**
5.5.1	Visiting Robot Maintenance and Overhaul	Gurren-Lagann and port maintenance facilities	On-spot tune-ups to prevent possible dangers arising on future trips for visitors; small convenience provided results in increase of guests to Columbiat	32
5.5.2	Dust Containment	Electrostatic emitting chambers	Separate rooms confine dust into one area, preventing spread into colony	32
MR	**Drawing(s) of robot repair facilities, including illustration(s) of measures implemented in order to prevent spread of dust contamination brought by visiting ships.**	**Refer to Figure 5.2.4.2**	**Electrostatic charges guarantee attraction of all dust particles; the quarantine of dust in one focused area makes it easier to collect and permanently dispose of it**	**32**
6.0	**Schedule and Cost**			**34-37**

	Requirements	Fulfillment	Justification	Page
6.1	**Schedule**			**34**
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	34
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**	**34**
6.2	**Costs**	**Costs includes the billions of dollars spent for each activity that relates to the construction of the colony.**	**Costs include aspects that would contribute in the constructing of the colony. Refer to Table 6.2**	**35-37**
6.2.1	Total Costs	Total costs are expenses that relate to the construction of the colony.	These include construction expenses and revenue. Refer to Table 6.2.1	35
6.2.1.1	Construction Expenses	Construction expenses include an estimated total amount of money spent on automation, personnel, and space vehicles.	Refer to Table 6.2.1.1	35
6.2.1.2	Revenue	Money from revenue would relate to daily colonial activities.	Fueling stations, maintenance, lodging, and tourism would relate to the Columbiat's revenue. Refer to Table 6.2.1.2	35
6.2.2	Cost Breakdown	Cost breakdown includes materials and robots that access with the settlers' everyday lives.	Costs regarding raw materials, automation, and personnel shall be included in the cost breakdown.	36
6.2.2.1	Raw Materials	Raw materials of Columbiat are the basic elements that sustain the settlers' lives in space.	Refer to Table 6.2.2.1.	36
6.2.2.2	Automation Costs	Automation is essential in assisting settler with everyday settlement.	Therefore, automation robots are crucial in the colony and must be available at all times. Refer to Table 6.2.2.2	36
6.2.2.3	Personnel Costs	Workers' salary shall range more than the salary of the same jobs on Earth.	Refer to Table 6.2.2.3	37
6.2.2.4	Space Vehicle Costs	Space vehicles would help further scientific research and experiment in space. They would also assist in carrying numerous cargoes throughout the colony.	Therefore, there must be many space vehicles at standby for the settlers' use. Refer to Table 6.2.2.4	37

	Requirements	Fulfillment	Justification	Page
6.2.2.5	Construction Sequence Costs	This includes all the cost necessary in building all of the aspects of the colony. Refer to Table 6.2.2.5	Refer to Table 6.2.2.5	37
MR	**Charts/Tables listing separate costs associated with different phases of construction**	**Refer to Table 6.2.2.1 to 6.2.2.5.**		**35-37**
7.0	**Business Development**	**Accommodation of cargo ships, medicine and office facilities, banks, fueling services, and tourist attractions.**	**Improving the quality and management of Columbiat (transportation, finance, tourist, and supplies). It would cost $500,000.**	**38-40**
7.0.1	Commercial and industrial venture designs	Designs must be similar to that of Earth, while maintaining a type of uniqueness that can only exist in space.	This would reduce homesickness, while still drawing many people from Earth to come to Columbiat, because of its appeals. Therefore, many of the structures in the colony must be similar to that from Earth.	38
7.1.0	**Transportation Node and Port**	**Types of transportation depend on what it carries. Most are controlled and handled by robots.**	**Ships coming and going to Earth are handled and piloted by humans. Tour buses and other vehicles involving carrying cargoes are also driven by robots, whereas settlers shall drive their own vehicles.**	**38**
7.1.0.0	Docking	Docking areas, cargo ships, passenger vehicles, research vehicles allow people, cargoes, and supplies to be transferred to the colony, which would contribute in the colony acting as a second home for the people.	To create a more organized and efficient system, vehicles are distinctly separated into categories according to the types of vehicles. Docking areas are customized according to the types of vehicles. For example, passenger vehicles would be led to passenger docking areas and facilities.	38
7.1.0.1	Warehousing	Warehouses must be near sites where construction or repairs exist.	This would reduce the amount of fuel required to travel to and from the warehouse. It would simply by more convenient and efficient for the majority of time.	38
7.1.0.2	Cargo-handling	Most of the cargoes would be handled by robots.	Cargoes are handled by the robots, which would calculate where to place the cargoes in the ships to reduce excess space. In contrast, they would also unload cargo and place them on vehicles to send them to their destinations.	38

	Requirements	Fulfillment	Justification	Page
7.1.1	Terminal Facilities	Terminal facilities are handled by robots and controlled by workers.	Robots would handle the cargoes and where the cargoes would need to go, while workers assist settlers and visitors with checking into or out of the colony. This would reduce time.	38
7.1.2	Activities	Many activities are designed for the public. They include recreation, resorts, restaurants, theaters, and amusement parks.	To fulfill means of daily lives, numerous activities are established as similar to those back at Earth to not only increase the amount of amusement, but also to prevent homesickness.	38
7.1.2.0	Rest	Resting quarters are designed for the pilots and workers of the colonies.	Resting quarters must be built near ports and working areas. These are the locations of the colony where the most life-threatening tasks are performed. Therefore, enough rest is essential for the pilots and workers in order to carry out such dangerous tasks.	38
7.1.2.1	Recreation	Tour buses are available every half hour. For long term residents, cyber cafes are also available. The library, a small shopping center, and parks are also available.	Electric tour buses would help publicize the colony, which would lead to an increase in the number of immigrants entering Columbiat. Cyber cafes would also allow people to communicate with people residing on Earth. They would help spread the news about Columbiat. Residents also have the option of visiting the library, shopping center, and parks.	38
7.1.2.2	Resorts	Two hotels are built in the two outer rings.	The hotels are built so that the distance between the hotel and the origin of the ring is the same as the distance between the hotel and the wall of the ring that borders space.	38
7.1.2.3	Restaurants	The design of the restaurants and the food will very much resemble that from Earth.	Food choices are accommodated according to the people's opinion, in order for the people to experience the uniqueness of dining in space while the feeling of eating on Earth remains.	38-39

	Requirements	Fulfillment	Justification	Page
7.1.2.4	Theaters	Theaters are built, so the people can constantly be updated about the entertainment and new movie releases from Earth.	This contributes in luring more adolescents and teenagers to live in Columbiat, since the they typically go to cinemas and theaters and watch new movies, which shows their most favorite actors and actresses. Not only do theaters attract teenagers, but it also attracts other people in all ages. Therefore, the theaters must provide the type of feel it does back on Earth.	39
7.1.2.5	Amusement Parks	Two amusement parks are established for the people.	In the amusement park, there are roller coaster rides, arcade rooms, food court, and a section reserved dedicated for infants and children. Another section includes an anti-gravity complex, where people may form into teams and play war games. This type of game would attract many people on Earth, thus increasing people coming to Columbiat.	39
7.1.3	Medical and Quarantine Centers	There is at least a medical and quarantine centers located in each of the rings of the colony.	Working and fixing parts in space may be more dangerous than it sounds. The amount of time to respond to a single miscalculation can lead to the fatality of many. Therefore, medical centers must be easily accessible for the people.	39
7.2	**Commerce and Financial Centers**	**The centers would involve business within the colony itself and with Earth.**	**Numerous types of offices would be built according to their uses and the types of companies that would support them.**	**39-40**
7.2.0.0	Office Facilities	Office sizes depend on the number of companies that will establish the offices.	Bigger companies would be able to finance bigger offices without the need of help from more companies.	39
7.2.0.1	150-Person Offices	Four companies would build 150-person offices.	These offices would be in charge of managing the finance and budget of the colony as a whole. Relations with the Earth also occur here.	39
7.2.0.2	100-Person Offices	Eight companies would build 100-person offices.	These offices would deal with how many ships can enter the colony a single day without disturbing the economy of the colony.	39

	Requirements	Fulfillment	Justification	Page
7.2.0.3	30-Person Offices	Fifteen companies would build 30 person offices	These offices include real estate type of finance. Their job shall be to assist the common people of the colony.	39
7.2.0.4	5-Person field Offices	Thirty companies would build 5 person offices.	These offices are in control of small businesses set up by the settlers themselves.	39
7.2.1.0	Banks	Banks are established for the companies, as well as for the settlers of Columbiat.	To encourage safety measures and prevent theft, it is best for the settlers to deposit their money into banks, which are heavily protected by hidden surveillance cameras and computerized password codes and locks to prevent theft.	39
7.2.1.1	Space-Based Companies	These companies' shall cooperate among themselves and with the Foundation Society to benefit the colony as a whole.	The companies shall give parts of their profits to the Foundation Society, which will use the money to fund projects, such as further expanding or upgrading the colony. It may also use the money to improve parks or waste collection.	39
7.2.1.2	Space Settlement Residents	The residents' lifestyles shall be no different than that on Earth.	The setting, buildings, recreation, parks, and the hospitals are designed to be similar to that on Earth, and the settlers shall not have any problem adjusting to the lifestyle in the colony.	39
7.2.1.3	Ships' Crews	Ships' crews and pilots would be similar to airplane pilots.	They would be provided with free service and housing in the colony. A special section in the hotels is reserved for the ships' crew and pilots.	39
7.2.2.0	Foundation Society Headquarters	The Foundation Society Headquarters exists in the Base and center of the colony, in the center ring.	The Foundation Society Headquarters overlooks and is responsible for the total control of every robot and event that relates to the colony. It controls the companies.	39
7.2.2.1	Business and Investment Empire	The Business and Investment Empire would often be obliged to hold meetings with the 150 person offices.	Refer to 7.2.0.1	39
7.2.2.2	New Settlement Opportunities	Real estate companies and offices are set up for people to visit.	Incoming settlers may visit the real estate centers to search for housing. During the time of searching for housing, the real estate company provides temporary housing for the settlers. The maximum number of days to reside in the temporary homes is 10 days. Afterward, they must be sent back to Earth if they do not find a house.	40

	Requirements	Fulfillment	Justification	Page
7.2.2.3	Settlement Services	Settlement services would involve the real estate, which is controlled by fifteen companies and thirty offices.	Daily waste collection is encouraged Refer to 7.2.0.3	40
7.2.3.0	Computer Networking	3 types of computer networks exist in the colony to increase security.	The Base of the colony has master control of all of the computer networks that exists in the colony. The second level type of computer network would be for workers and companies. They may only access their own level of networks. The third level of network shall be reserved for the residents at their homes. They are also restricted from accessing the other computer networks.	40
7.3	**Provisioning and Maintenance Base for Visiting Spacecraft**	**A crew of robots shall be prepared for each visiting spacecraft. They would constantly be on standby.**	**The robots would check for signs of damage on the exterior of the spacecraft and fix it. They shall also ascertain that there shall be no malfunctions on the computers.**	**40**
7.3.0	Fueling	Numerous fueling facilities are available throughout the colony for the people's convenience.	Many fueling stations are established ameliorate daily traffic. To reduce the amount of time spent at refueling the vehicles, robots are designed to refuel the vehicles.	40
7.3.0.1	Fuel Storage Facilities	Fuel storage facilities store hydrazine, nitrogen titroxide, helium-3, and deuterium.	Each fueling station would include all five of these fuel for the convenience of the settlers.	40
7.3.1.0	Maintenance	Maintenance crew is available in each of the ports.	The maintenance crew would be dispatched immediately if they detect that there is a malfunction in a vehicle. They would be deployed to fix the problem before the vehicles enter the colony or before the vehicles leave the colony. The crew would also be found at fueling stations for the same reason as the ones near the ports.	40
7.3.1.1	Cleaning	The cleaning crew is located in the fueling stations.	Since fueling stations are located throughout the colony, it would be best for the cleaning crew to be located at fueling stations.	40

	Requirements	Fulfillment	Justification	Page
7.3.1.2	Waste Collection	The waste collection crews are located near several of the docking areas.	The crew would be deployed every four hours. This would reduce the possibility of the spread of an outbreak throughout the colony. Keeping a sanitary colony would increase the population. After the crew accumulates the waste, they would be dumped at special areas in the colony.	40
7.3.1.3	Ships Repair	Ships repair are near docks. Vehicle repair centers are near fueling centers.	Ships pose as a risk to the structures within the colony if they are sent inside. Therefore, ships are repaired near the ports, where many of the required supplies are also located. Many required supplies are also located there. After the repair, vehicles may be refueled at the nearby fuel station.	40
7.3.2.0	Excess production	Some amount of excess production of food would continue to be on the market to be sold, until the date before expiration.	The food packaging would be checked every day in the morning. Packages found to have expired would be sent back to Earth to be taken care of.	40
7.3.2.1	Agriculture	Food and crops are grown at fields in the colony.	This would help reduce the expenditure of the colony. The food and crops would also be more fresh and healthy, without having to be shipped.	40
7.3.2.2	Supplies storage	Supply rooms would be near ports and near fueling stations.	This would allow other parts of the colony to appear more sanitized and organized.	40
7.3.2.3	Processing capability	Processing of the food would be handled by the robots.	Robots would harvest the crops and send them to food processing buildings where they are washed and packaged to be sent to markets.	40
7.3.2.4	Food crisis	At times of food crisis, the people may turn to the usage of excess production of food.	These food from excess production have been placed aside and saved for times such as food crisis.	40