NORTHDONNING HEEDWELL PRESENTS...

Bellevistar

"COME TO THE COSMOS!"

Edgewater High School
3100 Edgewater Drive
Orlando, Florida

20th Annual International Space Settlement Design Competition
Proposing Team Data 2013

Name of responsible teacher/advisor:	Carie L. Lopatka
School (or other Group Name):	Edgewater High School
School Address:	3100 Edgewater High School
School Address (2nd line):	
School City, State, ZIP or Postal Code:	Orlando, FL 32804
Country:	USA
Daytime Telephone at School:	407-835-4900
Message Telephone:	407-835-4900x6062505
Fax Number:	407-245-2758
e-mail address:	carie.lopatka@ocps.net
Last day of school before Summer 2013:	5-Jun-13

Contact information for responsible teacher/advisor when school is not in session:

Name if different from above:	
Address:	8440 Admiral Point
Address (2nd line):	
City, State, ZIP or Postal Code:	Winter Park, FL 32792
Country:	USA
Telephone (also evenings / weekends):	407-497-3184
e-mail address:	cl@awesomeguides.com

Name of alternate contact person (may be a student): Tyler Tripp
Telephone X day X eve X weekend: 321-278-3832
e-mail address: president.tempus@gmail.com

Names, [grade levels], and (ages) of 12 students currently expecting to attend the Finalist Competition:
(we request that participants be at least 15 years old, and not older than 19)

Tyler Tripp[12] (17)	Ashley Salva[11] (18)
Joshua Yandell[12] (17)	Jasper Zaporteza[10] (16)
Taylor Krublit[11] (17)	Paul Almodovar[12] (18)
Gina Dignam[10] (16)	Marjie Guss[10] (16)
Kim Pau[12] (18)	Marcus Smith[11] (16)
Ian Vanness[11] (17)	Wayne Hernandez[12] (18)

Names of two adult advisors currently expecting to attend the Finalist Competition:
Chelsea Rohrer Justin Sumpter

I understand that if our Team qualifies for the International Space Settlement Design Finalist Competition Aug. 2-5, we will pay for our own travel to/from Nassau Bay, Texas, USA.

Carie L. Lopatka April 19, 2013

Responsible Teacher/Advisor Signature Date

Table of Contents

EXECUTIVE SUMMARY

"[...]BECAUSE WHEN YOU GET OUT AND YOU LOOK BACK , YOU DON'T SEE THE UNITED STATES AND YOU DON'T SEE THE BOUNDRIES, YOU JUST SEE THE EARTH." -NORMAN CHAFFEE

Bellevistat

The Foundation Society's first venture, Alexandriat, has been a success as the first space settlement that supports human life. To keep Alexandriat's original purpose and core values, Northdonning Heedwell is proud to present the first major industrial center to further the space exploration and discovery, Bellevistat. Northdonning Heedwell hopes that this second settlement will provide for the major industrial needs and will be the future gateway for the rest of the Foundation Society's expansions.

Bellevistat has been created with the expansion of the industrial sector and the port facility in mind. The centrifuge will have possible expansion at both ends of it. The industrial center will be able to play with different gravities to see their effects on refining and production processes. Buckystructure production facilities have also been created to further play with the possibilities of the new material discovered at Alexandriat. The industrial sector will grow as the demand for industrial products increase furthering the efficiency and profitability of Bellevistat. The industrial docking facilities have been created to expand outwards and grow with the increase of industrial demand as Bellevistat grows. The docking facility also has separated out cargo and passenger unloading areas to improve the speed materials can be exported and imported from Bellevistat. Bellevistat is also proud to have a repair facility to ensure that the flow of industrial goods is not impeded by damages from traveling to and from the station. The repair facility has also been designed to expand beneath it to support the future large planetary ship assembly. This will support any possible future plans of the Foundation Society around the solar system.

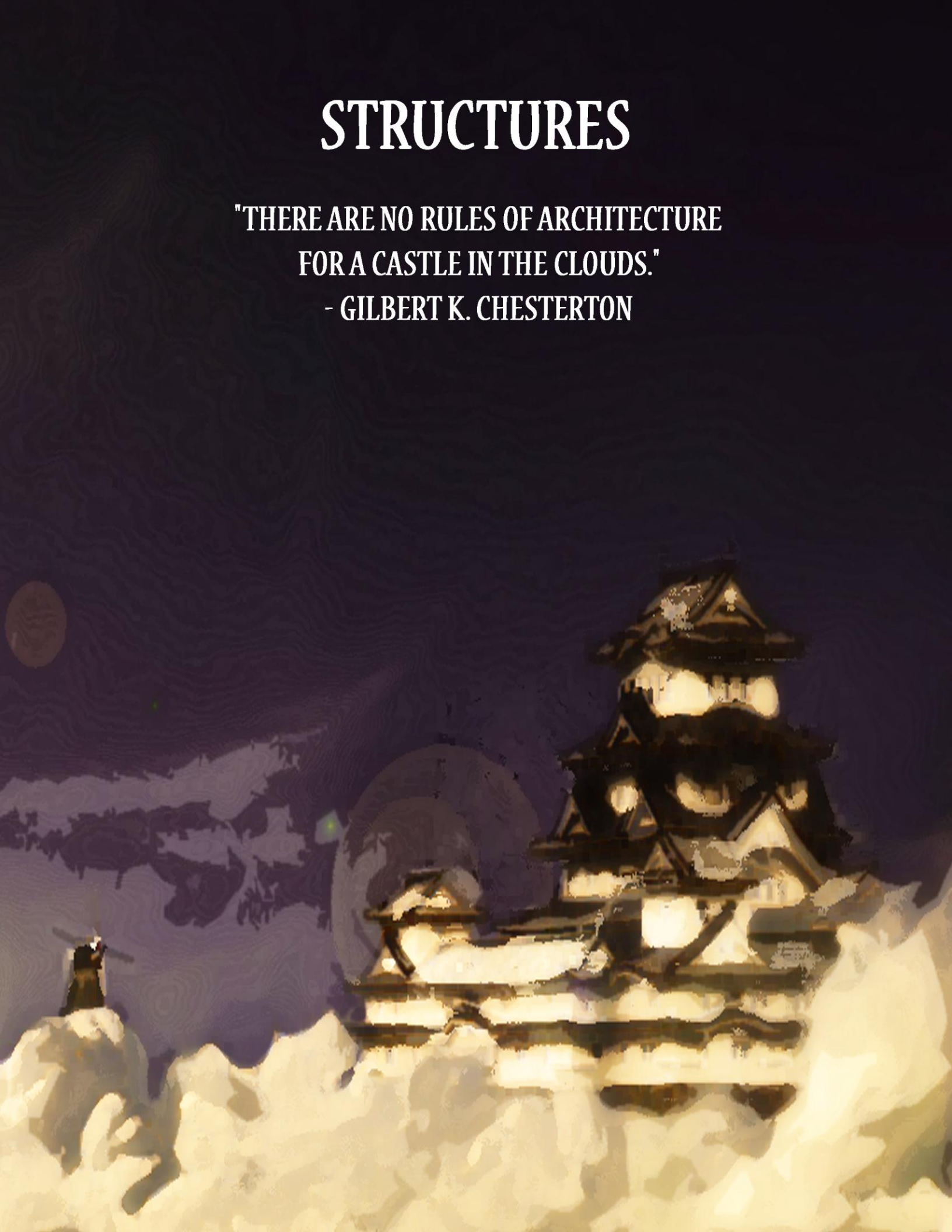
Even though industrial manufacturing is the main purpose of Bellevistat, the residential sector has not been overlooked as an important part of the settlement. The residential torus has been created to support multiple gravities to understand the effects each can have on the human body. This will help the Foundation Society gain an understanding of the human body in space for any future plans of expansion. Since the station is named after Bellevue, Northdonning Heedwell has put focus on supplying natural views to the residents of the settlement besides the basic needs of clean air, pure water, fresh food and shelter. The Grand Departure, a ride they go on upon arrival at the station, will give new residents or transients a view of the natural views that are around the station. Other features, like Spectacle in the Park and Melody Walk, will give residents and transients a view of natural beauty throughout the station. Transcendent Cosmos will give residents on the station a chance to view the cosmic phenomenon that occur naturally outside the station. Bellevistat also has an importance on making the residents and transients feel connected during the transients stay on the settlement. This method may possibly set a precedent for future designs to follow on the integration of short-term and long-term residents.

Automated features of Bellevistat reinforce the industrial aspects of the station. The automated abilities of Bellevistat will speed up the movement of goods throughout the station, from industrial docking to the industrial center and back, or finished products to the residential sector. The industrial processes are also all automated allowing quicker production and manufacturing of goods. The features provided through automation also allow easier access to docking by automating the docking for all visiting ships. The Tractim will assist in the docking of ships while the space tugs will help maneuver ships to the repair facilities. The automated elements of the settlement are designed to help maintain a happy, healthy population.

Bellevistat's design is focused on the current demand of industrial production and the future increase demand that will come with expansions. The industrial products produced by the station will ensure a safe investment for the Foundation Society. This will hopefully be the first of many successful business partnerships between Northdonning Heedwell and the Foundation Society.

STRUCTURES

"THERE ARE NO RULES OF ARCHITECTURE
FOR A CASTLE IN THE CLOUDS."
- GILBERT K. CHESTERTON



2.0 Structures

2.1 Exterior Configuration

2.1.1 Exterior Design

This image depicts the major visible features of the station.

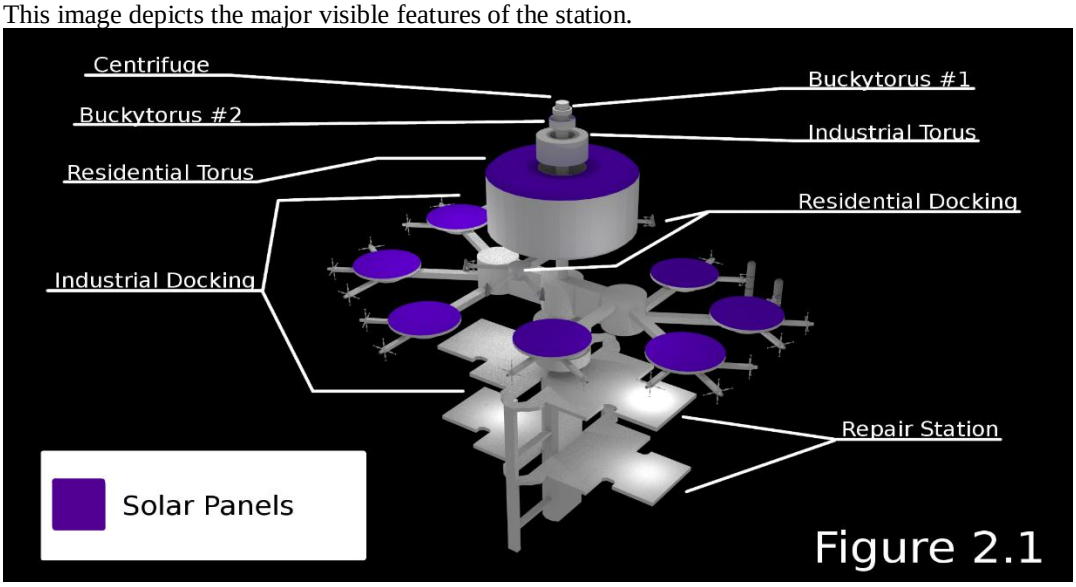


Figure 2.1

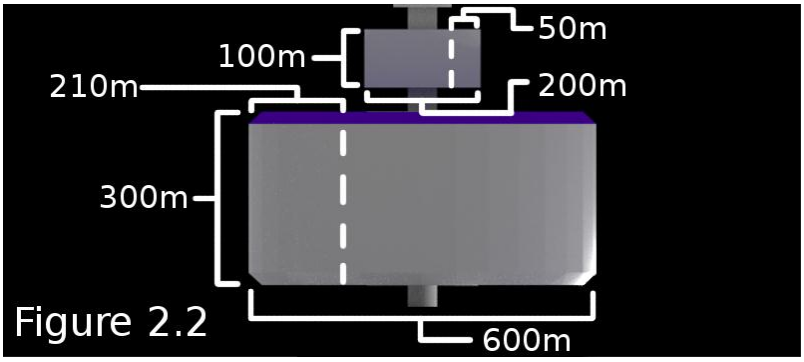


Figure 2.2

Figures 2.2 and 2.3 show dimensions for major features of the station.

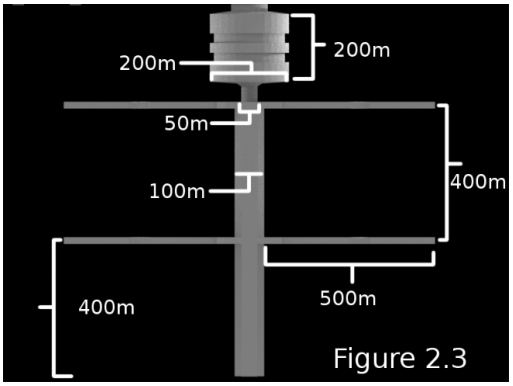


Figure 2.3

2.1.2 Construction Materials List

Table 2.1

Material	Amount Needed	Uses in Bellevistat
Maraging Steel	1.8×10^{10} kg	Structural support/ Magnetic tethering/ Internal construction
Regolith	4.4×10^{9} kg	Radiation Protection/Ballistic Protection
Silicon	1.1×10^{6} kg	Solar Panel Construction
Bamboo	2.2×10^{6} kg	Floors of buildings
Buckystructures (Silicon)	2.2×10^{6} kg	Walls of buildings/solar panel wiring
Glass	5×10^{5} kg	Natural views for several parts of the station

2.1.3 Hull Design

The hull design will be applied to all major volumes of the station. The outer layer of the hull will be maraging steel to provide a magnetic surface for tethering residents (see 4.3) to the outside of the hull. Regolith will protect against cosmic radiation and dampen ballistic damage. The last two layers of steel provide structural support for needed infrastructure space.

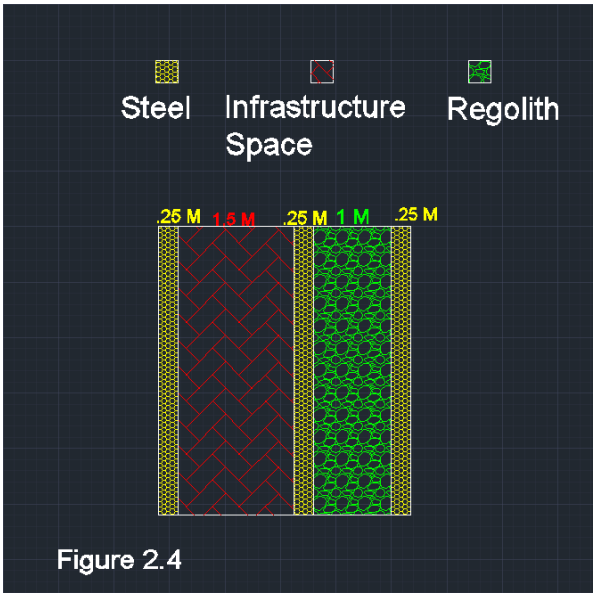


Figure 2.4

2.1.4 Non-rotating to Rotating Interfaces

An elevator will transport arrivals from the docking bays to a transfer station that will be located parallel position to the residential torus. Arrivals will then be put in a car that will accelerate to the angular velocity and position of the rotating spokes of the torus. They will then be transferred to the spokes' elevator and taken to their desired level of the torus. This process also applies to the industrial torus. See Figures 2.5 and 2.6

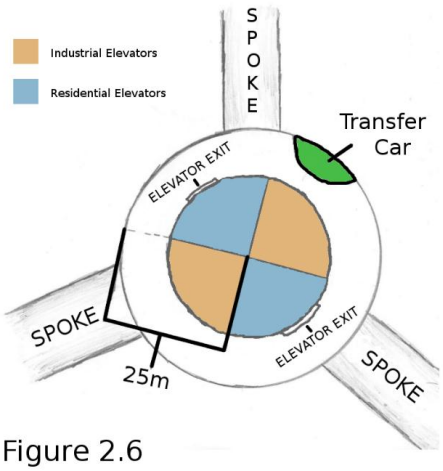


Figure 2.6

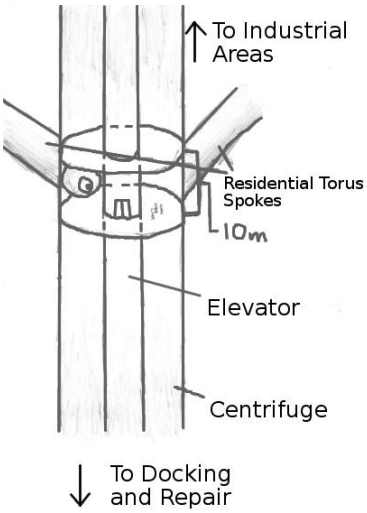


Figure 2.5

2.1.5 Volumes

2.1.5.1 Uses

Table 2.2

Volume	Uses
Residential Torus	Houses all permanent and transit residents, as well as support commercial and agricultural functions.
Industrial Torus	Refining any materials brought to station and constructing parts for interior structures and ship repairs.
Buckytorus #1	Production of buckystructures and store any extra products from the other production area and itself.
Buckytorus #2	Production of buckystructures
Centrifuge	Transport of materials and people in between sections of the station.
Residential Docking	Facilitates ships used for transportation of people only, to and from the station.
Industrial Docking	Facilitates ships used for the transportation of materials and products required for and resulting from industrial processes in the station.
Robot Bay	Houses all tug bots (see 5.5.1) for assisting damaged ships to repair docks.

2.1.5.2 Artificial Gravity

Gravity will be applied to the residential torus and buckystructure production torus. The residential torus will have three layers, each having gravities of 1g, 0.8g, and 0.5g, from the outermost to innermost levels. The buckystructure-production torus will have a gravity of 0.25g. Artificial gravity will come from the centripetal acceleration of the spinning torus. The torus will gain speed via detachable rockets.

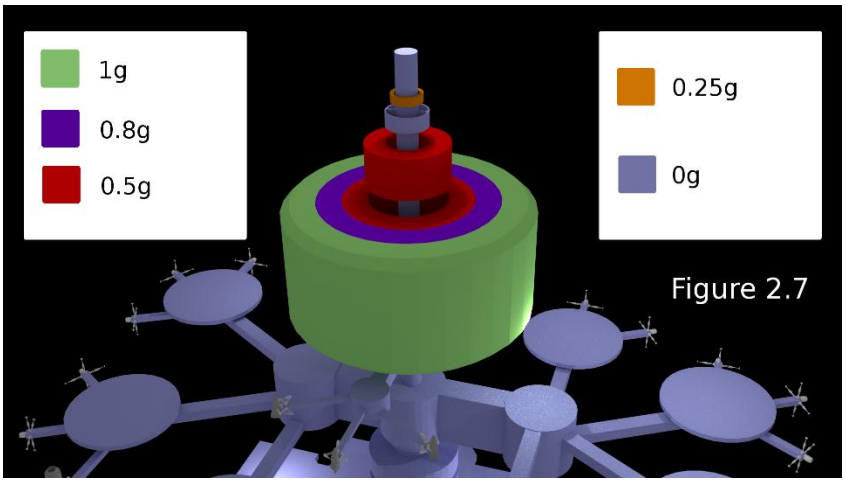


Figure 2.7

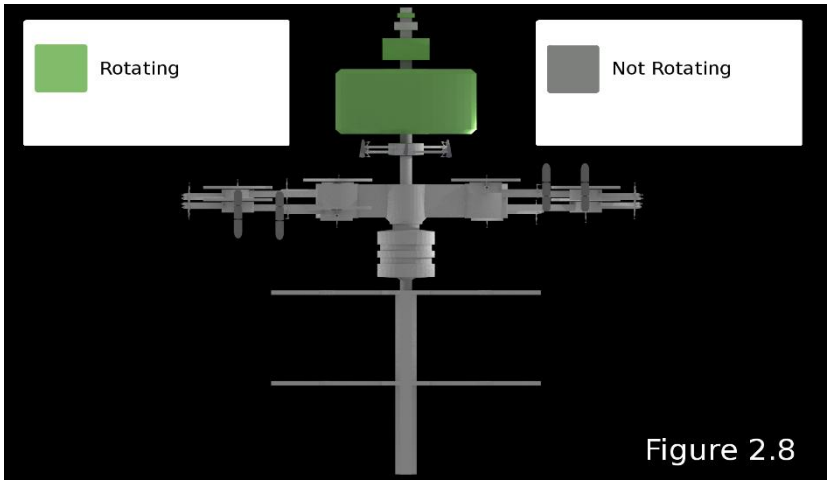


Figure 2.8

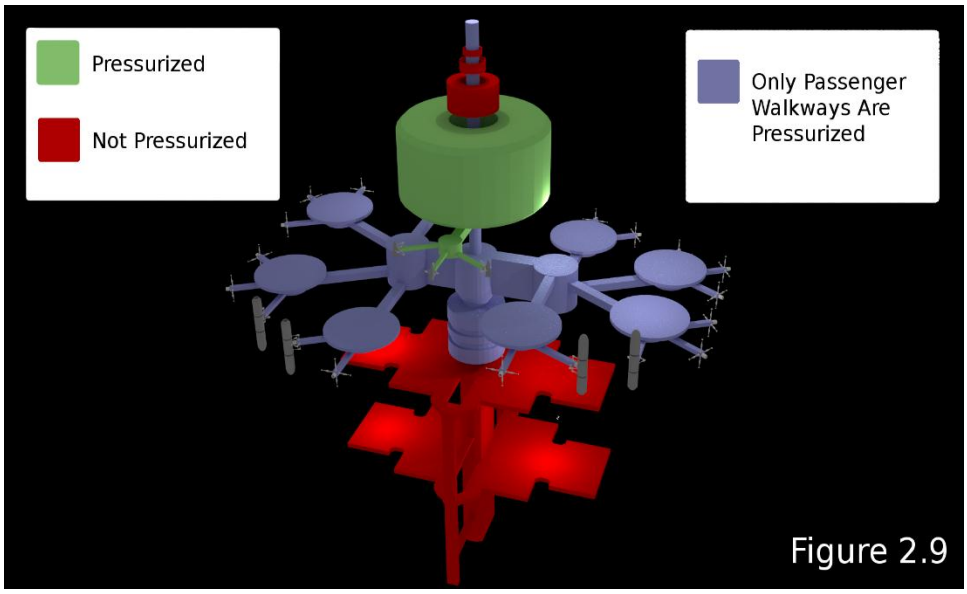


Figure 2.9

2.1.5.3 Pressurization

The residential torus, residential docking bay, transfer station, and elevators will be pressurized. The centrifuge, buckystructure production torus, industrial docks and repair docks will not be pressurized. For exact pressure measurements for different volumes and sections of volumes, see 3.2.1.

2.1.5.4 Isolation

Bulkheads will be located on each level of the station to prevent the spread of possible diseases, depressurization, and other unforeseen problems. The bulkheads will consist of 1m of maraging steel. There will be five bulkheads on each level, placed in equal increments around the down surfaces.

2.2 Internal Arrangement

2.2.1 Down Surface Layout

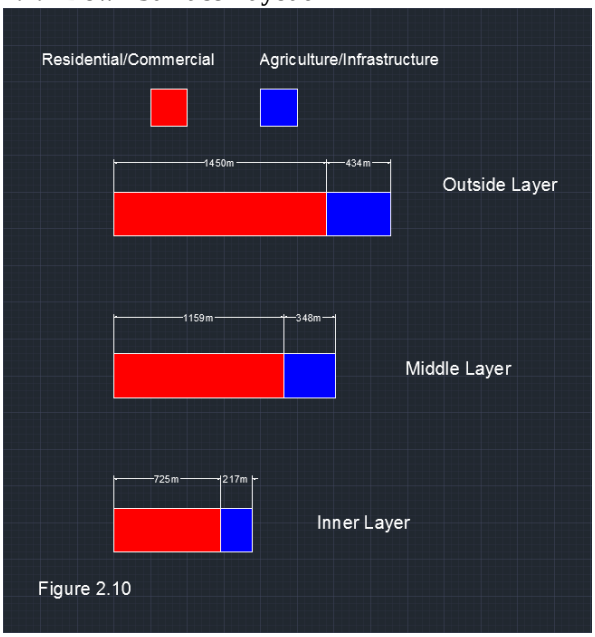


Figure 2.10

The torus will have 3 levels, each with different down surface areas. Each level has the same proportion of residential/commercial to agriculture/infrastructure areas. This will allow for easier transportation of food, water, waste, etc. to and from the two areas, as opposed to sending them to another level of the torus.

2.2.2 Orientation

This graphic shows the orientation of the down surfaces of the torus.

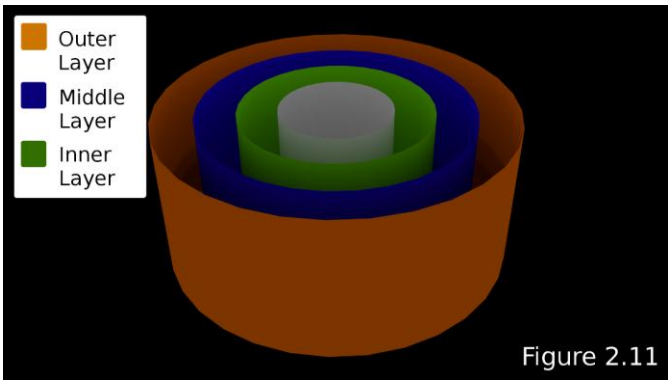


Figure 2.11

2.3 Construction Process

2.3.1 Exterior Construction

Table 2.3

#	Construction Phase	Description	Materials Needed	Projected Time
1	Patel	Centrifuge is built.	Maraging Steel, Regolith	May 15th, 2033-April 2034
2	Carlevaris	Mobile buckystructures torus is built.	Maraging Steel, Regolith	May 2034 - July 2034
3	Joli	Immobile buckystructures torus is built	Maraging Steel, Regolith, Buckystructures, Silicon (solar panels on north face)	Aug 2034-Sept 2034
4	Dahl	Industrial torus is built.	Maraging Steel, Regolith	October 2034-Dec 2034
5	DeGrailly	Industrial superior docking terminals and terminal bridges are constructed.	Maraging Steel, Regolith	Jan 2035-Mar2035
6	Calame	Industrial inferior docking terminals, space bridges, ship reception apparati, and secondary solar panels are constructed.	Regolith, Maraging Steel, Buckystructures, Silicon	April 2035-Aug 2035
7	Monet	Residential docking terminals, terminal bridges, and ship reception apparati are built.	Maraging Steel, Regolith	Sept 2035-Dec 2035
8	Lebourg	Residential torus is built.	Maraging Steel, Regolith, Buckystructures, Silicon	Jan 2036-Oct 2036
9	Harrison	Internal construction of residential torus and residential docking is built.	Buckystructures, Maraging Steel, Bamboo	Nov 2036- April 2037
10	Coulson	Repair station is constructed.	Maraging Steel	May 2037-Oct 2037
11	Hefferan	The residential, industrial, and mobile buckystructures tori will begin rotating. (see 2.3.2)	N/A	May 2037-June 2037

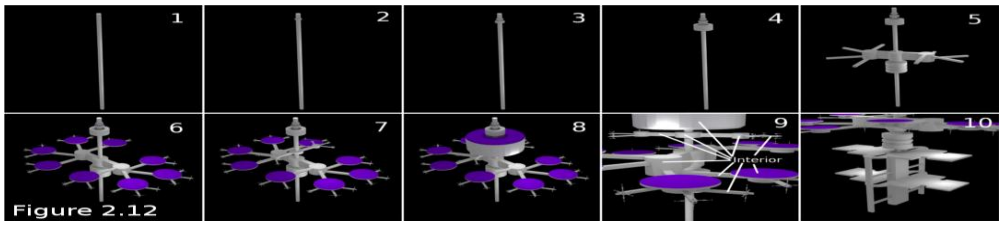


Figure 2.12

2.3.2 Initiation of Rotation

The rotating tori of Bellevistat will use staged combustion cycle bipropellant rocket engines based off of the NK-43 to initiate rotation, creating artificial gravity. These rockets have a high specific impulse, which will allow for easy evasion and rotation corrections in case of emergency. See Figure 2.13

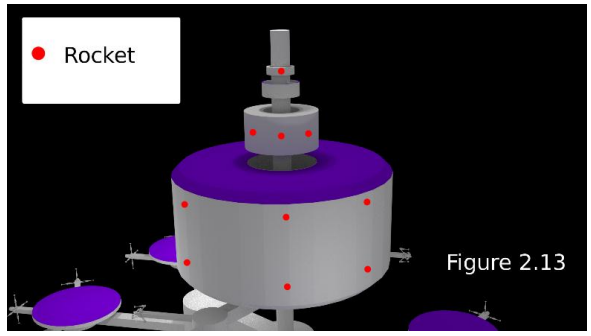


Figure 2.13

2.3.3 Interior Construction

Once the exterior construction of Bellevistat is complete, the industrial sections of the station will become fully operational. They will immediately start producing components for interior residential and docking structures out of buckystructures, steel, and bamboo. Components will be transferred to the residential torus and docking stations and will be used in construction by Armoire robots (see 5.1.3). After the interior construction is complete, industrial areas will be repurposed to produce other buckystructure products, which will only require a change in printing schematics.

2.4 Buckystructure Production Areas

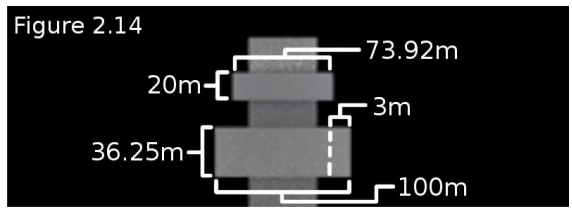


Figure 2.14

2.4.1 Locations of Production

There will be two areas for the production of buckystructures. One will be a mobile torus, dubbed Buckytorus #1, located at the very top of the centrifuge. The other will be an immobile torus-like structure, dubbed Buckytorus #2, located immediately below Buckytorus #1. Having two separate areas for producing buckystructures will make problems with production (hull breach, automation errors, etc.) less damaging to the economy and value of the station.

2.4.2 Transportation of Products

Raw materials will be transported from the industrial docking bay to both processing centers. There will be a set of elevators that travel up the main centrifuge and will transport the materials between the two facilities (see below). A transfer station similar to the one for the residential torus (see 2.1.4) will transport materials between the centrifuge and Buckytorus #1. After materials are finished, they will be transported either back to the docking bay or kept in storage area inside Buckytorus #1. The elevators will also deliver materials to and from the industrial torus as well as passengers to and from the residential torus. (See figure 2.15)

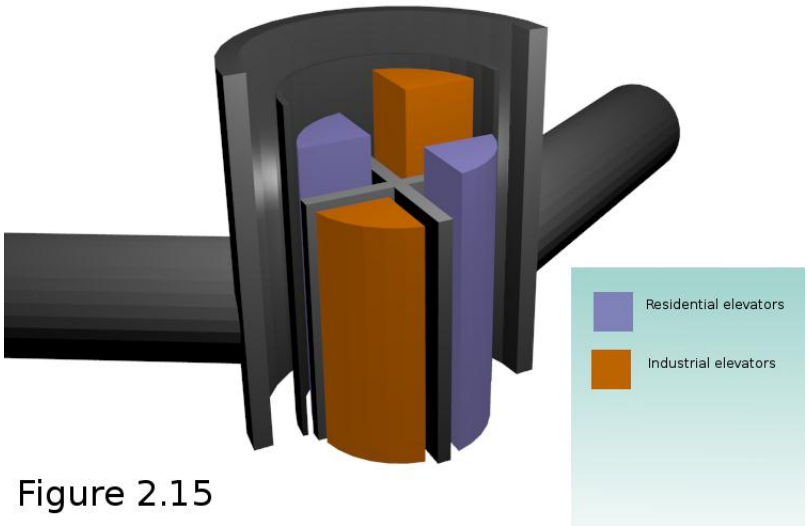


Figure 2.15

2.5 Docking Configurations

2.5.1 Industrial Docking

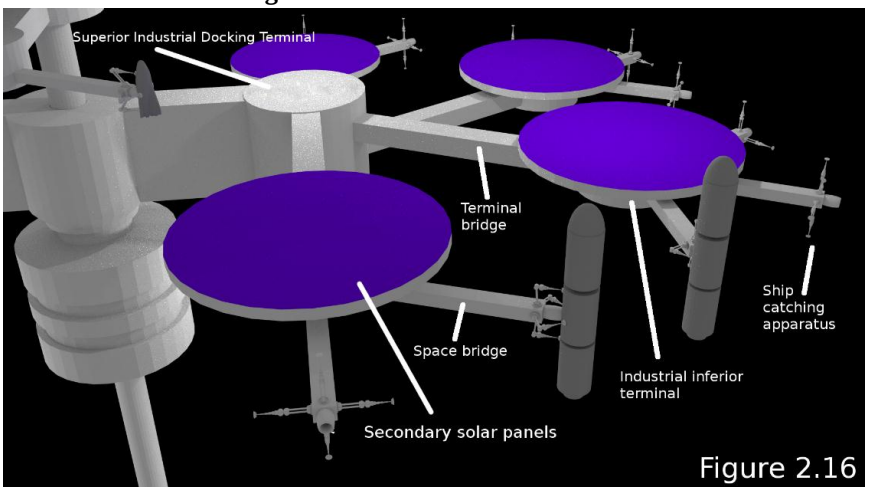


Figure 2.16

Once the cargo ship has been docked with the help of the Ship Catching Apparatus, the cargo will be sent down the Space Bridge into the inferior terminal. Inside the terminal, the cargo is processed (see 5.4.1) and sent to its desired location, which could be the terminal bridge or any other ships connected to the same terminal. A similar process is utilized in the superior terminal, where any cargo can then be transferred to the centrifuge (see 2.1.4, 2.4.2, and 5.4.1 for details on transportation of cargo to manufacturing areas). Solar panels will be used to power processes inside the terminals as well as throughout the entire docking process and other sections of the station.

2.5.2 Residential Docking

Once docked, residents will board The Grand Departure (see 4.5), which will take the through the jet bridges, inside the docking terminal, and to the centrifuge where they will board the elevators up to the residential torus. See Figure 2.17

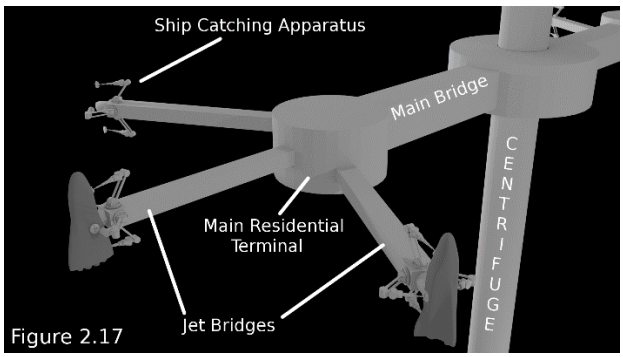
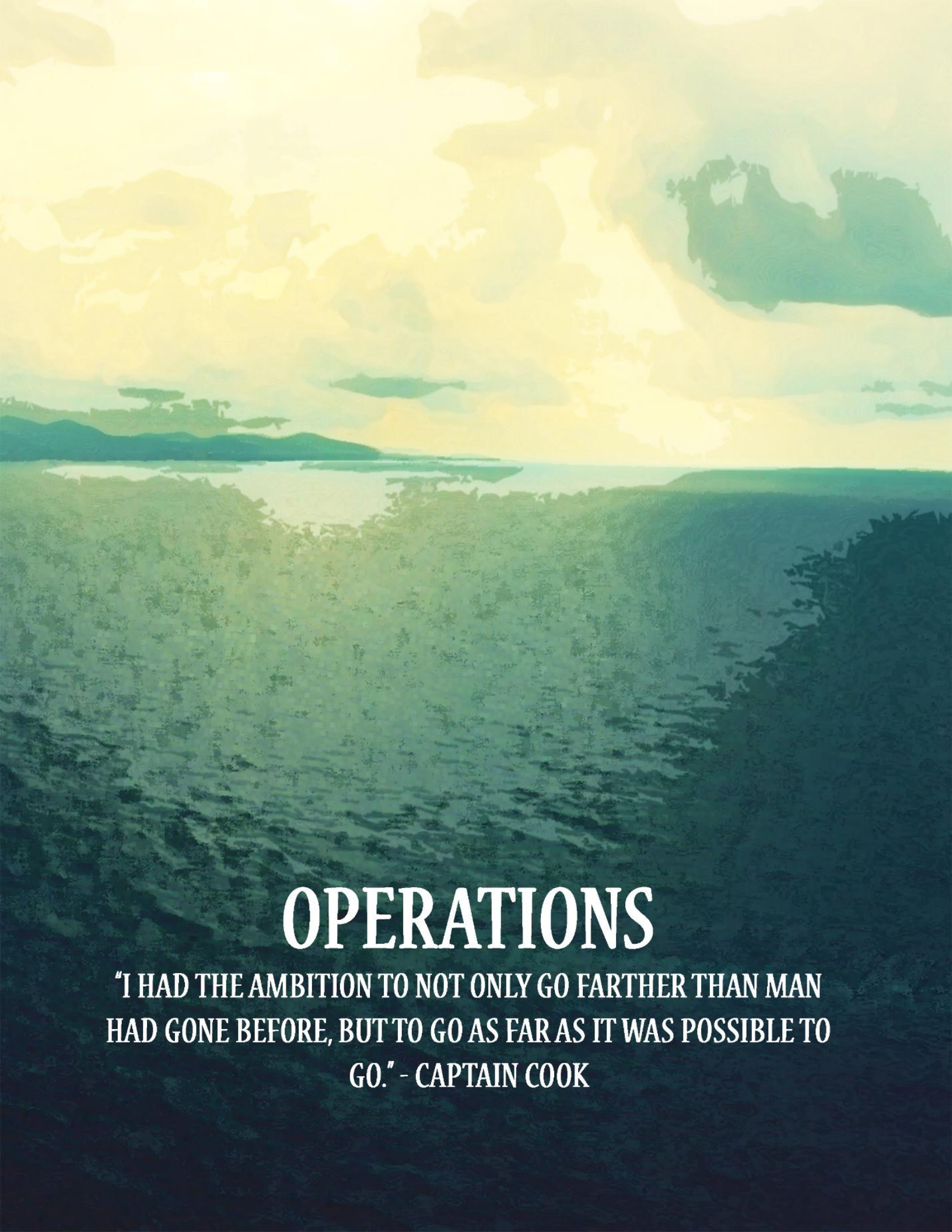


Figure 2.17



OPERATIONS

"I HAD THE AMBITION TO NOT ONLY GO FARTHER THAN MAN HAD GONE BEFORE, BUT TO GO AS FAR AS IT WAS POSSIBLE TO GO." - CAPTAIN COOK

3.0 Operations

Operations and infrastructure will provide systems for an efficient and safe environment for the inhabitants of Bellevistat.

3.1 Materials and Equipment

3.1.1 Materials List

Table 3.1 Materials

Materials	Purpose	Source	Quantity
Steel	Hull	Earth	18 X 10^9 kg
Regolith	Hull	Moon	1.2 X 10^9 kg
Maraging steel	Structural support/tethering	Earth	8.5 X 10^9 kg
Silicon	Solar panel construction	Moon	5 X 10^8 kg
Buckystructures	Thermal insulating; Electrical conduction; walls	Bellevistat	6.3 X 10^8 kg
LEDs	“natural” lighting system	Earth	1.2 X 10^7 kg
Aluminum	Trees	Earth	3.1 X 10^4 kg

3.1.2 External Transportation of Materials

The majority of Bellevistat’s materials will come from Earth, flown to low Earth orbit by Tranportatus (see 5.1.1), and then brought to L4 by Bellevistat’s space tugs. Regolith and silicon will be shipped in directly from the moon.

3.2 Basic Infrastructure

Bellevistat operations will use the most efficient and safe methods to provide for a healthy environment for those inhabiting Bellevistat.

3.2.1 Atmosphere

Level	Pressure	Quantity (m^3)
Outer Level	1 atm	3053628.59
Middle Level	0.8 atm	33080970.64
Inner Level	0.6 atm	13571680.26
Residential Pathways	0.8 atm	167.225472

Bellevistat will be broken down into three pressure groups of 1, 0.8, and 0.6 atm. Due to the need to separate these various pressure zones we will provide transportation between these rings using a series of pressurization and depressurization chambers (see 3.2.7). Humidity will be kept at 45 percent for optimum comfort. The atmosphere will consist of a composition of 80% nitrogen and 20% oxygen. An automated system will control the temperature of the station (see 5.2.1) but will include changes to emulate day and night (see 3.2.8). Buckystructures will be utilized for the purpose of thermal control due to their unique thermal insulating properties.

To cleanse the carbon dioxide out of the air and into usable oxygen, carbon dioxide scrubbers will be utilized. To remove the CO_2, the air goes through an aluminum tank where the solvent, ethanolamine, bonds with the CO_2. This is pumped to the agricultural sector where the plants transform the CO_2 to oxygen and is routed back to the residential area. These scrubbers will be located within the trunk of artificial trees both providing a view for the

residents of Bellevistat and symbolizing the purpose of actual trees. These “trees” will be placed throughout all three levels of the residential torus (see 4.1.2).

3.2.2 Food Production

Table 3.3 Agriculture

Product	Grams per person per day	Kg produced per year	Kg for 2 week contingency
Grown food (grain, fruit, vegetables, legumes)	2200	9234500	346701
Meat products	650	2728375	104099
Total	2850 g	11962875 kg	460800 kg

Food for Bellevistat’s residents will be produced by dynaponics, a highly efficient form of hydroponics where oxygen is supplied directly to the roots through bubble jets. This setup offers exponentially more efficiency over conventional farming. Crops will be tended by robot harvesters; there will be no need for weeding or any soil upkeep (see 5.2.1). For meat and proteins, animal stem cells will be brought from Earth and grown in vitro to be developed into muscle cells and formed into various cuts of meat through 3D printing. The crops to feed Bellevistat’s population will occupy 190,000 square meters, with another 10,000 square meters of farmland for bamboo and cotton, which will be used for clothes and building materials due to their light weight and strength. The agricultural production will take place within each level of the residential torus. The food will then be distributed via a tube system to appropriate areas. These tubes will run beneath each level of the torus and supply food coming from the agricultural area to both restaurants and homes.

3.2.3 Power

.

Table 3.4 Power

Power Use	Amount Allocated
Residential	25 MW
Agriculture	1.5 MW
Life Support	2.5 MW
Industrial	1 MW
Automated Processes	20 MW
Total	50MW

Bellevistat will be powered primarily by a solar panel array covering the sun facing side of the residential torus. Thin single-layer solar panels will be constructed on site out of crystalline silicon and buckystructure wires. The array will provide the required 50 megawatts to meet all of the station’s power need with an extra 2.5 MW worth of inactive panels in case any are damaged. In the event of any major power failure, a thorium fueled nuclear reactor will activate to provide up to 15 MW to keep industry, life support, agriculture, and lighting and other essential functions running. Thorium requires outside intervention to maintain fission, and will sit inert the rest of the time. Additional arrays may be constructed on the docking station as needed for expansion

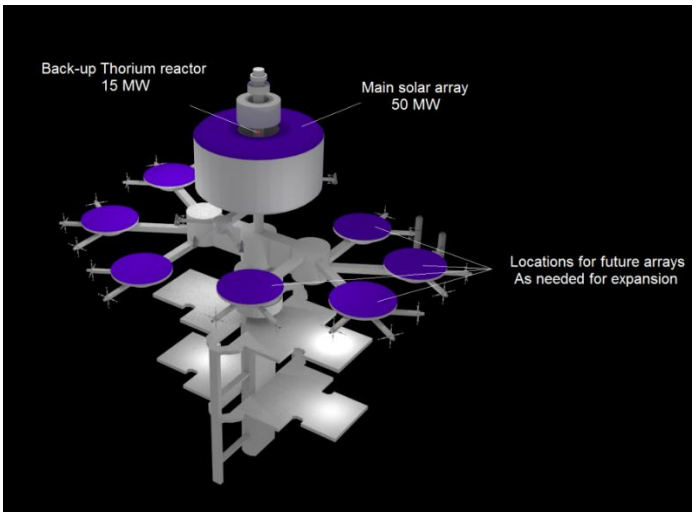


Figure 3.1 Power Diagram

3.2.4 Water Management

Water will travel to the water management center which is located on each level with agriculture and be sent through microfilters to remove large matter. Reverse osmosis will be used to filter out particles and ions out of the water. Waste materials found in the water will be taken to the waste disposal system via a system of ductile iron pipes that are pressurized via a water pump. The water will then go through a series of bactericidal UV lights that will eliminate pathogens within the water. Water storage will be divided within the neighborhoods of the station and kept recycling through using the process in the figure below. Per neighborhood, the water will be kept in an automated pressurized tank. If water were to become contaminated from a specific neighborhood the cycling process will be terminated. A contingency supply of water will be provided for said neighborhood by redirecting surplus from surrounding neighborhoods in via AC pipes. A filtration straw will be provided if a station-wide contamination occurs (see 5.2.1).

Table 3.5 Water Amount

Purpose	Amount
Agricultural	63500 L
Residential	235293 L
Contingency	279414 L
Total	578207 L

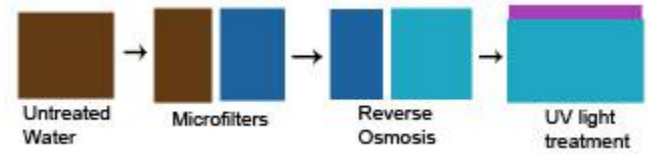


Figure 3.2 Water Treatment Process

3.2.5 Waste Management

Bellevistat will be able to eliminate large amounts of waste by using the Micro Auto Gasification System (MAGS) device. With this device Bellevistat can compress and burn any organic waste, both solid and liquid, into compressed ash and biochar, which can be used as a fertilizer for Bellevistat's agricultural purposes. The gases that are created in the chamber include carbon monoxide, carbon dioxide, hydrogen, and methane, which are burned up in the reaction to produce electricity and steam. This device is self-powering due to this reaction. Pyrolysis allows this waste to burn without the presence of oxygen, which is what makes the byproduct of the reaction usable char. Liquid chemical waste will be treated and separated in the water treatment processes we will also utilize (see 3.2.4). Solid waste as previously stated will be destroyed in the MAGS chamber. Solid industrial wastes such as metals, plastics, and glass will be recycled and reused to create a sustainable environment within Bellevistat. These materials can be melted in the desired form and stored until they are needed.

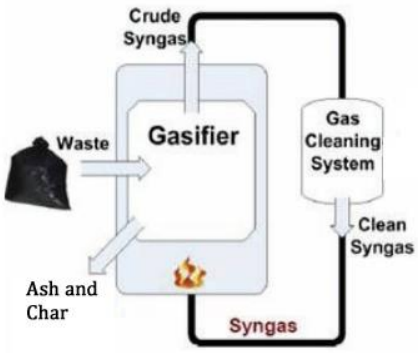


Table 3.6 Waste Amount

Waste Source	Approximate Amount (Metric Tons/Year)
Residential	8,350 tons
Industrial	4,400 tons
Agricultural	550 tons
Total	13,300 tons

3.2.6 Communication

Bellevistat will communicate with Earth through a high bandwidth laser communication array, which will provide residents a limited connection to Earth's internet. (See 5.3.4) Residents will be provided with Ecrans, a communication device made of flexible willow glass. They serve as a smartphone for basic use, and can unfold into a tablet or laptop as needed by the users (see 5.3.1). Wifi will be accessible throughout the station, and a cloud storage system will securely save all of the residents' important data.

Table 3.7 Communication Devices and Amount

Device	Purpose	Location	Quantity
Satellites	Communication with Earth	In Earth orbit	3
Ecrans	Internal communication	On residents	12000

3.2.7 Internal Transportation

Within the residential torus there will be stations where the residents may check out transportation vehicles with the option of recumbent tricycles, scooters, or roller blades. The bikes will include a battery power that will utilize humans' kinetic energy they exert while bike riding. The bikes are recognized to each person via internet in their Ecran (see 5.3.1). Once the bikes are returned to the station then the energy will be drained out of the battery and used in the main power supply. The energy of how much resident will be available on Ecran interface as to promote exercise (see 4.1.2). The roller blades will also have a spring attached in order to help residents brake. Helmets will be provided for all residents at the stations. Within the rings there will be disbursements of stations where residents will be able to choose their preferable transportation vehicle. According to the circumference of the rings within the residential torus the stations with be within increments of one fifth of a mile (see 4.1.2). Between the rings pressurized elevators will be used in order to maintain the varying pressures within the station.

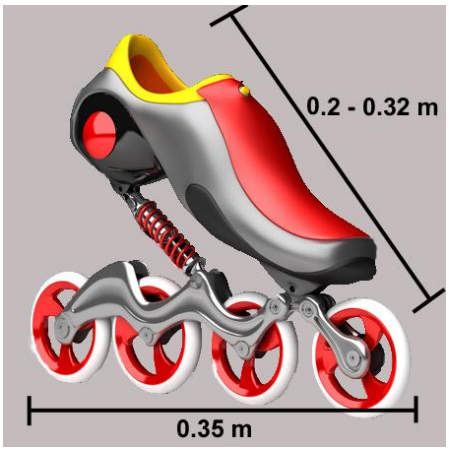


Figure 3.4 Rollerblades

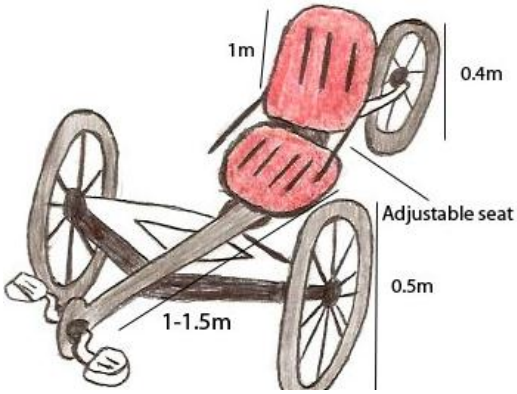


Figure 3.5 Recumberent Tricycles

3.6 Scooter

Table 3.8 Vehicle Amounts

Vehicle	Amount
Bikes	3000
Scooters	1000
Rollerblades	2000
Total	6000

3.2.8 Day/Night Cycle

Table 3.9 Day/Night Temperature

Time of Day	Temperature
Day	23° C (73.4 °F)
Night	18 °C (65 °F)

Corvalents will be used to provide a day and night mechanism by regulating internal temperature (see 5.2.1). The day and night ambiance will be simulated with a 2700 K color LED screen with a backlight. Using the LED screen will be most appropriate because it will give the residents a natural lighting system without simulating an unneeded Earth view. This system will also be utilized to display announcements to the community as necessary (see 4.2.2).

3.2.9 Storage

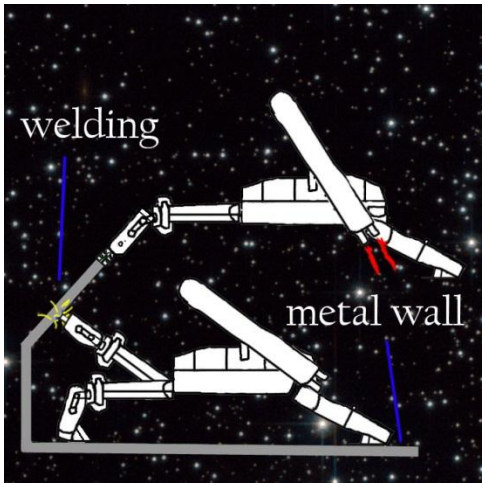
Table 3.10 Contingency Plans

	Contingency
Food	Two weeks' worth of food will be stored at all times in case of blight, brief exposure to high energy x rays will kill any bacteria or mold, and slows ripening and maturation, food will then be refrigerated.
Grown Food	346701kg
Meat Printer	104099 kg

Vehicles	A surplus of 500 of each vehicle will be kept aside in the residential torus.
Water	Surplus water from other neighborhoods will be used if a contamination of a single water treatment center occurs. If a station wide contamination occurs a filtration straw will be supplied (see 3.2.4, 5.2.1, and 4.1.2).
Power	In the event of a power failure, a Thorium nuclear reactor located in the centrifuge between the industrial tori that will activate to provide emergency power for life support, agriculture, industry, and lighting and other essential functions.
Air	The plants for agriculture will recycle CO2 back into oxygen, having farms on each level, they will keep CO2 levels at a safe tolerable level even if the carbon dioxide capture and filtration system fails.

3.3. External Assemblies and Bots

The Bellsator (see 5.1.2) will be responsible for constructing the hulls of the station, composed of steel and regolith. They will be able to manipulate the metal hull pieces and are equipped with ion welding beams to join metal segments. For the regolith portion, they will apply fine regolith in layers, similar to a 3D printer, in order to construct a firm, homogenous layer of space rock



3.7 External Assemblies and Bots

3.4 Paper Supply

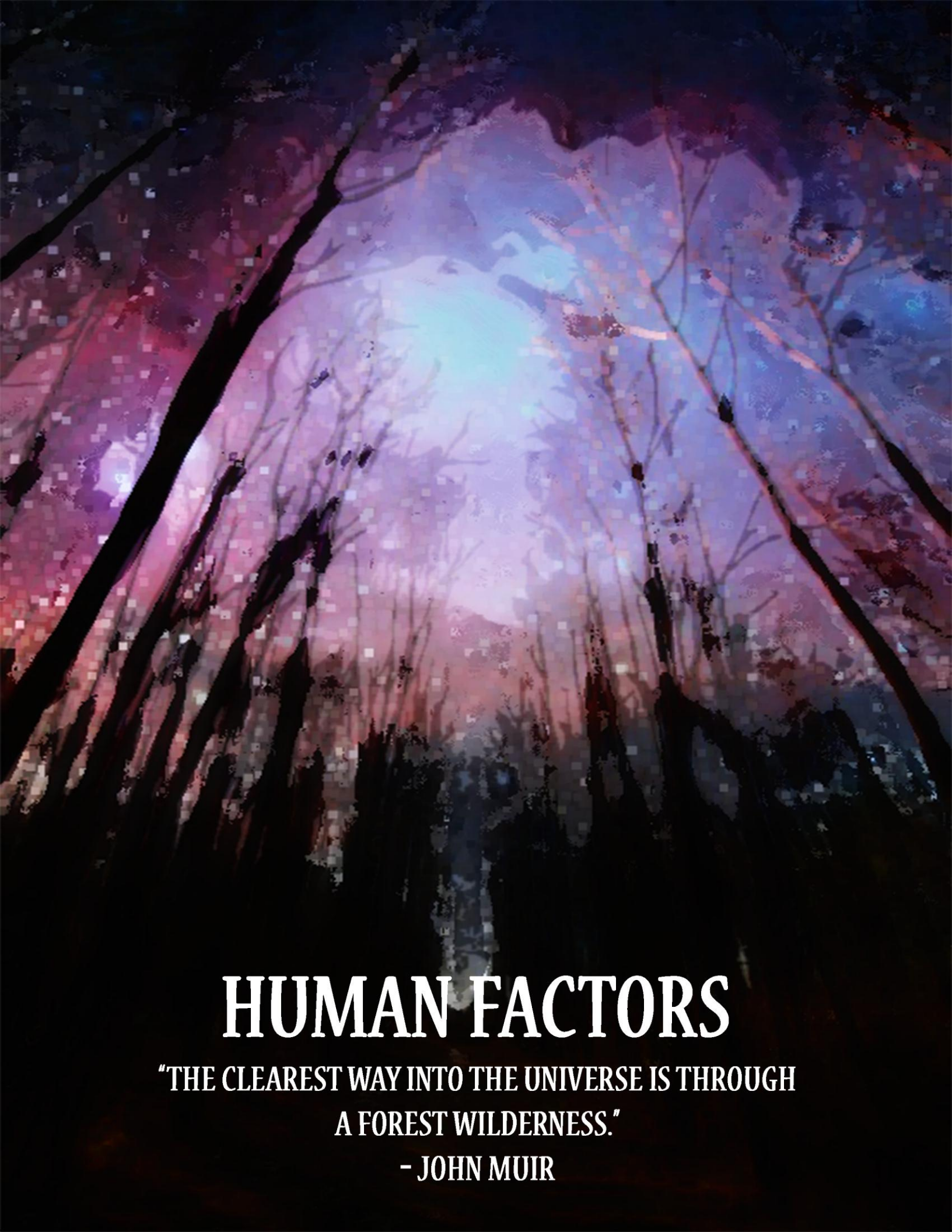
Cyanobacteria with modified organism strains will create paper by secreting cellulose under lights provided for synthetic sunlight. The cyanobacteria will be produced in a hollow tub with water. The plights will include three fluorescent lights to every incandescent as to provide light from both ends of the spectrum. The red of the spectrum helps plants to mature while the blue end prevents premature elongation. These cyanobacteria will be kept in three meter by three meter storage units. Cellulose will be extracted via the mixing of ionic liquids of 1-butyl-3-methylimidazolium chloride (BMIMCl) and 1-allyl-3-methylimidazolium chloride (AMIMCl). After extraction the ionic liquids will be recovered and reused. The cellulose will then be made into a pulp and spread into sheets to dry. A cellulose harvester automates this process (see 5.2.1). Pure cellulose is the most tenacious type of paper available. After residential use the paper will be returned to the same area and go through a recycling process as needed. Before the initial process of recycling, the paper will be divided based on weight. This process includes the adding of water to shredded paper to make a pulp and the refinery of that. The paper will end drying on the same platform as the paper that was made and redistributed throughout the station as necessary including providing for the walls of Bellevistat.

Table 3.11 Paper Processes Materials

Materials	Amount	Source
Cyanobacteria (in 3x3 m containers)	300	from Earth
Fluorescent Bulbs	2700	from Earth
Incandescent Bulbs	900	from Earth
Ionic liquids	900 L	from Earth
Industrial Curating Lab	1	Assembled on Bellevistat

3.5 Repair Docks

Repair services on Bellevistat will be fully automated. Once the visiting ship is docked, a computer will be able to scan the ship's malfunctions using backscatter x-ray transmissions. If a part is damaged a 3D printer and an electron beam freeform fabrication will be on hand to provide the appropriate part. Soleils will be on hand to fix any type of error (see 5.2.1). The repair docks will differ from the unloading/loading docks that with the repair docks the ship is not connected directly to any volumes of the station. Repair docks are located farther away from the industrial and residential tori in order to provide optimum safety precautions.



HUMAN FACTORS

"THE CLEAREST WAY INTO THE UNIVERSE IS THROUGH A FOREST WILDERNESS."

- JOHN MUIR

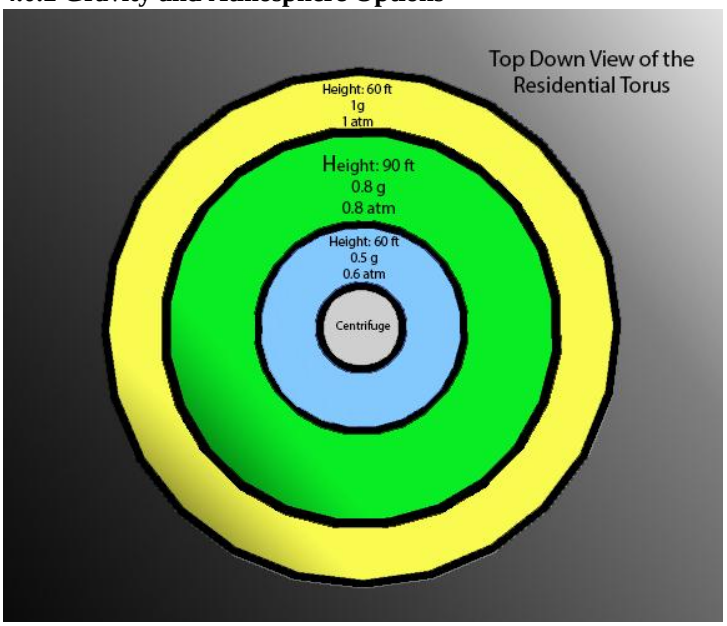
4.0 Human Factors

Bellevistat aims to be a revolutionary community by creating an environment reminiscent of urban Earth while embracing all the new opportunities brought from our unique situation and location to enhance daily life. A focus will be put on allowing residents to appreciate the natural beauty of both Earth and the cosmos as they live day-to-day in our luxurious, state-of-the-art communal venues and residences. And with an emphasis on residential cohesion, even transient populations will feel like a true member of the community with the beautiful view.

4.0.1 Natural Sunlight/Views of Earth, Moon and Sun

Passengers exiting the residential dock will be able to view natural sights in full when they are transported from the docking area to the residential torus via windows inside of the jet bridge. Within the residential torus, streamed natural views will encompass the outer walls of each residential ring like "windows". These windows will also be incorporated into various communal venues to emphasize the natural beauty of the surrounding environment. Furthermore, residents will have access to a stargazing facility within the central business district of the station (See 4.1.2 and 4.5 for more details).

4.0.2 Gravity and Atmosphere Options



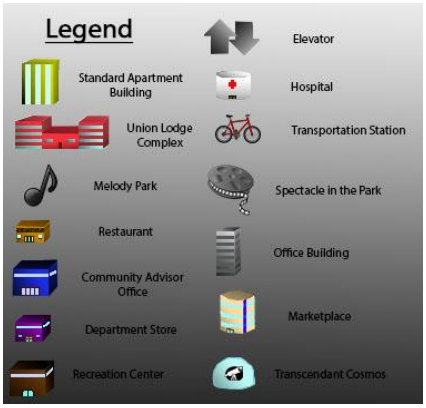
Depth of each ring: 277.17m.

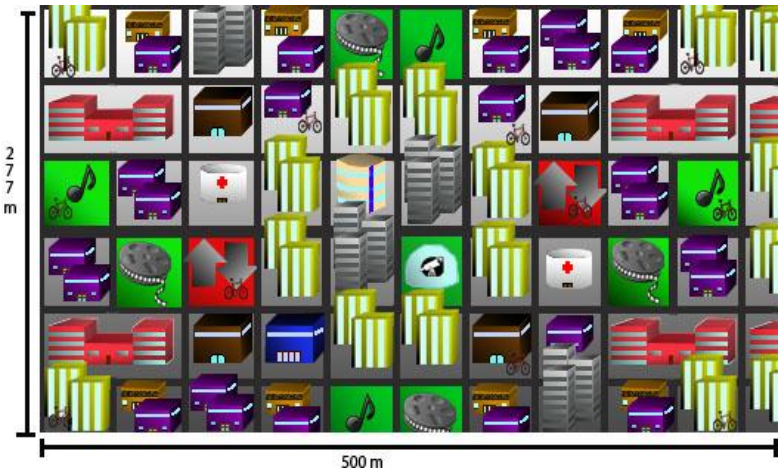
Using an artificial gravity system and pressurization (refer to 2.1.5.2, 2.1.5.3 and 3.2.1 for details), residents will have the option to live in areas with a low, medium and regular atmospherical pressure and gravitational force setting.

4.1 Community

4.1.1 Map depicting the Community Layout

Roads will be allocated 8.5% of the available surface area.





4.1.2 List of Community Services and various Amenities

Bellevistat will use various public amenities to enhance the comforts of Earth with the wonder of space. To do this, we supply a variety of venues that include open areas with long lines of sight, making additions to urban city concepts to make them into modern space settlement hotspots. Botanical Bistros, a series of themed cafes, will be available on the outer ring of Bellevistat. Residents will be able to order a meal and pay from their provided tablet and then pick it up at the food station so they can have a meal under the outer space sky. These meals will be prepared routinely and systematically for optimum efficiency, while maintaining all the flavor and care of a home-cooked meal. Bellevistat will also offer frequent community events (refer to 4.4.2) as well as entertainment features. These include the outdoor media viewing site called "Spectacle in the Park" as well as the "Melody Walk" that takes residents through a natural journey of flowers accompanied with music. A prominent site for community gathering events is the "Transcendent Cosmos", an enclosed dome area in which the surroundings of the station will be projected upon the ceiling in panorama fashion, creating a stargazing atmosphere for viewing cosmic phenomena. In addition, a variety of community services will be located in the multitude of "Union Lodges" (refer to 4.4.1). One of these events requires residents to team up to paint sectioned pieces of a lodge wall, and the community will vote on their favorite. This contest will have a theme each time and the winners get free tickets to a show at the Spectacle in the Park. The virtual nature expedition using virtual reality glasses and an interactive moving walkway called Didactic Adventure Simulator creates different wilderness terrains that give some of the required exercise called for on the station. Department stores will be available to sell clothes made on the station and those brought to the station from Earth. Transients can trade their "Earth clothes" for those that are made on the station. This will create a sort of thrift shop for the community that serves as a way to bring the station together (refer to 4.4.2).

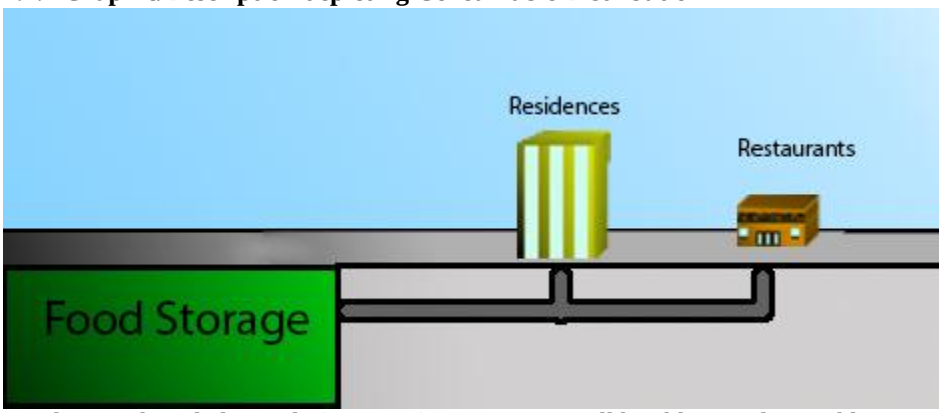
Individually, the residents will have a phone-like device called the Ecran that folds into a tablet. These can be used to do anything from day to day activities like grocery shopping to simple communication and diverse entertainment (refer to 5.3.1). The Ecran, as well as screens in the Union Lodge, will run Earth news to keep residents in touch. Transportation Stations (see point 3.2.7), which will provide recumbent tricycles, rollerblades and scooters to maneuver around the station, will also encourage exercise as well as giving a natural mode of transport. The energy created while using the transportation system will be stored in battery packs that can be plugged in at the Transportation Station near their destination. Later on, when the resident wants to go somewhere else, they can check out another mode of transport to get going to their next destination. The Ecran interface (refer to 5.3.1) will keep track of how much power residents are producing, encouraging them to keep exercising and help the community. Additionally a regular exercise regimen will be in place to maintain the residents' bone density and muscle mass for optimal health. Gyms around the station and workout areas at the Union Lodge (refer to 4.4.1) will top off the exercise options. Throughout the community there will be structures that look just like trees and filter carbon dioxide to be transformed into oxygen (refer to 3.2.1), serving the aesthetic and literal purpose of trees without taking up resources.

On every ring of the station there will be two hospitals to minimize the reliance of just one location for illnesses. These hospitals with contain FLAR robots to fill nursing roles which will also be available for housebound residents to aid in illness recovery. (Refer to 5.3.1 for more details on aforementioned bots.) In addition to robots that will assist in the community, Voiture bots will be available to maintain cleanliness in public areas. If water contamination occurs in a treatment facility then surplus water from a neighboring area will be pumped to the area in need. In the case of station-wide water contamination filtration straws (refer to 5.2.1 and 3.2.4) will filter the water and ultralight treat it.

4.1.3 Consumer Goods

Categories	Amount Required per Year	Description	Source
Toiletries	1,956,923 items	toothbrushes, toothpaste, hair brushes, etc.	Earth
Clothing	677,794 Items	shirts, shoes, pants, undergarments, footie pajamas, etc.	Earth, Bellevistat
Food	6,103,024 kg	proteins, fruits, vegetables, dairy etc.	Bellevistat
Medicinal	633,655 products	pharmaceutical, herbal, over the counter etc.	Earth

4.1.4 Graphic/Description depicting Consumable Distribution



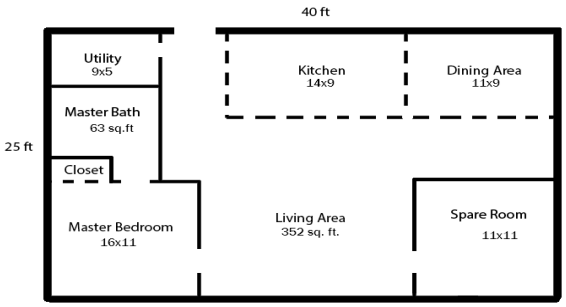
Raw food ingredients will be distributed to homes, restaurants and other various food vendors via a tubing system. (Refer to 3.2.2 and 3.2.9 for more info.) Residents will be able to order a variety of ingredients for meals with their personal devices, as well as order a specific quantity of snacks or desserts weekly to supplement their daily meals (see 4.2.3). Restaurants will be able to order weekly quantities of ingredients based on their menus and projected consumer demand. Toiletries, clothing and medicinal products will be available in their respective vendor locations across the community.

4.2 Housing

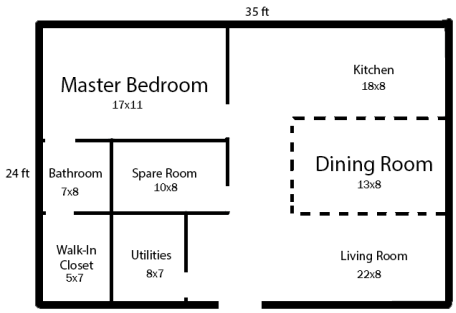
4.2.1 Floor plans depicting the variety of residences and their quantities

Note: All units will be in feet for floor plans.

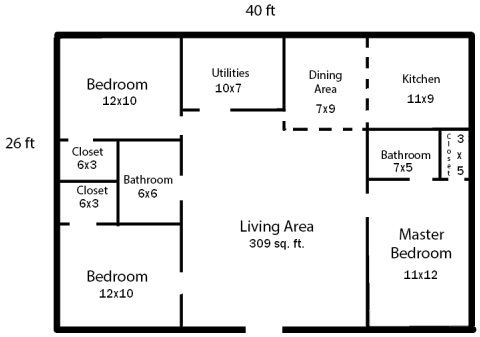
Type: Singles/Transient
Total sq.ft: 1000
Quantity of Design 1209



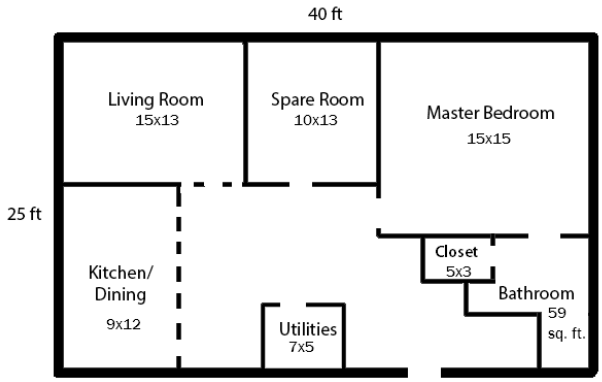
Type: Singles/Transient
Total sq.ft: 840
Quantity of Design: 1209

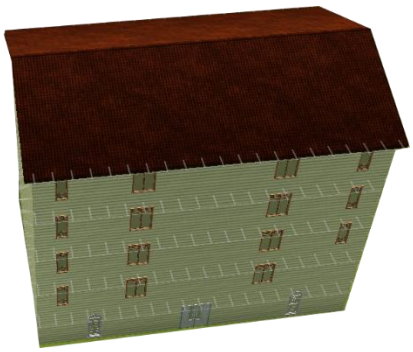


Type: Family
Total sq.ft: 1040
Quantity of Design: 1467

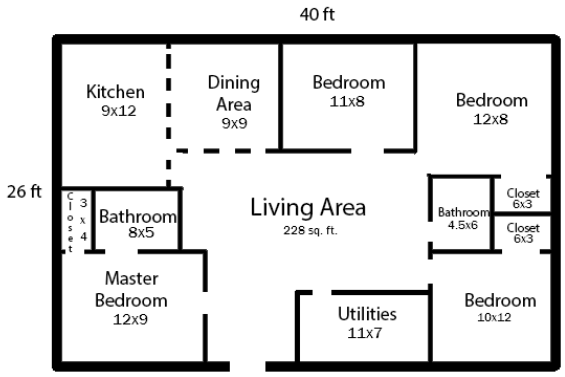


Type: Singles/Transient
Total sq.ft: 1040
Quantity of Design: 1209

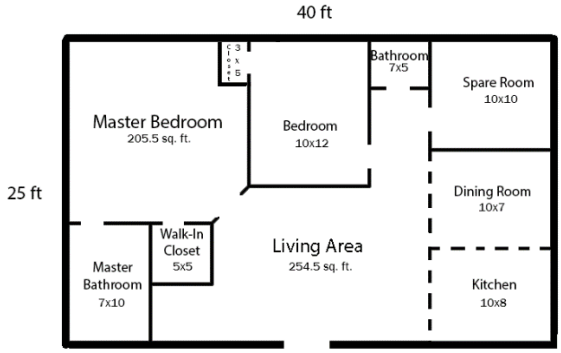


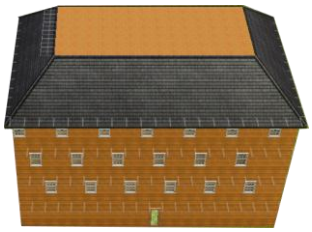


Type: Family
Total sq.ft: 1040
Quantity of Design: 1467



Type: Small Family
Total sq.ft: 1000
Quantity of Design: 1467





4.2.2 Housing amenities

Residents can flip a switch to have water "rain" down onto their window pane that will collect under the window and be cycled back to keep trickling, reminding them of Earth. Buckystructures and paper (refer to 3.4) that are made on the station will be used to build the walls, keeping sustainability high and costs low (refer to 2.1.2). Bamboo will also be grown on the station (refer to 3.2.2) to build furniture, clothing, decor and even the flooring. A scale in the shower floor will be in each bathroom that will keep track of any weight gains or drops as well as vitals, bone density and muscle mass. The exercise and food regimen will modify if necessary to reflect health changes. In the living rooms, floor to ceiling screens that can serve as a computer, television or game system. Kitchens will be designed in a space efficient manner, with appliances that can be tucked out of sight allowing more counter space for use in daily cooking. Groceries can be ordered either through a resident's personal device or through a tablet interface within the kitchen and will arrive in a chute to be placed where needed (refer to 4.1.4 and 3.2.2). The dirty dishes will be put inside a special cabinet that will dry wash the dishes (refer to 5.3.1) in order to save water. Bellevistat homes will conserve water and space by having dry cleaning machines in the homes, which wash and dry the clothes in one cycle.

For a variety of tasks residents may need inside of their residences, MLAR bots will assist with anything that the human wants or needs. (Refer to 5.3.1 for more information.)

4.2.3 Charts of Material Sources

Categories	Description	Source
Furniture	Couches, chairs, shelving, and cabinets.	Furniture will be made of bamboo and cotton which will both be grown on the ship. Steel will be imported to help reinforce bamboo for items as needed.
Appliances	Showers, toilets, sinks, washers, dryers, dishwashers and refrigerators	Showers, toilets and sinks are going to be constructed out of reinforced plastic that will be imported from earth. The washers and dryers are going to be imported directly from Earth. See 5.3.1 for more information about the Sanseau and the FLux (the dishwasher and refrigerator, respectively).
Amenities	Gaming consoles, floor to ceiling television screens, speaker systems, and entertainment systems.	The majority of the home amenities will be imported from Earth.

4.2.4 Growth over time

Bellevistat will consider population growth of about 5.5 % and accommodate for this in housing, food and other necessities. It is estimated that the population will grow from 11,000 to about 17,000 residents over ten years, so space to add more housing is allocated as such. Food will be made as needed, meaning that Bellevistat can sustain the growing population.

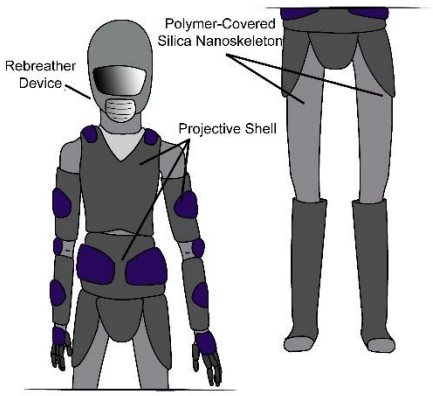
4.3 Safety Systems

4.3.1 Space Suits and Suit Safety Designs

The custom-fitted space suit utilizes resistance technology in the limbs to reduce muscle atrophy and bone loss. These state-of-the-art space suits contain 300 feet of tubing that makes efficient use of water cooling while simultaneously producing energy. This is done with thermoelectric nanocrystal-covered polymers that cycle in a way where it conserves heat and releases electricity. These polymers keep the water continuously pumping. This

conserved heat is kept in by a polymer-covered silica nanoskeleton that also serve to insulate against extreme temperatures and protect against radiation. If the suit gets ripped, it is designed to release chemicals in its polymers to seal the tear. The suit's exterior is a protective shell that prevents organ damage from counterpressure in its form-fitting foam. If the user is incapacitated, the space suit (refer to 4.3.1) will detect one's vital signs and the jetpack will override the mission and take him or her to the nearest airlock.

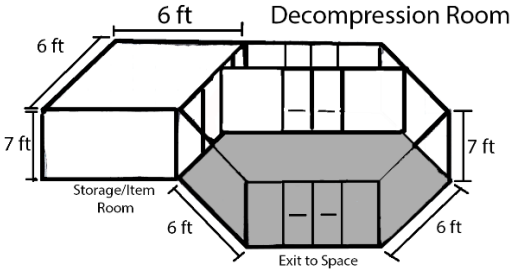
Instead of oxygen tanks, an oxygen layer is built into the materials of the suit and a rebreather device is integrated in the helmet. The inner layer is a cooling system in which water flows through thin tubes to keep an individual cool. Specialized tape repairs damage to the suit if the self-healing fails. If the damage is too severe, there is a warning system that signals the control room for immediate aid. There will also be bots that will be sent out to help the individual in any other urgent situation that arises as long as the individual is conscious and able to speak with the control room via an internal communication device located in the helmet. Also, each individual will have Propero devices (see 4.3.3) in order to help said individual get around.

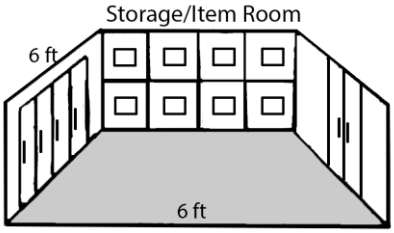


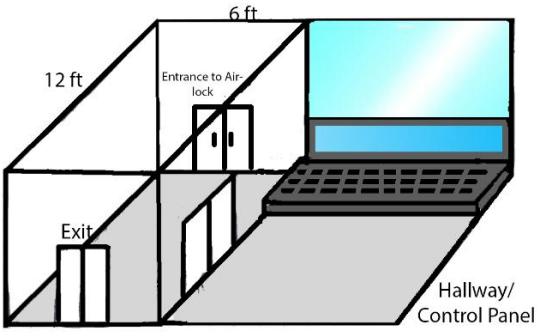
4.3.2 Airlock, pressure systems and airlock safety precautions

The airlock is divided into three components: the item room, decompression room and the control room. The item room holds all space suits along with the corresponding helmets. It also is equipped with lockers, so individuals exiting the room can safely store their items. The item room serves as a dressing room for aforementioned space suits. In the control room, Bellevistat scientists control everything that occurs in the decompression room. Said scientists can check on the health of individuals in the decompression room thus ensuring their safety while also making sure the individual in the decompression room gets decompressed properly.

Airlock Safety Precautions/Pressure Systems: After the individual is suited up he/she will enter into the decompression room. The decompression room is sealed tightly after that. It will go from 101 kilopascals to 70.3 kilopascals which last for 24 hours at least. The individual have to breathe in a mask and prebreathe pure oxygen air before 1 hour before exiting into space. Pressure gradually decreases then the individual can go into space.







4.3.3 Exterior Mobility device designs

To ensure safety in case of exterior inspection or repair jobs for the tori that require human input, a tether line attached from the inside of the airlock to the worker's personal suit as well as electromagnetic glove devices will allow workers to cling to the surface of the rotating hull. To reach the repair/inspection location, the workers will use an autopilot jetpack device, referred to as the Propero. The Propero is designed to allow humans to leave the space station and to maintain the space station from the outside. The backpack's six thrusters will be controlled by an autopilot system. The destination coordinates will be determined by the human's decision by (insert rectangular arm thing here). If the human goes out of boundaries of the area of his coordinates, he is automatically stopped and redirected back into the boundary. Manual overdrive can be done if the human takes both joysticks from the sides of the backpack. These connected joysticks allow the astronaut to control his thrusters on all three planes.

4.4 New Resident Integration

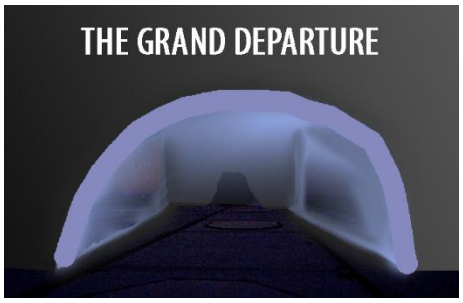
4.4.1 Physical Community Features for Transient Integration

Within Bellevistat, there will be fifty 'Union Lodges' which will be the hub of community services with respect to the social aspect of transient integration. The union lodges serve as a physical place where the residents and transients can mingle in a more casual way, as opposed to crowded community gatherings. It also will contain information about the many casual events that go on inside of Bellevistat as well as the many places that are on Bellevistat for the purpose of the community together (see 4.4.2 for more details). It can hold a variety of small scale activities such as art and music classes and community created club gatherings. Bellevistat will also have numerous venues that can contribute to the physical need for integration (see 4.1.2 for more details).

4.4.2 Social Feature for Transient Integration

Bellevistat will have a group of community advisors who can plan communal activities. These advisors will be able to decide when and where these activities will be appropriate. The community advisors will focus on bringing the transients and the permanent residents together in a cooperative manner, helping bond residents together on common grounds. A few of these many events will take place at 'Transcendent Cosmos', an area where the residents can congregate and watch a variety of the beautiful events that can be viewed from Bellevistat's position in space. 'Spectacle in the Park,' the sit-in movie/live action stage, will also serve as an area for the residents to come together to enjoy performances and movie showings in an expansive area with a clear view of the stars in the back drop. The Union Lodges are a place that the residents will have to be able to come together outside of the planned community events. It will also be a constant source of information about the many amenities on Bellevistat, such the thrift shops in which allow transients to exchange Earth clothing and fashion items for those made on the station. This particular location will help bridge a social gap between the residents and transients by becoming a hub of both station and Earth trends and fashion. Bellevistat residents will also be able to keep up with community events on the station with the LED lighting screen across the ceiling of each residential level. It will allow community advisors to announce upcoming and ongoing community events as needed, in turn making sure the residents are up-to-date with all of the happenings within the station. In addition to this, Bellevistat's residents can always keep up with local and Earth news with their mobile devices.

4.5 Passenger Receiving Experience



Once passengers land at the residential docking port, the Grand Landing, residents will be transported to their homes efficiently into their new homes with via the vehicle called the Grand Departure. This line of vehicles will safely transport newly released passengers by using a premade track in the zero gravity environment, taking them across the jet bridge, to the main centrifuge for transportation and finally to the residential torus. During this ride, the soon-to-be residents will fully enjoy the natural views that are available from the windows in the jet bridges while an intercom system will entail what these residents can expect once within the station. Luggage will be transported to homes using the maid bots, MLARs. These bots can use their scanners to identify who the luggage belongs to and where their new home location is.

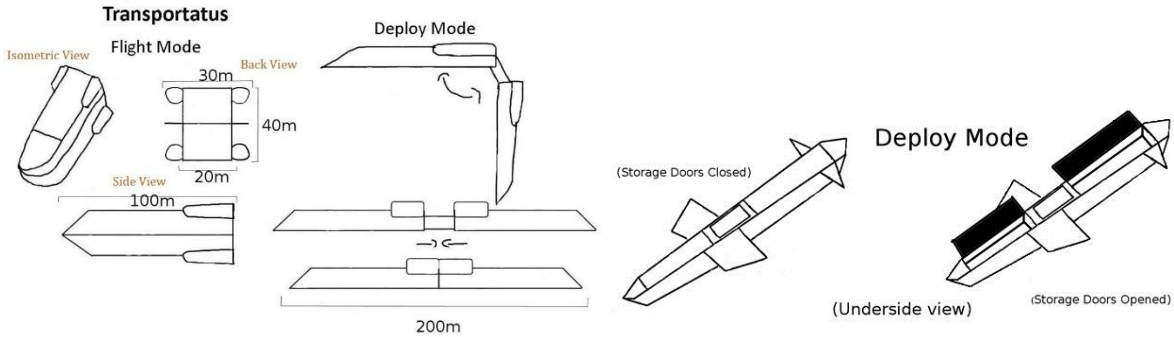

AUTOMATION
"ANY SUFFICIENTLY ADVANCED TECHNOLOGY IS INDISTINGUISHABLE FROM MAGIC."
-ARTHUR C. CLARKE

5.0 Automation Design and Services

5.1 Automations for construction process

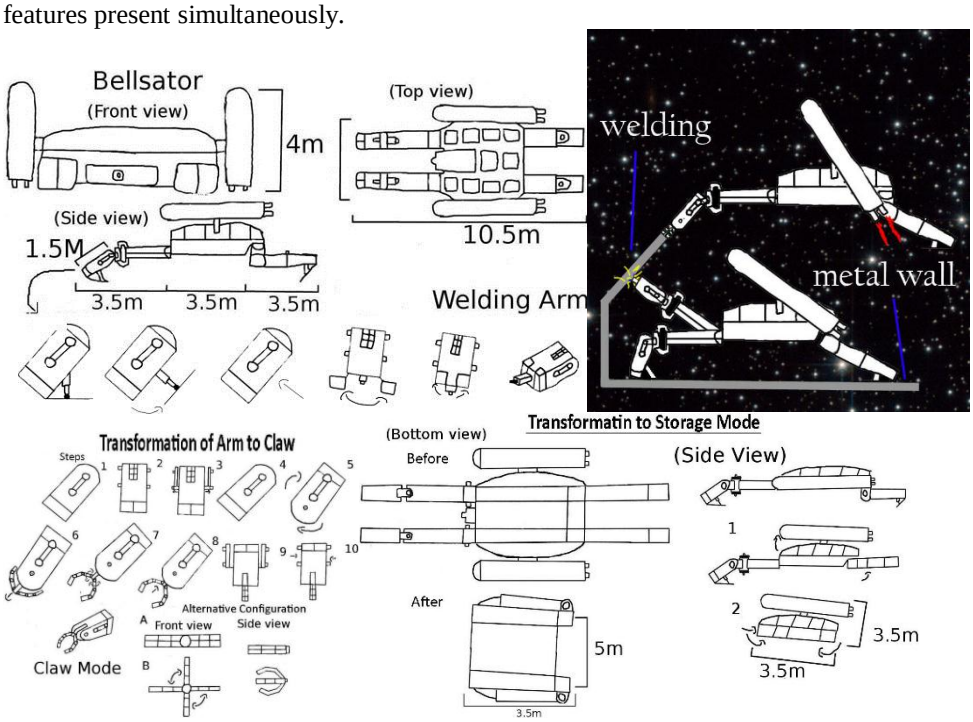
5.1.1 Delivery of Materials and Equipment

Bellsator and needed materials for construction will be delivered via Transportatus from Earth. Once it reach L4 Lagrange, Transportatus will split its rockets and open the storage panels deploying Bellsators and construction materials. Bellsators will then initiate construction sequence. When construction is complete, Transportatus will be used to transport materials and utilities for Bellevistat.



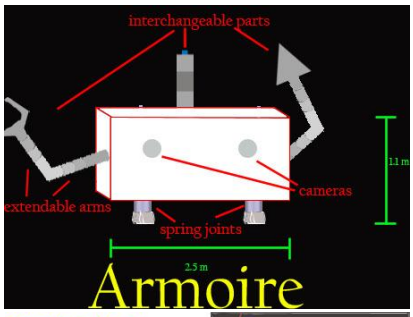
5.1.2 Exterior Construction

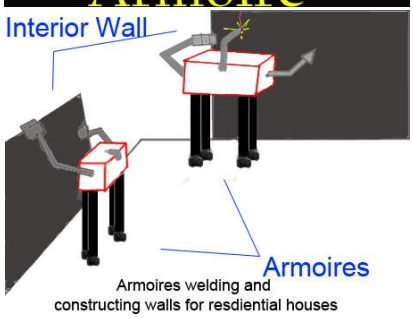
Bellsators will build the settlement. Magnetic panels are attached at the end of the limbs and this will enable Bellsator to attach to the settlement and its parts during construction to avoid materials from drifting. Two large thrusters will help the robot move. The thrusters can rotate on its axis 360 degrees allowing it to maneuver in all x, y, and z axis. The arms can transform from an electron beam welder to a 2/4 fingered claw. It can have both features present simultaneously.



5.1.3 Interior finishing

Interior finishing will be done by the Armoire. The Armoire robots will have a series of interchangeable parts, extendable arms, camera-scanner eyes, and spring loaded legs that will allow it to be able to perform multiple tasks and reach higher places than most of the personnel could reach. The interchangeable parts are located at the end of each arm and attach onto the holders just above the cameras. The extendable arms can retract inside each other and then fold within the robot when storage is necessary. The cameras can extend to get a better view so that it will have a more accurate sighting and can place the pieces more correctly. The "ankles" of the bot can extend an extra meter to provide the bot a boost in height. The wheels are pivoted along one join and can swivel around in any direction. These parts will work together to create the houses and the rest of the interior of the settlement.





5.1.4 Assembly of Settlement

50 Transportatus will be sent from Earth; Transportatus will carry 110 Bellsator each and 40 will carry the construction materials. Once it reaches L4 Lagrange, it will deploy the Bellsators and materials. Then, the Transportatus will return back to Earth and embark on its second trip to L4, carrying more materials. Each Transportatus will travel about 3-4 times.

All construction bots are made of carbon nanotubes and coated with cenosphere, which is a hollow sphere made of inert gas covered with silica and alumina. These two materials together will be able to withstand solar flares. The carbon nanotubes, being an extremely strong material, will allow the bots to go through any contingency and the cenosphere is lightweight, durable, insulated, and low cost.

5.1.5 Manufacture of furniture and appliances.

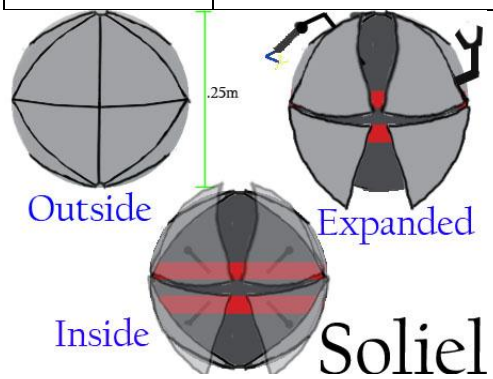
Furniture and appliances will be manufactured using the 3D printer machine, Bellprocer. Bellprocer will be able to print any piece no larger than 3.3x2.3x1.7m. In addition, if more than one piece can be assembled in the 3.3m by 2.3 m, the computer will print both simultaneously, but there must be a three inch gap between all pieces in order to rectify manufacturing errors. The pieces will be assembled in the main Rod and then transported to needed area.

5.2 Facility Automation

5.2.1 Automated systems for settlement maintenance, backup systems, and contingency plans

Name of Robot/System	Purpose
Corvalent	Acts as a trash can which separates organic and inorganic waste. Monitors temperature, air pressure, and air composition. Can put out fire via the pressurized foam stored. Boombox in its side plays music
Water Treatment System	Purifies water. See 3.2.4 for more information.
Chaleur System	Controls the station's temperature by cold plates and heat exchangers.

Soliel	Mechanical repair bot for the interior of Bellevistat. It consists a breakable outer shell with tregs, leg-like pieces that have several functions and an inner shell. Between the inner and outer pieces are two strips that are connected by a metal rod like a gyroscope. The inner piece is also connected by the gyroscope-like rod. The tregs can push off the ground and move the bot in the desired direction, and if needed they can open and expand the bot. When expanded, the bot has legs on which to stand on and can use its repair functions, as the tools are inside the inner ball. The uneven weight distribution from the top to the bottom for the inner sphere is used to keep it upright at all times. The repair tools come from within the inner sphere, and extendable arms allow the bot to reach high surfaces and such. Four "feet" are within the bot that can extend the bot up to 1 meter. In hard-to-reach areas the Soliel bot will be able to use Van der Waal's principle because of the microscopic hairs on the bot's outer shell. Two cameras are placed on each side of the robot, one on the top and one on the bottom. The bot will be able to use its instruments to fix any problem, from broken wires to unpowered electronics.
Voiture	Collects trash and cleans any difficult areas with scrubbers. Coats areas with a photocatalytic solution, allowing the object to self-clean. They will also collect the trash from the Corvalents and distribute them to the waste management system. They have flexible miniature cars with scrubbers for gritty substances, a storage area for trash, and an even smaller bot that will be able to clean surfaces via xenon UV light. The extendable arms can replace its multi-functional tips with any kind of tool they need, from claws to grab trash to scrubbers to clean the floor with.
Armoire	Interior construction bots that consist of interchangeable parts, extendable arms and camera and scanner eyes, and spring jointed legs. See 5.1.3 for more information.
Cellule	Gathers harvestable cellulose from the petri dish and transfers them to production facility
Cannabous	I: Gathers flourishing produce and transfers them to a food preparation area. II: Reaps industrial plants, such as bamboo and cotton and transfers them to production facility



Once construction is finished, the external construction bots will be coated with Bucky-structures and will become external repair bots for external repairs. If repair needs to be done outside during a solar flare, the repair bots already coated with Bucky-structures will be deployed. The construction bots will be made of carbon nanotubes and coated with cenosphere already if emergency repairs during a solar flare is imminent before any bots are coated with Bucky-structures. See 5.1.2 for more information on the original model of the construction bots.

Backup Systems

Backup Systems	Anomaly	Systems It Backups	Solution
Filtration Straw System	Contamination of Water	Water Treatment System	Filtration straws

Corvalent System	Air Imbalance	Green Air System	Corvalents alert the system and the system will undergo systematic changes according to the alert that is received
Thorium Reactor System	Power Failure	Solar Power System	Thorium Reactor provides electricity
Cor-Air System	Depressurization	Pressure Group System	Corvalents signify the Chaleur system and intense heat will be provided. Backup Chaleur bots can be deployed in dire situations.
Tentrification System	Broken Heater and Cooling System	Chaleur System	Backup Chaleur bots deploy within the residential sectors

Contingencies

Contingency	Response
Hull Breach	As soon as the hull breach is detected, any people within the immediate area will be relocated and the airlock doors will be shut before further atmospheric loss. Bucky-structure will be overlaid on top of the breach until bots can repair the hull back together.
Water Contamination	If contamination is detected, the section of water with contamination will be shut down and neighboring water systems will supply the water within a single contaminated neighborhood with their excess water. Filtration straws will be provided in the occurrence of a station-wide contamination. These filtration straws will severely decrease turbidity via ultralight and filters. See 3.2.4 for more information.
Air Contamination or Air Imbalance	Corvalents will alert the Green Air System when it has detected an atmospheric imbalance or contamination and the system will begin to equalize the atmosphere by either pumping more air through the air conditioning or sucking out the air by the artificial trees. See 3.2.1 for more information about the "trees".
Depressurization	Inhabitants will be escorted out of the area and the airlocks will shut. The pressurization chambers will focus on the specific areas, and the air conditioner will provide immense amounts of heat in the room.
Fire	Pressurized foam from the Corvalents will attempt to put out the fire. If the fire becomes too extensive, all airlock doors will lock and the room will become starved of oxygen.
Epidemic	Every area and person infected will be sectioned off from the rest of the population via LARs will diagnose the medical emergency and attempt to nurse the infected people back to health.
Power Failure	The Thorium reactor will be activated. It has enough power to process the basic systems of Bellevistat, and when it is no longer needed, it can be shut off quickly in order to minimize energy loss.
Heating Failure	If the Corvalents detect a drop in temperature, backup Chaleur bots will roll into the residential sector and provide heat.

5.2.2 Access to Station Interface

With the correct authentication, a tablet or computer will be able to directly connect to the computing and robot systems. Cloud storage will allow the information and data to be accessed from anywhere within the station, but the storage will not extend beyond the hulls of the Bellevistat.

A microchip, PRM, will be implemented within the mouth for each person. It will be either connected or within the tooth by permanent brace or physically on the tooth with special cement and hardened with UV light. Access to specific files will only be given to those who have been scanned of their chip from any PRM scanner (such as one inside the tablet), and higher level data will require more forms of authentication (refer to chart below). This will create a secure and safe network within Bellevistat.

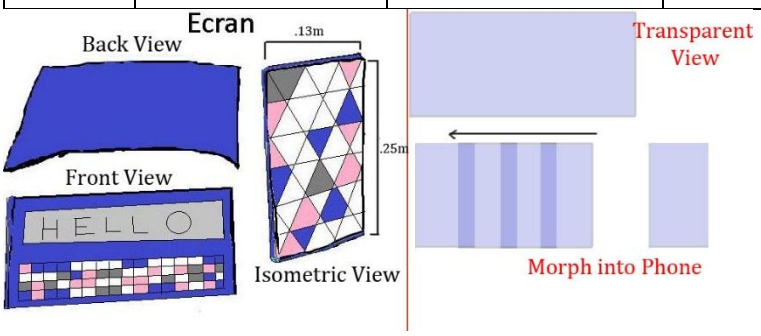
The authentication process will be done by radio waves. The program will pull up your profile and your security measure whenever you need to access data.

Authentication Process

Security Level	Authorized Personnel	Accessed Data	Security Measures
Zéro	Transients/residents	Cloud storage	PRM scan and/or password
Un	Fundamental employees and industrial workers	Private storage rooms, maintenance and industrial bots	PRM scan and password
Deux	Technical support engineers and Mechanics	Automated systems control and networking	PRM scan, finger scanner
Trois	System administrators	Station control	PRM scan, finger scanner, retina scanner

5.3 Habitability and Community Automation

5.3.1 Automation devices to enhance livability in the community and convenience in residence



The Ecran

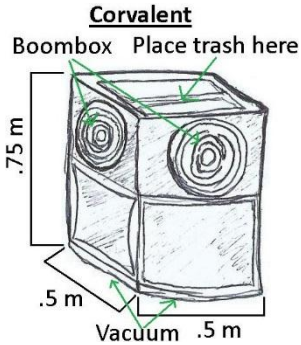
Ecran supplies basic amenities such as internal communication, virtual safety and mobility. Productivity in the work and residential environments is improved by luxuries such as bandwidth internet services. Through bandwidth telecommunications, connection is transmitted with little to no distortion. The structure is customizable in background color and interface, and its transparency can be adjusted so it is clear and see-through for augmented reality purposes. The device can fold into a portable phone that you can carry around for easier access and space. The Ecran is made of organic light emitting diode and carbon-nanotubes. Its computing system is the LSD system which uses light instead of electrons to transport data thus allowing faster data transfer, quicker computations, and less lag. The carbon-nanotube makes it resistant to water and to be a self-cleaning device.

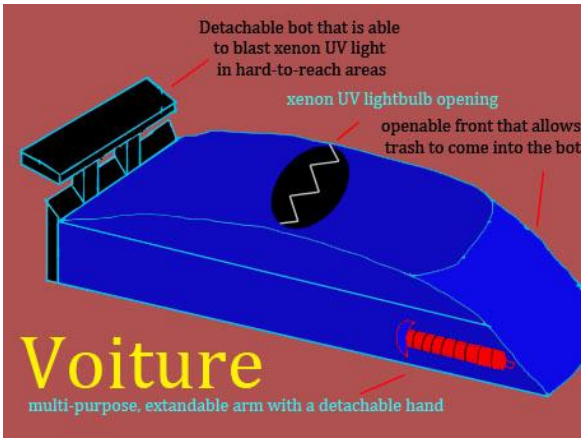
Consumable Distribution System

The Ecran allow people to choose their desired meal and it will be delivered via tubing systems built underground. See 4.1.4 and 3.2.2 for more information.

Corvalents

Corvalent is a trash can bot. When a trash thrown inside, it will scan the material. If the material is organic, it will store it in the organic section. If it's inorganic, it will store it in the inorganic section. This will ease the recycling process for organic and inorganic waste. Corvalents can be stationary but if it detects a liter, it will move toward it and suck it via the vacuum in its bottom side. It is also equipped with temperature, air pressure, and air composition sensors, thus allowing it to regulate the temperature, air pressure and air composition of the station. If an anomaly occurs in one of these, it will alert the Corvalent System which will assess the situation and solve it as needed: if uneven air pressure is detected or an unsafe amount of a certain gas is detected, the Corvalents will warn Green Air system, if temperature is off, it will alert the Tentrification System. The boomboxes within the trash cans can play music when needed. With a clean, fresh, and soothing environment, it will make residents happier, healthier, and more productive.





Voiture

The Voiture bots will coat the surfaces of the buildings, walls, streets, floors, and appliances with photocatalytic solutions. The photocatalytic solution will not only clean the surfaces and make it germ free but will also clean the air. The Voitures will re-apply the coating every three years. In hard to reach areas, Voitures will be able to clean the area with their mini xenon UV light

FLAR

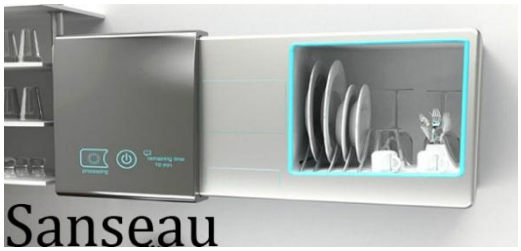
FLARs are nurse bots within hospitals. In an epidemic, FLARs will diagnose the problem and attempt to cure them. FLARs will be equipped with pulsed xenon UV light that will effectively clear any area that is infected. The light will activate in bursts and eradicate the bacteria, viruses, and mold. The FLARS, when needed, will coat the bathrooms with photocatalytic material to allow the bathroom to be self-sustaining.

MLAR

MLARs are maids that frequently interact with humans. They are bots that resemble humans and have scanners to help identify objects, from barcodes to microchips. When requested, they will accomplish household chores such as vacuuming, dry-cleaning, and garden maintenance among other things. When residents are entering the station, they will transport luggage to the homes. See 4.5 for more information on luggage transportation.

Bathroom

The bathroom will be a mainly a self-sufficient workload. The inside of the toilets will be self-cleaning with phosphoric acid while the toilets, sinks and bathtubs will be covered with photocatalytic material to break-down organic matter.



Sanseau

The Sanseau is a cabinet and dishwasher that uses CO_2 in liquid form to wash dishes. The process goes as follows: liquid CO_2 is sprayed onto the dishes, and because the surface tension is less, the dishes get a more thorough wash versus clumps of CO_2 sticking onto the plate. The liquid washes all the impurities down into a filter. Once all the liquid is out of the cupboard, the CO_2 is vaporized into a gaseous state, waiting to be used again for the next load. The gas chamber within the Sanseau stores all the CO_2, and a cooler allows it to return to liquid form. The only thing that will need to be replaced every few weeks would be the filter.

FLux

The FLux is a refrigerator made of polymer gel. This gel allows is extremely effective for cooling products and requires no energy to use. The FLux is extremely skinny compared to other refrigerators and can expand whenever food is put into it, allowing more food to be placed in its non-sticky gel. It also has no smell and can be easily moved around.


FLux

5.3.2 Automation Devices to Enhance Productivity in work environments

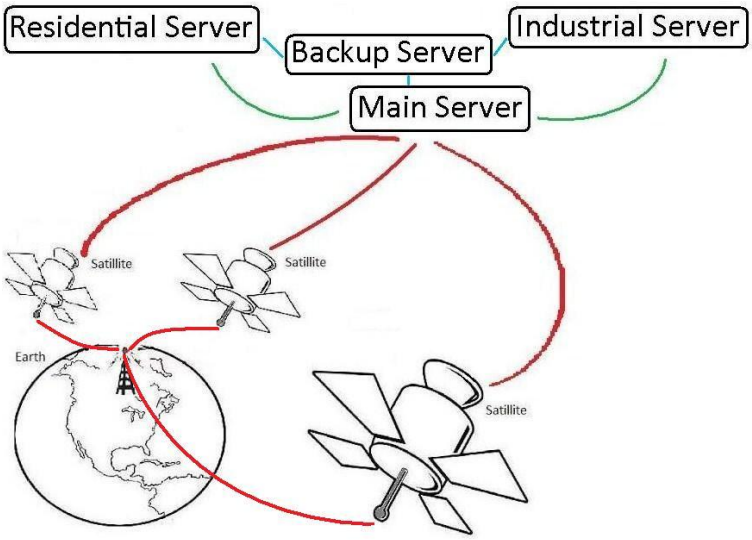
Cannabous I – Maintains edible plants and fruit and harvest them when they are ripe.
Cannabous II – Maintains non-edible plants used for industrial purpose and harvest them when they are ripe
Cellule – Maintains the artificial grown cellulose and harvest them when they are ready.

5.3.3 Privacy of personal data and control of systems in private spaces

The Ecran will scan the PRMs and pull your profile settings anywhere from any device. After five minutes of inactive use or the PRM is forty meters or more away (although the user can change the settings), the Ecran will shut down and the user will have to log in again. Each personal interface will have its own data saved on their specific cloud drive that can be shared or kept private.

5.3.4 Devices for personal use, delivery of internal and external communications services, entertainment, information, computing, robot resources

- External communication: Lasers Communication
  - Three satellites: earth server, satellite in geostationary orbit of earth, and server on Bellevistat.
- Internal communication: Super Wifi
  - The Ecran will be used as a multi-communication device that will allow everyday people to communicate effectively and efficiently. Because it uses the TV broadcast spectrum instead of the traditional wifi spectrum, it will be able to transfer more data at a faster rate and is available throughout the station. See 5.3.1 for more information.



Network Diagram

- Entertainment- Personal use
  - The residents of Bellevistat will use the Ecran for tasks such as using the internet, or smart phone features to communicate, to watch movies, play video games, or even personal schedule tracking with convenience.
- Information- Internet Access (Bandwidth) - The residents of Bellevistat will also use the Ecran for access to search engines and databases. See 5.3.1 for more information.
- Computing - The main Industrial and Residential servers will use Cerebrum as its computing processor. Because it can compute quintillion operations per second, this enables the scientist and engineers to perform real life simulations and perform complicated calculation. Handheld devices, such as the Ecran will use LCD. Because it uses light, it will be faster, which causes the user to perform task quicker and efficiently thus making him a happy person.

Servers	Data Capacity	Bandwidth
Residential	10 Eb	5 GB
Industrial	10 Eb	10 GB
Main	20 Eb	20 GB
External	5 Eb	1 GB
Backup	20 EB	15 GB

5.4 Cargo Interface

5.4.1 Automated Unloading System

<u>From ship to dock</u>

The cargo ship will eject it's underside into the dock. A L Robotic Arm will push the 15 ft. square by 60 ft. long ore containers from the platform into the transportation tube. The arm can extend like an antenna up to 50 meters and the end consists of a spring which pushes the containers. Fig. 1.

<u>From dock to refining facilities</u>

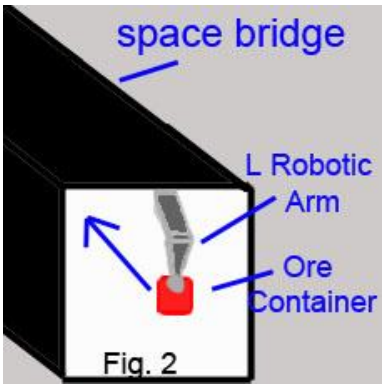


Fig. 2

In the middle between the ship and the space bridge, where all the cargo will load and unload, will be a universal airlock bridge. From there the cargo will proceed through the space bridge to the industrial inferior terminal, through the terminal bridge, and into the superior industrial docking terminal. Within the industrial inferior terminal will be the L Robotic Arms that will pivot on a central axis going vertically. There are many of them scattered throughout the terminals and at least one on each side of a bridge. Cargo will be gently "tossed" throughout the chambers by one L Robotic Arm and be caught on the other hand by another L Robotic Arm. Once the cargo reaches the superior industrial docking terminal, the cargo is sorted and placed accordingly by scanners and labels. Finishing the process will be the cargo leaving superior industrial docking terminal and into the centrifuge waiting for further deployment (such as refining industry). The many L Robotic Arms within the centrifuge will provide adequate transportation and sorting means.

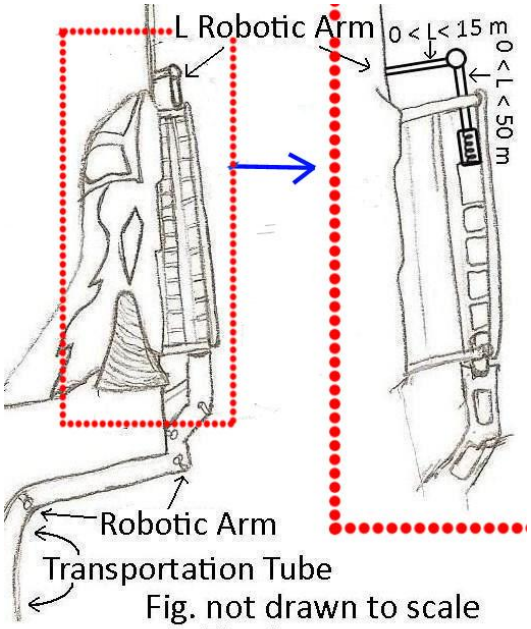


Fig. not drawn to scale
Fig. 1

The same process will occur when cargo is needed to be exported. The difference is the cargo will be sorted within the industrial inferior terminal. The L Robotic Arm will sort the cargo by their needed destination gathered from them scanning the cargo. If the arm malfunctions and clogs the containers, Soliel II will be sent to direct the traffic. (Look at Fig. 2)

<u>Soliel II</u> – The outer shell can fold up towards the camera for more room for the inner appliances. Soliel II will use its extendable arms to maneuver in the tube. It will use its artificial setae hands to grab and rearrange the clogged containers and push them in its right path.

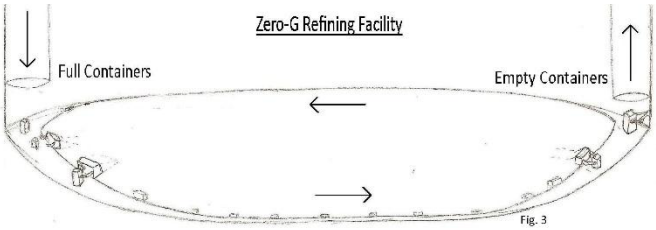


Fig. 3

<u>Unload containers in zero g and vacuum facility</u>

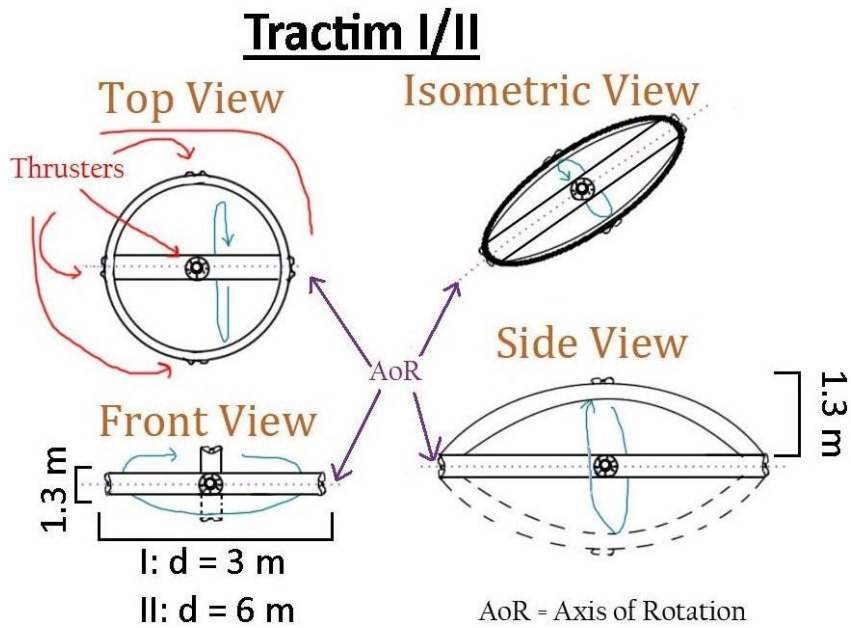
The containers will drop down from the tube and land on a fairly weak magnetic conveyor belt. There will be station with a robotic arm that will grab the containers from the belt and put them in the proper section.

5.5 Docking Automation

5.5.1 Automate final docking of ships in the various port facilities

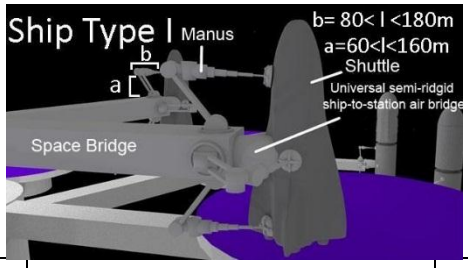
Automated Docking Procedure

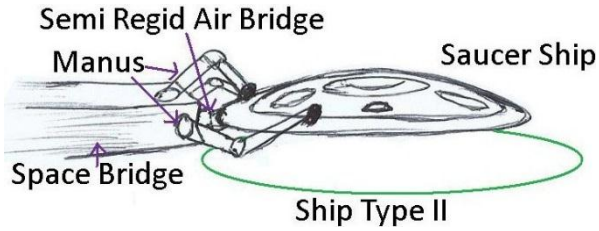
The ship will match the settlement's velocity so that it will be stationary with respect to Earth, Moon, and the station. Then, it will send a blueprint of its structure to the docking Control Tower. Using the blueprint, Tractim will place themselves in strategic positions along the ship's sides, top, and bottom; the Tractim's setae side will allow it to stick to the ship. Then, Tractims will configure the ship to the docking port using its mini-thruster. Once the ship is safely docked, Manuses will secure the ship. Tractim I is used for smaller ships while Tractim II will be used for larger ships.



Manus Robotic arm the holds the ships in place once it docks. Its hand will have a pad that carries a charge, thus when it touches with metal surface it absorbs the shock that will cause the ship to shake. Then, electricity is run through the pad to magnetize it and hold the ship. The arms are able to rotate and bend 360 degrees for every joint.

5.5.2 Docking Procedures





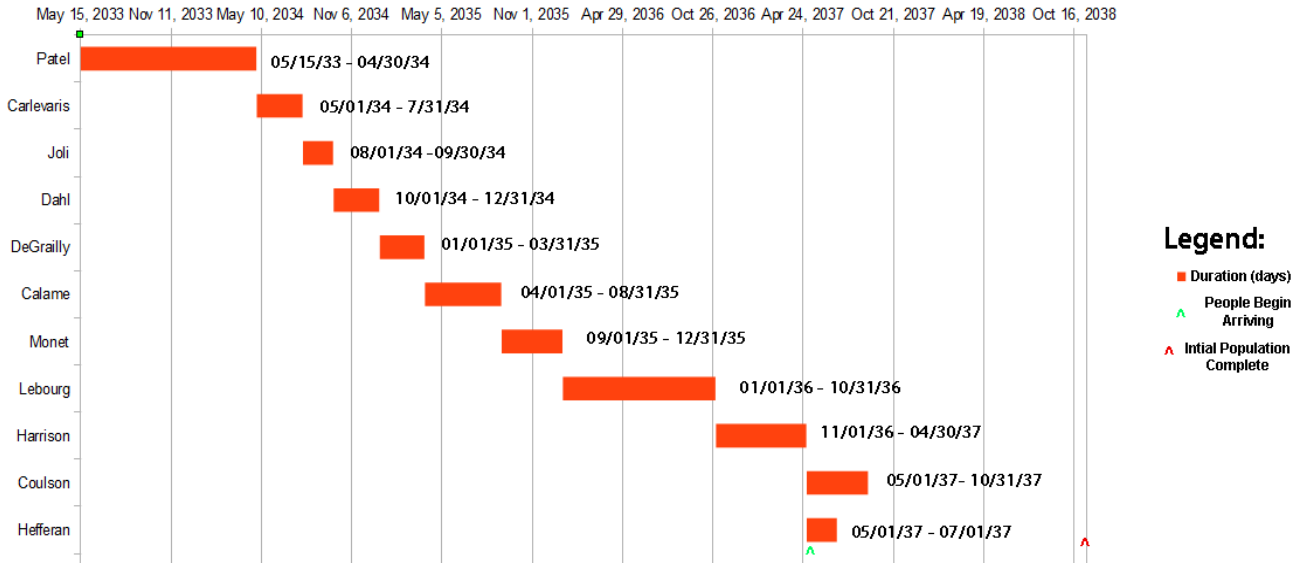
	Residential Dock	Industrial Dock	Repair & Maintenance Dock
1	Ship matches settlement's velocity	Ship matches settlement's velocity	Ship matches settlement's velocity
2	Tractim configures the ship to the dock	Tractim configures the ship to the dock	Tractim configures the ship to the dock
3	Manus holds the ship in place	Manus holds the ship in place	Manus holds the ship in place
4	Passengers dismount	Unload Cargo	Ops 3.5 maintenance run diagnosis
5			Repairing happens

SCHEDULING AND COST

"PHYSICS ISN'T A RELIGION. IF IT WERE, WE'D HAVE A MUCH EASIER TIME RAISING MONEY."

-LEON LEDERMAN

6.1 Construction schedule



The construction schedule states how long each phase of the construction process will last and the move-in date and the when the move-in completes. For a detailed information on each of the construction phases see 2.3.1.

6.2 Cost by Phases of Construction

6.2.1 Structure Costs

Material	Amount	Source	Cost
Maraging Steel	18,000,000,000 kg	Earth	$7,200,000,000
Regolith	4,400,000,000 kg	Earth, Moon	$1,500,000
Silicon	1,100,000 kg	Earth	$3,520,000
Bamboo	2,200,000 kg	Earth	$3,498,000
Buckystructure	2,200,000 kg	Bellevistat	$7,040
Glass	500,000 kg	Earth	$24,100
Total			$7,208,549,140

6.2.2 Operations Cost

Materials	Amount	Source	Cost
Nitrogen	46,000 kg	Earth	$184,000
Oxygen	13,000 kg	Earth	$138,000
LEDs	11311676 kg	Earth	$28,500,000
Aluminum	30679.8 kg	Earth	$46,000
Animal Stem Cells	50 kg	Earth	$250
Seeds	100 kg	Earth	$300

Water	578207 L	Earth	$144,560
Silicon	500,000,000 kg	Earth, Moon	$1,600,000,000
UV Lights	60	Earth	$3000
Fluorescent Bulbs	2700	Earth	$20,000
Incandescent Bulbs	900	Earth	$1500
Scooters	1000	Earth	$30,000
Rollerblades	2000 pairs	Earth	$50,000
Recumbent Bikes	3000	Earth	$750,000
Microfilters	80	Earth	$3,020
Thorium	100 kg	Earth	$50,000
Electron beam accelerator	1		$6,000,000
Cyanobacteria (in 3x3 m containers)	300	Earth	$2,500
Ionic liquids	900 L	Earth	$50,000
Industrial Curating Lab	1		$7,500,000
Thorium Molten Salt Reactor	1		$170,000,000
Micro Auto Gasification System	1		$5,000,000
Total			$1,818,473,130

6.2.3 Human Factors Cost

Item	**Amount Needed**	**Source**	**Cost**
Community Features	N/A	Earth	$237,510
Gym Technology	N/A	Earth	$113,800
Clothing Racks	240	Earth	$24,000
Transportation	34500	Earth	$6,071,000
Toiletries	267,230	Earth	$9,209,660
Clothes	45500	Earth, Bellevistat	$811,705,000
Medicine	123500	Earth	$1,580,000
Furniture	69,535	Earth, Bellevistat	$19,102,250
Food	11,962,875	Bellevistat	$48,760,000

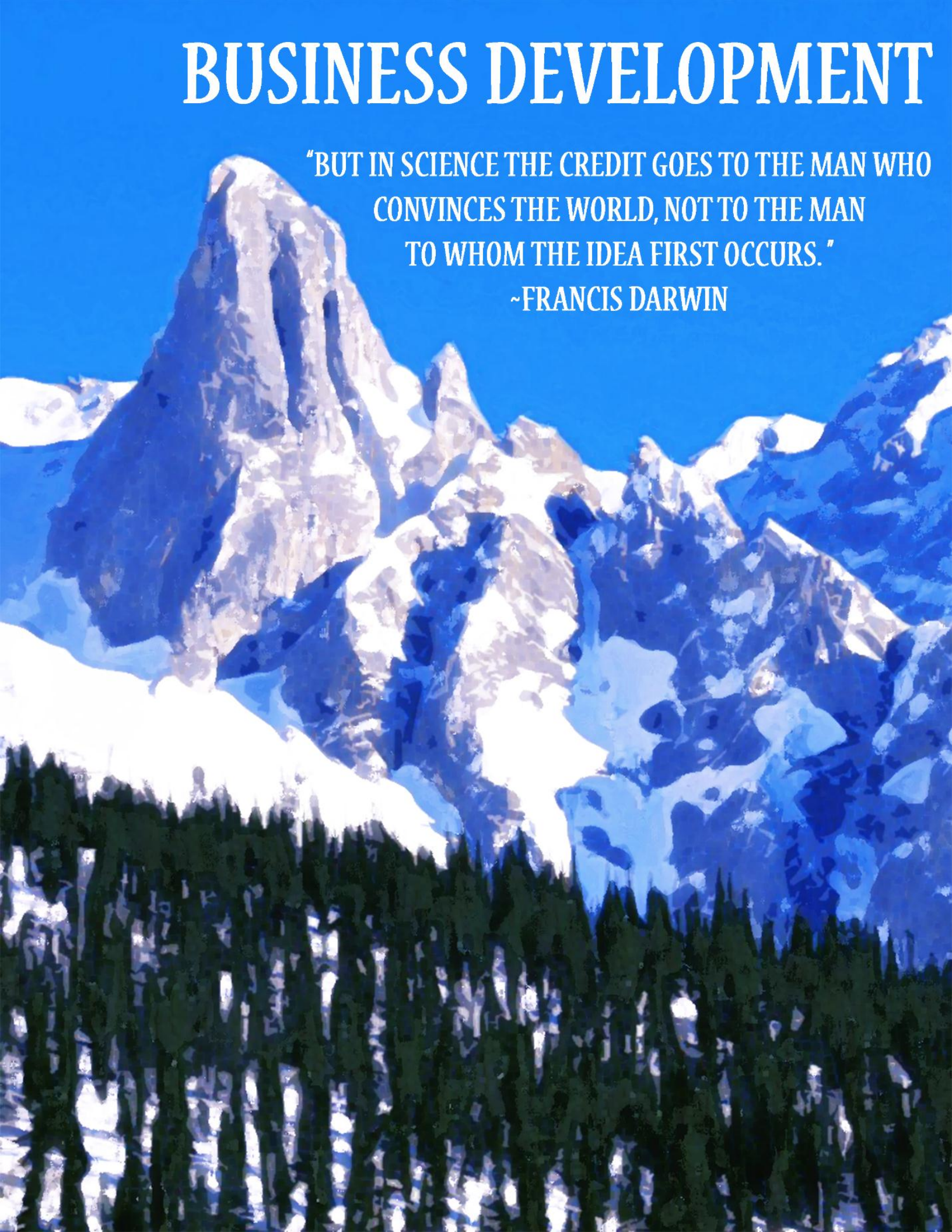
Appliances	45210	Earth	$21,700,800
Shower Scale (reads vitals)	12,500	Earth	$3,124,197
Tree Lights	15,070	Earth	$1,959,100
Waterfall Shower	12,500	Earth	$224,050
Total			$972,571,367

6.2.4 Automation Cost

Material	**Amount**	**Source**	**Cost**
Bucky-structure sheets	1.1×10^{12} m^3	Bellevistat	$35,200
Titanium alloys	310000 kg	Earth	$2,383,900
Micro-lattice of nickel phosphorous tubes	1.1×10^{12} m^3	Earth	$330,000,000
Photocatalytic solution	42437332m^3	Earth	$83,601,600
Artificial Setae	640000 m^3	Earth	$172,800,000
Electromagnetic Padding	800000 m^3	Earth	$336,000,000
Silicon nano chip	11,500 chips	Earth	$13,800
Carbon Nanotubes	290000 kg	Earth	$113,100,000
Cenosphere	1.1×10^{12} m^3	Earth	$141,900,000
Total			1,179,834,500

The grand total for Bellevistat would be $11,179,428,140.

BUSINESS DEVELOPMENT



"BUT IN SCIENCE THE CREDIT GOES TO THE MAN WHO CONVINCES THE WORLD, NOT TO THE MAN TO WHOM THE IDEA FIRST OCCURS."

~FRANCIS DARWIN

7.0 Business Development

7.1 Port Design

The industrial ports of Bellevistat have the ability to easily unload the cargo from each of the ships that dock. Using the L Robotic Arms (see 5.4.1) all cargo will be ejected from the underside of the arriving ships. This separates the cargo areas from the location where humans will depart from their ship. The cargo will be taken to the Superior Industrial Docking Terminal (See 2.5.1) and be stored in the terminal until delivered to the Industrial Torus. The storage space be spacious enough house both outgoing waiting to leave and incoming cargo containers waiting to be processed to help with the continuous flow of containers that will be incoming into the station. The containers will be moved to the industrial torus with an elevator and will sent up the centrifuge to be processed; once processing is complete, the materials will be shipped back down the centrifuge by using the elevator (See 2.5.2). The space bridge that connects to the ship also has the ability to handle non-standard container sizes because of the entry way is designed bigger than the standard shipping containers.

7.2 Manufacturing Goods

7.2.1 Conditions of Production

The buckystructure facilities each have different gravities, one .2 g and the other 0 g (See 2.4.1). Processes that require a different gravity will occur in either facility based on the process requirements. Since the buckystructure production tori and just above the industrial torus, transportation between the areas is small and use the L Robotic Arms to move the materials around in their containers. The industrial torus will hold numerous different type of processes to adequately handle the broad type of materials that will be shipped in, like metals needed to be refined or adjustments to a material through a different gravity.

7.2.2 Lease Space

The industrial torus will have empty space in the facility to lease out to companies. This is because manufacturing deals in a large amount of processes that other companies can use. The space that will be available to use for other companies is approximately 55 meters which is about one-third of the torus. The space allocated is big enough to house numerous companies and still have enough space for Bellevistat's operations to function without impairing them.

7.2.3 Delivery Paths

Delivery paths from the industrial torus and buckystructure facilities will use an elevator (see 2.4.2) to travel down to the docking stations, then the L Robotic Arms (See 5.4.1) will deliver the cargo to the Superior Industrial Docking Terminal awaiting for delivery to ships receiving materials; provisions for the visiting will also be delivered in the same manner as the cargo. For consumer use in the residential torus, the elevator can also stop on the residential level to deliver the goods to for commercial use on the station.

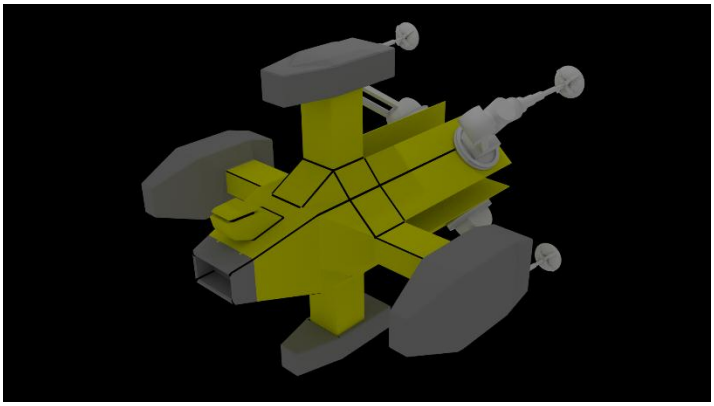
7.2.4 Manufacturing Expansion

The industrial torus will expand outward by increasing the height and length of the torus. The expansion of the torus will also keep the ratio between the space leased and production space for Bellevistat. Bellevistat has the design to naturally support the future ship assembly. The assembling facility will expand out from the base of the repair station. The facility will grow out from the centrifuge and be similar to the current port facility design. The parts and materials for the ships will be produced from the industrial torus. The torus will expand outward to provide for space for the production of parts and materials. The parts would be delivered down through the elevator system to the main hub of the ship assembling area. Then, the parts and materials will be moved around with the L Robotic

Arm to the proper section of the ship assembling area. The ships that are under construction will be held in place by the Ship Catching Apparatus (See 2.5). The ship will be put together through the use of Soleils.

7.3 Repair Station and Other Infrastructure

7.3.1 Space Tugs



Space tugs will be stationed directly above the repair dock. The space allocated above the repair station is large enough to hold all 10 tugs simultaneously. Space tugs are designed mainly for moving ships into the repair station, possible additional help with docking ship along with the Tractim (See 5.5.1) in case of an emergency and in case a hazardous situation aboard a ship occurs. The space tug uses the Ship Catching Apparatus (See 2.5) to attach itself to ships and move them where they need to go. It also as a small space bridge on the side of the Ship Catching Apparatus for emergency situations. The space tug is completely automated and is controlled when a ship sends a message to system administrator (See 5.2.2) which will activate the amount of space tugs needed through the system controls. In the future, the space tugs will also move out large interplanetary ships after they have completed construction.

7.3.2 Accommodation of different ships for repair

The repair docks are designed to handle different ship sizes. The current size of the repair docks handles most ship sizes. If the ship does not naturally fit, the space tugs will be used to move the ship into the repair facility will rotate and adjust the ship to fit the repair station the best. The space tugs will also move a ship around in the repair facility to assist in the repairing if the ship is too long to adequately correspond to the space allocated.

7.3.3 Port Expansion

The expansion of the Bellevistat's ports will consist of each of the designs turning the ends of the space bridges and the jet bridges, for the industrial and residential docking respectively, into terminals. Each of the new terminals would house three locations for docking like the current main residential terminal and inferior industrial terminal (See 2.5). The process would work on one of the bridges at a time so the flow of ships will not be heavily impeded. Bellsators will be used to construct the new terminal at the end of a bridge. Each new terminal will also possess three bridges for ships to land on (See 5.1.2). The Armoires will construct the inside of the each of the new terminals and will detail the inside of each new terminal to handle the separate cargo areas and will add on to the current Grand Departure system in the residential docking areas (See 5.1.3, 4.5).

7.3.4 Safety Procedures

If a hazardous situation occurs on a visiting ship, space tugs will be deployed to intercept the ship. The space tug will grab on to the ship and begin evacuating the humans aboard and the cargo on the ship through the space bridge on the tug. The Soleil will be deployed from the repair dock to come out and intercept the ship once the space tug has begun the evacuation. Another space tug will arrive to carry the ship to the repair area to fix the problem. The first space tug will go and dock at appropriate docking station and unload the passengers and cargo. If the ship is docked when the situation occurs, other ships will be redirected to other terminals when the situation occurs. Then the space tug will come and move the ship to the repair station for maintenance.

OPERATIONAL SCENARIO

"SCIENCE IS ALWAYS WRONG. IT NEVER SOLVES A PROBLEM WITHOUT CREATING TEN MORE."

-GEORGE BERNARD SHAW

8.0 Appendix

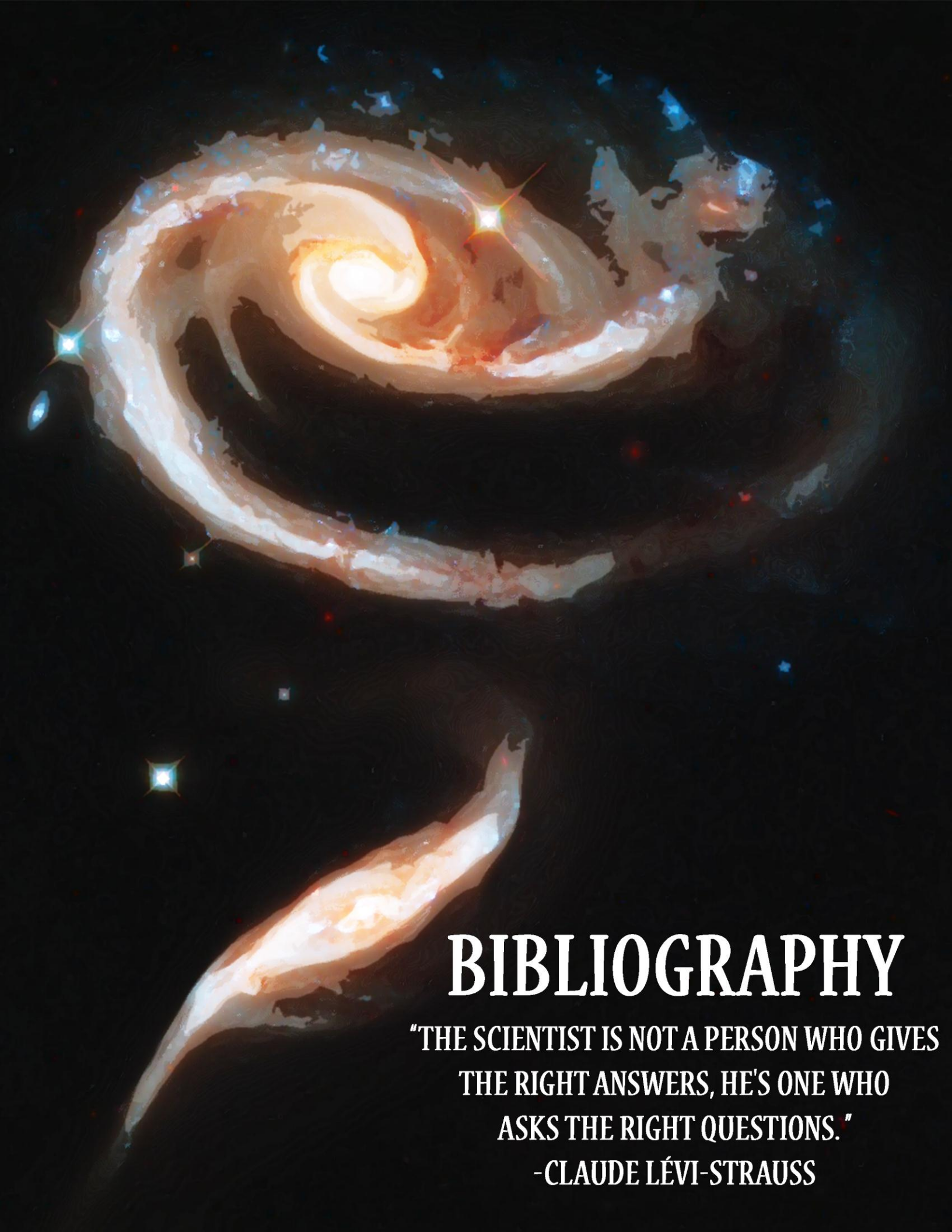
A. Operational Scenario

A.1

If there was a hull breach between two separate habitable volumes, the residents in the area would be evacuated from the areas to another part of the settlement. A warning will go out to all the residents in the area of the incident. Residents would flee to another level of the station until the damage has been repaired by robots. Armoire and Bellsator bots will be sent immediately to the site of the hull breach to begin repairs. The Bellsator will deal with the outside of the settlement while the Armoire will repair any damage inside. Since each level of the station has their own infrastructure from one another, supplies will be routed from the other sections of the station. The systems on the station will repressurize the section of the station back to where the pressure was before the hull breach. Residents will be given notice that that hole has been repaired and that the area is safe again. The residents would be allowed to repopulate the location where the incident occurs.

A.2

In the case of an industrial explosion, a warning will be issued around the industrial torus. The residents in the affected area will evacuate from the area. The station will also release more nitrogen and oxygen in the area to limit the spread of the toxic gas and heat. This will continue until the residents have reached a safe distance and left the immediate vicinity. Armoire bots will be dispatched immediately once the explosion occurs. The will repair the damage and seal the hole between the industrial work area and the industrial resident area. Once the hole is sealed and the residents have evacuated, the space will be depressurized to remove the toxic gas and heat in the facility. The atmosphere from inside will be pumped back into the industrial zone. The explosion would not cause a stop in production because of the facility being automated. The workers would return once the system administrators have deemed the space to be safe again and have pressurized it.



BIBLIOGRAPHY

"THE SCIENTIST IS NOT A PERSON WHO GIVES THE RIGHT ANSWERS, HE'S ONE WHO ASKS THE RIGHT QUESTIONS."

-CLAUDE LÉVI-STRAUSS

B. Bibliography

Structures:

1. Space. Digital image. *Pedals2people.org*. Pedals2People, n.d. Web. 5 Apr. 2013.
2. <http://www.pedals2people.org/wp-content/uploads/2011/07/Space.jpg>.
3. Langley, R. W. *Space Radiation Project*. *Barringer1.com*. Barringer 1, July 1970. Web. 1 Apr. 2013. <http://www.barringer1.com/mil_files/NASA-SP-8054.pdf>.
4. Rask, Jon. *Space Faring: The Radiation Challenge*. *Nasa.gov*. National Aeronautics and Space Administration, n.d. Web. 25 Feb. 2013. <http://www.nasa.gov/pdf/284275main_Radiation_HS_Mod3.pdf>.
5. "Titanium & Titanium Alloys." *Specialty Metals Supplier*. ATI, n.d. Web. 21 Feb. 2013. <http://www.atimetals.com/products/Pages/titanium.aspx>.
6. "Properties of Maraging Steels." *KEY to METALS*. Keys to Metals, n.d. Web. 13 Mar. 2013. <http://www.keytometals.com/Articles/Art103.htm>.
7. Meyer, C. *Lunar Regolith*. *Nasa.gov*. National Aeronautics and Space Administration, n.d. Web. 18 Apr. 2013. <http://curator.jsc.nasa.gov/lunar/letss/regolith.pdf>.

Operations:

1. "Cellulose Synthesis in the Cyanobacteria." *Cellulose Synthesis in the Cyanobacteria*. N.p., n.d. Web. 2 Apr. 2013. <http://www.botany.utexas.edu/mbrown/cyano/>
2. "Dissolution of Cellulose with Ionic Liquids and Its Application: A Mini-review." - *Green Chemistry (RSC Publishing)*. N.p., n.d. Web. 2 Apr. 2013. <http://pubs.rsc.org/en/content/articlelanding/2006/gc/b601395c>
3. "The Chemical Process Of Cellulose To Paper." *A Moment of Science RSS*. N.p., n.d. Web. 2 Apr. 2013. <http://indianapublicmedia.org/amomentofscience/chemical-cellulose-paper/>
4. "Facts about Paper and Paper Waste." *Facts about Paper and Paper Waste*. ID2Communications, n.d. Web. 6 Apr. 2013. <http://www.id2.ca/downloads/eco-design-paper-facts.pdf>
5. "What Is the Effect of Artificial Light on Plants?" *Gardenguides.com*. N.p., n.d. Web. 7 Apr. 2013. <http://www.gardenguides.com/88738-effect-artificial-light-plants.html>
6. "Water Treatment Chemicals." *Water Treatment Chemicals*. N.p., n.d. Web. 8 Apr. 2013. <http://www.lenntech.com/products/chemicals/water-treatment-chemicals.htm>
7. "Food Irradiation." *EPA*. Environmental Protection Agency, n.d. Web. 26 Mar. 2013. <http://www.epa.gov/radiation/sources/food_irrad.html>
8. "The Compass DeRose Guide to Emergency Preparedness: Hardened Shelters." *A Compass DeRose Guide by Steven J. DeRose*. N.p., n.d. Web. 1 Apr. 2013. <http://www.derose.net/steve/guides/emergency/hardened.html>
9. "Breakthrough: World's Most Efficient Solar Panel." *SmartPlanet*. N.p., n.d. Web. 10 Apr. 2013. <http://www.smartplanet.com/blog/intelligent-energy/breakthrough-worlds-most-efficient-solar-panel/12800>
10. "NASA to Boost Speed of Deep Space Communications." *Space.com*. N.p., n.d. Web. 11 Apr. 2013. <http://www.space.com/7815-nasa-boost-speed-deep-space-communications.html>

11. Feature, Kathleen DohenyWebMD the Magazine -. "Best Temperature For Sleep, Effects of Temperature on Sleep." *WebMD*. WebMD, n.d. Web. 12 Apr. 2013. <http://www.webmd.com/sleep-disorders/features/cant-sleep-adjust-the-temperature>
12. "Plasma Shield: Missile Stopper?" *Wired.com*. Conde Nast Digital, 07 May 2007. Web. 28 Mar. 2013. <http://www.wired.com/dangerroom/2007/05/plasma_shield_m/>
13. "Video: Military Garbage Burner Utterly Destroys Trash, With Tactical Precision." *Popular Science*. N.p., n.d. Web. 29 Mar. 2013. <http://www.popsci.com/technology/article/2011-11/new-military-garbage-tech-destroys-trash-tactical-precision>
14. "Micro Auto Gasification System." - *Office of Naval Research*. N.p., n.d. Web. 6 Apr. 2013. <http://www.onr.navy.mil/en/Media-Center/Fact-Sheets/Micro-Auto-Gasification-System.aspx>
15. "Waste Treatment and Disposal." *Google Books*. N.p., n.d. Web. 25 Mar. 2013. <http://books.google.com/books?id=JJBeTviuPeQC&pg=PA327&lpg=PA327&dq=char+disposal&source=bl&ots=xTJupx7ZCj&sig=UshUmyYY4YYUEKzp9eiaaJb0XTA&hl=en&sa=X&ei=QM5DUY7lDNS64AOMsIDQCQ&ved=0CGkQ6AEwCQ#v=onepage&q=char%20disposal&f=false>
16. "HSU Users Web Pages." *HSU Users Web Pages*. N.p., n.d. Web. 9 Apr. 2013. <users.humboldt.edu>
17. "Plant Lighting." *Plant Lighting*. N.p., n.d. Web. 4 Apr. 2013. <http://www.dahlias.net/seabox/lightem.htm>
18. "Eco Bikes: Valetudo – A Three-wheeled Commuter Bike Made from Recycled Plastic - Promoting Eco Friendly Lifestyle to Save Enviornment - Ecofriend." *Ecofriend Atom*. N.p., n.d. Web. 3 Apr. 2013. <http://www.ecofriend.com/eco-bikes-valetudo-a-three-wheeled-commuter-bike-made-from-recycled-plastic.html>
19. "Army Aims to Build "Zero Footprint" Camps." *Popular Science*. N.p., n.d. Web. 30 Mar. 2013.<http://www.popsci.com/military-aviation-amp-space/article/2009-07/army-aims-zero-footprint-camp>
20. "U.S. Military Waste to Energy & Fuel Gasification Prototype V2.0." - *Waste Management World*. N.p., n.d. Web. 30 Mar. 2013. <http://www.waste-management-world.com/articles/2012/12/u-s-military-waste-to-energy-fuel-gasification-prototype-v2-0.html>
21. Mokhtarani, Pouyan. *Mercury Skate for Smoother Ride on The Pavement and Decrease The Skater's Fatigue*. Digital image. *Tuvie. Design of Future.* N.p., n.d. Web. 12 Apr. 2013. <http://www.tuvie.com/mercury-skate-for-smoother-ride-on-the-pavement-and-decrease-the-skaters-fatigue/>
22. 3DRivers. *Scooter*. Digital image. *Turbo Squid*. N.p., n.d. Web. 13 Mar. 2013. <http://www.turbosquid.com/3d-models/3d-scooter-supermar

Human Factors:

1. 3D Printed Home Accesory. Digital image. *Tumblr.com*. Tumblr, n.d. Web. 18 Feb. 2013. <http://24.media.tumblr.com/tumblr_m9dxvhP5JW1r47jemo1_500.jpg>.
2. "ARIA | Overhead Shower." *Archiproducts*. Archiproducts, n.d. Web. 15 Feb. 2013. <http://www.archiproducts.com/en/products/47550/aria-wall-mounted-waterfall-shower-aria-overhead-shower-webert.html>.
3. Sofge, Eric. "The Deep-Space Suit." *PopSci.com*. Popular Science, 19 Nov. 2012. Web. 15 Feb. 2013. <http://www.popsci.com/technology/article/2012-10/deep-space-suit?page=2>.

4. Wills, Adam. "Forget the Air Car. Jetpacks Are Here!" *JewishJournal.com*. Jewish Journal News, 29 July 2008. Web. 20 Mar. 2013. <http://www.jewishjournal.com/geekheeb/item/forget_the_air_car_jetpacks_are_here_20080729>.

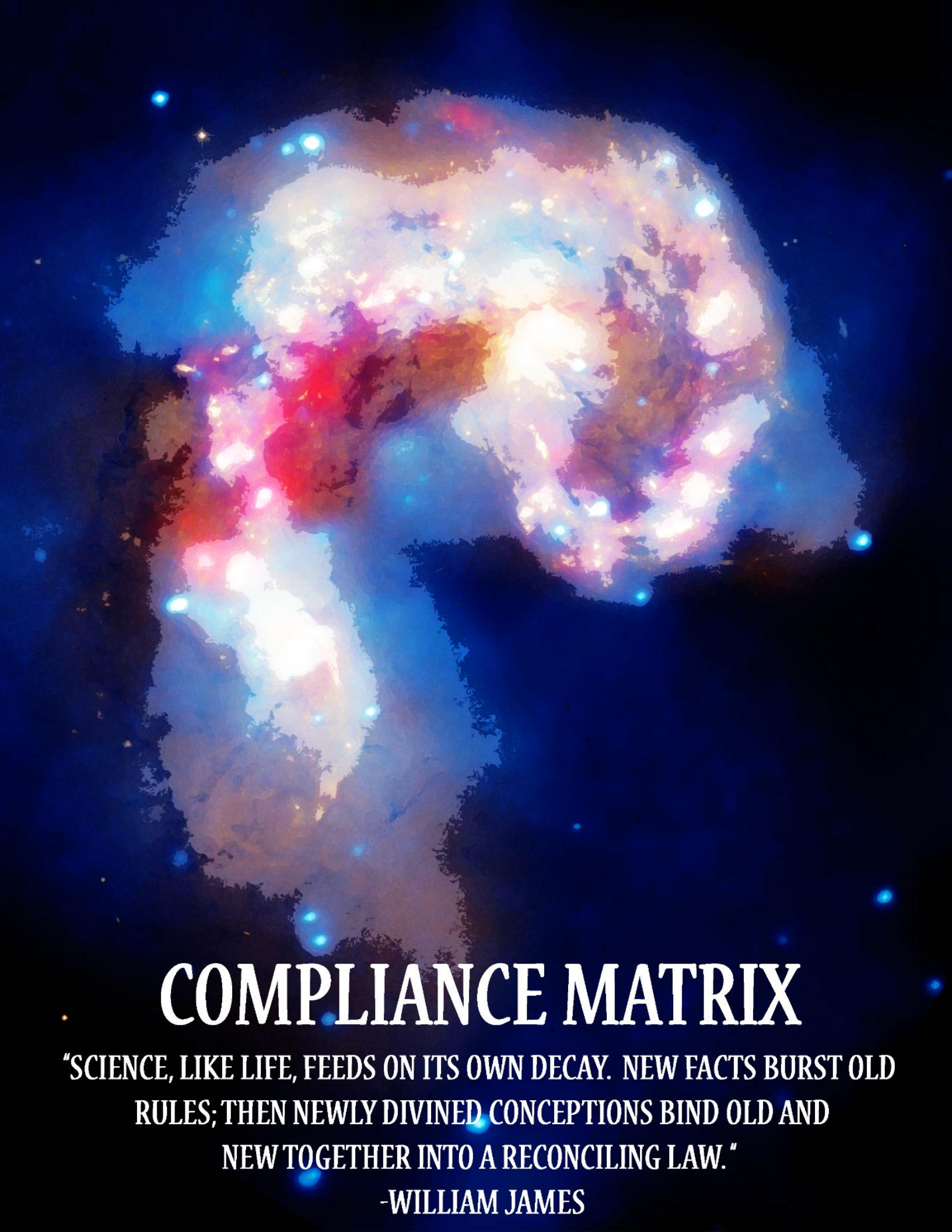
Automations:

1. Deyle, Travis. "Electroactive Polymers (EAP) as Artificial Muscles (EPAM) for Robot Applications | Hizook." *Hizook.com*. Hizook, 28 Dec. 2009. Web. 18 Apr. 2013. <http://www.hizook.com/blog/2009/12/28/electroactive-polymers-eap-artificial-muscles-epam-robot-applications>.
2. Kwak, Joshua. "Welding." *Welding*. Penn State Personal Web Server, n.d. Web. 5 Mar. 2013. <http://www.personal.psu.edu/jhk5143/edesgn100/project4/welding/>.
3. "Concentrators Enhance Solar Power Systems." *Nasa.gov*. National Aeronautics and Space Administration, n.d. Web. 19 Mar. 2013. <http://spinoff.nasa.gov/Spinoff2012/ee_5.html>.
4. "High Productivity Computing Systems (HPCS)." *DARPA RSS*. Defense Advanced Research Projects Agency, n.d. Web. 18 Mar. 2013. <http://www.darpa.mil/Our_Work/MTO/Programs/High_Productivity_Computing_Systems_(HPCS).aspx>.
5. Maksel, Rebecca. "What Happens If an Airliner Suddenly Loses Cabin Pressure?" *Air and Space Magazine*. Smithsonian, 24 Sept. 2009. Web. 19 Mar. 2013. <http://www.airspacemag.com/need-to-know/Need-to-Know-Cabin-Pressure.html>
6. *CLIPART 3D FUTURISTIC ROBOTIC COUPLE WALKING WITH THEIR DOG*. Digital image. *ClipartOf.com*. ClipartOf, n.d. Web. 14 Feb. 2013. <http://www.clipartof.com/portfolio/julos/illustration/3d-futuristic-robotic-couple-walking-with-their-dog-1114237.html>.
7. Faraco, Joao. "Refrigerator of the Future." *Caligraffiti.com*. Caligraffiti, 19 Oct. 2010. Web. 18 Feb. 2013. <http://www.caligraffiti.com.br/geladeira-do-futuro/>.
8. "Solar Flares." *Cenotechnologies.com*. Ceno Technologies, n.d. Web. 18 Feb. 2013. <http://cenotechnologies.com/facts01.php>.
9. Kurp, Josh. "What Everyone Should Know About Concert Hologram Technology." *Uproxx RSS*. Uproxx, 17 July 2012. Web. 17 Feb. 2013. <http://www.uproxx.com/technology/2012/07/5-things-everyone-should-know-about-concert-hologram-technology/>.
10. "Power Wash." *YankoDesign.com*. Yanko Design, n.d. Web. 28 Feb. 2013. <http://www.yankodesign.com/2012/09/10/power-wash/>.
11. Buczynski, Beth. "A Waterless Dishwasher You'll Never Have To Empty." *EarthTechling*. EarthTechling, 13 Sept. 2012. Web. 28 Feb. 2013. <http://www.earthtechling.com/2012/09/a-waterless-dishwasher-youll-never-have-to-empty/>.
12. "The FireAnt Hexapod Robot." *Zenta RSS*. Zenta, 3 Feb. 2013. Web. 28 Feb. 2013. <http://robot-kits.org/>.

Cover Art:

1. Space Aesthetic. Digital image. *SpaceTelescope.org*. Space Telescope, n.d. Web. 16 Apr. 2013. <http://www.spacetelescope.org/static/archives/images/screen/heic0206g.jpg>.

2. Ocean. Digital image. *Dekiwallpapers.com*. N.p., n.d. Web. 16 Apr. 2013. <http://www.dekiwallpapers.com/wp-content/uploads/2010/06/Endless-Ocean.jpg>.
3. Forest. Digital image. *Widewallpapers.net*. N.p., n.d. Web. 16 Apr. 2013. <http://www.widewallpapers.net/mod/nature/1280x800/nature-wallpaper-1280x800-002.jpg>.
4. Space and Stars. Digital image. *MidnightandMythos*. Wordpress, n.d. Web. 16 Apr. 2013. <http://midnightandmythos.files.wordpress.com/2012/01/earth-from-space-with-stars.jpg>.
5. Earth. Digital image. *Kirksville*. K-12, n.d. Web. 16 Apr. 2013. <http://www.kirksville.k12.mo.us/khs/teacher_web/alternative/UltimateEarth.jpg>.
6. Midnight Path. Digital image. *Favim.com*. Favim, n.d. Web. 16 Apr. 2013. <http://s3.favim.com/orig/45/forest-landscape-milky-way-night-path-Favim.com-402969.jpg>.
7. Flying Castle. Digital image. *Deviantart.net*. Deviant Art, n.d. Web. 16 Apr. 2013. <http://th04.deviantart.net/fs71/PRE/f/2011/331/d/3/flying_castle_by_vifram-d4hgn0u.jpg>.
8. *PIA-03519*. Digital image. *Nasa.gov*. National Aeronautics and Space Administration, n.d. Web. 18 Apr. 2013. <http://www.jpl.nasa.gov/spaceimages/images/wallpaper/PIA03519-1280x800.jpg>.
9. Mountain Range. Digital image. *Hdwallpapers*. N.p., n.d. Web. 16 Apr. 2013. <http://www.hdwallpapers.in/walls/brooks_mountain_range_alaska-normal.jpg>.
10. Night Sky. Digital image. *Ucr.edu*. University of California, Riverside, n.d. Web. 16 Apr. 2013. <http://math.ucr.edu/home/baez/eso_night_sky.jpg>.



COMPLIANCE MATRIX

"SCIENCE, LIKE LIFE, FEEDS ON ITS OWN DECAY. NEW FACTS BURST OLD RULES; THEN NEWLY DIVINED CONCEPTIONS BIND OLD AND NEW TOGETHER INTO A RECONCILING LAW."

-WILLIAM JAMES

C. Compliance Matrix

Point	Title	Brief summary of section
1.0	**Executive Summary**	Bellevistat will be the first large settlement orbiting Earth.
2.0	**Structures**	Bellevistat's structural design allows for industrial expansion and emphasizes natural views.
2.1	Exterior Configuration	The station is designed to allow easy access to the residential areas for humans, allow the industrial facilities to not have to deal with human traffic, and the repair station is situated away from the central areas for safety.
2.1.1	Exterior Design	The station will consist of a centrifuge with 4 toruses: 2 buckytori and the residential and industrial torus. It will also include both a residential and industrial docking station, and a repair station.
2.1.2	Construction Materials List	The structure will be constructed out of Maraging Steel and Regolith. Silicon and buckystructures will be used in solar panels. Interior construction will use bamboo in addition to the steel and buckystructures.
2.1.3	Hull Design	The hull will be comprised of layers of maraging steel, regolith and steel.
2.1.4	Non-rotating to Rotating Infrastructure	An elevator will transport arrivals from the docking areas to a position parallel of the appropriate torus, then put in cars to accelerate to the angular velocity and position of the rotating spokes of the torus and transferred to the spokes' elevator for transportation to the correct torus level.
2.1.5	Volumes	The volumes of the station are designed to allow the each adequate space for all supplies on each level.
2.1.5.1	Usage of Areas	The residential torus will hold communities as well as agriculture. The industrial torus will be used for refining materials and constructing interior structure and ship repair parts. Buckytorus 1 and 2 will produce buckystructures and 1 will contain storage for their products. The centrifuge will transport people and materials between sections. The docking areas will receive ships for their categories respectively. The robot bay will house tug bots.
2.1.5.2	Artificial Gravity	Artificial gravity will be created by the centripetal acceleration of the spinning tori using detachable rockets. Gravitational forces vary between sections.
2.1.5.3	Pressurization	The residential torus and docking by, transfer station and elevators will be pressurized.
2.1.5.4	Isolation	Bulkheads consisting of 1 m of maraging steel will be placed on each level to prevent spread of various problems.
2.2	Internal Arrangements	The internal arrangements are situated to allow access to all the needs in each tori.

2.2.1	Down Surface Layout	Residential/commercial and agriculture/infrastructure areas will be divided proportionally within each level of the residential torus.
2.2.2	Orientation	The orientation of the down surface will consist of an outer, middle and inner layer.
2.3	Construction Process	The construction process states how long it will take to construct the full station.
2.3.1	Exterior Construction	Exterior construction will be divided into 11 stages.
2.3.2	Initiation of Rotation	Rotation of tori will be initiated using staged combustion cycle bipropellant rocket engines.
2.3.3	Interior Construction	Interior construction components will be produced immediately after the industrial torus is fully operational. The interior construction process will be done by Armoire robots.
2.4	Buckystructure Production Areas	The buckystructure production areas will be divided into two separate facilities to manipulate the traits of the product.
2.4.1	Locations of Production	There will be a mobile and immobile torus primarily used for buckystructure construction.
2.4.2	Transportation of Products	A set of elevators will travel up the centrifuge to transport materials between facilities.
2.5	Docking Configurations	The docking configuration is designed to separate the residents from the industrial goods.
2.5.1	Industrial Docking	Ships will be docked safely with the Ship Catching Apparatus. Cargo will be sent down the Space Bridge to be processed in the inferior terminal and then sent to the desired location. A similar process is used for the superior terminal. Solar panels will power processes related to the terminals and docking as well as other sections of the station.
2.5.2	Residential Docking	Residents will board the Grand Departure and safely be transported to the residential torus.
3.0	**Operations**	Efficient and safe operations will be utilized on Bellevistat.
3.1	Materials and Equipment	The list of materials needed to construct the interior facilities produced by Operations.
3.1.1	Materials List	Steel, regolith, maraging steel, silicon, buckystructure, LED's and aluminum will be the primary materials used in the Bellevistat.
3.1.2	External Transportation of Materials	Most of the materials will be imported from Earth using Transportatus and safely brought to L4 with Bellevistat's space tugs.
3.2	Basic Infrastructure	Operations will use the most efficient and safe methods to provide for a healthy environment for those inhabiting Bellevistat.

3.2.1	Atmosphere	Pressurization will be varied in each level. Humidity will be kept at 45%, an automated system will control temperature and synthetically made “trees” will convert CO2 to oxygen.
3.2.2	Food Production	Crops will be grown through dynaponics, and meat will be produced by 3D printing stem cells grown in vitro into cuts of meat.
3.2.3	Power	Bellevistat will be powered by a solar array built on the residential torus, and more arrays will be constructed on the docking station for expansion. There will also be a back-up Thorium reactor.
3.2.4	Water Management	Water will be filtered of ions and particles using reverse osmosis and will go through bactericidal UV lights to eliminate pathogens. Water storage will be divided between neighborhoods. There will be a contingency supply of water as well as a supply of filtration straws.
3.2.5	Waste Management	Large amounts of waste will be eliminated via the Micro Auto Gasification System (MAGS) device. Ash and biochar will be used for fertilizer. Gases will burn up by the reaction to produce steam and electricity.
3.2.6	Communication	Communication to Earth will be done via a high bandwidth laser communication array. Residents will use the Ecran for their communication needs.
3.2.7	Internal Transportation	Residents will be able to check out various transportation vehicles. Bikes will be to utilize humans’ kinetic energy and will be drained into the main power supply at transportation stations.
3.2.8	Day/Night Cycle	Temperatures will vary slightly dependent on time of day. A ceiling LED screen will be used as a natural lighting system.
3.2.9	Storage	Appropriate supplies of food, water, power and other necessities will be kept for contingency reasons.
3.3	Construction Machinery	The Bellsator will be used for construction of the hull.
3.4	Paper Production	Paper will be produced using cyanobacteria with modified organized strands by secreting cellulose under synthetic sunlight.
3.5	Repair Services	Bellevistat will use a fully automated repair system to fix a variety of ship malfunctions, damages and errors.
4.0	**Human Factors**	Bellevistat will be a revolutionary community that embraces natural beauty within a modern space settlement environment.
4.0.1	Natural Sunlight and Views	Natural views will be available when leaving the residential docking area, on the outskirts of each residential ring and from within our stargazing facility.
4.0.2	Gravity and Atmosphere Options	Residents will have the opportunity to live in the following environments: 1 g, 1 atm; 0.8 g, 0.8 atm; and 0.5 g, 0.6 atm.

4.1	Community	Communities will include a variety of venues and amenities that will assure residents will maintain traditional comforts while allowing them to embrace new ones.
4.1.1	Community Layout	The community layout will be designed with common urban arrangements in mind, creating a familiar environment for residents.
4.1.2	Community Services and Amenities	Many of our community venues will emphasize the natural beauty in the views we can observe from our location in space. For the residents' convenience, we supply a wide assortment of amenities to make transportation and communication easier. Contingencies will be in place for residential safety.
4.1.3	Consumer Goods	Bellevistat will be supplied with an array of products required for everyday life.
4.1.4	Consumable Distribution	Food products will be distributed via tubing systems. All other consumables will be available in their respective vendor locations.
4.2	Housing	Bellevistat will have a diverse collection of housing opportunities with population growth in mind.
4.2.1	Floor Plans	With 6 unique flooring designs, permanent and non-permanent residences will find a home that will fit their needs and lifestyles.
4.2.2	Housing Amenities	Homes will be supplied with a range of appliances and systems to assist residents in their daily lives.
4.2.3	Charts	Much of our housing items will be imported directly from Earth.
4.2.4	Growth Over Time	Bellevistat will anticipate a 5.5% growth rate and will accommodate accordingly.
4.3	Safety Systems	There will be a variety of systems and solutions implicated to create a safe low-to-no gravity environment.
4.3.1	Space Suits and Suit Safety Designs	The space suit will be equipped to handle low atmosphere and gravitation working environments. It will also be equipped to emit warning signs to a control room, should the wearer require immediate assistance.
4.3.2	Airlock, Pressure Systems, and safety precautions	The airlock will be designed to create a safe and easy process when exiting and entering the station.
4.3.3	Exterior Mobility Device Designs	The Propero will assist workers in transporting to exterior repair and inspection locations safely and will be able to transport users back to safety, if needed.
4.4	New Resident Integration	Bellevistat aims to create a cohesive residential population.
4.4.1	Physical Feature	Union lodges, among many other locations, will fulfill the need for a physical congregation area.
4.4.2	Social Feature	Community advisors, with the assistance of many announcement systems, will be able to create and advertise events when appropriate. Thrift stores and Earth

		news updates will assist in bridging any social gaps between transient and permanent resident populations.
4.5	Passenger Receiving Experience	Passengers will safely and efficiently be transported to the residential torus with the combination of safety precautions and the "Grand Departure" vehicle, as they observe natural views and are informed of the variety of venues that are in store.
5.0	**Automation**	Robots and automated systems are available to improve experience in Bellevistat.
5.0.1	Inventory of Devices Needed	List of robots, devices and systems in the settlement
5.0.2	Types, Security, and Capacities of Devices	A cloud system along with a central core hub will be used along with cryptographic hardware for security.
5.1	Automations of Construction Process	Automated processes and bots will be used for the construction of Bellevistat.
5.1.1	Delivery of Materials and Equipment	Materials and equipment will be brought from Earth via Transportatus.
5.1.2	Exterior Construction	Exterior construction will be carried out by Bellsator.
5.1.3	Interior Finishing	The Armoire will be utilized for interior construction.
5.1.4	Construction Process	Transportatuses will transport construction robots and materials to the L4 Lagrange Point. Bellsators initiates construction sequence. Transportatus will deliver more material.
5.1.5	Manufacturing of Household Goods	The Bellprocer will build appliances and furniture using 3D Printing.
5.2	Facility Automation	A variety of processes and bots will be used to make the interior of the settlement run smoothly and efficiently.
5.2.1	Automated Systems for Maintenance	Maintenance bots will be around Bellevistat to help the operation of the settlement. Construction bots will be coated with Buckystructures for exterior maintenance during solar flares.
5.2.2	Industrial Security Measures	Security for industrial purposes. Main security measure would be the PRM, or personal retainer microchip.
5.2.3	Residential Security Measures	Security for residential purposes. Main security measure would be the PRM, or personal retainer microchip.
5.3	Habitability and Community Automation	Automated robots and systems will be used to make peoples' lives happier, healthier, and more productive.

5.3.1	Automated Devices to Enhance Livability	A variety of robots are available to assist every human need.
5.3.2	Automated Devices to Enhance Work Productivity	User friendly Ecran, insanely fast computer processors, and high bandwidths will all aid in productivity.
5.3.3	Privacy for Personal Data	The Ecran only opens data of PRM it identified.
5.3.4	Personal Devices	Ecran, the device made for mankind.
5.4	Ore Container Unloading	A system that use minimum energy is employed.
5.4.1	Automated Unloading System	Unload containers from ship, transport it to the zero g facility, and unload containers to zero g refining facility.
5.5	Docking Facilities	The versatile combinations the Manus and Tractim can form allows any type and size of ship dockable.
5.5.1	Automated Final Docking	Once Tractim configures the ship, Manus holds it down.
5.5.2	Docking Procedures for Each Dock	Ship slows down, Tractim configures the ship, Manus stabilizes the ship, and semi-rigid air bridge connects to the door.
6.0	**Schedule and Cost**	The planned cost and construction time for Bellevistat.
6.1	Design and Construction Schedule	Bellevistat will take 5 approximately years to be fully constructed and populated.
6.2	Costs	The cost of Bellevistat will vary from section to section dependent of the required items with the total cost being: $11,179,428,140
7.0	**Business Development**	Bellevistat will be a major industrial center and launch point for future settlements
7.1	Port Design	The ports have been designed to have the ability to accept cargo continuously, easily ship goods around the station, and be able to handle nonstandard containers
7.2	Manufacturing Goods	The industrial torus will be able to support different conditions to change product attributes, have space available for leasing to other companies, delivery routes to docked ships, and the expand to produce a interplanetary ship assembly area.

7.3	Repair station and Other Infrastructure	The repair station will be produced to accommodate different ships with space tugs stationed right above it. The docking facility is created to expand outward with a system set up to safely clear a hazardous situation on a visiting ship.