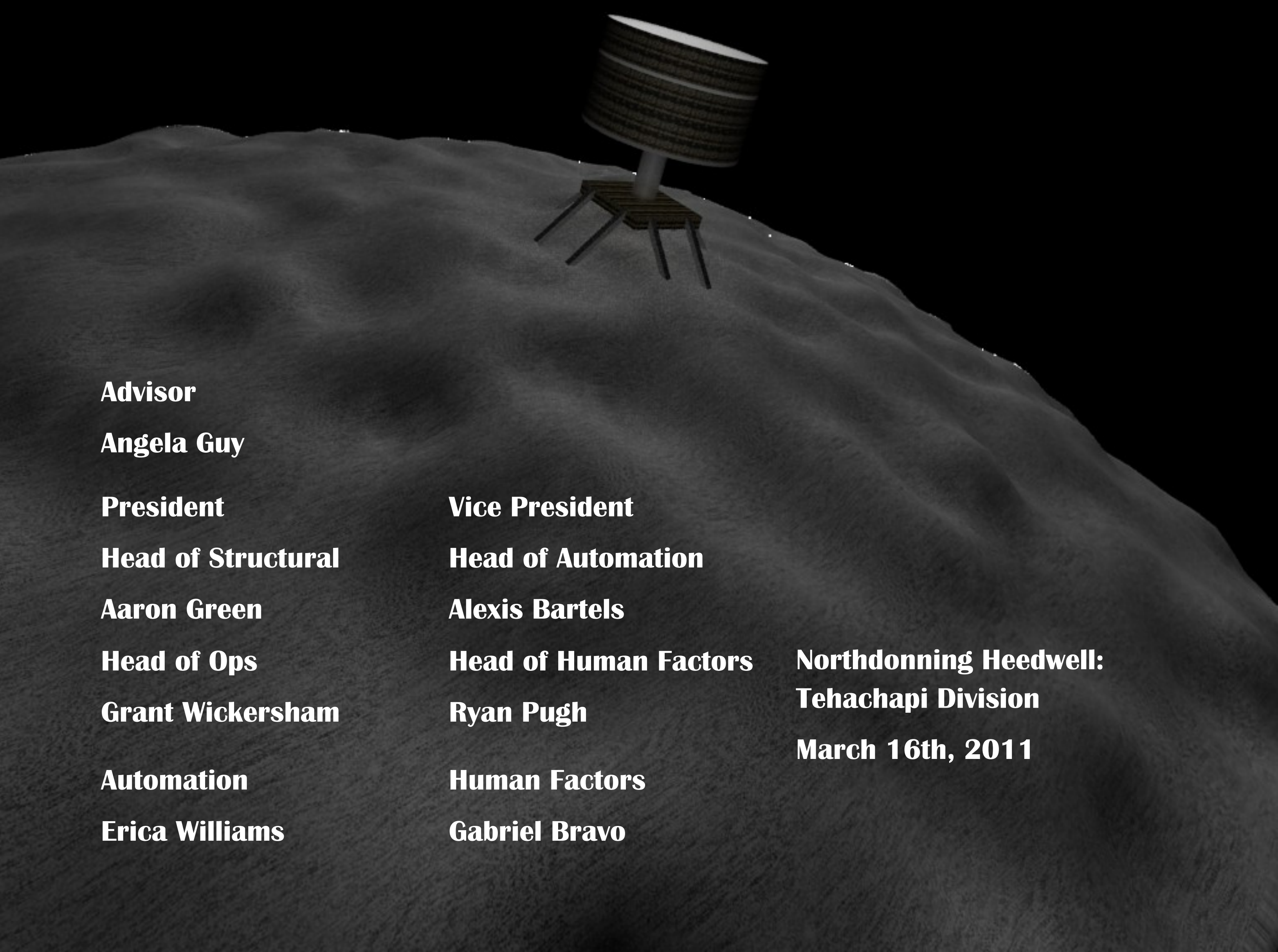
Astoria



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March 16th, 2011

1.0 Executive Summary

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For decades, man has looked down two roads. Down one road lie the stars and the expanse of seemingly limitless vacuum populated by a multitude of potentially new scientific and economic opportunities, which organizations such as the Foundation Society have set out to take hold of. This road has been faithfully walked by the Foundation Society since the establishment of Alexandriat, all the way through Argonom.

There is another road however, and in this day and age of space exploration and harnessing of the Final Frontier, it is often overlooked and ignored as a source of possible aerospace engineering applications. This is the world found in a single drop of pond water, the world of amoebae and paramecia, of bacteria, viroids, and prions, and most importantly of all, the bacteriophage.

The bacteriophage is a marvel of engineering, a machine designed to use the materials and mechanisms in other cells to propagate itself based upon its own genetic code. We of Northdonning Heedwell have not forgotten this marvel of nature and have appropriated its functional but graceful design as a template for our latest and greatest design: Astoria.

Astoria will function as a gateway to future mining opportunities in the asteroid belt as well as provide raw materials for construction of other mining sites that will be inevitably be constructed as time goes on and the human demand for resources grows, as will the profitability of an outpost that will be used to pave the way to future exploitation of resources elsewhere in the outer solar system.

As pioneers in the field of engineering, we of Northdonning Heedwell are pleased to present for your approval, the latest and greatest of Northdonning Heedwell designs. With the aesthetics and efficiency of system perfected in nature, and incorporating facsimiles of biological systems at every possible juncture, we give you Astoria.

2.0 Structural

2.0 Structural

Taking its cues from the efficiency and style of a bacteriophage, Astoria will provide a safe, productive, and comfortable environment for all 11,500 residents through the use of redundant safety measures, convenient transportation methods, and natural views of space via the transparent 'window' on the two vertical ends of the capsid.

2.1 Exterior Design

The station, like any organism or machine, can be broken down into even more basic structures. For Astoria, these are: the capsid (also referred to as the head), the central tube, the base, and the tail fibers.

The head of the station is the location of all permanent and transient communities and is the major hub of the station. The head is subdivided into three cylinders, two of which being purely residential in nature and a third being a 'common' area or downtown between the two.

Figure 2.1: Astoria Exterior

The central tube extends along the length of the station, providing a medium for all transportation between the upper and lower portions of the station. It also provides a convenient zero gravity workspace for several operations mechanisms and processes.

The base of the station is the major docking station as well as the juncture from which men and machinery are transported to the asteroid's surface for mining purposes.

The tail fibers are the only part of the station that directly contacts the surface of the asteroid. They attach the station as well as provide a considerably large space for storage and operations equipment.

The entire station is pressurized up to 13.5 psi as all of the above regions of the station are used for storage habitation or transportation. Gravity however is only present in the two residential rings and the single 'common' ring.

The multilayer system of fail-safe devices and structural supports that keep the thriving city in space safe are present in 2.4 and will be discussed there.

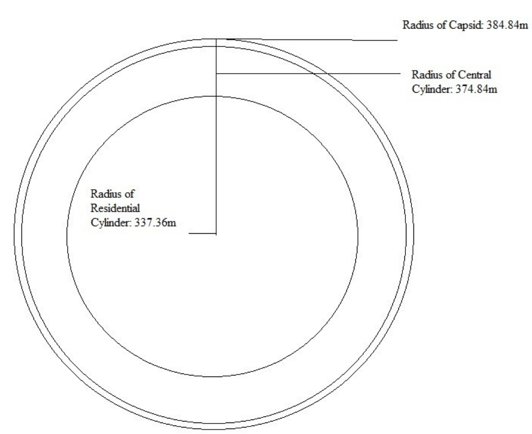


Figure 2.2 Top View of Astoria Capsid

Structure	Height	Width	Depth	Diameter	Volume
Capsid	680 meters	N/A	N/A	632 meters	2.133 x 10^8
Residential Cylinder (x2)	265 meters	N/A	N/A	618.5 meters	7.962 x 10^7
Common Cylinder	150 meters	N/A	N/A	631.75 meters	4.702 x 10^7
Central Tube	500 meters	N/A	N/A	100 meters	3.927 x 10^6
Base	100 meters	700 meters	700 meters	N/A	4.900 x 10^7
Tail Fibers (x8)	600 meters	50 meters	50 meters	N/A	1.500 x 10^6

Figure 2.3 Measurements of Station Components

2.2 Down Surfaces

The massive 'down' surface area of Astoria is carefully allocated according to need.

Type of Down Surface Area	Total Square Meters Allocated
Residential	1,029,829 m^2
Commercial	297,705 m^2
Industrial	315,000 m^2
Agricultural	223,367 m^2
Storage	844,456 m^2
Docking	490,000 m^2
Total	3,200,357 m^2

Figure 2.4 Down Surface Measurements

The orientation of the down surface in each of the structures is discussed below:

In the cylinders within the capsid, all down surfaces are oriented towards the sides of the station, facing space; this is also true in the hollow area of the capsid as well as the central tube and tail fibers. In the base, the down surface for each face will be facing toward the exterior of the station, as no gravity is effecting that section and is thereby made more productive for heavy ore processing and loading and unloading of cargo vessels.

2.2.1 Residential Down Surface

Both transient and long term residents will live in comfort within the two residential cylinders located within the capsid. These cylinders will be laid out in a standardized series of communities with a few models of housing to choose from.

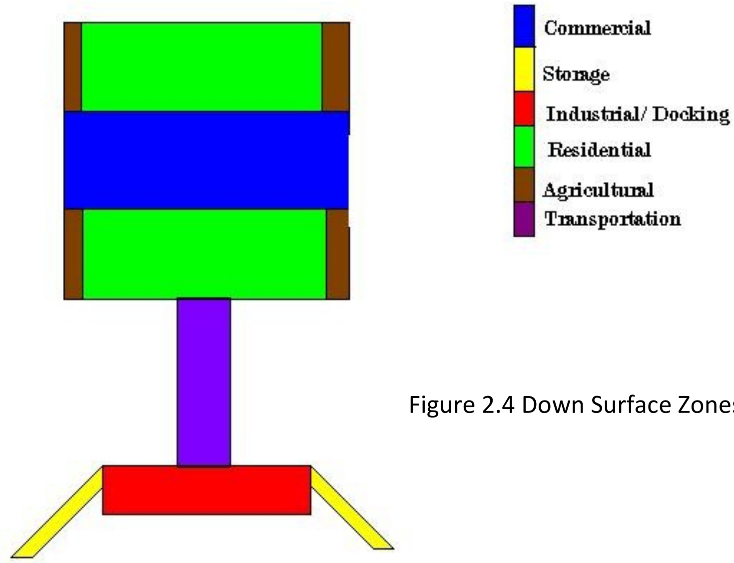


Figure 2.4 Down Surface Zones

2.2.2 Commercial Down Surface

The commerce of the station will take place in the common cylinder of the capsid, said cylinder functioning as the hub of intra-station activity. The common cylinder will also feature rest and recreation centers for crews of vessels docked at the station as well as various civic buildings such as schools and hospitals.

2.2.3 Industrial Down Surface

All manufacturing activities, including ore processing, fabrication of robots, etc., will take place in the base of the station, thus taking advantage of null-gravity applications for manufacturing processes.

2.2.4 Agricultural Down Surface

The agricultural activities of the station will take place primarily on the inside edge of the capsid that is not in near contact with the common cylinder. This agriculture is focused on mass production and will supply the stations needs, and beyond, in bulk.

2.2.5 Storage

Storage space will be available in the tail fibers of the station. Storage space designated for agricultural products will be located within the previously mentioned agricultural area. Other consumables as well as temporary storage space will be available in the base of the station.

2.2.6 Docking

Areas designated for the loading and unloading of ore and consumables are located at the base of the station only.

2.3 Construction Process

Construction of Astoria contains eight primary stages of construction. The first begins with the construction of the residential cylinders. The cylinders will be assembled at Aresam station as will the other components making up Astoria. The second stage of construction will be the assembly of the common or civic cylinder. The third stage of construction will be the connection of all three cylinders and the assembly of an all-encompassing capsid around the three.

The fourth phase of construction will begin the bottom half of the station. The central tube of the station is assembled out of a flat sheet later rolled into a cylinder and stored until stage eight. The fifth stage of construction is that of the base of the station, the exterior is assembled first, proceeding inward, adding the honeycomb-like structure of the base.

The sixth stage of construction is the construction of the tail-fibers. As they function as little else but

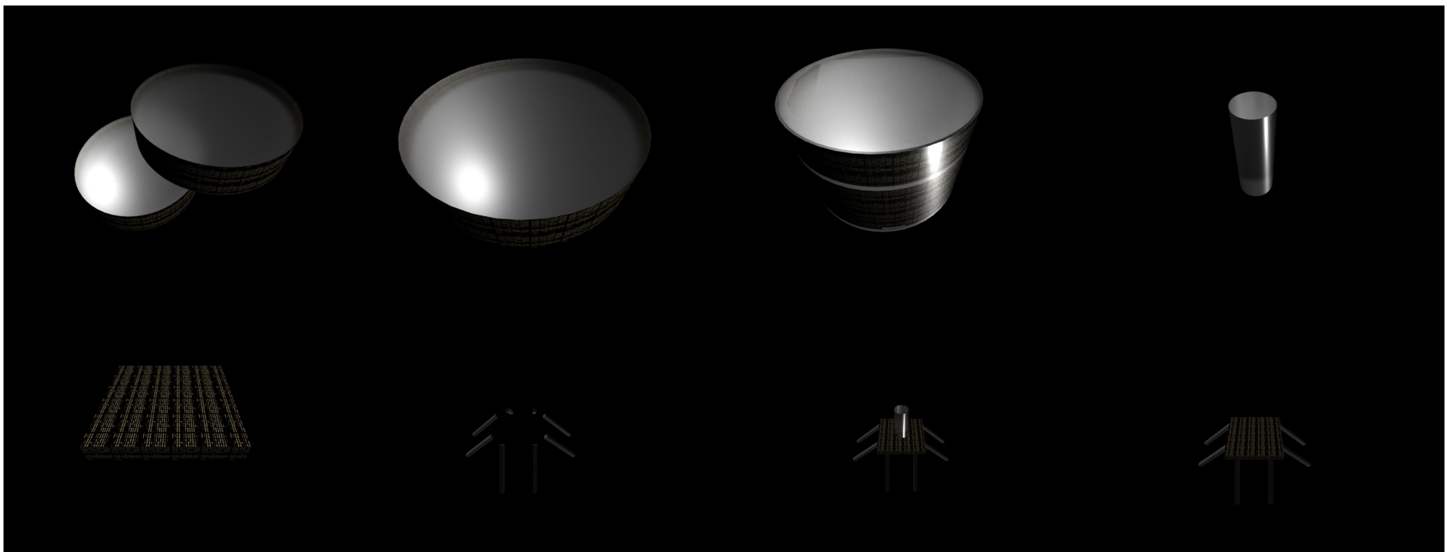


Figure 2.5 Construction Process

storage facilities and are the attachment of the station to the bedrock of the asteroid as well as storage, they will be little more than a series of honeycomb structures.

The seventh stage of construction will be the attachment of the tail fibers of the station to the base. The eight stage of construction will be the attachment of the central tube to the base. The ninth phase will be to attach the upper and lower halves of the station and integrate all conduits, wiring, etc. between the two.

The tenth phase of construction will be to construct the interior of the station, the residential units, as well as all commercial, industrial, agricultural and all other buildings and mechanisms will be constructed during this phase. The eleventh stage of construction will be to send the station to the asteroid. It is during this stage that the three cylinders inside of the capsid will begin to spin at the rate specified in section 4.() by means of a series of magnets attached to both the cylinders and the interior of the capsid.

Having arrived at the asteroid, stage twelve will begin. The station will physically attach itself to the asteroid through a series of magnetic clamps and physical drills embedded in each of the tail fibers. Once this is complete, stage thirteen, settlement of residents and establishment of a base camp on the asteroid's surface will begin.

2.4 Damage Control and Repair

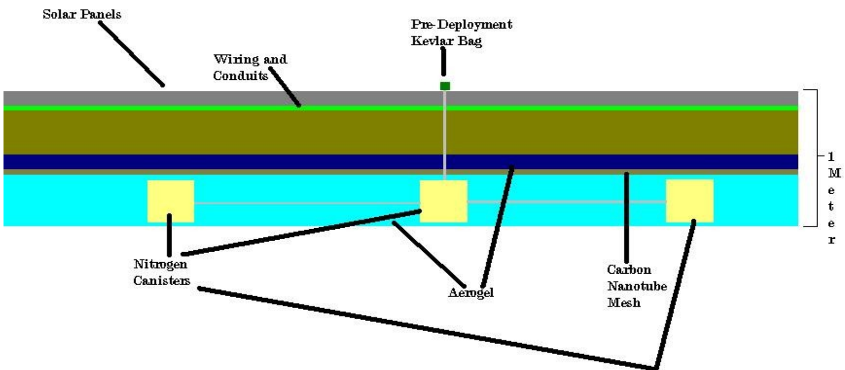


Figure 2.8 Layers of Protection Within Astoria Hull

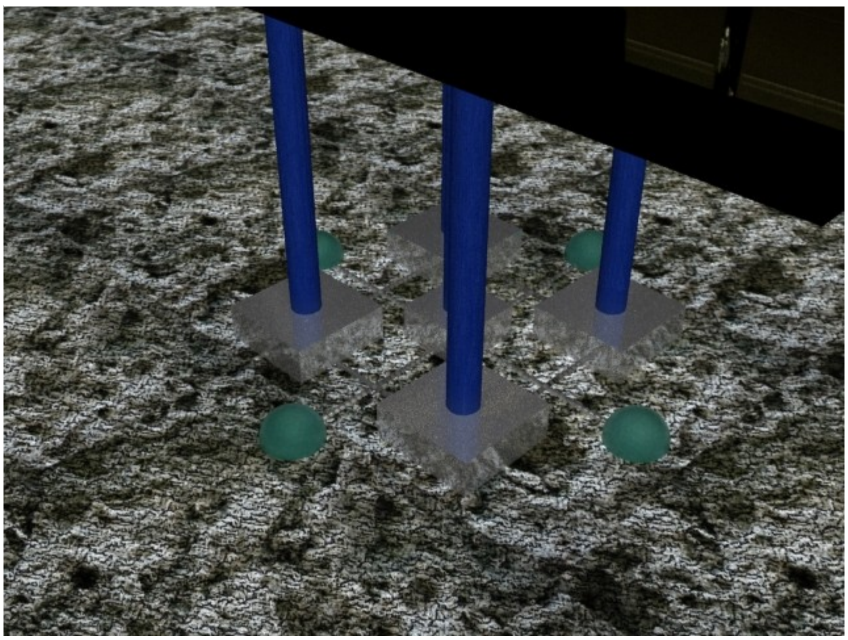


Figure 2.7 Artist's Conception of Mining Camp

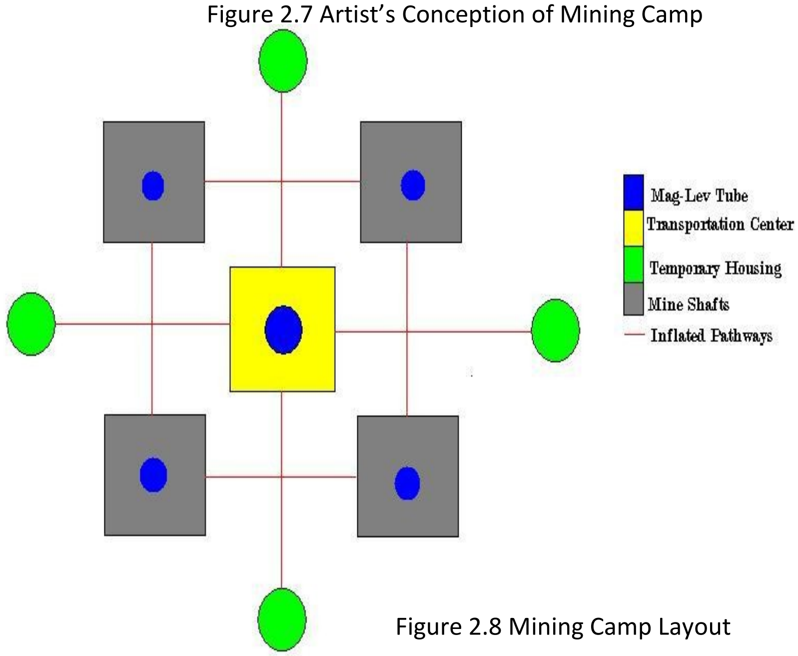


Figure 2.8 Mining Camp Layout

As small particulates will frequently impact the hull of Astoria, constant maintenance is a necessity. To ensure that minor hull repairs are carried out, a series of small robots will be continually deployed along the exterior of the hull.

Though infrequent, larger bodies can cause great damage to the station. To prevent this, the station has a unique protection system that can be utilized should the situation call for it. The station, below its layers of solar panels will have several canisters filled with chilled and compressed nitrogen gas. These, when heated to roughly 90 degrees Celsius will expand very rapidly into a Kevlar bag attached to the exterior of the station. This bag, increasing in size to over 100 cubic meters, will act as an airbag, deflecting any particulates too large to be dealt with by the station's hull.

2.5 Mining Camp

The mining camp, located on the asteroid's surface will provide direct access to the asteroid. Transportation from the station to the mining camp is accomplished by means of a Mag-Lev elevator located in the center of the camp. Encompassing the elevator is the transportation center; it houses storage facilities for recently mined ore as well as the above mentioned elevator.

Adjacent to the transportation center are a series of inflatable tubes connected to four temporary housing units as well as the entrances to four separate mine shafts, upon which are separate Mag-Lev tubes, in which are carried raw ores destined for processing in the station.

3.0 OPERATIONS

3.1 Station Location

Astoria will be located on the asteroid 216 Kleopatra. Iron and carbon, essential ingredients for steel, are both readily available in the asteroid belt along with smaller quantities of silicates in certain asteroids.

Figure 3.1 Materials Required For Construction

Materials	Source
Aluminum	Moon
Carbon	Asteroid Belt
Iron	Asteroid Belt
Hydrogen	Moon
Oxygen	Moon
Silicon	Asteroid Belt
Steel	Asteroid Belt
Titanium	Moon
Carbon-nanotubes	Earth
Copper	Earth
Lead	Earth
Polymer Plastics	Earth

3.2 Elements of Basic Infrastructure

Figure 3.2: Air Composition

78% Nitrogen Gas	2.538(10^11) Liters
21% Oxygen Gas	6.834(10^10) Liters
1% Water Vapor	3.254(10^9) Liters
100% Total	3.254(10^11) Liters total (at 101.3 Kilo-

3.2.2 Astoria will utilize both hydroponics and aeroponics to grow its food. The growing areas will be on the inside of the hull in zero-g. Plants will be harvested by an automated system through the track system that will be placed throughout the growing area. The automated system transfers the plants to vacuum storage chambers and from there the food can be moved through vacuum tube to the ordering areas in the residential quarters.

3.2.3 The primary sources of power for the station will be an array of solar panels covering the exterior of the station as well as fission reactor within the base of the station.

3.2.4 49,690 L of water will be needed to sustain the residents of Astoria and to hydrate the crops. 36,465 L is needed for the population and 13,225 L for the crops. Water could be pumped into an area between the outer hull and the inside of the station for storage and shielding.

3.2.5 All metals and plastics will be melted down and recycled. Solid human waste will be subjected to extreme temperatures to kill any harmful microorganisms, and the resulting product will be mixed into the solution that is sprayed on the roots of the plants in the aeroponics system to provide nutrients. Liquid human waste will undergo a filtration process which kills all microorganisms and removes uric acid, urea, and creatinine.

3.2.6 Astoria will feature a station wide announcement system for emergencies, a wireless network for personal audio and video communications, and a microwave communications array for contact with Earth and other stations.

3.2.7 The communities have the perfect design for bicycle routes, and as such bicycles will be the main type of transportation. Between ring transport is achieved with a maglev tram system that connects the rings in a series of tubes.

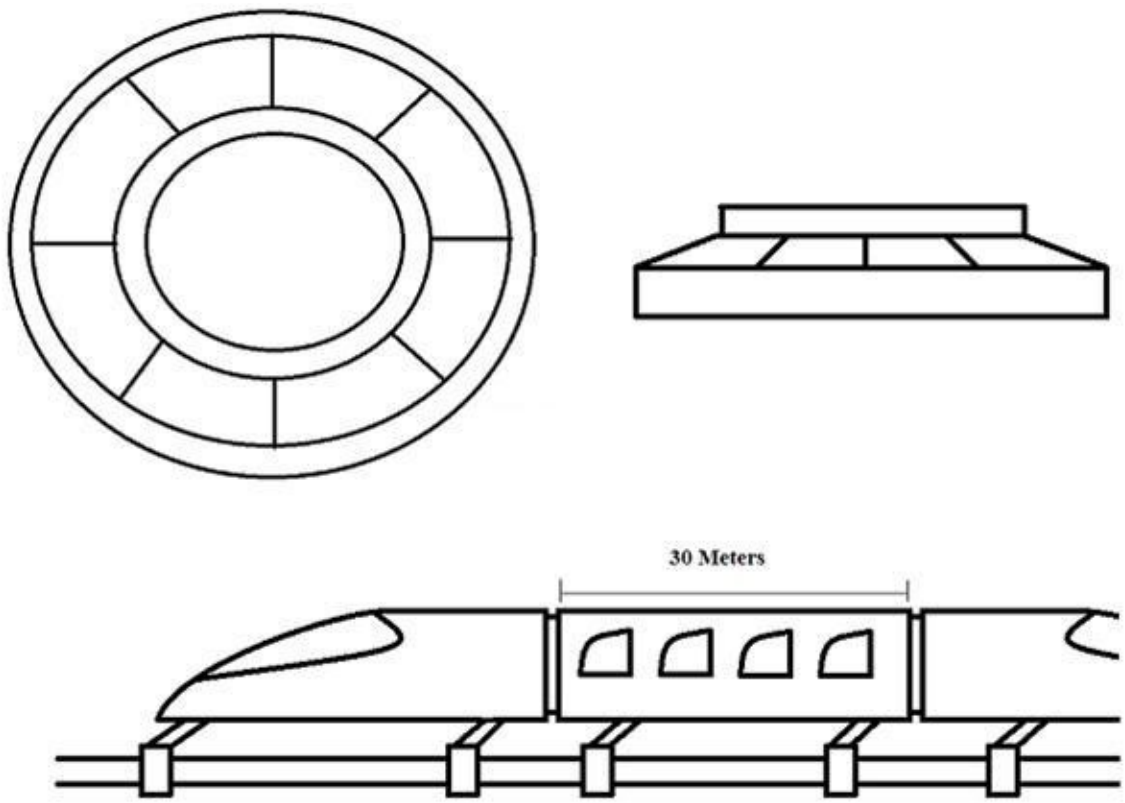


Figure 3.3 Tram System

3.2.8 Astoria's day and night cycle will be maintained with artificial light with sixteen hours of daylight and 8 hours of night.

3.3 Machines Used In Construction

One of the first robots used would be a girder layer. This robot moves via a track made up of the girders which it has placed. Girders would be held in the upper receptacle where they would be attracted toward the bottom by a not-too-powerful electromagnet and would be forced out by a piston of sorts. Then the grasping arm would grab it and swing it into position where a welding unit underneath would secure the girder as part of the track. In this way a frame for the station could be easily erected.

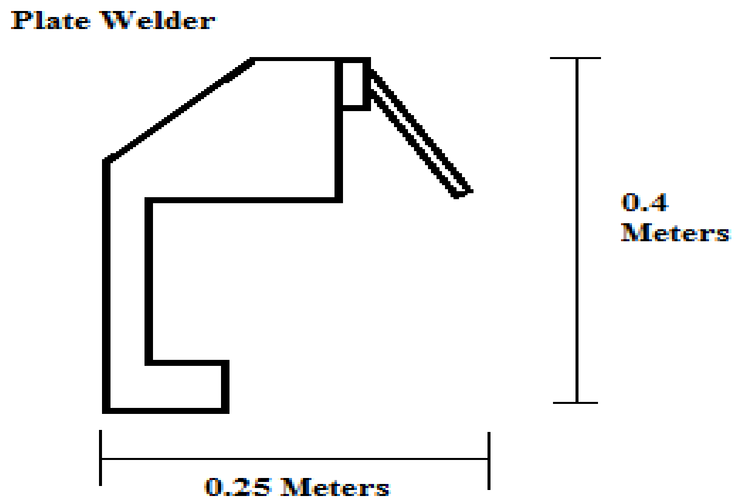


Figure 3.4 Plate Welding Robot

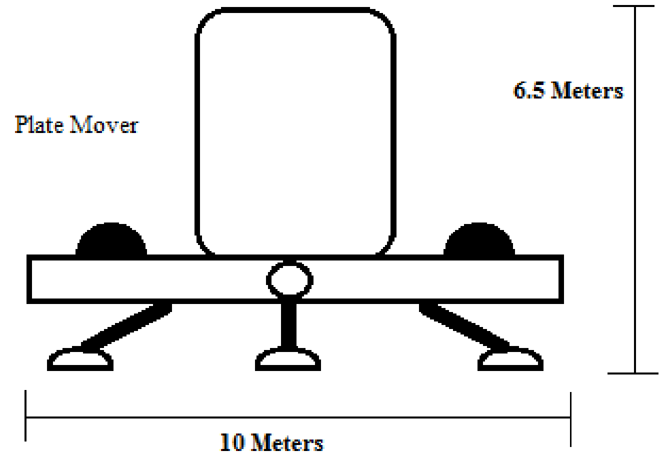


Figure 3.5 Plate Moving Robot

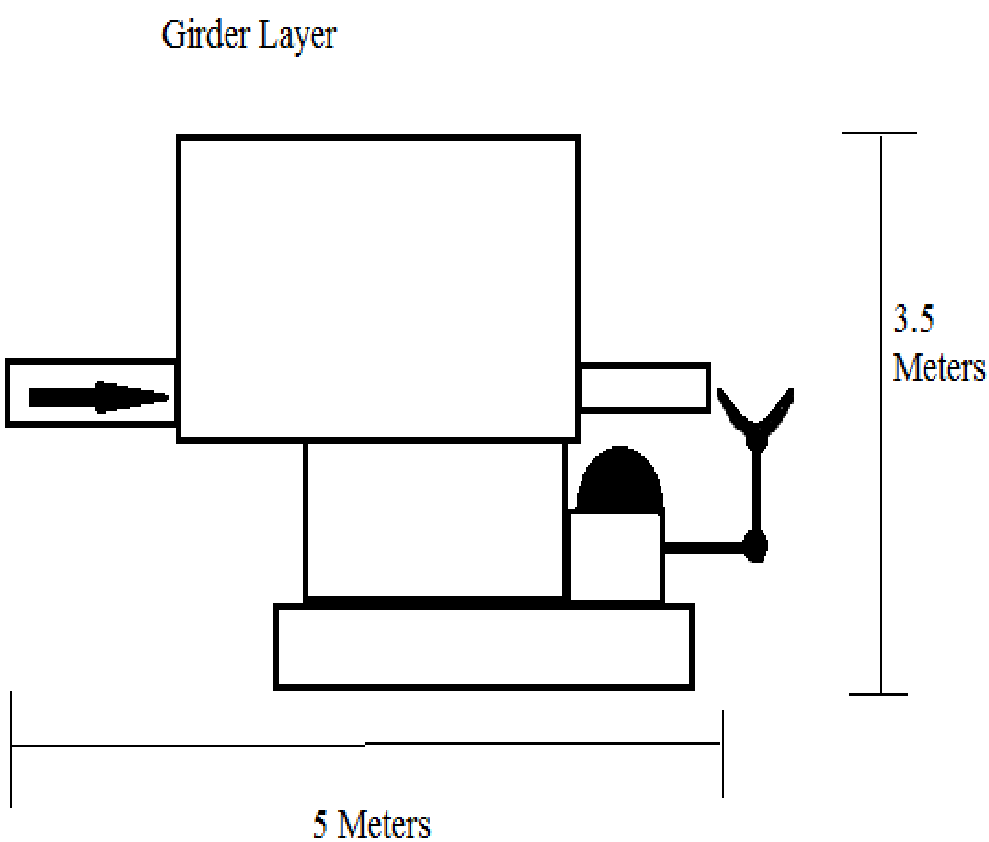


Figure 3.6 Girder Laying Robot

Another robot would move the plates of steel or plastic needed for construction into place. In the initial stages of construction it would move steel plates using electromagnets at the base of its feet, and in the housing above there would be several batteries powering the magnets. It would also house fuel for the small jets on the robot which would allow it to maneuver in zero-g. Once atmosphere is throughout the station, this robot could be used to maneuver plastic plating, with air pressure, the electromagnets could be swapped out for vacuum suction cups and the batteries for a motor which would generate the vacuum.

The last robot needed would be extremely simple. It would travel along the girders laid down by the first robot and weld the plates that had been laid down by the second robot to the girders. It would have an arc-welding system.

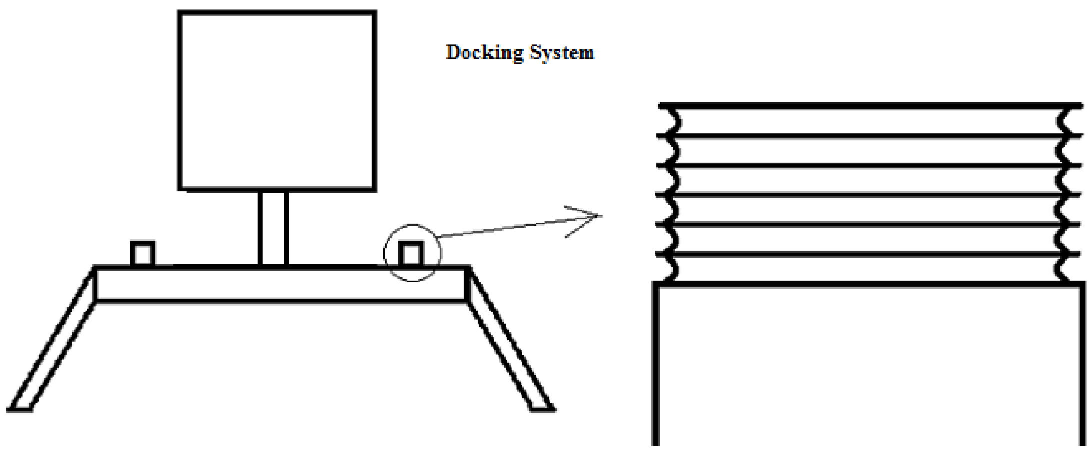
3.4 Station Movement

Thrust, acceleration, and fuel requirements for the movement of the station are impossible to calculate due to the unknown mass of 216 Kleopatra. However, the station will be equipped with three liquid fuel rockets on the sides of the cylinder for emergencies.

3.5 Docking

Figure 3.7 Docking System

Kleopatra also has two small moons which could easily be accessed for mining. The base of the station will have a docking area with many places for tubes that will extend and lock with incoming vessels. The ore in these vessels cannot simply be dumped thanks to zero gravity. Instead ore will be stored in a circular container that has a large piston at one end. The piston will slowly move forward and force the ore out of the cargo hold of the vessel and into the holds of Astoria.



4.0 Human Factors

4.1 Communities

The station has two different kinds of communities. It has 300 residential communities in the two Residential Cylinders, and one large community in the Common Cylinder. There are 275 long-term residential communities, and 13 semi-term residential communities, and 12 extra communities to allow for growth and overflow. The communities are distributed throughout the interior of the cylinders which are inside the capsid.

4.1.1.2 Residential Communities

In each Residential Community there are 40 people. The dimension of each residential community is as follows: 44.196 m by 77.724m. There are approximately eight married people, approximately 23 single people, and 1 family of 5. Houses are designed to be easily adapted with interchangeable rooms for customization based on situation as needed. At the center of each community is a Food Vending Machine shack that is supplied with food product, which can be ordered by any resident, via vacuum tubes connected to the "Kitchen" in the common Community. In the center of each community is also a small park with grass and trees. Also in-

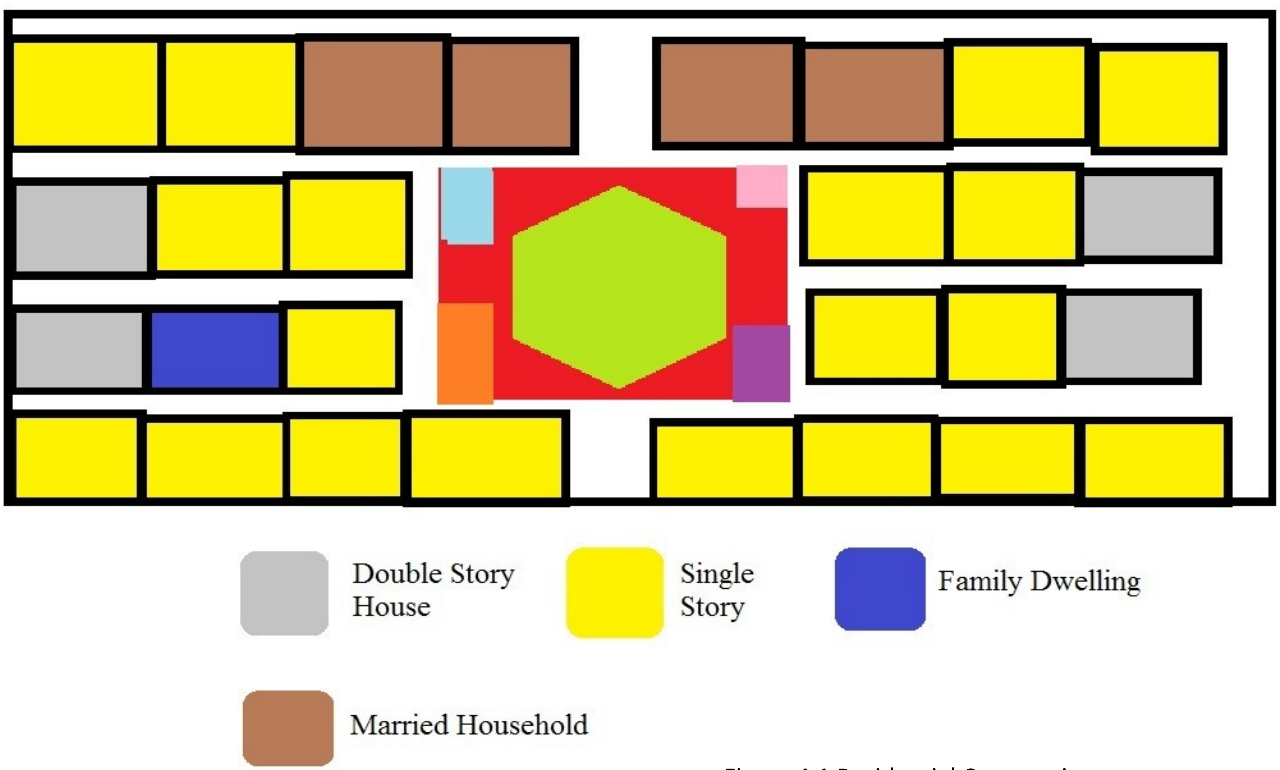
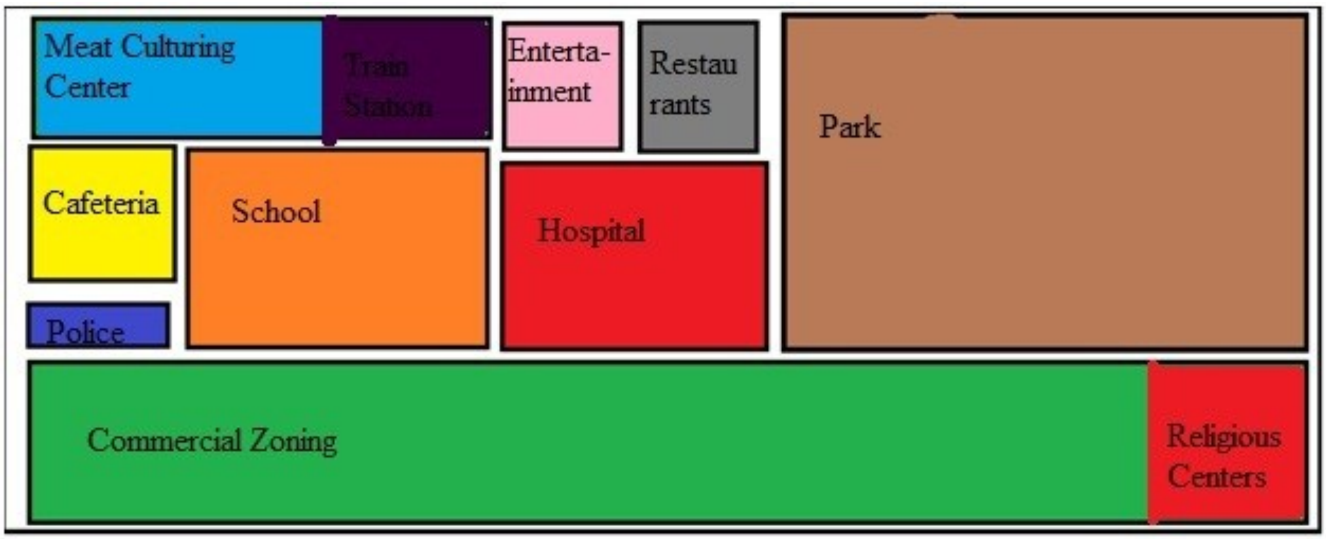


Figure 4.1 Residential Community

cluded is a small medical shack which contains basic first aid supplies, and an emergency response robot. There is also a restroom in the center of each residential community, and a Communal Computer is also in the center of the community, as well as an elevator leading to an elevated speed train that allows people to more quickly travel to the common ring.

4.1.1.3 Common Cylinder Community

The Common Cylinder Community, unlike the Residential Cylinder Communities, does not repeat throughout the Common Cylinder, but rather it is one large community spanning the inner wall of the Common Cylinder. The Common Cylinder Community's dimensions are 150m high by 1982.59999m long. It is designed with a main hospital capable of providing extensive medical care, a "Kitchen" where food from the farms is prepared and sent to communities upon order via vacuum tube, a recreational sector with various buildings providing a plethora of entertainment, a commercial sector, where buildings can be rented out to companies for a variety of purposes, a park, much larger than the parks in each residential community, a small police station, and a wide cultural selection of restaurants. There are several religious centers available to the Residents of Astoria; they are located here in the Common Cylinder.



4.2 Common Cylinder Community

4.1.2.1 Consumable Goods

Food grown in aeroponics and the meat growing center includes Avocado, Quinoa, Artichoke, Asparagus, Broccoli, Carrot, Potatoes, Oranges, Tangerines, Grapefruits, Pomegranate, Grapes, etc., chicken, beef, pork, ostrich, etc.

Amounts of Food Grown: Protein: 2,208,000oz Fruit: 1,472,000oz Vegetables: 1,472,000oz

4.1.2.2 Food Distribution

Food is grown on the inner wall of the capsid and then robots take the food grown to the "kitchen" to be processed and cooked and packaged. Then a system of vacuum tubes distributes food from the "kitchen" to the vacuum tube stations in each residential community according to orders placed by residents at said stations.

4.2 Housing

There are six permanent resident house designs, each with slight variations between them, with sq footage varying from 900 sq ft to 1,800 sq ft. Bedrooms can be modified to accommodate changing demographics al-though the standard community comes with one double storied family house capable of accommodation a family of five, 19 single story houses capable of accommodating one person per house, four double storied houses capable of accommodating one couple per house, and four double storied condos with one person per floor.

4.3 Spacesuit

The spacesuit pictured below, designed by Northdonning Heedwell, is made to function in an environment of little to no gravity. It has several built in communications device as well as emergency rations in case of an emergency.

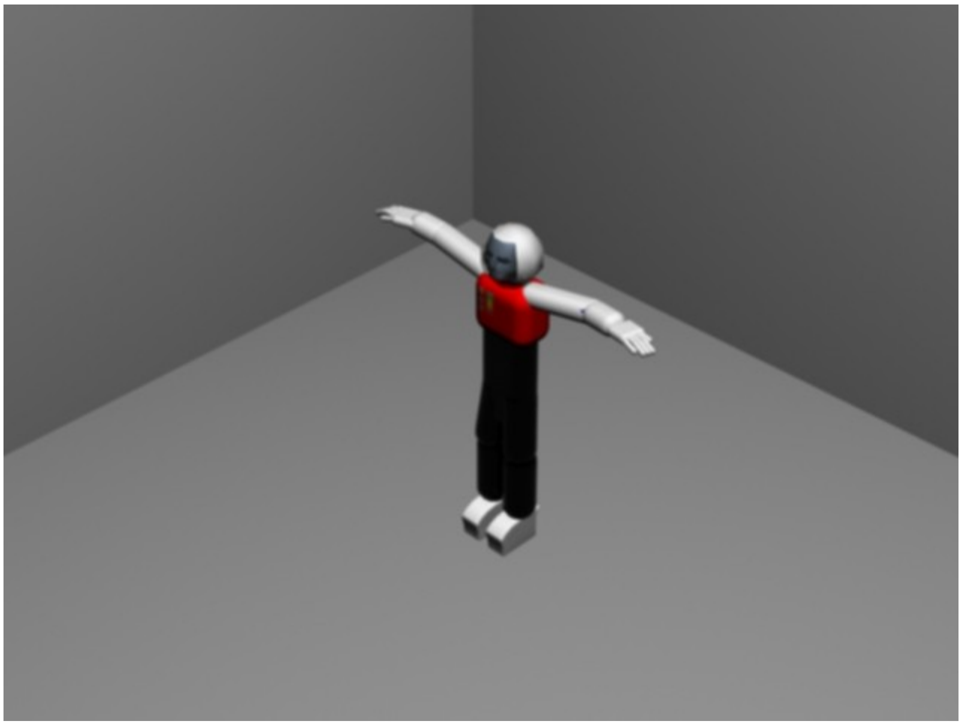


Figure 4.3 Spacesuit Design

4.4 Gravity Specifications

The Residential Cylinders are designed to rotate at a rate such that a full rotation is completed every 3 hours 40 minutes 18 seconds 21 milliseconds 36 nanoseconds. The dimensions of the residential cylinders, per cylinder, are 309.2539699m in radius, 1,943.1m in circumference. These dimensions as well as that spinning rate result in an environment of 0.9 gee in the Residential cylinders, ideal for daily home life. The spinning rate of the Common Cylinder is the same so that traversing between the Residential and Common Cylinders can be done simply by walking or taking the train between the two. The dimensions of the common cylinder are 315.5405889m in radius and 1,982.59999m in circumference, and these dimensions are designed such that at the specified rotation rate, the Common Cylinder has a simulated 1 gee. This one gee environment is especially beneficial to children, in that the school in the Common Cylinder, thus providing them with several hours of exposure to 1 gee, as required for their healthy growth. The dimensions and spinning rate were determined such that the residents on the station will not experience the ill effects of being spun around too quickly because of a small radius.

4.5 Semi-Term Residents' Integration

Semi Term Residents will be provided with instant move in, i.e. pre-furnished, houses thus allowing them to immediately integrate into Astoria. Included in their houses are PDAs that include information about the station, thus allowing them to immediately integrate into Astoria society.

5.0 Automations

5.1

Robots Used For Construction

Construction will be carried out by a barrage of Type A, 2A, 3A and 4A robots with construction attachments. 500 chassis total will be devoted to construction and maintenance of the station, both outside and inside. After the completion of the exterior of the station, the robots will be assigned tasks on the interior of the station. These robots will be tracked and monitored by a computer network system. Upon the completion of tasks, the robots will either be assigned a new one, ordered to form a new chassis configuration or will be sent to storage in the Tail Fibers.

Expandable chassis will be used throughout the station. The base chassis, referred to as Type A, will be two feet wide by one foot long by one foot high with two wheels at both ends of the chassis. Additional chassis of the same dimensions can snap on to expand the base size of the robot. The largest chassis size is unlimited. The most common chassis are Type 2A, a chassis with four wheels, and Type 3A, a chassis with 6 wheels. On top of the robots are interchangeable "shells" which protect the mechanics which also attach to the chassis. The robots also have attachments which outfit them for different jobs. This concept creates maximum recyclability of the robots so after one job is finished they can be reassigned with different attachments to fulfill a different job. There will be 5000 total Type A chassis total, distributed and recycled throughout the station.

5.2

5.2.1 Business

Programmable ID card that identifies people, gives them access to areas depending on their security clearance, provides funds for meals and purchases. Devices are placed on doorways, stores, grocery stores, homes and secure areas. Residents swipe card for access to homes and work, to purchase items, and for identification. Temporary guests will be issued the same sort of cards and will be required to return the card before leaving. If lost cards are lost, the user simply reports the lost card

5.2.2 Maintenance repair

The robots will have several central core zones where robots are collected when sensors indicate a repair needs to be made or when an update needs to be made to the robot. The robots which need updating will be repaired by other robots while the robots to be repaired will be first analyzed by robots to see if a repair can be made autonomously in the factory. If a repair can be made by another robot then the job will proceed. If not, then a human will repair the robot using on hand parts or equipment shipped in from Aresam or fabricated in on sight factories. Recycling construction bots.

5.2.3 Safety functions

Robotic cameras are sealed in domes on buildings. The cameras semi-autonomously observe residents. If a problem arises, whether it be a security, disciplinary or medical issue, the camera will detect a change in the regular flow of traffic. At this point, depending on the issue which arose, either a first aid-robot or a police-robot will be scent to the scent. The first-aid robot will aide the patient until larger ambulance bots can arrive at the scene to transport the patient to the hospital. If there was a crime, a police robot will be scent to sort out the scene and if required, take disciplinary action. The decision to do this will occasionally require the help of an operating official. Additionally incidents can be phoned in or reported at medical shacks which are strategically located about the

5.2.5 Emergency Plans for Failure

Robots are locked down in the event of a failure. They have an emergency stop switch which cuts the feed of the network to the robot. Because of a feature in the programming, when the feed to the network is lost, and the failing robot is shut off. Units then have to be reactivated after repair by authorized personal or remotely after or sight inspection.

5.3 Enhancement of Livability

5.3.1

Upon entrance into the Astoria, people will be injected with alpha and beta nanites that will assist white blood cells in quickly identifying various pathogens to prevent the immune system from becoming helpless. After 5 generations of dividing the alpha nanites, from a starting batch of 1 million, will be not have sufficient materials to continue surviving and will dissolve into the blood stream. They will be composed of organic carbon polymers. The more permanent beta nanites will have a starting population of 10 million and for the most part will be permanent assisters in maintaining body structure i.e. helping to fix a broken bone or a torn muscle. Robots for surgeries will be designed to perform minimally invasive surgeries. They will have several different arms with interchangeable sterile tools and cameras that will allow it to see. It will be programmed for a large number of surgeries. Teachers will be aided by the PPC for the posting and receiving of assignments, class work and notes. It will also allow students to check the PPC for video recordings of the class if they wish to examine it. For energy saving purposes many of the robots are powered by SCS (solar conservation system). This device allows the robots to uses the excess visibility lighting in the ship that would otherwise be converted to heat and other forms of energy.

5.3.2

The PPC or portable processing core is a small device to be carried around by the residents that operates as a computer and provides communication and entertainment services. It contains a receiver that will communicate with the wireless network which is contained in the center of the station that allows the PPC's internet and communication functions to be used anywhere within the Astoria station. It contains a keyboard for precision and voice activated features that will provide residents with a variety of options and uses. The PPC has a large screen and can be carried around as easily as a small book. Operates for both work and play purposes.

5.3.3

To save time and energy, daily household chores are handled by the highly specialized robots within the community center. Cooking for instance is handled by the FC (food center) so that all people need to do is order a meal from the diverse selection that is available on the menus and within minutes the food will be sent to them via vacuum tube. The same follows for other tasks such as laundry and dishwashing. Messes that cannot be moved are carried out by the AM units.

5.3.4

The maintenance of the station and individual housing units will be monitored by the AM (automated maid) units. There are three classes of the maid unit, class one deals with any cleaning that involves the usage of water and have been especially designed to use said water as efficiently as possible, class two use high concentrations of the UV rays found in lights to sterilize, and the last is built sturdily so that it may pick up debris of various sizes and shapes. The AM units have been programmed to identify certain objects as garbage or certain areas that need to be cleaned periodically but can also be easily reprogrammed to fit the stations or households needs and are compact enough so as not to be a bother to the inhabitants. The agricultural-bots are tasked with the care and harvest of the various plants aboard the Astoria and have appendages that make this task quick and effective. Since our plants are grown in zero gravity and offered nutrients through aeroponics the agricultural-bots have been given the proper tools to ensure that each plant is given the proper nutrients, plant and distribute seeds, prune and harvest. For the production of meat, simple robots have been assigned the job of stretching the farmed muscle daily and operate similarly to taffy pullers.

5.3.5

The computer is able to identify individuals through a retina scan. When someone first enters the station their patterns are stored in the computer and they are given clearance according to their function and rank.

5.3.6

For home improvement and furnishing tasks, the residents of Astoria use the mobile construction robots (nicknamed spiders due to their appearance). The spiders carry needed equipment on their backs and use their many arms and construction tools to complete the requests of inhabitants. The spiders are quite versatile and can also be used to repair both the inside and outside of the ship by adding just a few attachments.

5.4 Robotic Components in Zero-Gee

In the center of the Astoria complex there is a powerful wireless network that not only makes communication within the ship possible but is also connected to several satellites orbiting earth making communication with the mother planet easy and convenient. Information from earth is constantly received by the system and automatic updates occur every few minutes.

5.4.1

Even though the wireless server is very reliable and kept under the watch of several technicians, in the case that it were to somehow become damaged or something were to interfere with the transmission the people of Astoria would be alerted of the problem through the backup intercom system spread throughout the ship. This system would ensure that productive work cold still continue in an emergency and only people with clearance would be allowed to use them.

5.5 Mechanisms of Unloading Ore

5.5.1

Since Astoria gets its various minerals and ores from surrounding asteroids the VCMs (versatile chaise miners) have been designed to be as minimally invasive as possible, so as not to disturb the integrity of the asteroid, and highly mobile. In their basic designs, these robots all have the same base and have different attachments added to them in order to determine what function they will have. This feature is highly useful because it makes storage of the VCMs easy and makes it possible to squeeze them through tight places and assemble them again in a larger area. With attachments sites that allow the VCMs to connect to one another these robots can form an assembly line which will help save space since they don't need to move around as much. They are also equipped with large wheels that allow them to travel through deep dust and debris. Before actual mining can begin, a few carts with specialized attachments are sent to examine the chemical composition of the soil. Depending on whether people think the conditions are adequate to suit their purposes, a highly precise sonic drill (with adjustable sizes and intensities) will be attached to several chaises along with Claws to pick up the ore, and storage containers to transport and carry the valuables. Once enough ore is collected in the containment VCMs attachments they will be sent back to the base where the ore will be refined and compacted by Crush robots into long, large rectangles. The VCMs will be store power in a long lasting d type battery. Though they must occasionally visit the station to recharge, there is enough energy stored within the d-type batteries to allow the VCMs to circle the earth four times.

5.5.2

The RAD or rapid assembly droid will be in charge of the construction of Astoria. With the basic blue prints already preprogrammed, the RAD itself will be comprised of the main core tubing of the Astoria and with the use of several mechanical limbs will construct the complex around itself before completing the internal construction to ensure that contaminants and space debris will not interfere with the more delicate inner circuitry.

5.5.3

Refining operations will be kept simple by merely heating up the raw ores and separating the rock and metal once they have reached the optimum temperature. This will be accomplished using the previously mentioned Crush robots, which, after they have disposed of the excess rock, will form the metal into the rectangular shape and cool them once this has been done. The Crush robots will then take the finished product and eject it into the storage facility behind them.

Robot	Use	Function	Size	Number
Chassis	The base to which other attachments are added.	To transport the attachments to the ore.	2m x 1m x 3m	100
Sonic Drill	To precisely tunnel and break apart rock.	Drill where it has been assigned without compromising the integrity of the asteroid.	2m x 1.5m x 1m	20
Containment Unit	Storage for ore.	To protect the ore from damage and to contain it until it is to be unloaded.	2m x 3m x 2.6m	52
Rock Composition Analyzer	The analysis of the chemical composition of asteroid fragments.	Takes small samples of the rock and tests their chemical composition for any desired minerals.	2m x 3m x .5m	5
Claws	Grabbing valuable minerals and moving debris out of the way	Uses its long arms to reach around and pick up ore and deposit it into the Containment Unit and pushes debris out of the way of other chassis.	2m x 6m x 2m	23

Figure 5.1 Robots Used In Mining

6.0 Schedule and Cost

6.0 Schedule and Cost

Astoria is a station of possibilities. The possibility of new mining colonies in the asteroid belt, a series begun by this undertaking, is an idea worth many times its initial cost. This station can be used not only for mining, but for scientific research as well, allowing us to peer into the cosmos, and to select sites for future colonization. The station, in the Foundation Society's hands, can be a powerful tool, a gateway to the outer solar system, and beyond.

6.1 Schedule for Completion

Figure 6.1 gives a list of all the steps required for the construction of Astoria. This is based on the assumption that a finalized contract will be signed by September 9th, 2071. Prices for all steps are also given.

6.2

Included in the table is a series of costs that will need to paid during the construction process, including labor and fueling costs.

6.2.2

In the following table is also a list of annual costs and revenue sources. This is a standard plan that could be utilized for any station built within the asteroid belt with a focus on mining activity.

Step	Beginning	Duration	Ending	Cost
Hiring of Person-nel	September 10th, 2071	3 Months	December 10th, 2071	$415,000,000
Gathering of Re-	December 10th, 2071	14 Months	February 10th, 2073	$50,500,500,000
Transport of Mate-	February 15th, 2073	8 Months	October 15th, 2073	$910,000,000
Phase I	October 20th, 2073	4 Months	February 20th, 2074	$450,000,000
Phase II	February 25th, 2074	2 Months	April 25th, 2074	$300,000,000
Phase III	April 30th, 2074	3 Months	August 30th, 2074	$400,500,000
Phase IV	September 5th, 2074	3 Months	December 5th, 2074	$275,500,000
Phase V	December 10th, 2074	5 Months	May 10th, 2075	$260,750,000
Phase VI	May 15th, 2075	2 Months	July 15th, 2075	$125,000,000
Phase VII	July 15th, 2075	1 Month	August 15th, 2075	$66,000,000
Phase VIII	August 15th, 2075	2 Weeks	September 9th,	$25,000,000
Phase IX	September 15th, 2075	2 Weeks	September 29th,	$35,000,000
Phase X	October 5th, 2075	6 Months	April 5th, 2076	$1,450,000,000
Phase XI	April 25th, 2076	4 Months	August 25th, 2076	$550,000,000
Phase XII	August 25th, 2076	1 Week	September 1st, 2076	$25,000,000
Phase XIII	September 1st , 2076	6 Months	March 1st, 2077	$975,000,000
Foundation Society Assumes Control on March 2nd, 2077				

Figure 6.1 Schedule For Completion

Time for Construction: 6 Years, 5 Months, 2 Weeks, 2 Days

Total Cost of Construction: $56,763,250,000

Annual Costs (Beginning January 1st, 2078):

Workforce (2000): $355,750,000

Maintenance: $75,000,000

Imports: $1,750,000,000

Industrial Costs: $245,000,000

Total: $2,425,750,000

Annual Revenue (Beginning January 1st, 2078):

Tourism: $375,000,000

Exports: $2,350,000,000

Commerce: $75,000,000

Industry: $250,000,000

Repair of Vehicles: $125,000,000

Mining: $4,125,000,000

Miscellaneous: $200,000,000

Total: $7,500,000,000

Profit: $5,074,250,000

Figure 6.2 Annual Revenue and Costs

7.0 Business Development

-Harvesting and Processing Infrastructure

As materials are sent up from the mining camps on the surface of the asteroid, Mag-Lev elevators automatically transport the raw ore to the processing facility. After being irradiated with UV light, and sifted for differing materials, the ore is then transported to any number of processing facilities where the ore is melted into units for transport to Aresam or Earth, or manufactured into a product to be exported or stored and used on the station. Port facilities will be able to accommodate a large quantity of temporary storage. As mined products and imports will frequently be changing hands, the bulk of the base of the station will be divided into a large quantity of such units for easy access once a vessel arrives.

-Services for Remote Mining and Other Expeditions

The mass production mentality of Astoria, similar to that of a well managed factory, would produce more than enough product to ship to other expeditions. Using aeroponics, chicken and beef cell cultures, and the latest in plant genetics, Astoria will be able to produce sufficient quantities of material to supply other Foundation Society projects with consumables.

Storage for the agricultural products will be found in two main sections of the station. The first is located as part of the agricultural section inside of the capsid, while the other is located on the outermost section of the base of the station. Both will package products into vacuum sealed bags, as well as chill and regularly irradiate them to keep them fresh and sterile until they are needed.

Rest and relaxation is necessary for the continued psychological and physical health of the crews of the vessels that will bring products to and from Astoria. To this end, the common ring of the station will feature hotels, restaurants, and other healthy forms of entertainment to keep crews in top condition.

As ships travel, they encounter various particulate matter that will slowly degrade systems if left unchecked. To repair such damage, a section of the base is devoted to two repair depots that will feature entirely automated systems to replace damaged equipment and mend hull damage incurred on the way to the station. Insofar as refueling is concerned, the tail fibers and base of the station provide enough storage and production facilities for up to 4,000 cubic meters (141,259 cubic feet) of LH2 and 1500 cubic meters (52,972 cubic feet) of LOX.

-Sensing and Imaging Equipment

The base of the station will feature an optical telescope with a lens diameter of six meters. The telescope will be mounted vertically on a side of the station that does not feature any docking ports, thereby providing for a clear view. It will be isolated from the rest of the station by a means of a mesh, coating any connection with the station and acting as a shock absorber for any vibration caused by station operations/

In keeping with Astoria's secondary goals of performing research in the outer solar system, a second, large radio telescope will be set up outside of the station. This dish will be located at least 700 meters from the station and will be connected via an insulated tunnel exiting at the mining camp. This dish will have a diameter of 150 meters and is too far from the station for any major vibration to reach it. As is necessary for any modern community, an internet connection and real time communications with Earth is necessary. To further that purpose, on the opposite end of the base from the optical telescope, a tight beam communications device will send laser pulses to a satellite orbiting the asteroid. Those pulses will be relayed to multiple receiving stations at Aresam, Argonom, Columbiat, and Earth.

APPENDICES

Appendix A: Operational Scenario

Ryan, a 38 year old man that works on identifying and analyzing asteroids day in Astoria, is well off.

This man takes one of the Segway's that are left charging outside of his house and goes off to work after a good breakfast. His drive usually takes him 30 minutes and when he gets to his headquarters research facility, He must confirm his identity with an iris scanner followed by a hand analyzer and a swipe of a quick card with his credentials on it. This card lets computers know that he has entered the building and starting his day at work. Here he goes and hooks his Segway to a nearby recharging bay. After he goes to his boss, an Al with a virtual avatar as a human interface for further instructions about his next assignment. At lunch he can either go to the cafeteria with his co-workers or go home for a quick snack, after he swipes his card letting the computer that he will be gone for lunch. Here in the cafeteria he can swipe his card for buying his food through the use of credits. After work he swipes his card again and is released from work to go home for dinner or to go to one of the station's many recreational centers. If Ryan, for example, wanted a book he could go to one of the local commerce centers in the common cylinder and purchase said book.

Erica, a 35 year old woman, follows almost the same schedule except that she must go though certain procedures that prepare her for her work. One of these procedures is a test to make sure that her hand and eye coordination is acceptable. Erika repairs robots and operates them on asteroids. At lunch time she can choose whether to go home or stay at the cafeteria. If Erika had a leaky sink she could report it to the station's maintenance center and they would send a robot to repair damage. If Erika needed some shoes, one of the station stores in the common cylinder would sell her a pair at the cost of a few credits.

Grant whom is a ten year old on this station has a different schedule. He gets to go to school around 10:00 am station time. He will have that time to get ready for school. When he is ready he will be taken to the pick up bay by school staff that will come for him at his home when he is ready. Each child will have a card that is attached to the backpacks/ folders that they carry to go to school. They will also be carrying an identification ring that is on their right ring finger. They will attend school for 3 hours then have a recess/ lunch of an hour then continue to have school for another 4 hours. Grant is going to be attending his homeroom where he will be learning arithmetic, English, social studies, and science. After school he can either go to a tutor where he will get help with his subjects or he can attend in activities in one of the near playgrounds/communities. If Grant's mother wanted to buy her son a birthday present. She could go out and locate a toy/gift shop located in one of the commerce centers of the common ring.

Julia a 4 year old girl has a completely different schedule. She will stay at home or go to a daycare center. There in the daycare or at home she will have a babysitter who will teach her English or any other type of subjects that she must need to learn before attending school. She will be able to play with other children of her age. If Julia were to get sick and needed medicine all she would have to do is go see a doctor. From there the doctor can prescribe her medicine and ask her parents if they wanted her medicine to be in her food or if she would like to take it straight from the bottle. Medical equipment/products are paid for by the Foundation Society, as a healthy populace is in the best interest of the Society.

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