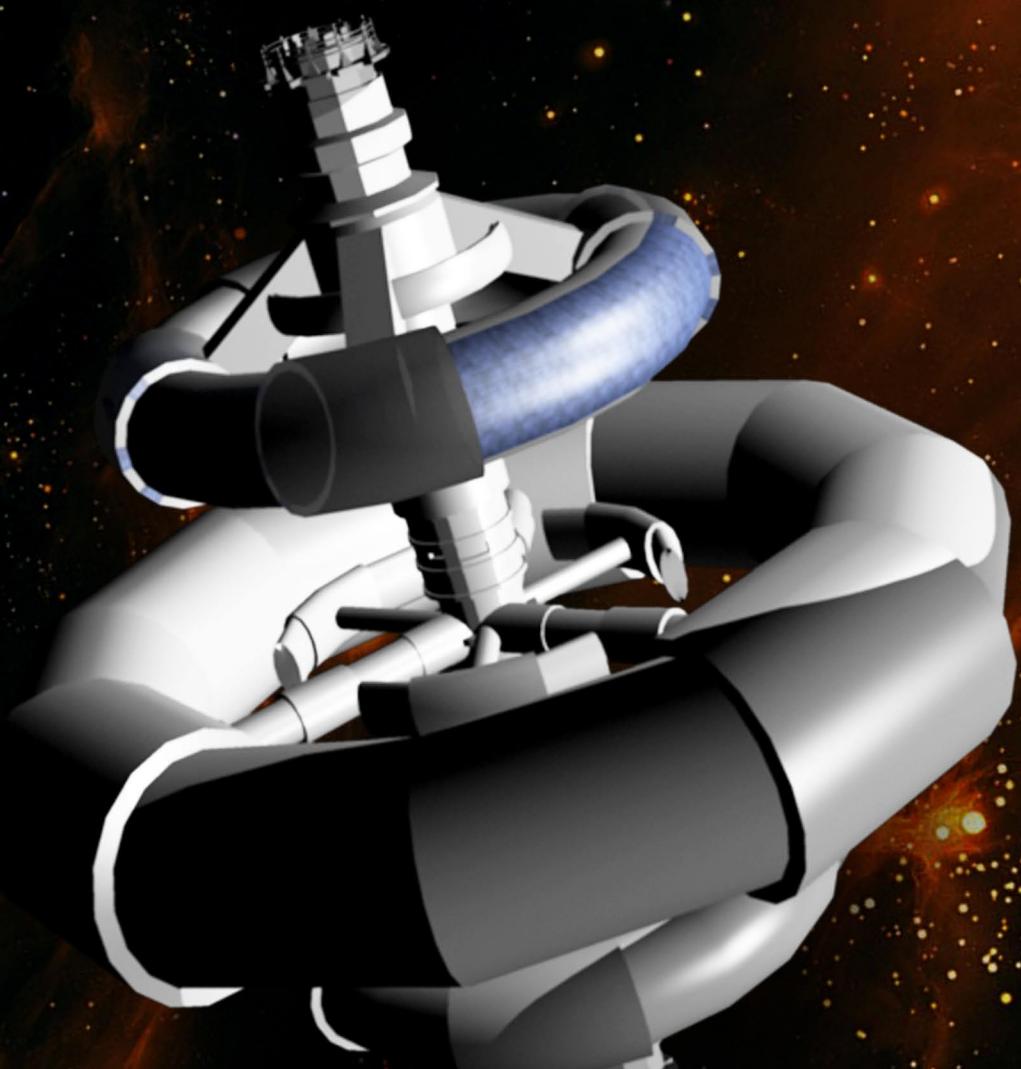




NORTHDONNING HEEDWELL



MODERN SCHOOL
BARAKHAMBA ROAD

Proposing Team Data

Name of responsible teacher/advisor: Divya Sahdev

School (or other Group Name): Modern School

School Address: Barakhamba Road

School City, State, Zip or Postal Code: New Delhi -110001

Country: India

Daytime Telephone at School: 011-23311618

Cellular or Mobile Phone: 011-23311619

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E-mail address: modern@modernschool.net

Last day of school in Fall 2015: -

Contact information for responsible teacher/

advisor when school is not in session: 9312999655

Names, [grade levels], and (ages) of 12 students currently expecting to attend the Finalist

Name if different from above: -

Address: 5, Ashiana Apartments, 2nd Floor, Suraj kund

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Country: India

Telephone (also evenings / weekends): -

E-mail address: divyasahev@gmail.com

Competition: (we advise that participants be at least 14 years old, and not older than 19)

Shanil Samantara [12] (17)

Abhiraj Chaudhary [12] (17)

Tushar Goswamy [11] (16)

Dakshayan Varshney [11] (16)

Joyta Singh [11] (16)

Divija Bansal [11] (16)

Daipaiyaan Chakraborty [12] (17)

Hrithik Bansal [10] (15)

Paavas Bhasin [11] (16)

Shreyas Kapur [12] (17)

Harsh Gupta [9] (14)

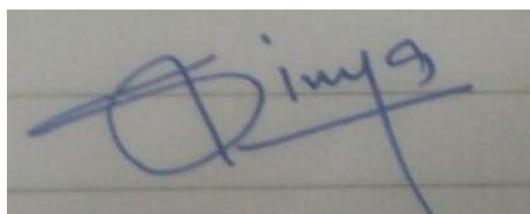
Samridh Gupta [10] (15)

Names of two adult advisors currently expecting to attend the Finalist Competition:

Mrs Divya Sahdev -

I understand that if our Team qualifies for the Asian Regional Space Settlement Design

Finalist Competition January 2016, we will be expected to finance our own travel to from Om Shanti Retreat Center, Manesar and share the cost of boarding / lodging during the competition.



Responsible Teacher / Advisor Signature

25th November, 2015

Date

Acknowledgements

We take this opportunity to express our profound gratitude to the following:

First of all, we would like to thank the organisers of Asian Regional Space Settlement Design Competition for giving us this unique platform, which has changed our outlook towards space habitation and has given us valuable lessons.

We would also like to thank our principal, Dr. Vijay Datta for his unconditional support and encouragement. Our teacher and mentor, Mrs. Divya Sachdev, for her valuable guidance and support. She provided us important tips and suggestions, which improved our document and put us on the right track.

Mr. Anil Gupta for helping us with the calculations and providing information about feasible technologies.

We also thank our parents for providing moral support and motivating us towards our final goal. Without their unconditional support, this report would not have been a reality.

Researching and preparing this report has been an amazing experience and has created memories, which we will cherish during the rest of our lives. It has truly been an enthralling and knowledgeable journey which culminated in this report. We are really pleased and thankful to the aforementioned people who supported us throughout this project and propelled us towards completing the project report.



THE EXECUTIVE SUMMARY

'Mankind was born on Earth. It was never meant to die here'

–Interstellar

Since time immemorial, Mother Earth has been the provider and the protector of the human race. And as we have loved and lived on this beautiful little planet, we have gazed into the skies and dreamt of the stars. What was once a distant dream is now a daily occurrence. We have defied everyone who ever said 'the sky is the limit'. We have made space our home and insured the survival of our species.

However, today we face a peculiar predicament. The population remains ever expanding, however the resources remain limited. Furthermore, the flame of curiosity and the desire of knowledge never dims. In such a scenario, the need to continue exploration runs wild.

To serve as a great leap for mankind, we hereby propose a unique settlement that will give us precious opportunity to explore the vast universe and it's still vaster capabilities

The word settlement is rather deceiving. We provide to you Astoria, a 'settlement' that doesn't settle for anything less than the extraordinary.

Located in the asteroid belt, Astoria will primarily serve as a mining and civilization hub.

It's technologically advanced, perfectly compliant and highly innovative structure will make it a leap into the future.

Astoria's convenient location and advanced technologies will ensure maximum utilization of asteroid, space and human resources. This will provide a plethora of job opportunities, a healthy economy and the resources we humans require for the present and the future.

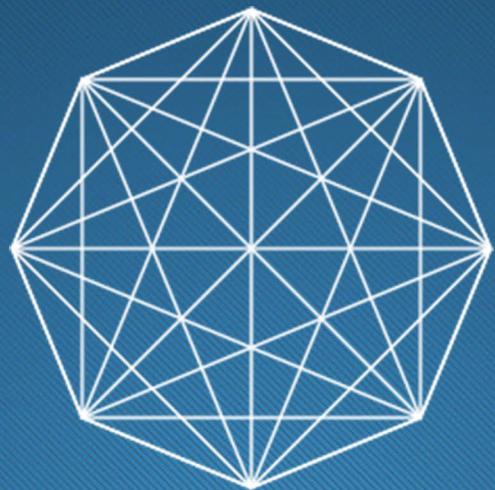
A day in the life of an Astorian will involve occupation, recreation and a healthy social and communal life.

Maintenance of health and safety will be of primary concern.

Essentially, Astoria will be the land of union of technology and man at the most fundamental level. Higher intelligence will help humans expand and improve their own capacities to beyond perceivable imagination.

Most importantly, Astoria will provide to us the opportunities to explore the depths and secrets of space and the universe.

We stand on the threshold of a glorious future, and Astoria is the doorway we seek.



STRUCTURAL DESIGN

2.0 STRUCTURAL DESIGN

The main structure of Astoria comprises of a primary Residential Torus in the center, an industrial torus and a secondary residential torus located symmetrically about the primary torus, and an interior torus arranged in a concentric fashion as shown below. All these structures are connected to the central hub via connecting spokes. Both ends of the central hub house two docking stations for transportation of goods and people from Astoria to other locations and vice versa. Astoria, located close to the asteroid (6178) 1986 DA, will provide an earth like environment for 16000 residents and upto 500 visitors. It will facilitate mining operations to nearby asteroids and will act as a hub for processing and transporting important resources to Earth .

2.1.0 MAJOR HULL COMPONENTS

The Major Hull Components are:

1) Primary Residential Torus

The primary residential torus will house about 12240 (76.5% of the total population) people including all 960 children and their parents. It will have artificial gravity, pleasant living conditions, sunlight and natural views of the space outside thereby providing an earth-like environment

2) Secondary Residential Torus

The Secondary residential torus is where 3760 residents (27.5% of the total population) and the visitors (about 500) will live. Most of the residents living here will be employed in the secondary settlements for mining activities due to its close proximity to the lower docking station. The secondary torus, just like the primary torus will be equipped with all facilities to create a comfortable environment for its residents.

3) Tertiary Concentric Torus Structure

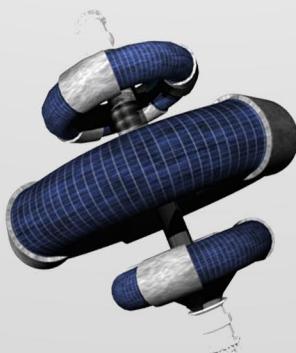
The tertiary concentric torus is where agriculture and food production will take place.

4) Industrial Torus

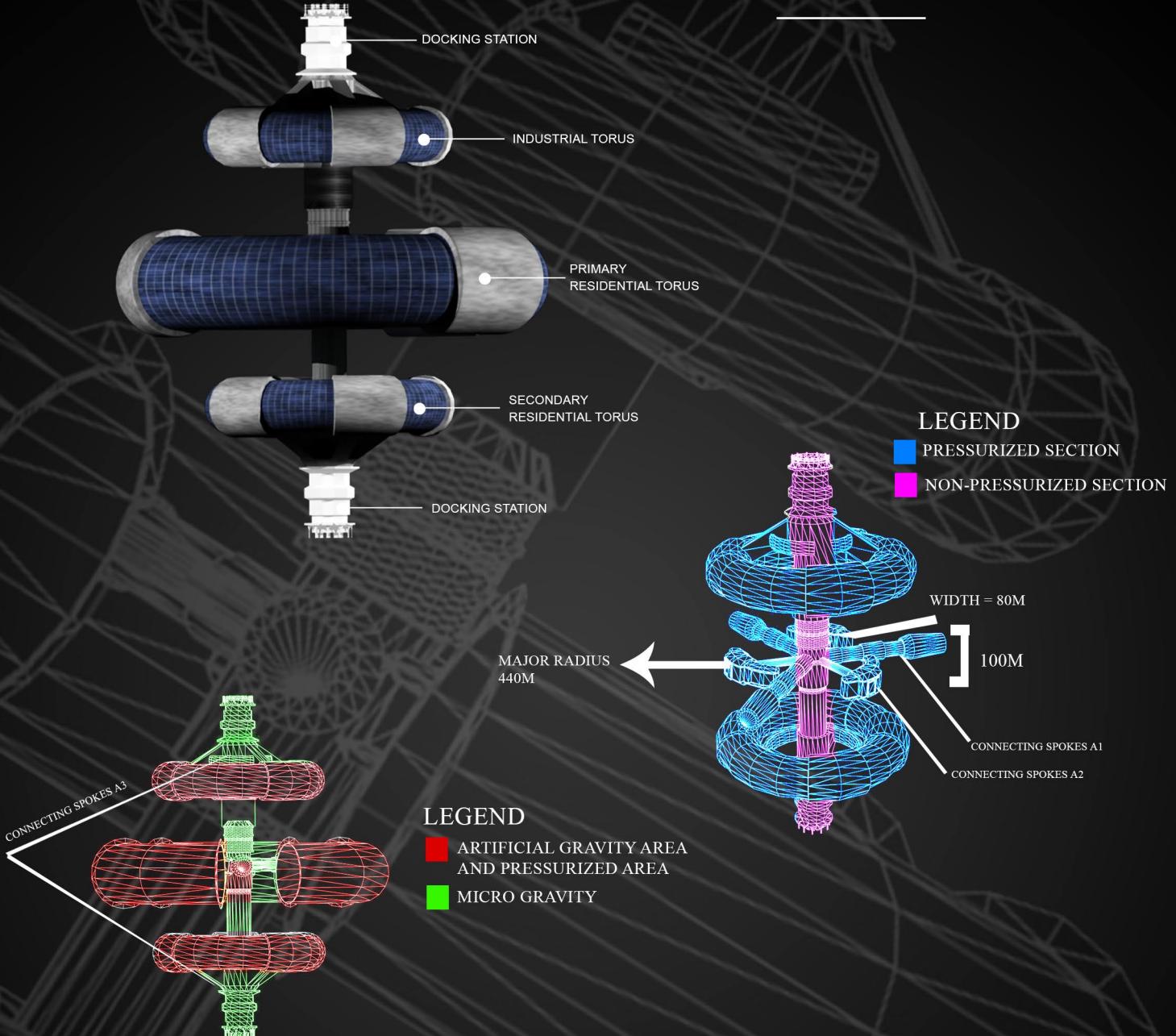
The industrial torus will be the main hub for Astoria's business activities and will house all major industries, production units and research facilities.

5) Central Cylinder

The Central Cylinder will act as the main structure for transport of materials and residents within Astoria. It will also house the industrial and agricultural storage sections, the aircraft and robot repair sections and the rotation interfaces for the rotating sections.



FULL VIEW



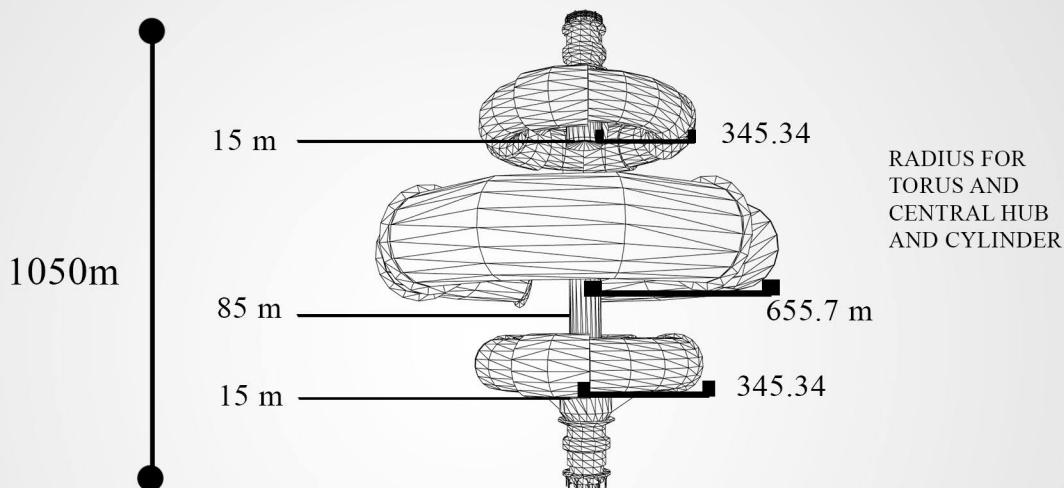
CROSS SECTION VIEW

down surface area
water pipelines and electricity
MILE (section 5.1)



2.1.1 DIMENSIONS OF MAJOR HULL COMPONENTS

S.No.	Components	Rotation Radius (m)	Major Radius (m)	Minor Radius (m)	Width (m)	Length/ Height (m)	Down Surface Area(m ²)	Total Surface Area(m ²)	Volume (m ³)
1	Primary Torus	593	655.7	530.3	-	-	590722.6667	1171264	46017128.62
2	Secondary Torus	303.34	345.34	261.34	-	-	177469	358616	10562287.97
3	Concentric Torus	400	440	360	80	100	335500	1006500	20130000
4	Industrial Torus	303.34	345.34	261.34	-	-	177469	358616	10562287.97
5	Connecting Spokes(A1)	-	15	-	-	445.3	-	-	314764.02
6	Connecting Spokes(A2)	-	15	-	-	275	-	-	194386.04
7	Connecting Spokes(A3)	-	15	-	-	176.34	-	-	124647.40
Central Hub									
8	Central Cylinder	-	85		1050	-	-	-	23832907.27



2.1.2 SALIENT FEATURES OF ASTORIA

- 1) Multiple Tori connected to the central hub cater to the various needs of the residents of Astoria and facilitate industrial activities for economic growth.
- 2) The tori have been strategically positioned to minimize movement within the settlement in case of an emergency thereby reducing the chances of a stampede. A proper evacuation plan has been developed along with the required structural design to ensure a proper evacuation.
- 3) Each Torus has been supplied with pleasant and comfortable living conditions including artificial gravity, temperature and pressure conditions, sunlight etc. to ensure an earth like environment for the residents.
- 4) Astoria has smart glass coverings on each residential torus for providing natural views of the space outside as well as adequate sunlight. Thermal radiators are present to prevent the settlement from over heating and create a comfortable atmosphere. It is equipped with proper shielding mechanisms for protection from all kinds of space debris, rocks and asteroids that might damage the settlement. Secondary Settlements have been designed which will improve services to the residents of Astoria and will facilitate mining operations.

2.1.3 ROTATIONAL INTERFACE

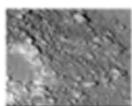
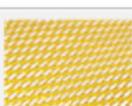
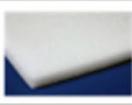
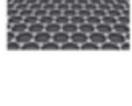
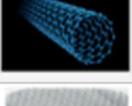
Astoria has 4 rotating tori connected to the central hub via connecting spokes. Between these connecting spokes and the central cylinder, there will be an array ceramic ball bearings which will help in stabilizing and giving a rotational axis to all the rotating tori. Resistant to extreme wear and tear, Silicon Nitride balls are 2.3 times harder than hardened steel. The rotational interface, hence will use a layer of ferro fluid along with ceramic ball bearing array.

2.1.4 RATIONALE FOR SELECTED ROTATION RATES AND ARTIFICIAL GRAVITY MAGNITUDES

S.No.	Structural components	Pressure(psi)	Rotation Rate(revolutions per minute)	Artificial Gravity(g)	Justification
1	Primary Torus	13.38	1.13	0.85	<ul style="list-style-type: none"> -Reduced Structural Maintenance Costs - Less deviation from 1g thereby providing a comfortable environment -Relatively slow rotation rate to prevent motion sickness and other medical conditions
2	Secondary Torus	13.38	1.58	0.85	<ul style="list-style-type: none"> -Reduced Structural Maintenance Costs -Comfortable Environment for residents and visitors -Rotation Rate allows for a compact structure as well as prevention of any medical conditions
3	Industrial Torus	13.38	1.33	0.6	<ul style="list-style-type: none"> -Lower costs for maintaining its structure -Better efficiency of industrial processes -Low rotation rates provide a comfortable environment for the people working in this torus
4	Concentric Torus	13.38	1.13	0.57	<ul style="list-style-type: none"> - Same rotating interface as that of Primary Torus, hence rotation rate is same - Healthy growth of plants which ensures better productivity
5	Connecting Spokes(A1 and A2)	13.38	1.13	Variable	<ul style="list-style-type: none"> - Quick transportation and swift evacuation in case of an emergency
6	Connecting Spokes(A3)	13.38	1.58	Variable	-Quick Transportation

2.1.5 CONSTRUCTION MATERIALS OF MAJOR HULL COMPONENTS

Astoria will utilize resources from nearby asteroids like titanium, aluminium, regolith etc. as well as resources from bases on mars and moon. Materials like Aluminium Oxynitride Glass, Super Adobe, Carbon Nanotubes and Aluminium Titanate mesh will provide a rigid and sturdy structure for Astoria. One of the main construction material used is micro lattice, which is the lightest metal on earth but possesses immense strength and flexibility. It is also an efficient shock absorber and can easily recover even after significant compression , making it the perfect candidate for construction.

Construction Materials			
S.No.	Material	Texture	Features
1	Micro Lattice		-Lightest metal -Shock absorbing qualities -Flexibility
2	Ferro-nickel Alloy		-Provides strength and stability to the structure
3	Titanium		-High tensile strength -Crack Resistant -High Corrosion Resistance
4	Silicate Minerals		-Hard and rigid structure -Easily available on all nearby asteroids
5	Asteroid Regolith		-Effective radiation shielding -Easily available on all nearby asteroids
6	Twaron		-Impact Resistant -High Tensile strength -Thermally stable
7	Polyethylene Foam		-Absorption and dispersion of radiation
8	Nextel		-High Tensile Strength -Impact Resistant -High Thermal Resistance
9	Super Adobe		-High Tensile Strength -High Resistance to Solar radiation
10	Aluminium Oxynitride Glass		-High tensile strength -Shock Absorbing qualities
11	Graphene		-High Electrical conductivity -High mechanical strength -High absorption rate of incident sunlight(useful for construction of solar panels)
12	RTV Adhesive	-	-Excellent Adhesive Properties -Heat and UV resistant
13	Sealant Gel	-	-Restricts formation of air bubbles and cracks on the layer. -Combustion resistant properties
14	Carbon Nanotubes		-Very high tensile strength -High thermal resistance
15	Aluminium Titanate Mesh		-High Tensile Strength -Adds Structural stability -Shock Absorbent
16	Reflective Smart Glass		-Opacity can be controlled by applying the desired potential difference -Reflective properties

2.1.6 RADIATION AND DEBRIS PROTECTION

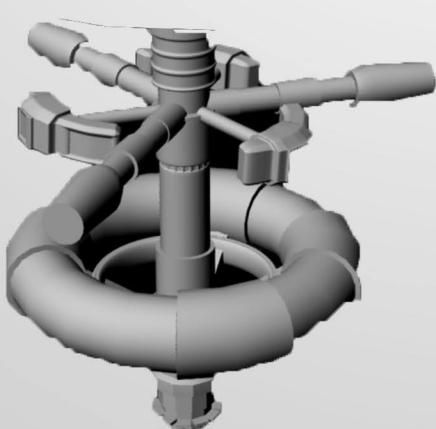
Astoria will use a whipple shield like concept (similar to the micrometeoroid protection mechanism currently employed in the ISS) to provide protection from space rocks and debris as well as radiation. The whipple shield mechanism which we will use consists of a multilayered shield (refer to figure) and a thin aluminum ‘wall’. The wall is located at a certain distance from the multilayered shield, and when a particle(like a micrometeoroid) strikes this ‘wall’, it breaks up into a cloud of tiny fragments. By the time these pieces travel the distance between the wall and the multilayered shield, they are so diffused that they cannot penetrate the shield. The multilayered shield has been designed so that it can handle all forms of debris even if they are able to cross the wall without much fragmentation. The shield also comprises of materials like regolith from asteroids and polyethylene for radiation protection.



Layers for radiation and debris protection.. These black lines represent RTV Adhesive.

2.1.7 EMERGENCY EVACUATION

In case of an emergency, The Structure formed by the concentric torus, the secondary torus(along with the lower docking port) and the part of the central cylinder connecting these 2 structures will be isolated. Residents from the primary Torus will quickly be shifted to the concentric torus via the connecting spokes (A1) which contain the Evacuated Tube Transportation Mechanism to facilitate swift evacuation.



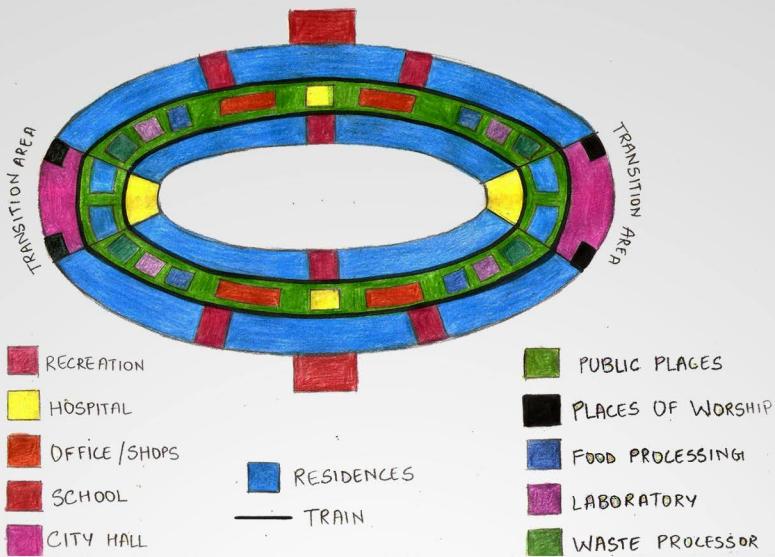
(above) The evacuated sections of astoria will look as shown. The connecting spokes A1 will also get detached resulting in the final evacuated section



(Above) The Evacuated Tube Transport Mechanism which will be employed in the connecting spokes to assist swift transport and evacuation.

Image courtesy: www.et3.com

SECTION 2.2



Primary Torus

Category	Surface Area per person(m ²)	Total Residents/ households	Net Surface Area (m ²)	Levels	Effective Down Surface Area(m ²)	Upper Base	Underground Base
RESIDENTIAL	49	12240	599760	4	149940	149940	-
BUSINESS, SHOP, OFFICE PUBLIC PLACES: HOSPITALS	3.3 0.3	12240 12240	40392 3672	3 2	13464 1836	13464 1836	-
SCHOOL(S)	1	960	960	2	480	480	-
RECREATION	1	12240	12240	1	12240	12240	-
PUBLIC OPEN SPACE	10	12240	122400	1	122400	122400	-
ASSEMBLY HALL, CHURCH SERVICE INDUSTRY	1.5 4	16000 12240	24000 48960	1 2	24000 24480	24000 24480	-
STORAGE	5	16000	80000	3	26666.666 67	26666.666 67	-
TRANSPORT(TRAIN + LAND 50%)	12	12240	146880	1	146880	73440	73440
MECHANICAL SYSTEMS, COMMUNICATION WASTE TREATMENT	0.5 4	12640 12240	6320 48960	1 1	6320 48960	6320 -	- 48960
ELECTRICAL SUPPLY & DISTRIBUTION	0.1	12240	1224	1	1224	-	1224
MISC.	2.9	12240	35496	3	11832	11832	-
TOTAL			1171264		590722.67	467098.67	123624

(NOTE: In calculating these values, although the number of residents in the primary torus is 12240, but for certain categories like mechanical subsystems, storage, etc. which are valid for all residents/households, the number of residents has been considered accordingly.)

Secondary Torus

S.No.	Category	Surface Area per person(m ²)	Total Residents/ household s	Net Surface Area (m ²)	Lev els	Effective Down Surface Area(m ²)	Upper Base	Lower Base
1	RESIDENTIAL	49	3760	184240	4	46060	46060	-
		49	500	24500	4	6125	6125	-
2	BUSINESS, SHOP, OFFICE	3.3	3760	12408	3	4136	4136	-
3	PUBLIC PLACES, HOSPITALS	0.3	3760	1128	2	564	564	-
4	RECREATION	1	3760	3760	1	3760	3760	-
5	PUBLIC OPEN SPACE	10	3760	37600	1	37600	37600	-
		10	500	5000	1	5000	5000	-
6	SERVICE INDUSTRY	4	3760	15040	2	7520	7520	-
7	TRANSPORT	12	3760	45120	1	45120	45120	-
		4	3760	15040	1	15040	-	15040
		4	500	2000	1	2000	-	2000
9	ELECTRICAL SUPPLY & DISTRIBUTION	0.1	3760	376	1	376	-	376
		0.1	500	50	1	50	-	50
10	MISC.	2.9	3760	10904	3	3634.67	3634.67	-
		2.9	500	1450	3	483.33	483.33	-
	Total			358616		177469	160003	17466

Concentric Torus

S.No.	Category	Surface Area Per Person(m ²)	Total Residents/ Household s	Net Surface Area(m ²)	Levels	Effective Down Surface Area(m ²)	
1	PLANT AREA	44	16500	726000	3	242000	
2	ANIMAL AREA	5	16500	82500	3	27500	
3	Food Processing, Storage etc.	4	16500	66000	3	22000	
4	Agricultural Drying Area	8	16500	132000	3	44000	
	Total			1006500		335500	

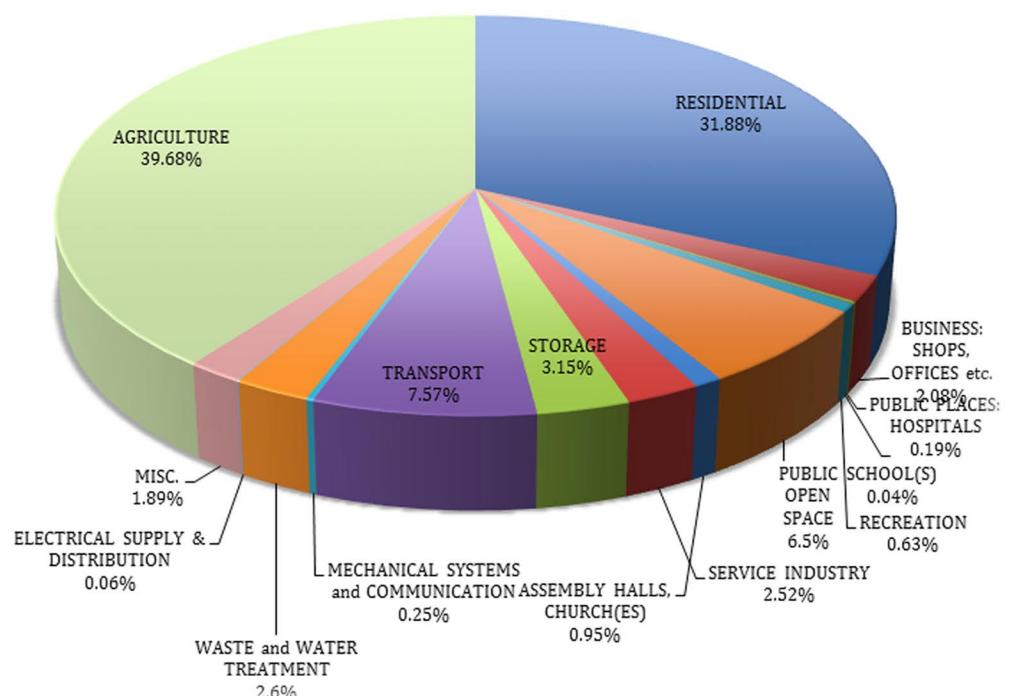
(Note: Certain values for the surface allocation have been inspired from the data available at settlement.arc.nasa.gov. Based on this data, the values for other sections have been calculated depending upon the design specifications of Astoria)

Industrial Torus

For Area Utilization of industrial torus refer to sec 7.1

<u>Area Utilization</u>			
S.No.	Category	Surface Area Utilized(m ²)	% of total area utilized
1	RESIDENTIAL	808500	31.88
2	BUSINESS: SHOPS, OFFICES etc.	52800	2.08
3	PUBLIC PLACES: HOSPITALS	4800	0.19
4	SCHOOL(S)	960	0.04
5	RECREATION	16000	0.63
6	PUBLIC OPEN SPACE	165000	6.50
7	ASSEMBLY HALLS, CHURCH(ES)	24000	0.95
8	SERVICE INDUSTRY	64000	2.52
9	STORAGE	80000	3.15
10	TRANSPORTATION	192000	7.57
11	MECHANICAL SYSTEMS and COMMUNICATION	6320	0.25
12	WASTE AND WATER TREATMENT	66000	2.60
13	ELECTRICAL SUPPLY AND DISTRIBUTION	1650	0.06
14	MISCELLANEOUS	47850	1.89
15	AGRICULTURE	1006500	39.68
Total		2536380	

Area Utilization



SECTION 2.3

Construction Sequence:

A construction base will be established at Ceres where exchange of important construction materials will take place and it will also act as port for receiving material from other base until a docking port for Astoria has been constructed. Materials that are required from Earth will be transported to the base at Mars (Aresam) and at Moon(Bellevistat).From here, the materials received from Earth as well as other important materials present on Mars and Moon will transported to Ceres. The construction of the Settlement will take place near Ceres and will propelled to its intended orbital location once the construction is complete.

Step 1: Construction of Central Hub:

A mesh like structure of the central cylinder will be constructed using materials from Earth and other bases as well as from Ceres. This step also includes construction of the rotational interface and the connecting spokes for the industrial torus. **Time Period: 2 years**

Step 2: Construction of Docking Ports

After the mesh is complete, tiling of the Cylinder and the connecting spokes (of the industrial torus) along with the construction of both docking ports will take place. The construction of the thrusting sections will also take place under this section. **Time period: 2 years**

Step 3: Construction of Industrial Torus

After Step 2 is complete, The tiling of the docking ports and the thrusting section will take place. This will be accompanied by the construction of the mesh of the industrial torus and the rotational interface of the primary torus. This step also includes the construction of the mesh of the connecting spokes of the secondary torus. **Time Period: 1.5 years.**

Step 4: Construction of Secondary Torus

Tiling of the Industrial Torus and the connecting spokes of the secondary Torus will follow step 3. Then, construction of the mesh of the secondary torus and the connecting spokes of the concentric torus will take place. By this time the docking ports would've become functional and humans would be sent to make sure that everything is fine in the industrial torus. **Time Period: 1.5 years**

Step 5; Construction of the Concentric Torus

Now, Tiling of the secondary torus and the connecting spokes of the concentric torus will take place. During this time, humans will begin to use the industrial torus as a living and working base. The industrial torus will be utilized for harnessing the resources present on the nearby asteroids for constructing the rest of the settlement including the primary torus. Construction of the mesh of the concentric torus and the connecting spokes of the primary torus will take place simultaneously.

(Time Period: 2.5 years)

Step 6: Construction of the Primary Torus:

Tiling of the concentric torus and the connecting spokes of the primary torus is completed. After this, the construction of the primary torus begins. While this is going, more humans are transported to Astoria, who begin pressurizing the tori that have been constructed and assist in the industrial processes already being carried out in the industrial torus. The construction of the interior down surfaces of the industrial torus, the secondary torus and the concentric torus takes place alongside.(- Time Period: 3 years.)

Step7: Completion of the primary torus

The tiling of the primary torus followed by the construction of interior down surfaces takes place. Establishment of industries and residences takes place, along with the setting up of solar panels, life support systems and other essential buildings. Construction of proper transportation mechanisms within the torus and central cylinder also takes place under this process.

Time Period: 4 years

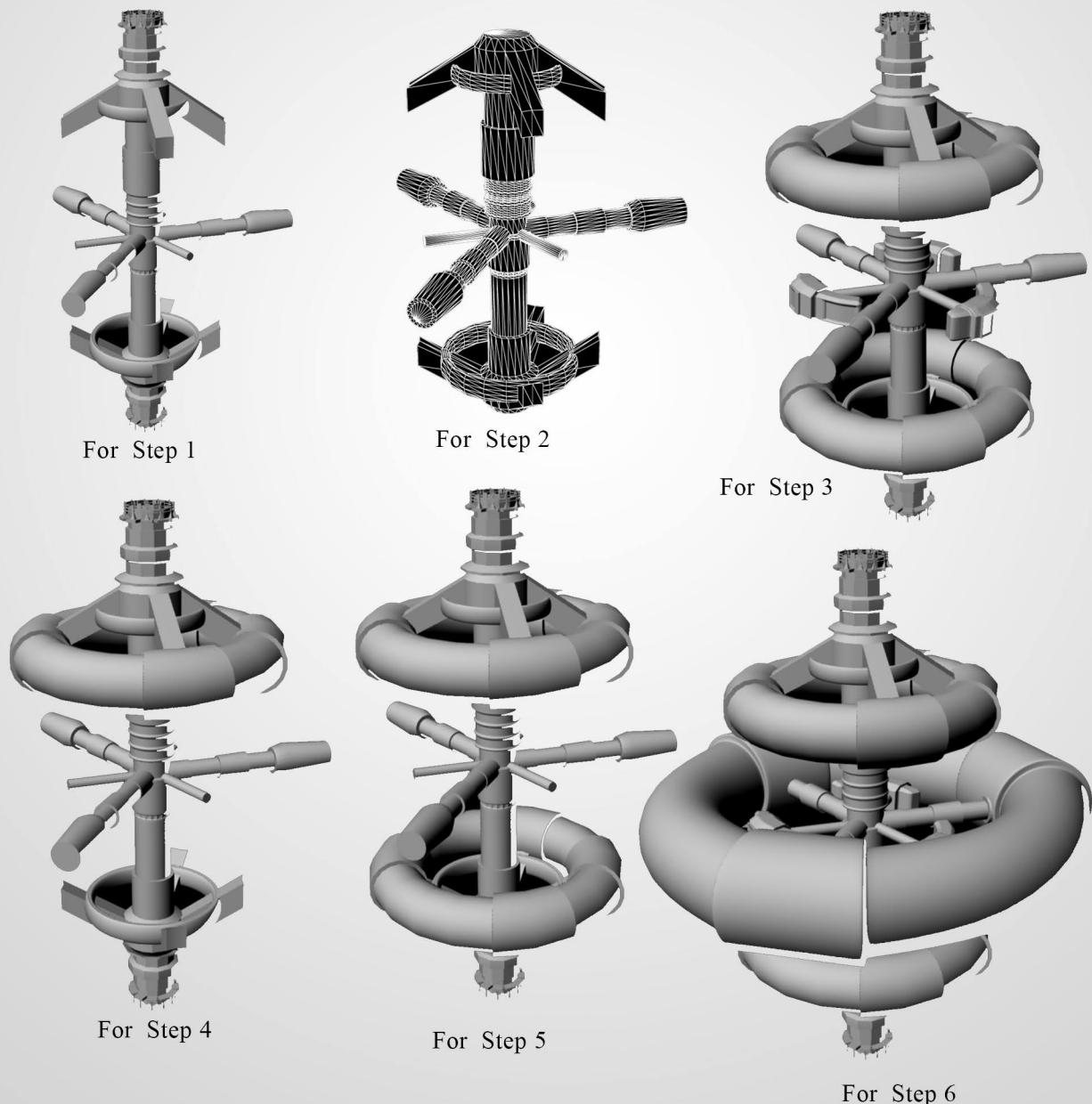
Step 8: Completion of the construction and habitation

Finally, artificial gravity is applied by means of rotation, construction of all the internal buildings is completed, and all communication and electrical systems begin functioning. Agriculture and food processing mechanisms are completed. Once all necessary security checks have been made and all life support mechanisms are functional, the settlement will be ready to welcome its residents who will begin a new phase of their lives aboard ASTORIA.

Time Period: 1 year

Total Time: 20 years

NOTE: For construction technique of interior structures refer to section 3.3. 4



SECTION 2.4

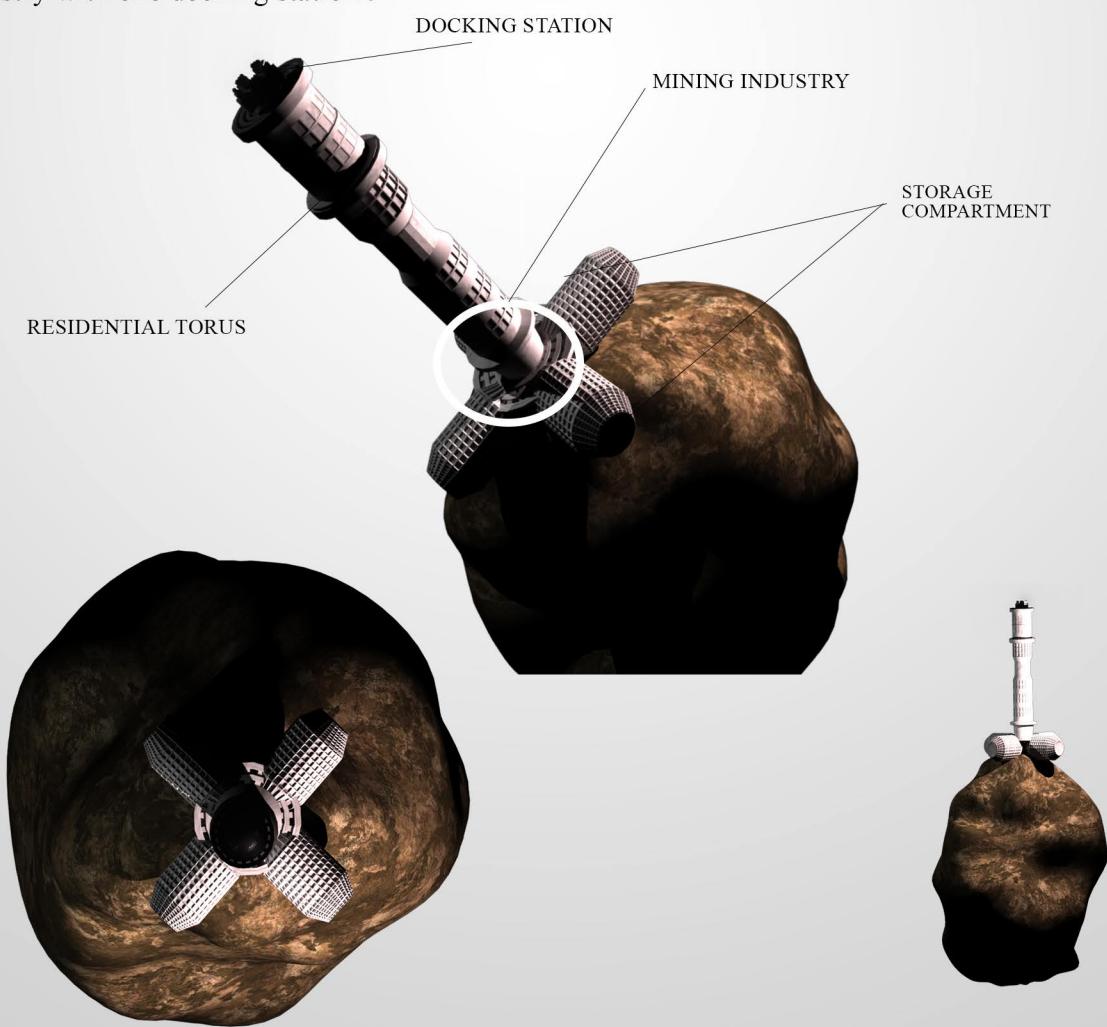
Shielding and Damage Repair

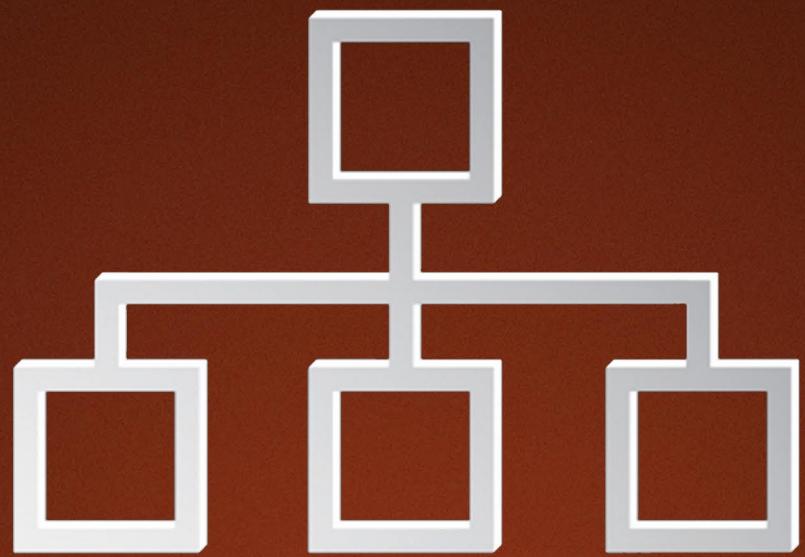
For shielding from large rocks and debris, Astoria will employ the Laser Ablation technique. Under this technique, a high-powered laser will be used to alter the path of an incoming rock such that it does not collide with the settlement. The laser ablates or vaporizes the surface of the rock, thereby reducing its mass. This, in turn, causes a change in its momentum and the rock gets deflected from its original path. Generally, the momentum change is delivered in the direction of the laser's incoming beam.

For damage repair, Astoria will be equipped with specialized robots and 3d printing machines that will be capable of immediately producing the component of the required dimension (depending on the damage) and the repair robots will quickly use the 3d printed components to fix the damaged sections. For more info, refer to section 5.1 EDRB [External Damage Repair Robot]

SECTION 2.5

Secondary Settlements will be located at 6 orbital locations(section 3.5).These secondary settlements will house engineers, mining workers, technical staff etc. who will be employed in various mining and processing activities. The settlements will consist of a residential torus and a mining industry with one docking station .





OPERATIONS INFRASTRUCTURE

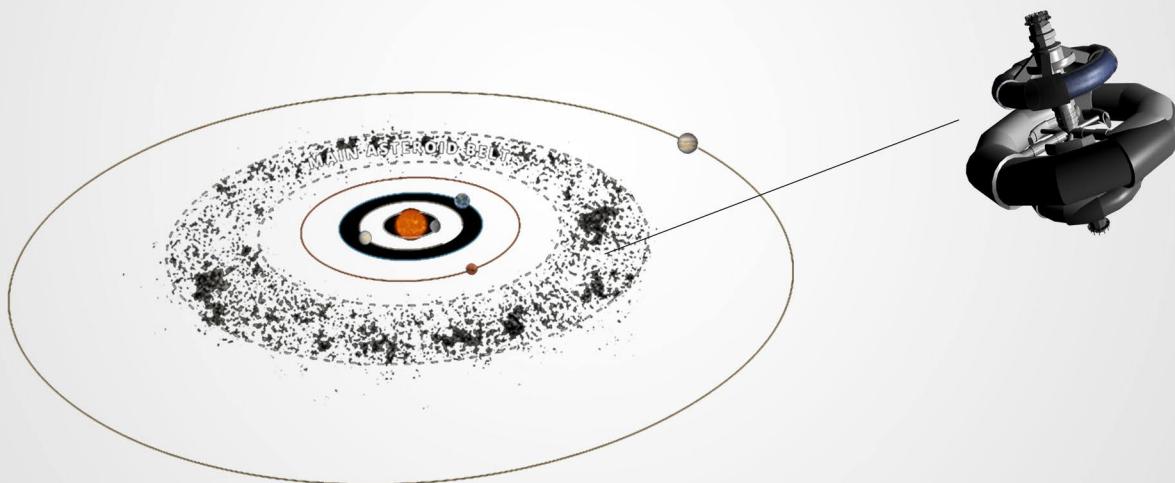
SECTION 3.0 OPERATIONS

We see Astoria as a product of over century of innovation and as a landmark in the history of humanity, inspiring centuries more of expansion and innovation. Astoria aims to be a new civilisation par-excellence, acting both as a benchmark, as well as a launching platform for various other space civilisations in the future.

SECTION 3.1 ORBITAL LOCATION

We propose to locate Astoria near (6178) 1986 DA, following an orbit similar to it, and about 10 miles away from it. It is a 2.3 km diameter M-type asteroid, having its semi-major axis some 2.809 AU away from Earth. It has a core mainly consisting of mineable Nickel and Iron, with huge deposits worth trillions of Platinum and Gold.

The primary source of raw materials would be Earth, from where the raw materials in abundance from Earth will be sent to the docking stations at our settlements on Mars and Moon, taking additional materials from their resources onto 1 Ceres. Iron and Nickel from Ceres will be mined and moulded into useful forms, giving a strong backbone to the Astorian structure. Low gravity and escape velocity will help in the remaining construction; from where on Astoria will be launched in path of its primary orbit, with additional raw materials for the secondary settlements on other asteroids. Once in place, construction for these settlements will undergo on (6178) 1986 DA.



The advantages of selecting this particular orbit/asteroid are:

- Low gravity, reducing power consumption of construction
- Identified as a Near-Earth asteroid with easy transport from the moon too
- This would mean reduced fuel usage and greater stability of spaceships

Specifications of (6178) 1986 DA	
Aphelion	4.457 AU
Perihelion	1.161 AU
Semi-major axis (What Astoria will follow)	2.809 AU
Orbital Period	1719.446 days
Orbital speed	17.77 km/s
Inclination on axis	4.310°

Various types of materials are required in different quantities when establishing a new settlement. Here, you can find a list of some materials found in bulk quantities in Astoria:-

Material	Source
Iron	Initially Earth, later (6178) 1986 DA

Nickel	Initially Earth, later (6178) 1986 DA
Graphene	Initially Moon, later synthesised
Hydrogen/Oxygen	Initially Earth and Mars, later Ceres
Micro Lattice	Earth
Carbon Fiber	initially moon, will be synthesised later on astoria

3.2 RESIDENTIAL INFRASTRUCTURE

Despite from being a majorly industrial unit, Astoria aims to provide luxurious living at the same time. Residing in the primary torus (torus 2), the residential area will be at the heart of Astoria. We believe that humans are the most valuable resource, and only if we provide them with our best, will they work to their potential.

3.2.1 ATMOSPHERE/CLIMATE/WEATHER CONTROL

The internal atmosphere and weather will be akin to that on Earth, with a few fine touches to make it an ideal year. There will be gas chambers for each torus, obtaining gases from a primary gas resource near the principal axis.

Another main component of the system will be regulators and sensors which will identify the composition and pressure, and if any discrepancy is found with the set weather, it will be adjusted accordingly.

The agricultural area will have different temperature and humidity corresponding to different requirements of different crops. These will be aligned with suitable conditions on Earth, and controlled with the help of individual regulators.

The working area will have a certified 35% humidity and 25 degree Celsius temperature, making it an ideal weather to work it. A more rigid set of regulators will be used for it.

The residential area will however have more variety (Refer to tables underneath)

Basic Air Composition in Astoria		
Substance	Percentage (By Volume)	Source(s)
Oxygen	24.96%	Mars/Ceres
Hydrogen	0.00005%	Mars/Ceres
Nitrogen	72.395%	Mars
Carbon Dioxide	0.11%	Mars/Humans on board
Argon	0.934%	Mars
Water Vapour	1%	Derived from biodegradable waste
Other Gases	0.60%	Varied

Climate in Residential Areas			
Simulated Season	Month(s)	Temperature	Humidity`
Summer	April-June	25-35 C	50-60%
Monsoon	July-August	25-30 C	70%
Autumn	September-October	15-20 C	40%
Winter	November-February	5-15 C	20-30%
Spring	March	20-25 C	40-50%

Highly photosynthetic plants will be placed throughout Astoria to constantly covert Carbon Dioxide to Oxygen, in addition to obtaining it through electrolysis. Rain and hail, will be performed by sprinklers releasing different types of precipitation.

3.2.2 FOOD PRODUCTION

Astoria aims to be a self-sufficient settlement, and thus internal production and proper distribution of food becomes vital.

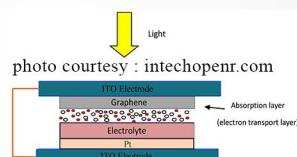
The large mass of agricultural area will be present between the primary residential torus and the principal axis. Aeroponics will be put to use in this gravity less land, and a huge variety of crops will be grown, spanning all of the Earth's food types. Micro propagation will be used. All these will increase the yield, decrease the growth time, minimize chances of a faulty crop and reduce water consumption and area required. Aeroponics also increases size of vegetables, and their vitamin content. Natural lighting will be used, alongside special light emitting diodes in the frequencies of red and blue that would increase the yield. Watering for the plants will be carried out water droppers located near the roots of the plants. They will carry the cleansed water from biodegradable waste compartment. **Meat**, on the other hand, will be synthetically produced. Meat will be cultured through the tissues of an animal, thus ending slaughter, yet feeding all aboard. High protein soya milk will be rationed, extracted from the bulk of Soya crops grown internally. Robot harvester chains will be applied upon checking of maturity of crop. These will first store crops inside them, and will later be sent into the main storage, which will be divided into three parts: **Live Storage**: 40% of the produce will be transferred to the live storage, which acts as the main source to the kitchens and pantry. **Cold Storage**: 50% of the produce will go into cold storage, which will act as a secondary supple for the pantry. Produce will be slowly taken from it upon depletion of primary storage. **Deposits**: 10% of the produce will be frozen, away from the primary torus, as an emergency supply in case of breakdown of food supplies.

3.2.3 ELECTRICITY GENERATION, DISTRIBUTION AND ALLOCATION

Electricity is arguably the most important resource common to both residents and the industries. Electricity in Astoria will have three main sources-

1. Primary Source – Solar Panels:

The Asteroid belt receives about only 18% to Earth, but we use Graphene solar panels, more efficient than those generally used on Earth. Most of Astoria will be covered in them, thus providing a large area exposed to sunlight. **Secondary Source – Plasma Arc Incineration**: This will act as a secondary source for energy. For more information about this, refer to sub-section 3.2.5. **Tertiary Source – Hydrogen and Oxygen**: In an unforeseen circumstance of improbable failure of the first two sources, hydrogen and oxygen will act as fuels to generate electricity.



of solar energy as compared which are seven times the Earth. Most of Astro-

3.2.4 WATER MANAGEMENT

All through the human history of search for intelligent lifeforms elsewhere, water has been one of the first criteria searched for. Similarly, in search for ideal extra terrestrial settlements, water is often considered the most exciting prospect. Astoria, as a settlement, will at first carry huge resources of water from Earth, and in its initial stages will also get water from the settlements on Moon and Mars. But as Astoria becomes fully functional, it will be self sufficient. Water will be extracted from the surface of Ceres and is synthesized from the hydrogen and oxygen resources. Water from precipitation, agricultural activities, human activities and human waste will be extracted and treated to be potable again. For other uses of water and water management, refer to section 4.

3.2.5 HOUSEHOLD AND INDUSTRIAL WASTE MANAGEMENT

Waste from the various torii will be divided into mainly 3 parts:

1. Biodegradable Waste: This would include all the human waste and other waste mostly from the agricultural area. This waste will be further divided into two parts: Liquid and Solid. Liquid will additionally be extracted from semi-solid waste. This liquid, will be further purified and used for three main purposes: Water for human processes, irrigation and rain, and to extract hydrogen and oxygen for fuel. The solid waste will be mainly used as manure and to restore soil for agricultural purposes.
2. Recyclable Waste: Recyclable waste mainly from industry and the primary torus will be refurbished in the industrial torus, with different materials being recycled into basic forms, which will be used for manufacturing industrial equipment for Astoria and its secondary settlements.

Non-biodegradable, non-recyclable waste: It will be used to produce extra electricity. The tried and tested Plasma Arc technology will incinerate these materials, giving away usable amounts of energy

photo courtesy : waste2energyworld.com



3.2.6 INTERNAL AND EXTERNAL COMMUNICATION

The power of language and the efficiency of communication is what has helped humans reach way above other species. Here at Astoria, we take this innovation another step further with revolutionising our way of communications inside a settlement. IRIS, or the Instant Relay Interactions System, is a wrist band given to all residents above age 8 Astoria. IRIS, named after the Greek goddess of communication, will primarily consist of high intensity and low range projectors which will display the screen on the left arm of each individual. Sixteen close range proximity sensors will turn the hand into a touch screen by sensing the position of touch. It will also contain other parts like camera and motion sensors for its various other purposes. Three dimensional versions will also be available for higher ranked personnel. All these will be integrated with the wireless fidelity for each torus, acting as the facilitator for all forms of communication. The residents of Astoria temporarily residing on secondary settlements on asteroids will connect their IRIS to a transportable wireless fidelity. Astoria will connect to the stations at Earth, Mars and Moon using modulated neutrino and gravitation wave emissions, which will be sensed and interpreted by huge receivers on the receivers end. This technology works on the fluctuation of normal emissions, sending data by these simple modulations. It is extremely fast, effective and is not affected by any interfering matter. Thus, even when blocked by various asteroids, the messages from Astoria will still reach other settlements efficiently. Radio frequencies of electromagnetic spectrum will be used to communicate with the secondary settlements.

3.2.7 INTERNAL TRANSPORTATION SYSTEM

Efficient transportation is vital for any settlement, and Astoria will have a well planned, well developed transportation system. The primary transportation system inside every torus would consist of two parallel circular tracks running right throughout the torus. The larger, outer path will consist of human transportation system consisting of monopods running constantly in the path. This means that at any given point of time, a point on track will have a monopod on it. The second, inner path will be for transportation of various kind of objects, from parcels to food. Both these trains will work on the magnetic levitation system, thus causing no accidents or mishaps. There will also be small pressure driven vehicles available for emergency transport. These will also have an ignition option, using Hydrogen as a fuel in exceptional circumstances. Aside from this, there will also be bicycles, called Biastocvcs, assigned to each individual. They will not only function as safe and environment friendly mode of personal transport, but it will also keep in check the fitness levels of the residents and the mechanical energy produced in the process of pedalling, will be stored as electrical energy and will be utilised in simple daily household devices.

For transportation between the three tori, the principal axis will have a toriporter, a pressure driven elevator functioning as a way to transport men and materials amongst the torii.

Thus, the transport system uses minimal resources and gives nearly a hundred percent efficiency.

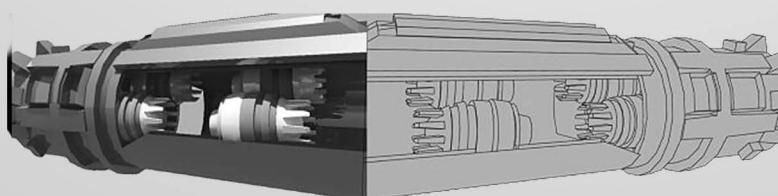


image courtesy : previous year project 'aresam'

Biastocvcs(bicycle)	
Magnetic levitation train	
Magnetic Strip for transportation	
Saviour (medical robot)	

Toriporter

3.2.8 DAY/NIGHT CYCLE PROVISIONS

The primary residential torus in Astoria will be divided into two symmetrical divisions. They both will have opposite day/night cycles which means that their daytime will differ by approximately 12 hours. There will be two transitory zones between the two communities, which will contain common areas and shared resources such as hospitals, community building places and restaurants. These transitory zones are vital as they reduce the psychological impact one would have suffered if they had to travel directly from one half to another. It also plays a huge role in community development, acting as a mediator and bonding ground between the two communities. The main source of light is the sun, whose light will be diverged and converged according to need through smart glass technology. This will require minimal energy to function.

This day/night cycle makes Astoria a settlement one of a kind. Due to different work timings of both the communities, work will go on for all 24 hours of a day. The industrial torus will have a uniform lighting system, ambient to provide an ideal workplace environment. This non-stop work will bolster the industrial front of Astoria. Thus, Astoria will provide all the functionality of a 24 hour working facility, without causing any of the psychological and physical harm of strenuous night shifts. (More information on smart class refer to sec 4.1)

3.2.9 CURRENCY

Currency is often a defining feature of a country, or in this case settlement. Astoria will introduce a new currency called the Diram, named after the ancient Greek currency. It is a form of cryptocurrency, that will not be in comparison to any currency on Earth. Prices of objects will constantly be moderated through an online system which will value the product according to its availability and need. The currency will not be in a hard form. It will be integrated into an e-wallet in the IRIS of each individual. Dependents will acquire money from their guardians.

3.2.10 EMERGENCY STORAGE FACILITIES

Although Astoria will initially be dependent upon Earth and the Mars and Moon settlements for its raw materials, it aims to be a self-sustaining settlement. In any case, there are special provisions for times of exceptional difficulties. The cold storage food [3.2.2] will be enough to feed the population for over a year within two years time. The left over from cold storage shall be exported. Emergency fuel will be obtained from the Hydrogen and Oxygen mined at Ceres. Emergency water will be obtained from Ceres, as well as through cleansing processes as described in 3.2.4

3.3 MACHINERY

Use of 4D printing material allows settlement components to unfold with the passage of time and take up the desired shape when deployed. This saves launch volume and makes it easier for construction in orbit.

All robots are modular in nature. The materials required for assembly of robots like titanium, aluminium, etc will be mined, processed and transported from the nearby asteroids to Astoria for utilisation. Their modules are divided into core functions, much like a robotics kit. These core functions include locomotion, end-effector, and sensory feedback. Different modules are automatically assembled into new robots by deployed assembly stations that rip apart existing robots and turn them into robots that are required for the current critical process.

Construction is fully automated. The transition from one stage to another, however, is manned. This is to prevent a window of time to correct mistakes. Examples of stages include: initial foundation, structure torus construction etc. Construction will be controlled initially by a pair of powerful K40 CPU's that will be preprogrammed and would later be shifted to the swarm (described in 5.3) in later stages.

Once the robot docking station is complete, robots will be assembled based on need. For instance if the current stage requires a lot of welders, robots with a welding module will be assembled and sent.

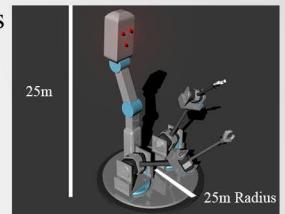
Each robot is controlled wirelessly on a high frequency radio. Each robot uses the same radio signal in addition to visual landmarks to accurately localize itself with respect to the assembly station.

Job Description	Module Category
Placing, lifting and moving. General purpose suction and handling of small and medium sized parts and panels.	End-effector
Ethanol based propulsion for fine movement.	Locomotion
Long range LIDAR scanner (360 degree, short-pulse 3D scanner)	Sensory
Welding and soldering, general purpose heating	End-effector
Cargo movement, heavy cargo area	End-effector

Construction Extérieure (French for Exterior Construction)

A self-dependent, self-sufficient and self-sustaining swarm of construction robots that will never let a scratch on Astoria. DSS-M

(MAKER) This swarm of robots will carry out all the making/assembling operations of various materials for the construction of Astoria. It will consist of several high speed, 3D cameras to capture each and every intricate vertex of a part. It will have a main controlling computer that will be directly linked to the main servers from which it would retrieve all the plans and information required to build Astoria. It will use a pair of mechanical arms to manually assemble the parts and will be equipped with a metal 3D Printer to print out a part in case that part is not available or is misplaced.

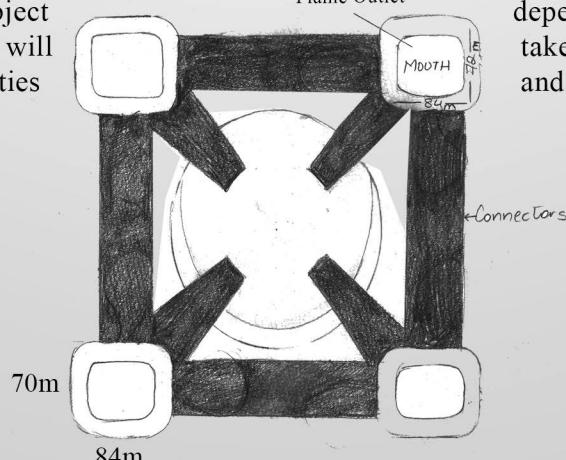


3.4 PROPULSION SYSTEM

Astoria is located in the heart of an Asteroid Belt, one of the "liveliest" places in the solar system. It is placed near an asteroid with a comparatively safer orbit as exceptionally few major collisions have been reported on the asteroid. Any asteroid or dust particle smaller than a radius of 4.7 metres will cause no harm to the Astoria structure.

For bigger collision course objects, Astoria has a state of the art propulsion system. Unlike most of the technology in Astoria, the main source of energy for them is not the sun, rather they derive power from a separate hydrogen and oxygen fuel tanks worth 100000 gallons of fuel each. These fuels already have a high calorific value, and with our efficient ignition system, the fuels are used to their maximum potential.

An imminent collision Astoria can be predicted 20-25 hours in advance using our radar technology spanning more than half the breadth of the asteroid belt. This leaves enough time for avoiding the asteroid. The propulsion system will manoeuvre Astoria 2-5 kilometres away from the predicted path of the collision object depending on the size of the object. This short process will take up to 40 seconds during which all industrial activities and modes of public transport will be halted.



3.5 SECONDARY SETTLEMENTS

Although Astoria is centered around our "home" asteroid, it aims to create and spread its wings all throughout the asteroid belt. The secondary settlements of Astoria are crucial parts of the economic and developmental layout of it. Asteroids are found to have various materials that are needed in our other settlements.

Various crucial and rare materials can be extracted from relative ease from the asteroids, rather than the Earth. Mining forms the bases of Astoria's purpose, and secondary settlements are at the center of all of this. Initially, 6 secondary settlements will be deployed, which will reside in 6 different asteroids, all varyingly composed, so as to provide a large variety of materials to Astoria, and in turn the other settlements. Each settlement will consist of three major parts:-

1. Mining and Industry - This will consist of the major part of the secondary settlement. Various mining techniques will be carried out depending upon the density and different layers of the asteroid in consideration. Once extracted, the materials will be industrially treated to convert them into researchable, and transportable form.

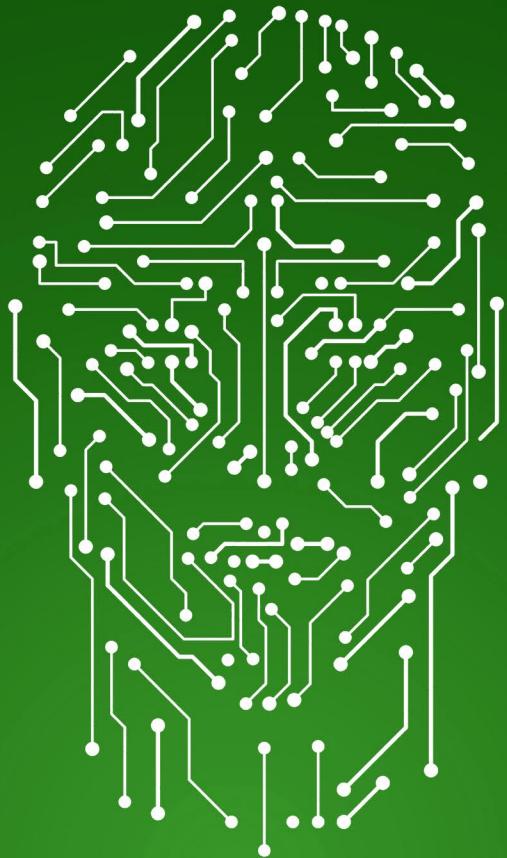
2. Research Laboratories - These will be the second part of the layout of the economic backdrop of the secondary settlements. Materials, once extracted and roughly treated, will arrive here to be assessed. They will undergo a variety of tests which will predict all their properties. The laboratories also have research related purposes, and will study the asteroid and other materials for scientific purposes.

3. Residential area - Secondary settlements have the clear intention of being a work-oriented settlement, hence very few non-workers (including children) will be found there. This area will consist of closely bound, multi-storey houses, located near transportation to the mining fields. Each settlement will also have a small community area which will consist of basic amenities and com-

munity shared resources like hospitals, shops, grocery stores et cetera. As Astoria settles deep into the asteroid belt, it will explore more of it. Researchers will constantly look for asteroid with the potential to house and secondary settlement, thus expanding our horizons. Various new prospects will come up as reserves of previous asteroids run out. At any given point of time, no more than 10 secondary settlements would be sponsored by Astoria due to constraint of resources.

However, other settlements (from Mars, Moon and Earth) will be encouraged to sponsor these settlements, with Astoria acting as a mediator and supporter. This way, mankind will be able to expand throughout the asteroid belt, utilising the plethora of resources that the Asteroid belt holds for us. When the resources of an asteroid run out, and it is no more viable for the mining processes to continue, the secondary settlement will be abandoned by the workers, and it will be converted into a tourist hub. Tourist from not only Astoria, but the other settlements too can and will visit these secondary settlements. The former settlements of other asteroid like the Ceres will be used for various other purposes.

Asteroid	Diameter	Semi-Major Axis	Spectral Type	Mineable Materials	Approximate Value
Ceres	945 km	2.7675 AU	G-type	Water, various precious metals	10 trillion dollars
Davida (511)	290 km	3.164743701 AU	C-type	Nickel, Iron, Cobalt, Water, Hydrogen	140 trillion dollars, along water resources
Diotima	208.77 km	3.068255149861212 AU	C-type	Nickel, Iron, Cobalt, Water, Hydrogen	120 trillion dollars, along with water and hydrogen resources
Palma	188.62 km	3.1481487133 AU	B-type	Carbon, Iron, Ammonia	110 trillion dollars
Anacostia	86.19 km	2.7430421 AU	L-type	Magnesium, aluminium, silicon, iron	130 trillion
Notburga	100.73 km	2.5743123 AU	Xc-type	Platinum, cobalt	150 trillion dollars



HUMAN FACTORS --- AND --- SAFETY

SECTION 4.0 (INTRODUCTION)

Astoria marks the leap of mankind into the age of the great unknown. The settlement aims to support the industrial process and provide a comfortable lifestyle for its residents. It boasts of opulent homes, advanced medical facilities, prestigious educational amenities, parks and recreation for relaxation and different sports for entertainment.

SECTION 4.1 COMMUNITY DESIGN AND SERVICES

Sunlight and Natural Views

Instead of using bulky mirrors whose inclination has to be varied continuously and constructing an additional section for natural views, a layer of smart glass can be used on the torus. Smart glass is a solid state thin film device made from special liquid crystal material, whose opacity can be controlled by applying the desired voltage across its ends. When left unattended, the particles are scattered and hence allow light to pass through them almost completely. However, when certain potential difference is applied, the particles come together and reduce the amount of light passing through them. At a certain voltage, these devices can become opaque/reflective, thereby not allowing light to pass through them at all. Smart glass can not only help in creating day and night cycles and provision of ample sunlight but can also help to provide natural views to the residents of Astoria.

Recreation and Entertainment

Certain low gravity environments of Astoria can lead to diseases and disabilities. To ensure peak health, strength and immunity, to prevent muscle weakening, decrease in bone density, depression, etc. and to ensure a healthy and engaging utilization of free time, all residences will be provided with high-tech exercising facilities.

Low-g sports:

Water Polo and Swimming: In decreased gravity, water will remain liquid but flow freely. Waves will be large but very slow. Water will glide slowly. Furthermore, ceiling-suspended downward facing pools will be a possibility.

Football, Hockey, etc.: Players and the ball/putt will glide and bounce by large uniform amplitudes. This will make the sport smoother, communal, more challenging, and certainly more fun.

Outer-Space Exploration: All residents will be free to avail 24-7 space exploration services that allow exploration and tourism to all safe and reachable parts of the solar system.

Panoramic Trampoline: Trampolines with phosphor-bronze coils of adequate restoring force and a taut canvas will be provided outside the settlement in zero-g for residents in bodysuits and helmets to bounce on up to a 100 meters. Strong elastic tethers with adequate regulation of downward pull will be latched on the resident for grip and retrieval. This will allow the resident to view space from another level, quite literally.

Low gravity sectors where ‘flying’ or ‘floating in air’ with wearable-wings will be common practice.

Projections and Lucidity: Deep sleep chambers will be commonly available. They will allow user small durations of lucid sleeping, regulated by biometrics, to give them the sensation of being in the projection of their chosen environment. This will help in relaxation as well as enable user to relive memories of Earth

Interactive projections of libraries programmed with integrated projection of books, theatres with integrated projections of movies, interactive projections of video games that give a physical feel to a virtual-reality game, and many other projected environments will provide users the entertainment and environment of their liking.

Museums will display the rich history of space exploration and mankind through the ages

Cinemas have been established and will showcase movies of all genres, documentaries and biopics.

Parks and other open spaces have been maintained to enable leisurely strolls and to promote the aesthetic beauty of the settlement.

Places of worship have been set up. Residents are free to make contributions to these places and add their own idols and scriptures since religion is a right on Astoria. Residents are free to practice any religion and not practice any at all.

City halls have been established and will serve as the chief administrative buildings of Astoria. It has been built with a great variety and flexibility of purpose in mind. It has facilities for various civic and cultural activities including stage performances, exhibitions and festivals.

Health and Medicine

Humans are physiologically well-adapted to life on Earth. Consequently, space inhabitation can have many negative effects on the body if the right precautions are not taken. Significant adverse effects of long-term weightlessness include muscle atrophy and deterioration of the skeleton. Other significant effects include a slowing of cardiovascular system functions, decreased production of red blood cells, balance disorders, eyesight disorders and a weakening of the immune system. Additional symptoms include fluid redistribution (causing the "moon-face" appearance), loss of body mass, nasal congestion, sleep disturbance, and excess flatulence.

Space medicine is a developing medical practice that studies the health of astronauts living in outer space. The main purpose of this academic pursuit is to discover how well and for how long people can survive the extreme conditions in space, and how fast they can re-adapt to the Earth's environment after returning from space. Space medicine also seeks to develop preventative and palliative measures to ease the suffering caused by living in an environment to which humans are not well adapted.

A major effect of long-term weightlessness involves the loss of bone and muscle mass. Without the effects of gravity, skeletal muscle is no longer required to maintain posture and the muscle groups used in moving around in a weightless environment differ from those required in terrestrial locomotion. Those muscles then start to weaken and eventually get smaller. Advances in research on exercise, hormone supplements and medication may help maintain muscle and body mass.

Astoria offers advanced medical aid through 3 hospitals with the latest facilities and equipment along with remarkable infrastructure. Each hospital contains 1000 beds each while the staff consists of 200 surgeons, 300 nurses and other specialists. 6 clinics are available for regular check-ups, basic first aid and minor ailments. Each person has a device that helps them to keep track of their biometric stats and first aid facilities have been provided at each home. The hospitals boast of having quick response to emergencies and are well prepared for trauma situations. Ambulances are available at all times.

AILMENT	TREATMENT
Depression	
Isolation	
Stress	
Insomnia	
Hallucination	
Kenophobia	
Reduction of Bone-Mass	
Cardiovascular Deconditioning	
Osteoporosis	
Weightlessness	
Fatigue	
Disruption of Vision	
Disruption of Taste	
Fluid Redistribution	
Claustrophobia	
Homesickness	
Growth of Kidney Stones	
Asphyxiation	
Solipsism syndrome	
Confinement	
	<ul style="list-style-type: none"> • Professional help • Earth like environment • Social and interactive atmosphere • Maintained day/night cycles • Meditation and yoga • A proper and balanced diet • Views of Earth • Open areas • Artificial gravity provided for adequate hours • Entertainment • Adequate spacious surroundings • Top notch medical aid • Rest and Recreation • Systemic desensitization (consecutive exposure to phobic objects) • Cognitive behavior therapy • Support groups • Regular checkups and exercise • Radiation shielding • Safety measures in low g areas • Space suit and protective clothing • Proper medication and observation

Governance

Astoria is a secular sovereign democratic liberated republic. The constitution of Astoria will follow the system of democracy and equality. It aims to establish a society based on democratic values and social justice. Every person shall be granted fundamental human rights and the duty to protect those of others. The government will be elected by adults above 18 years of age and will preside for 4 years following election.

Industry

Mining is the primary commercial activity on Astoria and its various succeeding stages (which include processing, refining, excavation, production and distribution) will be a great source of employment and industrial development.

Employment will also be available at the various educational, medical and recreation facilities. Residents are free to set up shop in the assigned area.

Agriculture

Crops will be grown within settlement under Earth-like regulated conditions as well as outside settlement. The available nutrients and general natural surroundings on Astoria are favorable for growing only leafy greens and legumes. Wheat, rice and other such crops will be grown exclusively within the settlement. Sunlight and seasons will be regulated as required for each crop. Drip irrigation, hydroponic systems, aerial/vertical farming and by-products of industrial processes such as hot water and nutrient rich slurry will also be put to use.

CROP	g/m^2 /day
Pea	169
Tomatoes	150
Beans	146
Oats	145
Barley	130
Lettuce and Cabbage	127
Radish	107
Corn	67

Potato	66
Wheat	53
Rice	50
Apple	99
Banana	97
Orange	56

FOOD

FOOD	ANNUAL CONSUMPTION (per person)	CARBOHYDRATES	PROTEINS	FATS	CALORIES (per gram)
MILK	30 gallons	4.5%	3.7%	4.0%	0.42
MEAT					
Chicken	28 Kg	0%	27%	14%	1.97
Egg	250 eggs	1.1%	13%	11%	1.55
Beef	23.6 Kg	0%	26%	15%	2.5
Pork	40 Kg	1.5%	21%	6%	1.45
Fish	18.4 Kg	1%	22%	12%	0.89
MAIN CROPS					
Pea	40 Kg	14%	5%	0.4%	0.81
Tomatoes	38 Kg	3.9%	0.9%	0%	0.18
Beans	37 Kg	63%	20%	0.5%	3.29
Potato	26 Kg	17%	2%	0.1%	0.77
Wheat	25 Kg	71%	14%	2.5%	3.39
FRUITS					
Apple	25 Kg	14%	0.3%	0.2%	0.52
Banana	25 Kg	23%	1.1%	0.3%	0.89
TOTAL	454 Kg				

DISTRIBUTION

All processed crops, fruits and vegetables along with their consumer-products will be available in supermarkets and grocery stores. Food will be supplied from farmers to markets under strict ration policy based on population density of the respective settlement. Storage in granaries will be controlled and maintained to decrease wastage and hoarding. Food will be regularly checked by laboratories for cosmic as well as human pathogens. All wastes will be recycled and used for biogas, manure and fodder. Amenities such as milk will be directly supplied to every residence. Other basic amenities will also be eligible for direct supply-system. All workings of the food supply, storage and recycling will be overseen by the voted Future Foods committee of each residential sector.

Waste-Management and Cleanliness

All residential and commercial segments of the settlement will have superficial inconspicuously-pressured suction pores on the surface that will ensure zero dust and water accumulation. Several waste-suction portals will be installed in every segment of the settlement. Specific portals for edible-based, recyclable, electric and radioactive wastes will be constructed. All waste will be directed to respective treatment facilities. Indestructible and untreatable toxic wastes will be transported to other settlements for industrial and laboratory use or for storage for future possibilities.

Water

Water is the primary requirement of any settlement. The hydrogen and lithium found in water can be used to make fuel. The oxygen procured can be used to maintain the atmosphere. Water is essential for sustenance of life.

Primary source of water to Astoria will be Mars and Ceres. Cargo space-vehicles will ensure regular supply of water from the underground subsurface reserves of Ceres and Mars as demand increases.

4.2 RESIDENTIAL DESIGN

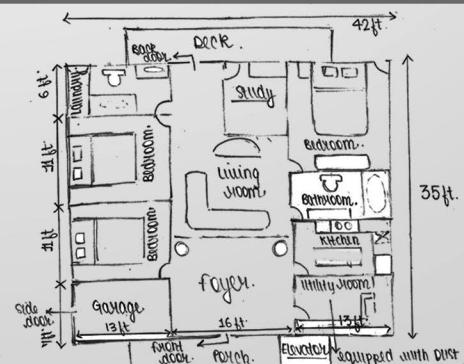
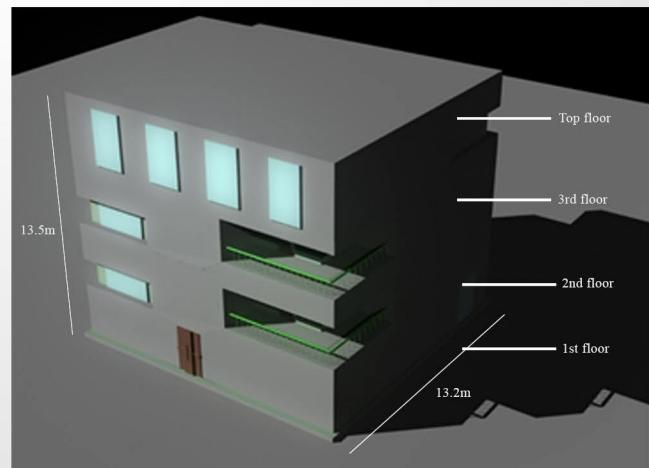
The Roman architect Vitruvius said all buildings should have three things: strength, utility, and beauty. Even in space architecture these are some of the first things we consider. However, the tremendous challenge of living in space has led to habitat design based largely on functional necessity with little or no applied ornament. In this sense space architecture as we know it shares the form follows function principle with modern architecture.

The focus of this residential design is to ensure that a united and integrated population inhabits Astoria. Each residence is within reasonable distance to all necessary facilities like hospitals, school, governing offices etc. Basic amenities like water, electricity, food etc will be available at all times. One of the main goals of the residential design is to provide a relaxed and happy environment which combines elements of lifestyle on Earth and in space and strikes the perfect balance. The homes have been inspired by their Earth counterparts and residents can views earthen sceneries from their windows; all designed in order to battle homesickness and isolation with subtlety.

The house will be built with super adobe. This process entails making bricks from a combination of clay, asteroid sand and dirt, straw, and a binding agent. The bricks don't erode with time, are water-proof, easily repaired and environment friendly with high tensile strength and low thermal conductivity.

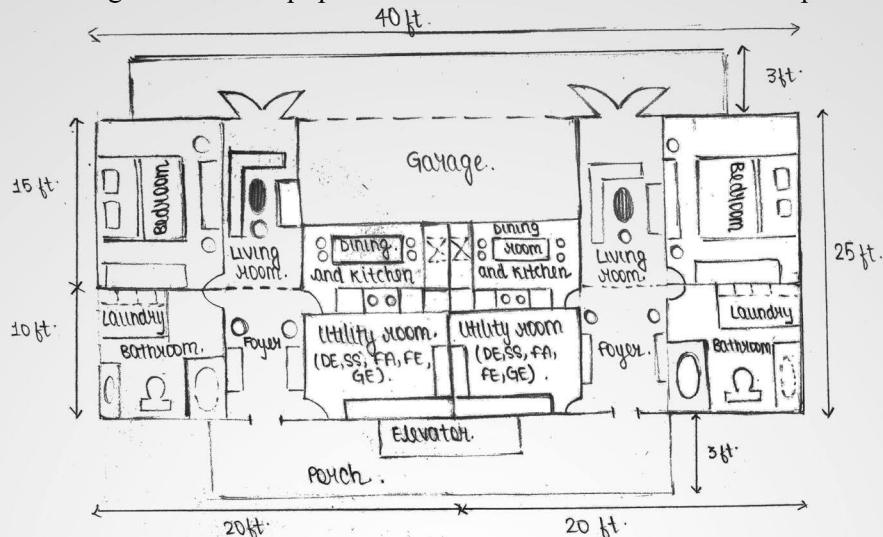
The furniture will be made largely of fiber reinforced composites. A fiber-reinforced composite (FRC) is a composite building material. The designated waste or base raw materials used in this instance are those of waste thermoplastics and various categories of cellulosic waste including rice husk and saw dust. It is essentially a wood substitute made from wood scraps and recycled plastic which ups its durability factor. It doesn't have to be dyed nor does it stain. Thus all the furniture will be lightweight, durable, easily manufactured and comfortable.

Furniture Piece	Home 1	Home 2	Home 3	Home 4
Dining Table	4	4	8	8
Chairs	12	8	8	8
Sofa	4	4	8	8
Bed Set	8	4	8	8
Study Table	4	4	8	8
Cupboard	4	4	8	8
Shelves	4	4	8	8



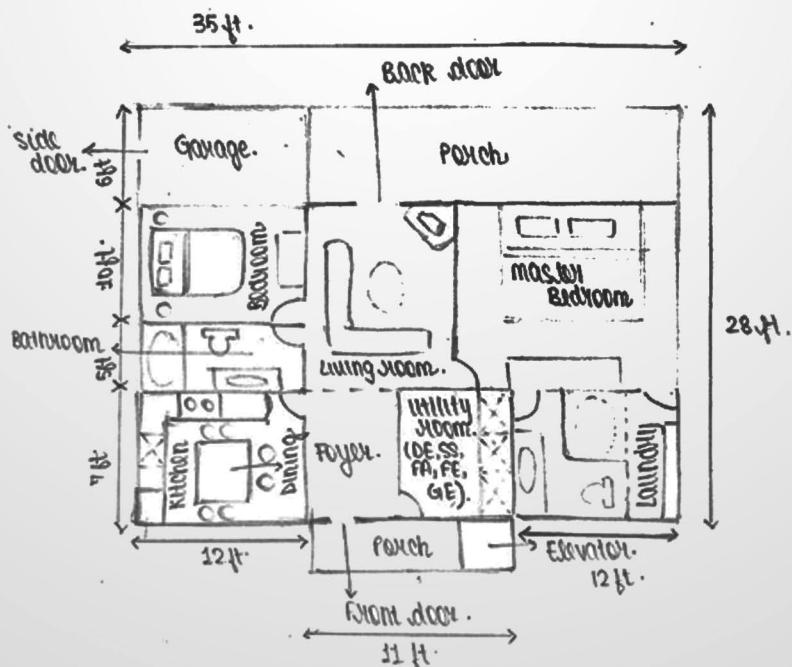
HOME 1: FAMILY

This four storey building is capable of housing two families in accordance to the allocated required of area per individual and yet manages to provide a luxurious and comfortable home. It boasts of 6 bedrooms, 4 bathrooms, a laundry facility, waste disposal system balconies, a modern kitchen and dining room, a spacious living room amongst other facilities. It also has built in cabinets and shelves along with other equipment for convenience and to ensure a pleasant stay.



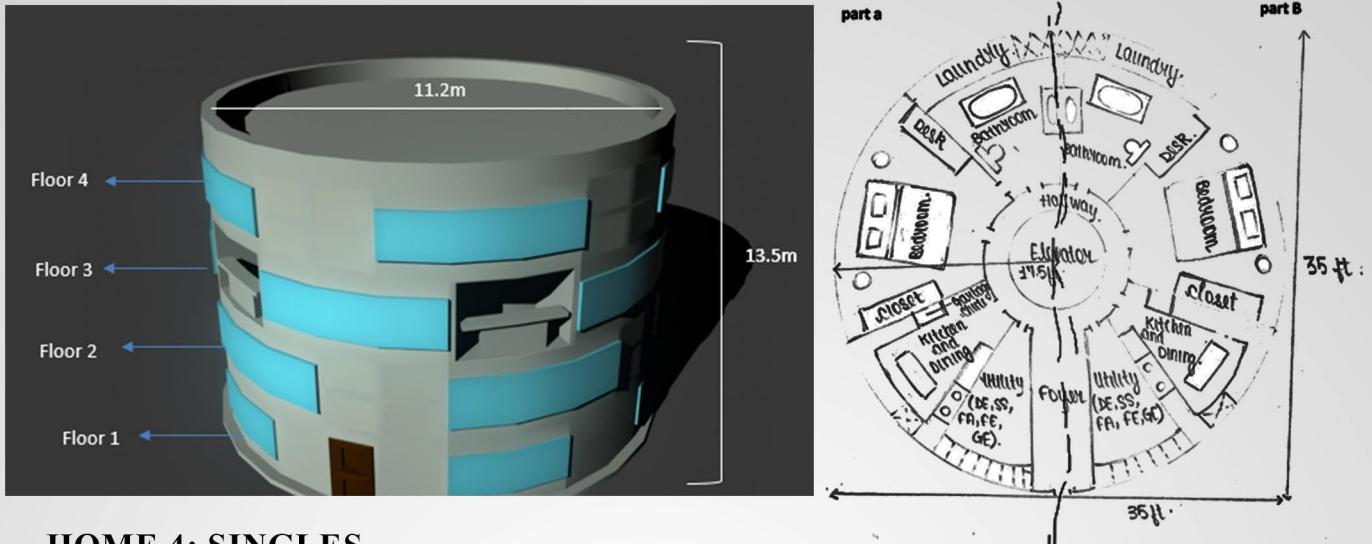
HOME 2: MARRIED ADULTS

Another four storey building which will accommodate married adults. It houses 2 bedrooms, 2 bathrooms, a garage, a state of art kitchen and dining and a living area. It has pre-installed furniture to ensure smooth transition into the Astoria lifestyle.



HOME 3: SINGLES

A departure from the norm, this 4 story apartment building provides comfort with class. It can house 8-12 people at a time. Each resident is provided with a bedroom, a bathroom, closets, desks, shelves, kitchen and dining along with a utility room.



HOME 4: SINGLES

A classic building with an easy elegance. It boasts of a deck, a bedroom, a bathroom, a kitchen and dining area and not to forget, a blank canvas this is a minimal room to personalize as per your need. It can house 4-8 people at a time

Resident type	Number of houses of the type
Family	240
Married Adults	960
Single I	640
Single II	640

SECTION 4.3 SAFETY MEASURES

Space Suits and Clothing

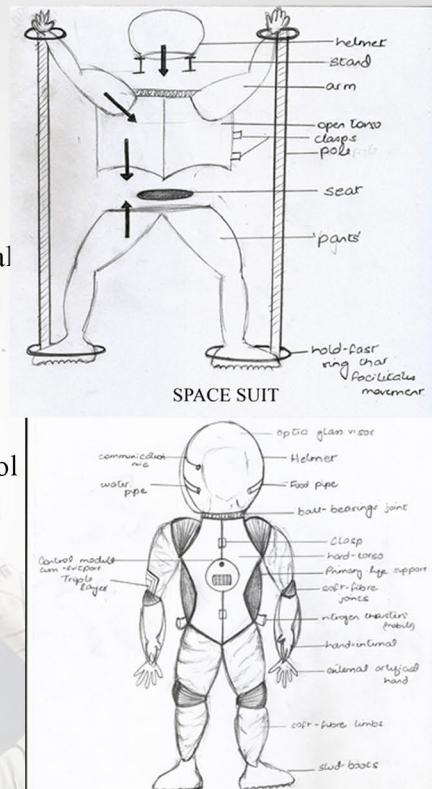
Those residing in residential safe zones under protected and regulated environment will be free to wear anything.

Any movement in the settlement outside residence will require all inhabitants to wear comfortable and flexible protective gear to ensure initial safety in case of breach-emergency. The gear will be a skin-tight bodysuit with gold and titanium stitching to create strain equally on all parts of the body that will counter body pressure in case of loss of atmospheric pressure. The resistance thus created will be proportional to that of real gravity and will substitute for loss of artificial gravity during breach or malfunction

The semi-rigid rib structure will contain biometric sensors, thermal insulation and an adequately dosed patch of insulin, pure oxygen and chromium in direct contact with the wearer's skin. In case of atmosphere breach, the patch will automatically administer its contents in the tissues and arterial capillaries to minimize decompression sickness before the wearer can safely access a proper space suit. This suit will ensure survival for at least 60 minutes until the patch's contents run out, following which the wearer must access a space suit. The bodysuit is self-healing and will repair all ruptures by simple chemical action. An integrated water-capillary system will maintain body temperature.

The space suit will be primarily used for exploration outside settlement. It will incorporate a walk-in front-entry to ensure quick access. It will be a high pressure zero-pre breathe suit. A hybrid of soft fiber joint-parts and a hard torso, it will have three major layers. The innermost layer will be an integrated water-capillary and chemical system for cooling and excretes. The outermost Titanium Micro-lattice, Dacron and Mylar based layer will be hard and indestructible. Micro-lattice also performs thermal insulation, shock absorption and traps solar energy for use as suit-battery. The middle layer will maintain biometrics and will be made of glass fibers coated with thermoelectric nanocrystals that will absorb heat and discharge electricity which will be used to provide battery-life to the suit. A control module will be fitted in front of the hard torso. The back will be fitted with the primary life support system and nitrogen-thrusters.

The helmet will contain a smart glass visor, as used in the Sunlight screens of Astoria along with the clear, super-light and super-strong ceramic, aluminum oxynitride. This will be fitted with a display to provide analysis and information on the wearer's biometrics, surroundings and provide direct communication with all settlement-bases. Insides of the helmet will have access to food-pipes, water-pipes and oxygen. The helmet structure will be fitted with lock-and-key joints and ball bearings on top of the hard-torso to facilitate free movement. Each hand will be attached to an external artificial hand via biometrics which will be under complete control of the wearer's hands on the inside of the suit. This artificial hand will be coated with asteroid dust to ensure a lasting and resourceful compatibility with the surroundings that will help the hand interact and perform. The bodysuits can be simply folded and stowed with normal clothes. Weekly maintenance and check-ups of the bodysuits will be performed by the nearest laboratory. The space suits will be stored in vertical position, facing forwards in an electric and thermally insulated cupboard for maintenance. Monthly check-ups will be performed by the laboratory. Donning and doffing the bodysuit will be similar to wearing pants and a shirt. The hard upper torso with arms and the lower torso with legs will be separated and stored as shown. The person will sit on the seat between both halves and pull up the lower torso to their waist and legs through. They will then pull down the upper torso and clasp both together tightly. Helmet will then be jointed on the neck of the suit. Life support and control module will then be worn over the suit.



Airlock

Since our space suits are high pressure suits, the need to pre-breathe is eliminated. Thus only a single vault airlock is required. The vaults will be sealed with hatches that consist of latches, a gearbox, motor system, a window, a hinge and a handle.

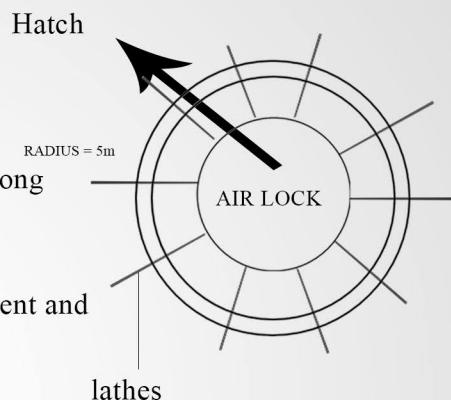
Every airlock hatch will have an additional emergency hatch that will seal the vault in case of loss of pressure beyond acceptable limits.

In addition, to facilitate convenient and immediate exit, the perimeter of the settlement will have multiple hatch-openings attached to the suit-port of a spacesuit hanging outside. Inhabitant will simply enter the spacesuit through the suitport without need of airlock. Similarly an inhabitant in outer space can simply attach his spacesuit from outside via its suitport to the hatch and the wearer can exit the suit and enter the settlement via this port. Pressures of the settlement will match the pressure inside the spacesuit.

Physical safety

Tethers

- Carbon nanotubes will be used to make highly extensible, strong and conducting tethers.
- These tethers will be kept taut using pulley release systems.
- They will supply electricity to surface vehicles in the settlement and exploration vehicles connected to space shuttles.
- They ensure retrieval in emergencies.
- They will also be used as propeller systems. Rotating tethers will conserve momentum for orbital maneuvering.
- Heat produced by friction will be consumed by thermo conductors and supplied to the settlement to prevent overheating.
- Heavy holdfasts will minimize vibrations.
- Tethers will also grapple large dangerous meteorites and asteroids and change their trajectories to prevent collision with the settlement.
- Simple non-conducting tethers will be used by explorers when moving in zero-g outer-space, to connect them to their space shuttle.



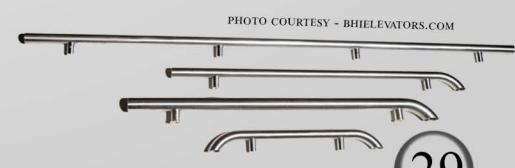
Handrails

Outer surfaces of all space vehicles and all outer segments of the settlement will have adequately spaced aluminum handrails to facilitate movement by grappling for humans in zero-g.

Cages

Very small cages with internal pressure greater than their surroundings made of extremely elastic, strong and light, tightly woven fibers will be stored for later use in a pressure equalizer. In case of emergency, the pressure equalizer will be disabled and the cage will expand to a massive size.

One side of the cage incorporates a door and a lock system, all made of the same fibers. This structure can hold both humans and equipment. It can be gripped to the surface with drill-locks as well as tied to a hook or rail. It may also provide protection from external animate and inanimate dangers.



Drills, Adhesives and Magnets

To scale rough terrain on foot and maintain grip on shuttle-surfaces, all equipment and spacesuits will have inbuilt drill and adhesion systems.

- Drills will penetrate into the surface to hold object in place.
- Peptide based adhesives that become stronger in the absence of moisture will be used to hold objects in vacuum. To reverse this process, proteases will be applied on the adhesive.
- All equipment will also have integrated magnets to ensure metal-to-metal adhesion.

Vehicles

Four types of extra-settlement vehicles which will be modular in nature will be used by residents of Astoria- the basic design will be of a model capsule which will further input parts for specific tasks .

1. Surface vehicles to access regions in the low-g environments of Astoria outside the settlement
- Smooth terrain vehicle** - A cockpit shaped like a football mounted on a fixed base fitted with disc shaped tires that are primarily tubeless, it will run on plasma-ion thrusters that run on solar energy. Anything from water to argon will be a potential propellant. The cockpit can be raised, lowered and rotated as need be.

The vehicle will be fitted with all necessary exploration and communication equipment along with emergency survival resources.

Vehicles covering short distances will be connected to the settlement via highly extensible tethers for retrieval in case of engine failure. These tethers will be made of conducting of wires to facilitate supply of electricity to the vehicle. They will be kept taut using a pulley release system.

Rough terrain vehicle/ primary exploration vehicle- A capsule mounted on a mechanical tripod and attached with two robotic arms controlled from inside the capsule.

The legs of the tripod and the robotic arms will run on electricity generated from a hydraulic and turbine system driven by the Casimir effect. A U-shaped external tube system will be installed. The tube will regulate its own pressure to prevent boiling of water in the vacuum. It will have one very small end and one large end. Two uncharged aluminum plates placed nanometers apart will undergo Casimir effect in the vacuum and come closer. A very fine empty tube will be placed between the plates which will be connected to the U tube. The plates will apply pressure on the fine tube which will compress the liquid in the smaller end of the U-tube which will create a large force on the other end of the U-tube in accordance with Pascal's law. This very large force will run a turbine that will generate electricity to run the legs and arms.

The capsule will be connected to the settlement with tethers as well for short travels. These will supply electricity and ensure retrieval in emergency.

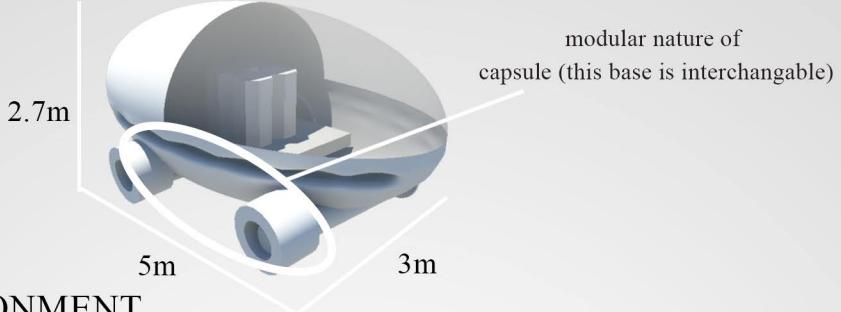
2. **Tourist vehicles** for travelling of humans to other space settlements and destinations

ITN-assisted regular vehicles-These vehicles will be simple space shuttles launched in zero gravity via rotating tethers. They will use plasma-ion thrusters to reach plotted orbital tides of the Interplanetary Transport Network. Using orbit-tidal thrust, they will travel on the mapped and predicted tidal flow with added assist from magnetic solar sails for improved speed. They will be equipped with all necessary equipment for landing with respect to their destination.

Distant-travel vehicles- Space shuttles for distant travel will use rotating tethers and Hohmann transfer orbit mechanism for launch and landing. All electricity for travel will be supplied by solar energy and radioisotope thermoelectric generator. It will have mechanisms for ablation and an independent space capsule that will be ejected in emergency.

In places with orbital stations, the space shuttle will be parked on the orbital station and the space capsule will be used to penetrate the gravitational field of the destination.

3. Cargo vehicles for exporting and importing resources- similar to the ITN assisted vehicles and distant travel vehicles based on cargo load. However no survival and emergency equipment will be required. Vehicle machinery will be controlled by robots inside the vehicle and on the control base on Astoria.



4.4 1G ENVIRONMENT

Education

Acceptable development of children through their growing years requires daily exposure to 1g for at least 3 hours a day. Since all children residing in Astoria will attend school, the primary wing of the school will rotate at the required speed in order to provide the additional 0.2g needed to fulfill this specification. Thus, the net gravity experienced by the children will be: $0.8 + 0.2 = 1g$. The settlement will have 1 school and college which will follow a three tier system; primary, elementary and higher secondary. The school uses advanced technology and computerized methods for studying purposes. The staff and alumni consist of the sharpest minds of the century. The school uses both practical and theoretical methods and strives to strike the right balance between the two. Day trips around the settlement are planned often in order to provide glimpses of the internal workings of the settlement. Immense focus is shed on character building and thinking outside the box. Imagination and dreams are cultured and unleashed. The college offers a wide range of courses to choose from and hands on experience with professionals from around the globe.

Acceptable development of children through their growing years requires daily exposure to 1g for at least 3 hours a day. Since all children residing in Astoria will attend school, the school will rotate at the required speed in order to provide the additional 0.2g needed to fulfill this specification. Thus, the net gravity experienced by the children will be: $0.8 + 0.2 = 1g$.

The rotation will be at slow speed and will be done in a manner that would prevent any motion related sickness.

4.5 SECONDARY SETTLEMENTS

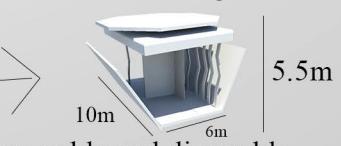
Population Distribution

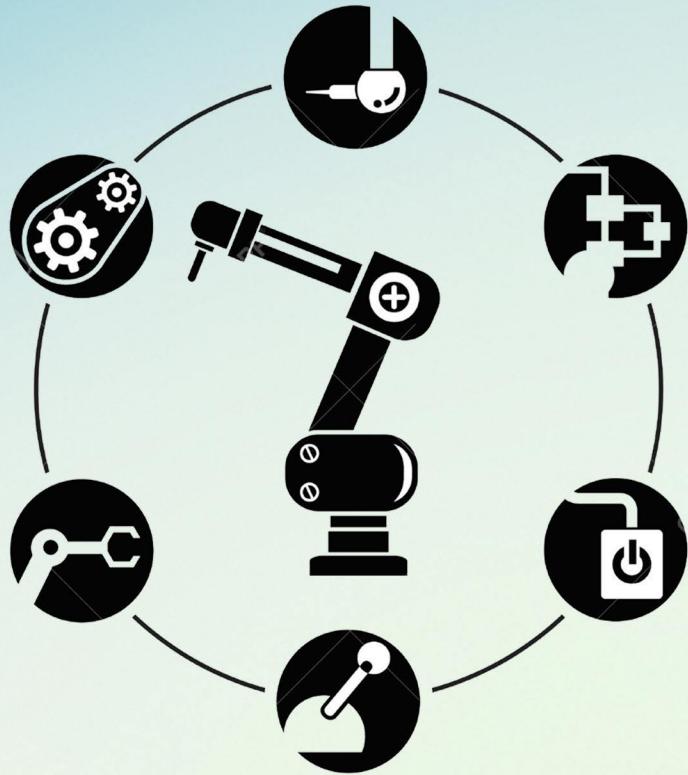
Since the secondary settlements are work oriented the population will mainly consist of adult men and women of working age. Each secondary settlement will accommodate approximately 650 residents. They will be provided with basic amenities such as hospitals, state-of-art residences, recreational areas, public spaces, etc. Since most of the population will be involved in mining or research, health maintenance will be given top priority.

Amenities - Refer to section 3.5

Instant Move-in Cabins

These cabins will support the transient population of Astoria. Easy to assemble and dissemble, these instant move-in cabins will feature heavily in secondary settlements. They can accommodate up to 2 people and provide all basic facilities with a spacious infrastructure.





AUTOMATION DESIGN

AND SERVICES

AUTOMATION DESIGN AND SERVICES

This aims to provide the designs as well as functionality of all the high tech robots and computer systems in Astoria, from robots for construction, be it interior or exterior, computer systems for storage, processing, backup of data to robots designed specially to enhance liability in the community, productivity in work environments and convenience in residences. In order to ensure proper functioning of the settlement Astoria, various unmanned tasks have been assigned to specific robots each with its own capability of doing a certain task in an orderly and algorithmic manner.

Refer to 3.3

SECTION 5.1 AUTOMATED CONSTRUCTION AND TRANSPORTATION

Transportation For Automatización Interna

MILES: Magnetic Induction and Levitation for Energy and Sailing

The surface of Astoria will have a small track and a long metal plate embedded in it, both will be closer to each other. The whole length of the track or the guide way, will have pairs of copper coils in a figure 8 manner on either side which will act as electromagnets. Beneath the large metal plate would, at some intervals, be copper coils that will, using the principle of electromagnetic induction will transfer energy to the bottom plate of Automatización Interna containing the two coils, one coil which will act as an energy source and will draw power from the ground plates to charge the high capacity lithium polymer batteries as they commute and the other coil which will act as a magnet.

A repulsive force and an attractive force induced between the magnets are used to propel the Automatización Interna. The propulsion coils located on the sidewalls on both sides of the guide way are energized by a three-phase alternating current from a substation, creating a shifting magnetic field on the guide way. The on-board superconducting magnets are attracted and pushed by the shifting field, propelling the Automatización Interna forward..

Automatización Interna (Spanish for Internal Robot)

A fully automated, self-learning robot that will cater to all the technological needs inside of the settlement.

ACLFER: All Condition Layer for Exterior Robots

This is a multipurpose composite material specially developed for the Construction Extérieure robots of Astoria. It will feature a 2" thick reinforced transparent Plexiglas upper layer with a high flex solar panel layer beneath it and reinforced carbon fibre coated with barium sulphate followed by a titanium and Kevlar lining. The upper layer of Plexiglas will withstand all the space debris, the solar panels will capture solar energy and convert it to electrical energy thus making all the robots energy efficient. The carbon fibre layer coated with barium sulphate will help protect all the robots from UV radiation, cosmic radiation and solar flare, thus enabling all the robots to be fully functional and carry out all the operations in the activity of solar flare. The Kevlar will help protect the robots from alpha and beta particles and the titanium will provide as a base material for all the robots.

Automatización Interna (Spanish for Internal Robot)

A fully automated, self-learning robot that will cater to all the technological needs inside of the settlement.

IB-I (INDUSTRIAL)

This industrial version of robot will act as a computer technician and each residential area along with the material processing labs and the main server rooms will have this species of bot. This robot will be equipped with wireless fidelity and wireless fidelity direct modules along with a set of MCU's or microcontroller and a data storage set. For the hardware, these robots will have various kinds of interface ports like VGA, USB, DVI-d, fibre optic and other high speed data transfer ports that will allow it to plug itself into another computer, robot or server for analysis. The robot can then periodically check on the computing devices of its sector to ensure their proper functioning and will automatically fix and debug any malfunction if required. The robot is also capable of repairing domestic use devices like the Beta One or the IRIS if any glitch occurs. The robot will have a small compartment in the back which will act as a storage for tools if a person requires it to fix a mechanical error. For shuttling around the settlement, all IB-I's will use the MILES [Magnetic Induction and Levitation for Energy and Sailing] technology.

IB-D (DOMESTIC)

This domestic version of robot will be the personal butler to every inhabitant in the settlement, catering to their every need. The robot will be driven by simple MCU's like the arduino, Intel Edison and the raspberry pi board, and will be equipped with several cameras as well as microphones. It will use simple text to speech conversion algorithm to communicate with the inhabitant in a lively manner. It will have a holographic projector embedded in it to simulate a virtual environment as per the users wish for entertainment or any other purposes. It will have a pair of pneumatic arms which mimic the movements of the human hand to perform various domestic tasks like getting certain products or groceries on the users command. For shuttling around the settlement, all IB-D's will use the MILES [Magnetic Induction and Levitation for Energy and Sailing] technology.

IB-H (HELPER)

This class of robot will act as a helper to all those in need. Again, it will be driven by simple MCU's like the Arduino, Intel Edison and the raspberry pi board, and will be equipped with several 3d cameras as well as microphones and will use simple text to speech conversion algorithm to communicate with the inhabitant. The robot is specially designed to help out the ones who are especially abled or the elderly. It will scan the IRIS of the inhabitant which will indicate if that inhabitant is in need of special care or not. Then according to the syndrome of that person, it will constitute a self-learning algorithm to assist that person and help him/her out in any way it can. For shuttling around the settlement, all IB-H's will use the MILES [Magnetic Induction and Levitation for Energy and Sailing] technology.

Construction Extérieure (French for Exterior Construction)

Refer to 3.3

DSS-T (TRANSPORTER)

This series of robots are the best in their field for multiple cargo transportation be it human beings, mined ores or construction material, capable of functioning to its full capacity in zero 'g' and able to face all kinds of projectiles or rubble of small space particles it might encounter. In order to withstand the great impact of all the space rubble this vehicle may encounter, a special kind of technology is used called the ACLFER. It's a special kind of material engineered specifically for use in harsh environments. This layer will not only protect the DSS-T from impact and damage but will also act as an energy source and provide power to the transporter using the light rays of the sun and converting them into electricity through photovoltaic cells.

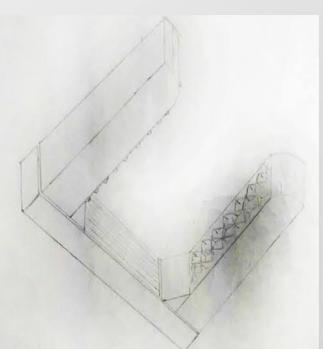
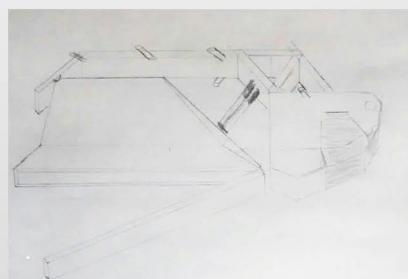
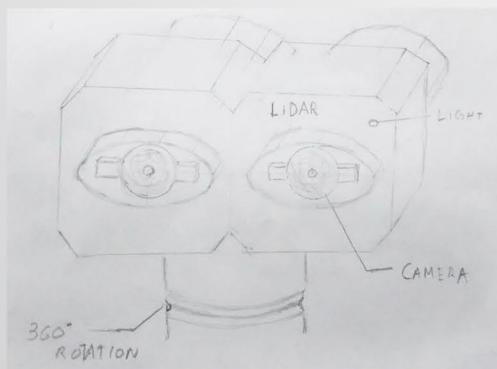
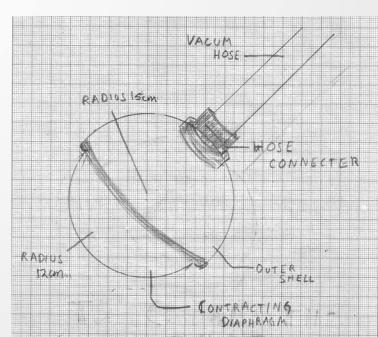
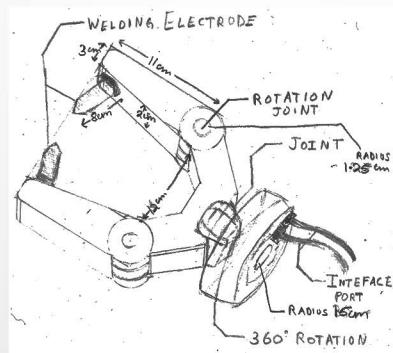
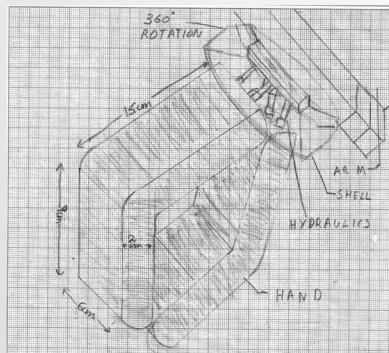
The transporter will have a set of thrusters which will help it to shuttle from Astoria to the mining base. The DSS-T will consist of a big box made out of x with a closable hatch on the top controlled by a pair of high torque pneumatic actuators for receiving all the materials whether for construction or for mining purposes.

There will also be another set of hatch or door on the back side of the transporter which will act as a guide way to move the materials from it to Astoria. When the DSS-T will attach to Astoria's dock, the hatch of the transporter will open up to transfer the mined ore or the hoarded construction material. The front of the DSS-T will have a sapiens box which will consist of 6-8 seats for human beings to sit on and travel from Astoria, the primary settlement to various places of interest nearby like the mining base. The front will also have the cockpit although the DSS-T is fully automated, in case of any mishap, there will always be the option for a human to take over and manually manoeuvre the transporter.

EDRB [External Damage Repair Robot]

These as the name suggests are exterior damage repair robots or the EDRB's capable of carrying out repair operations in the unfavourable conditions of zero 'g'. These will have a set of inbuilt computers with self-learning artificial intelligence which will constantly scan the exterior of Astoria periodically, the high speed 3D cameras attached to it will detect the damage, capture the image, analyse the problem and then look for its solution using complex algorithms and mathematical calculations. In case of it being unable to identify the problem or the solution, it will immediately contact the in house technicians of a 'technical glitch' in order to fix the problem right away. The robot will have various kinds of interface ports like VGA, USB, DVI-d, fibre optic and other high speed data transfer ports that will allow it to plug itself into another computer, robot or server for analysis. To fix a mechanical problem, the robot will be equipped with a set of arms which will be capable of mimicking all the various movements of the hand to repair the problem.

The modular nature of construction bots make them excellent candidates for maintenance. For instance, bots with a scanning robotic arm will continually scan the torus for structural faults and would relay scanned information to the swarm. The swarm would then decide whether the fault is a simple repair or not, notifying authority if it is major or automatically assembling and sending the appropriate bots to the site. Procedures will be authorized only for specific member of the settlement via IRIS (section 5.3.1)



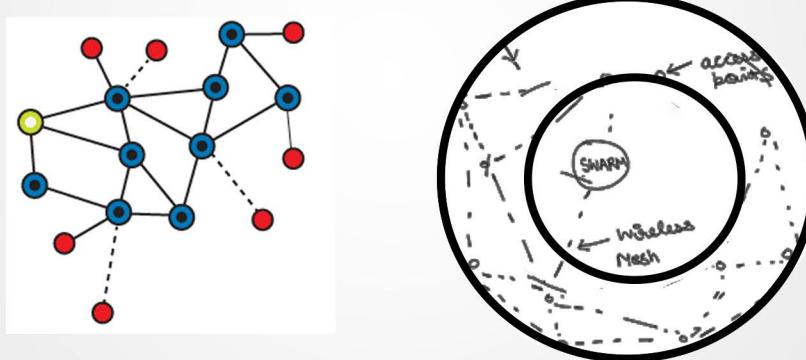
5.3 HABITABILITY AND COMMUNITY AUTOMATION

Astoria will feature a revolutionary computing technology that will allow computing to be delivered as a distributed network instead of a single CPU. Astoria would have 3 cluster centres, their combined computing power and specifications are given below.

Cluster ID	Adjusted Clock Speed	Total Computing Power	Usable Physical Memory	Number of Nodes
Cluster A	1 PHz per node	3458 PHz	750 TB	3458
Cluster B	1 PHz per node	5647 PHz	750 TB	5647
Cluster C	1 PHz per node	3458 PHz	750 TB	3458

All three clusters work in a “swarm” i.e. there is no central cluster. Computing is distributed equally across these centres. Using a cluster instead of a CPU has many advantages:

1. The network has no idle time, and redistributes the computing of the entire settlement based on need. Hence the system is 100% efficient.
2. Multiplication of large tensors required for deep belief networks that are used as part of the artificial intelligence happens an order of magnitude faster than single core CPU's
3. The cluster, overall consumes less power than a single CPU and has a high FLOPS to Watts ratio and is cheaper to run in the long run.
4. Maintenance is much easier as only the failed nodes must be replaced.
5. All computing devices act as merely an interface to the swarm, and all communication is RSA encrypted with a 2048-bit encryption key, that would take a computer double to computing power of the swarm ~1000 decades to crack by brute force.



5.3.1 HABITUAL COMMUNICATION

Astoria will be dotted with wireless access points and all devices would be able to seamlessly switch between access points. The AP's will be spaced and planned out such that each habitable location in the entire settlement has a signal strength of at least -60 dB and an average of -30 dB that would provide for an average transfer rate of 1 gigabit per second. All access points form a “mesh” to communicate and hence do not require any wires.

IRIS

For basic information refer to 3.2.6

All computation is offloaded to the swarm and thus can be manufactured very cheaply.

- The IRIS acts as an identity card at all times and can only identify its actual user by biometrics. This module works on RFID and can work even if the battery is discharged.
- The IRIS also acts as a crypto-currency wallet and can carry out exchange of money again, based on RFID and can work without power.
- Apart from storing credentials and working as a wallet, its primary use is that of a mobile device used for communications.



Beta One

Each Astornite can also chose to use Beta One, head-mounted device. It will be extremely lightweight and can be worn as a pair of spectacles. Beta One's main purpose is to serve as a health monitoring and quick display device. It features a large holographic display and a time of flight camera to make seamless interaction with holograms possible. It measures all biometric feedback such as heart rate, calorie intake and oxy-hemoglobin and updates it to the swarm for speedy diagnosis. It also displays these vitals as a heads-up display if the user chooses to. Beta One is an extension to IRIS and serves as a display to it, allowing all functionality of IRIS hands free.

5.3.2 HABITUAL AUTOMATION

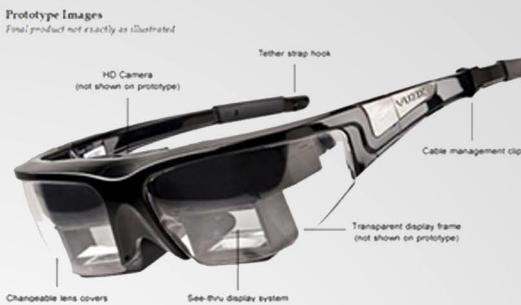
Terminals

Apart from mobile devices, Astoria will have terminals that act as an interface to the swarm. These terminals serve to be general purpose computers but can easily be programmed to automate routine intellectual tasks using Artificial Neural Networks and a simple to use and graphical AIML (Artificial Intelligence Mark-up Language). It will also have plenty of pre-made programs to automate repetitive tasks without any effort.

Baxter

Baxter is a general purpose robot that can be programmed to any physical repetitive tasks.

- One Baxter is assigned to each family.
- Baxter's already have a lot of built-in templates for automating physical tasks.
- Baxter is modular in nature, and can change its end effectors to do different task



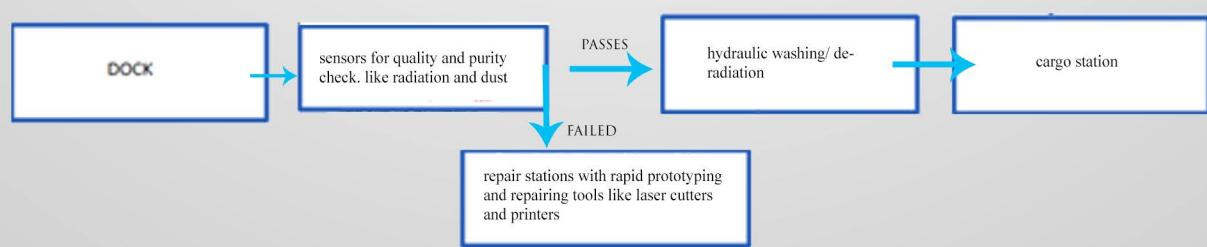
5.4 AUTOMATION FOR MINING

EXMR: Extra Terrestrial Mining Robots

Extra Terrestrial Mining Robots or EXMR's will help in carrying out all the mining work in zero 'g' that is, drilling of rocks and asteroids to make them into a more manageable material and transportation of ore from the mining settlement to Astoria. The robot will have a high torque motor with a large drill bit which will be laser guided. The drill itself will be made out of hardened titanium and will have a diamond dust coating on the outside which will make it easier for it to pulverize the rocks. For the main hull and exterior of the robot it will use the same ACLFER technology in order to withstand space debris and be self – sufficient. The propulsion system for this robot will be a hydrogen and oxygen combustion for production of thrust.

The EXMR will also have a two axis mechanical arm attached to it with a 3 jaw grabber to pick up maximum or each time and place it into the transporter that is the DSS-Which will transport it from the mining settlement to Astoria

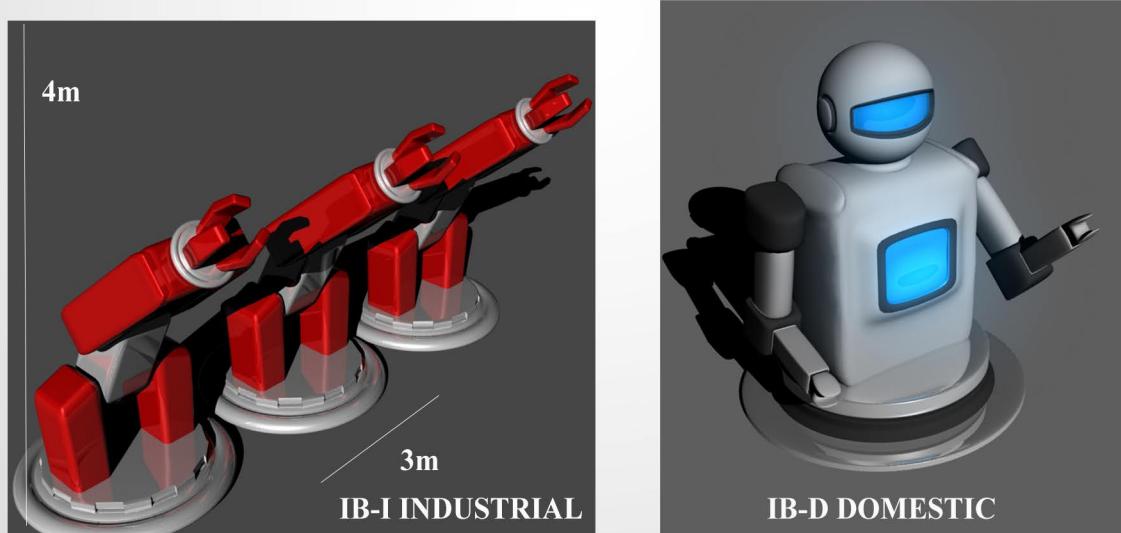
5.5 DOCKING STATION



(Semi-Automatic with 35 engineers to handle repairs)

- Cargo ships once docked follow a fully automated procedure till loading stations.
- Sensors automatically check for hardware failures and contamination (from dust, radiation etc.)
- Minor contamination is treated with simple high pressure hydraulic washing and chemical de-radiation procedures.
- If severe repairs are needed, ships are transferred to the repair station where engineers use rapid prototyping tools to fix the issues.
- In any case, the Cargo, if accepted is sent over to the cargo area.

S.No.	Robot Name	Dimensions [meters] [Length*Breadth*Height]	Number
1.	IB-I (INDUSTRIAL)	3*3*4	67
2.	IB-H(HELPER)	0.5*0.4*0.7	250
3.	IB-D(DOMESTIC)	0.8*0.8*1	100
4.	DSS-T(TRANSPORTER)	5*8*4	70
5.	EDRB(EXTERNAL DAMAGE REPAIR ROBOT)	2*2*2	200
6.	EXMR(EXTRA-TERRESTRIAL MINING ROBOTS)	3.5*3*5	50
7.	Construction Extérieure	25*25	150
8.	BAXTER	0.4*0.5*0.4	2680
9	Iris		16700

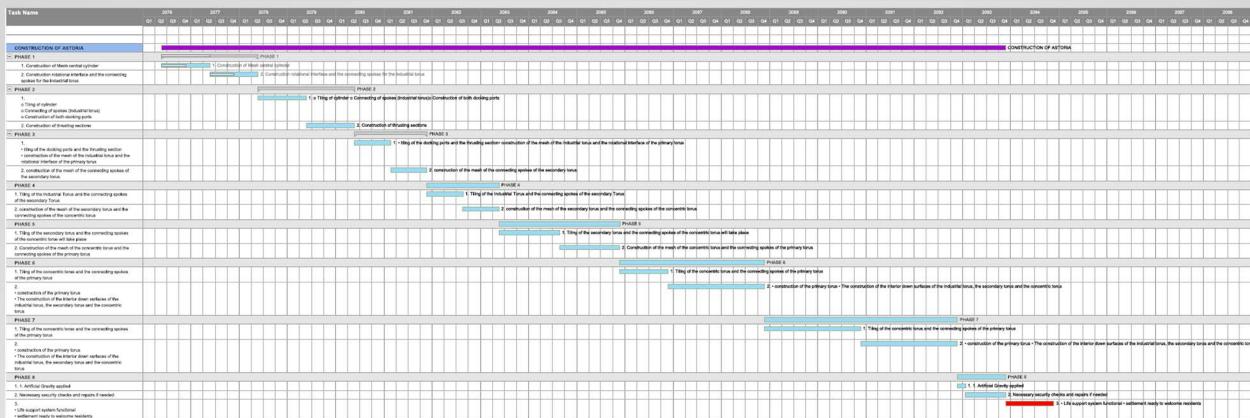


Contingency Plans			
Emergency	Solution/Possible Precautions	Response Time	
Debris Penetration	The EDRB (EXTERNAL DAMAGE REPAIR ROBOT) will step in and repair all the damages it can in minimum time possible.	Less than 24hrs depending on the damage	
Server Network Failure	An alert will be captured by the IB-I (INDUSTRIAL) which will first try to sort out the problem wirelessly or else physically interpret the solution.	Less than 6hrs	
Medical Emergency	As soon as there will be a sharp, noticeable decline in the heart rate of a person, it will be captured by IRIS, that will alert the IB-H(HELPER)	Depends on the condition	
Docking Failure	IF the issue is software related, the IB-H will try to sort it out or else the IB-D (Domestic) will step in. The patients will be transported through the saviour (section 3.2.7)	Less than 12hrs	



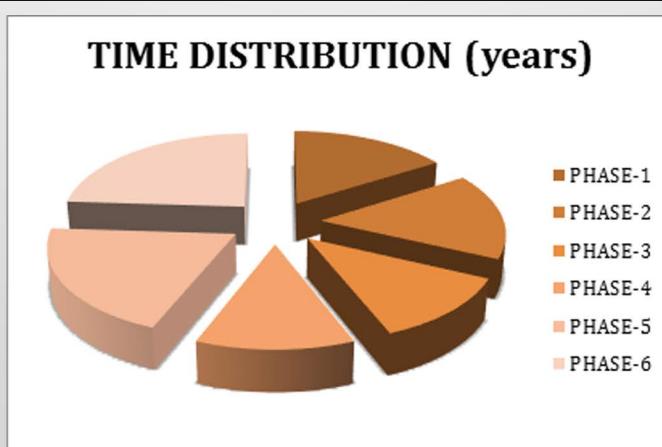
SCHEDULE AND COST

6.1 SCHEDULE 6.1.1 SCHEDULE GANTT CHART



PHASES	DURATION	COMPLETION DATES	TASKS
PHASE-1	2 years	21 May 2078	1. Construction of Mesh central cylinder 2. Construction rotational interface and the connecting spokes for the industrial torus
PHASE-2	2 years	21 May 2080	1. <ul style="list-style-type: none"> o Tiling of cylinder o Connecting of spokes (industrial torus) o Construction of both docking ports 2. Construction of thrusting sections
PHASE-3	1 year 6months	21 November 2081	1. <ul style="list-style-type: none"> • tiling of the docking ports and the thrusting section • construction of the mesh of the industrial torus and the rotational interface of the primary torus 2. construction of the mesh of the connecting spokes of the secondary torus.
PHASE-4	1 year 6months	21 May 2083	1. Tiling of the Industrial Torus and the connecting spokes of the secondary Torus 2. construction of the mesh of the secondary torus and the connecting spokes of the concentric torus
PHASE-5	2 years 6months	21 November 2085	1. Tiling of the secondary torus and the connecting spokes of the concentric torus will take place 2. Construction of the mesh of the concentric torus and the connecting spokes of the primary torus
PHASE-6	3 years	21 November 2088	1. Tiling of the concentric torus and the connecting spokes of the primary torus 2. <ul style="list-style-type: none"> • construction of the primary torus • The construction of the interior down surfaces of the industrial torus, the secondary torus and the concentric torus
PHASE-7	4 years	21 November 2092	1. <ul style="list-style-type: none"> • The tiling of the primary torus followed • construction of interior down surfaces 2. <ul style="list-style-type: none"> • Establishment of industries and residences • setting up of solar panels, life support systems and other essential buildings • Construction of proper transportation mechanisms within the torus and central cylinder
PHASE-8	1 year	21 November 2093	1. Artificial Gravity applied 2. necessary security check and repairs if needed 3. <ul style="list-style-type: none"> • Life support system functional • settlement ready to welcome residents

6.1.2 PHASES



6.2 COSTING

An idea, a concept like Astoria is dreamed of by humankind once in a millennium. Thus, Astoria is a priceless to humankind. Still, we need to put Astoria on pages and we need a well-defined cost estimation. This section will focus mainly on this part.

There are various types of costs, as listed below

Transport, Communication and Social Technology

Device/Equipment/Machine For the public	Price per person for maintenance	Initial Cost (per piece)	Total Cost
IRIS	35\$	900\$	15300000\$
MagLev Citizen Train	165\$	1,537,000,000\$	160,000,000,000\$
Toriporter	200\$	1,270,000,000\$	1,300,000,000\$
Bicycles	25\$	120\$	2,500,000\$

Astoria Construction costs

Refer to 6.2.3

Reaching The Asteroid Belt (Orbit)

Part Of Travel	Estimated Cost
Earth to Mars	260,000,000\$
Earth to Moon	220,000,000\$
Mars/Moon to Ceres	850,000,000\$
Ceres to Orbit	700,000,000\$
Total Cost	2,030,000,000\$

Payments to Workers

The pay will be divided into two parts, the Astorian Currency Dimes, and US Dollars.

Type Of Job	Astorian Currency	US Dollars
Heads of Department	10000000\$	500000\$
Researchers	3000000\$	400000\$
Industrial Workers	2000000\$	350000\$
Teachers/Community Areas/Social Work	1750000\$	400000\$
Secondary Settlement A-class	5000000\$	450000\$
Secondary Settlement B-class	3000000\$	350000\$
Secondary Settlement C-class	2000000\$	300000\$

Secondary Settlements

Sections (per settlement)	
Human Resources	14,000,000,000\$
Transport Cost	11,000,000,000\$
Mining Cost	21,000,000,000\$
Research Cost	6,000,000,000\$
Miscellaneous	3,000,000,000\$
Total Cost	55,000,000,000\$

Cost Of Raw Materials: Constructural

Materials	Actual Cost	Effective Cost
Nickel	150000000\$	12000000\$
Iron	190,000,000\$	14000000\$
Titanium	170000000\$	22000000\$
Silicon	140000000\$	20000000\$
Graphene	60000000\$	18000000\$
Aluminium	110000000\$	10000000\$
Carbon-Based Misc. Materials	90000000\$	17000000\$
Micro-Lattice	155000000\$	27000000\$
Misc. (Super Adobe, Polyethylene et cetera)	590000000\$	340000000\$
Total Cost	1655000000\$	480000000\$

Residential and Community Costs

Thing	Initial Cost	Maintenance Cost per year
Swimming Pool	100000\$	17500\$
Sports Ground	550000000\$	300,000\$
Outer Space Tourist Explorations	700000000\$	14000000\$
Cinemas, Restaurants, Malls and Restaurants	900000000\$	120000000\$
Parks And Open Spaces	350000000\$	40000000\$
Hospitals	400000000\$	150000000\$

Agricultural and Research

Thing	Initial Cost	Additional Cost per year
Agricultural Crops	90000000\$	7000000\$
Agricultural Machines	350000000\$	3500000\$
Agricultural Soil, Precipitation, lighting et cetera	300000000\$	12000000\$
Lab Research: Industrial	2500000000\$	450000000\$
Lab Research: Medical and Humans	1500000000\$	400000000\$

Total Costs

Astoria aims to be an abode not only for its residents, but science too. Thus it has an infinite numbers of small parts, and each come with a cost. However, the major ones have been mentioned here. Some of them may be common, and there may be many more. Keeping all that in mind, the final, preliminary estimated cost of Astoria is \$245,087,000,000

For sensing and imaging of outer solar system celestial objects these vessels would move out of ASTORIA (with the telescopes intact) and will carry out the recording.

These vessels would have enough fuel (LOX and LH₂) for a month out of ASTORIA.

These vessels would also contain communication facilities, radio communications which would travel at the speed of light (299,792,458 m/s). The communication system would include a 4.1 meter diameter parabolic dish high-gain antenna to send and receive radio waves via the three Deep Space Network (DSN) stations on the Earth. These modulated waves would be placed in the S-band (about 13 cm in wavelength) and X-band (about 3.6 cm in wavelength) which would provide a bit rate of 127.2 kilobits per second.

Given the distance between earth and Ceres (taken for consideration) that is 1.77 AU, The radio communications send from the ALPHA AND BETA VESSELS would reach earth in 883.24 seconds or in roughly 14 and 3/4th quarters of a minute.

As a secondary option electron beam communication would be used which would be 94% efficient compared to the radio communication. Whereas within ASTORIA optical fiber communication technique would be used for data processing, transmitting telephone signals, Internet communication etc.



BUSINESS DEVELOPMENT

BUSINESS DEVELOPMENT

Asteroids are mostly composed of carbon, with smaller amounts of nitrogen, hydrogen and oxygen, while the ones located at the far reaches of the asteroid belt are made up of silicate rock. Metallic asteroids are composed mainly of iron with a minor mixture of nickel, iridium, palladium, platinum, gold, magnesium, osmium, ruthenium and rhodium. Asteroids consist of over a million kilograms of the above mentioned minerals plus a minor quantity of undiscovered elements which makes them a principal factor for business expenditure.

7.1.1 ASTEROID MINERAL EXTRACTION AND REFINING:

All 4 main spacecraft vessels would contain 2 extraction tubes made up of aluminum.

Techniques such as shaft mining for large Bright S and Bright M asteroids ,surface mining for small Bright S and Bright M asteroids , strip and subsurface mining for Dark C asteroids. These minerals in the form of ores would be stored in REDIT CHAMBER consisting of 10 dome shaped sachets made up of tantalum each having a radius of 30 feet, 5 for solids, 3 for liquid and 2 for gaseous minerals. These ores would be transported to PRODUCTION CHAMBER 1 or 2 depending upon the mineral for further processing and refining of asteroid materials

After refining ,these pure minerals would be transported to the INDUSTRIAL CHAMBER located in the lower torus through sealed aluminum coated iron boxes on conveyor belts made up of rubber, PVC, Urethane, Neoprene, Nylon, Nitrile, Polyester and leather. Here these minerals would be further organized to form products for export and trade.

The finished products would be then stored in the STORAGE CORNER till the time being. They would be transported from the INDUSTRIAL CHAMBER through cylindrical tubes made up of titanium-tantalum alloy each having a radius of 2 m.

The tourism spacecraft that would visit ASTORIA would contain a separate compartment for the transport of finished products back to earth. The dimensions of this compartment would be 40 feet in length, 17 feet in height and 27 feet in width.

7.1.2 RECEIVING INCOMING RAW MATERIALS:

As soon as the main vessels dock in ASTORIA at the DOCKING CHAMBER, 4 cylindrical extended tube lines each having radius of 1 m would attach to the sachet opening in the REDIT CHAMBER. These cylindrical tubes would take these pre-processed minerals to their respective chambers for processing (like oxygen and hydrogen to PRODUCTION CHAMBER 1).

7.1.3 DUST REMOVAL AND REGOLITH HEAT SHIELD:

All the spacecrafts that dock at ASTORIA would enter the ASTEROID WASTE REMOVAL SECTION first (if there is no need of any repair before moving to the docking chamber) here. Magnetic attraction forces would attract the regolith's static charge and eventually remove the dust attached to its surface. The dust collected on the interior of the spacecraft would first be perceived with the help of REGO FINDER that would study its magnetic charge. The collected regolith on the interior would then be removed by MAGNETIC BRUSH and SD's. After fully cleaned the spacecraft would move to FUELLING AREA 1 or 2 (depending on the type of spacecraft).

The regolith extracted would then be used as a heat shield for the excavation vehicles. The in-situ resource utilization (ISRU) devices. – ISRU which derives O₂ and other materials from regolith would leave a hot slag or glassy melt as a waste stream. This hot regolith would be poured into a heat shield mold form.

7.2.1 AGRICULTURE PRODUCTION AND STORAGE:

The essential elements of plant growth consist of

Nitrogen, phosphorus, potassium, calcium, magnesium, chlorine, iron, manganese, zinc, copper , nickel, Silicon, sodium, cobalt, Hydrogen, oxygen, and carbon. The metallic ions plus carbon and oxygen would be extracted from Bright M and Bright S asteroids whereas the other elements would be extracted from Dark C asteroids. Elements other than oxygen, nitrogen and hydrogen would then be taken to PRODUCTION CHAMBER 2 where they would be processed by Froth flotation technique that would make use of 3 cylindrical shaped vats each having a radius of 25 m and height 37m .

1. CRUSHING VAT: the ore would be crushed here and then treated with laser etching technique which will make these particles hydrophobic.

2. OIL VAT: would be used on a partial basis for all those elements that do not acquire hydrophobic state. In this chamber, pine oil would be used to bind to for example copper compounds, but not to the unwanted rocky material.

3. WATER BATH VAT: The treated ore would be then put in a large bath of water containing a foaming agent and air would be blown through the mixture to make a lot of bubbles. As they are water-repellent, the coated particles of the metal compound would be picked up by the air bubbles, float to the top of the bath, and flow out over the sides.

The rest of the rocky material would stay in the bath.

The waste material (rocky material) would then be taken to the EXCRETION chamber where they would be neutralized in a blast neutralizer, leaving no residue behind.

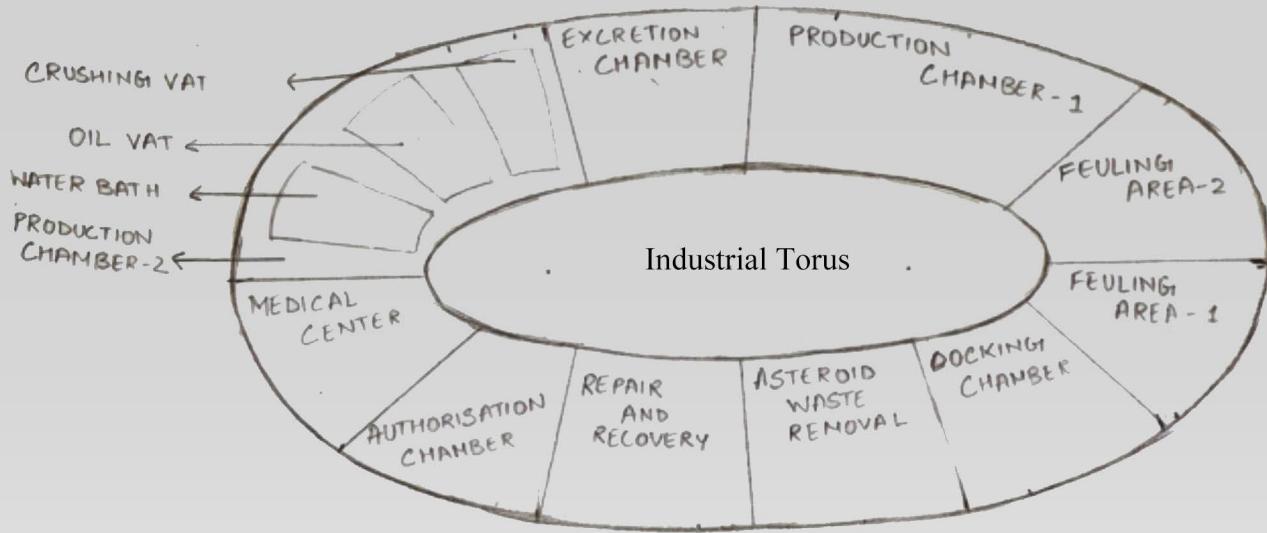
The pure metals produced here would be transported to the lower INDUSTRIAL torus via the HNO pipelines. a separate GAMMA storage unit in the form of a cylinder for these metals would be present in the lower torus having dimensions of 24 m in height and 15 m of radius. There would 15 chambers , one for each of the processed minerals and would be made up of titanium-tantalum alloy. Depending upon the needs of each of the different agricultural plants these processed minerals would be transported to the agricultural site present in the lower torus.

The finished agricultural products would then be stored in the STORAGE CHAMBER for further use present in the lower torus. There would be 30 cylindrical shaped chambers each having a radius of 30 feet and height of 65 feet.

7.2.2 CREW SERVICES AND REST AND RECREATION:

There would be a separate DOCKING CHAMBER in the upper torus for visiting spacecraft crew to dock. The space crew would then be taken to the AUTHORISATION CHAMBER through a sealed doorway where all the dust and regolith would be removed. Since dust particles (on asteroids) contain a core of ferrous iron.

There would be a custom made MAGNETIC BRUSH, designed to attract the regolith's static charge and eventually to remove dust. To control the humidity in the air which would prevent the build-up of static charge on the regolith specially modified HVAC systems would be used. Highly flexible SWIFTER DUSTER (SD) having bristle size of 10-9 would be further used to remove minor non-magnetic dust particles. After full cleansing of their space-suit they would head to the MEDICAL CENETER for further rehabilitation. The crew would then proceed to the living quarters located in the middle torus for their further stay at ASTORIA.



<u>Chamber</u>	<u>Chamber sub-vats</u>	<u>Total no. of units</u>	<u>Down surface Area allocation per unit(m²)</u>	<u>Total down surface area occupied by chamber(m²)</u>	<u>Percentage of Total Down Surface Area</u>
PRODUCTION CHAMBER 1	1. oxygen cryogenic liquid cylinder	8	262.78		
	2. k1 dewars				
	3. hydrogen interchanger liquefier	8	262.78		
	4. k2 dewars	8	262.78		
				26,213	14.77
		8	262.78		
PRODUCTION CHAMBER 2	1. crushing vat	2	1964.28		
	2. oil vat	2	1964.28	26,213	14.77
	3. water bath vat	2	1964.28		
FUELLING AREA 1	1.HNO pipeline system	9.6 km(in length)	53.7		
	2. mining spacecraft fuelling location			10,000	5.63
		2(1 for LOX and 1 for LH ₂)			
			1200		
FUELLING AREA 2	1.tourist spacecraft and protracted operations(more than 9 months) spacecraft				
		3	1200	11,000	6.19
DOCKING CHAMBER	1.docking for 12 spacecrafts	15	1200	19,000	10.71
ASTEROID WASTE REMOVAL	1.regolith removal for 5 vessels at a time	5	1200		
	2. waste removal equipments	340	17	16,000	9.02
REPAIR AND RECOVERY	1. repair equipments and their spacing	543	Varies from 15 to 125		
	2. housing space for 6 space crafts				
				19,000	10.70
			1200		
AUTHORISATION		6			
	1. waste removal equipments	90	Varies between 13 to 113		
	2. crew space				
MEDICAL CENTER		300		17,000	9.58
	1. medical equipments	600	Varies between 9 to 100	20,000	11.27
EXCRETION CHAMBER	1. blast neutralizer	8	468		
				13,043	7.35
	2. excessive storage vats	4	250		
SPACESHIP DIMENSIONS	-----	15(including tourism space crafts)	1200	18,000(OVERALL Of all the space crafts)	

<u>Total Surface Area(Excluding the space crafts)</u>				177,469	

EXCRETION CHAMBER	1. blast neutralizer 2. excessive storage vats	8 4	100 468 250	13,043
SPACECRAFT DIMENSIONS	----- -----	15(including tourism spacecrafts)	1200	18,000(OVERALL)

7.2.3 SPACECRAFT REPAIR SERVICES

The spacecraft if necessary would first head to the REPAIR & RECOVERY SECTION located in the upper torus. The repair section would consist of all the necessary materials required for the spacecrafts re-functioning. It would also hold pre made lithium batteries, fuel cells, TPS elements, digital nanoelectronics, spacecrafts engine plus 2 tons of repairing spacecraft exterior metal. After fully cleaned and repaired the spacecraft would move to FUEL-LING AREA 1 or 2 (depending on the type of spacecraft).

Travelators would be attached in all chambers for movement of spacecrafts from one chamber to another.

7.2.4 FUELLING SEVICES FOR SPACECRAFT TRAFFIC:

The upper torus would enclose PRODUCTION CHAMBER 1 in where half of the gaseous oxygen and gaseous hydrogen (extracted from asteroids) would be converted into liquid hydrogen and liquid oxygen for aircraft use whereas the leftover would be used for various purposes like agriculture etc. There would be 16 cylindrical chambers 8 for oxygen (cryogenic liquid cylinder) and 8 for hydrogen (interchanger liquefier) each having two hemispherical dome at the top. The total height of the chamber would be 48 feet with a radius of 30 feet. The total capacity of each of these chambers would be 165,000 cubic feet.

OXYGEN PRODUCTION:

Liquid oxygen would be produced in a cryogenic liquid cylinder satisfying the above mentioned dimensions (made up of tantalum metal). It would be operated at a pressure ranging between 18 to 37 bars .To prevent head pressure of liquid oxygen, the final product would be instantaneously transferred to specially designed K1 dewars present in the production chamber 1 only having the same measurements as that of the cryogenic liquid cylinder but would be made up of titanium metal coated from the interior with neon.

HYDROGEN PRODUCTION:

Liquid hydrogen would be produced by the use of Joule-Thomson effect and the hydrogen-Claude process in an interchanger liquefier made up of Aluminum-plate heat exchangers and expansion turbines with dynamic gas bearings. As a source of liquid air, liquid nitrogen would be used. Nitrogen would come from Carlsbergite mineral from the Bright S asteroids and would be produced in a separate NITROGEN orifice where the compressed nitrogen gas would cool down in a counter-current heat exchanger. The finished liquid hydrogen products would be transferred to the K2 dewars present in the production chamber 1.

This entire system would be connected through specially manufactured HNO Pipeline system which would be an upgradation to the current oxygen, hydrogen and nitrogen (satisfying all the properties of these piping phenomena) piping systems and would also be corrosion resistant. Purging would be done with helium which would be extracted from the Dark C asteroids. Liquid transfer lines would be vacuum-insulated to minimize product loss through vaporization .All pipeline equipments would be electrically grounded and bonded before transferring liquid.

For fuelling of spacecraft traffic LOX and LH₂ would be transported through the HNO pipeline system to FUEL-LING AREA 1 which would be manually operated. A secondary location for fuelling of all tourist spacecraft traffic would also be there. These spacecrafts would be fuelled at FUELLING AREA 2

Given the amount of oxygen and hydrogen availability in the asteroids, production of these gases in the liquid form could take place for well over 150 years.

7.2.5 SPACE TUG SERVICES:

ASTORIA would also have 2 extra surveillance-cum-recovery spacecrafts, having the same physical structure as that of the main vessel. Each of the 4 main mining space crafts would contain an advanced navigational beacon which would help locate the exact position and distance on the vessel from the main ASTORIA space station. A highly modified CCD detachable space camera would be placed in each of these 4 aircrafts. In case of any emergency, the main ASTORIA facility would be able to control this camera. This camera would be able to tell the type, magnitude and extent of the disaster.

The recovery vessel would hence act accordingly. The recovery vessel would also consist of EXTENSION ARMS which would attach to the SURFACE HANDLES of the main vessel, to control the inadvertent movement of the main vessels. After this a fully enclosed BI-SECTIONONAL cylindrical moveable tube would attach to the upper frame of the main vessel, where the main cockpit is located. All humans would be evacuated first as they would head to the recovery vessel. After all humans have been evacuated a humanoid robot team assisted by 3 humans (attached by space safety tethers to the recovery vessel) would cease all the major electrical, fire or other major hazardous outbreaks. The EXTENSION ARMS would now reel the main vessel in and they would head back to ASTORIA as a single unit. Upon reaching ASTORIA , the main vessel would be deployed to the REPAIR & RECOVERY SECTION where further convalescence would take place.

7.2.6 LONG RESCUE MISSIONS

For space tug or rescue operations lasting for more 3 months a separate “BYZANTINE VESSEL” would also be in function. This spacecraft would work on an advanced IND121 engine. This engine would heat plasma to extreme temperatures using radio waves. Strong magnetic fields would then guide this highly energized plasma back through the rear end of the engine. The maximum speed of IND121 would be 102 km/s. the vessel would also contain 68 PLSS life support system each containing 4 oxygen tanks. the two primary tanks each will have a volume of 3,980 cm³. They would contain a total of 0.55 kilograms of oxygen at a pressure of 5,860.5 kilopascals which would be used both for breathing and for suit pressurization. The would last for well over 9 hrs. The two secondary oxygen tanks would have a volume of 1,460 cm³ and would contain a total of 1.19 kilograms of oxygen at a pressure of 41,368.5 kilopascals. These would last for approximately 1 hrs and all other basic PLSS facilities. The RECOVERY VESSEL would also contain 4 FLVS automation vehicles that would be 4.6 m long, 3.2 m wide and 4.4 m in height for deep asteroid recovery . It would be powered by radioisotope thermoelectric generator (RTG). FLVS WOULD BE equipped WITH an X band transmitter and receiver that can communicate directly with ASTORIA space station , and a UHF Electra-Lite software-defined radio to communicate with the RECOVERY VESSEL. It would be equipped with eight 1 m diameter wheels in a rocker-bogie suspension. The recovery vessel would also contain a separate ASYLUM section to treat the severely wounded. All basic facilities and commodities would be available on this vessel

7.3 RADIO TELESCOPE AND OPTICAL TELESCOPE

5 cylindrical shaped MOVEMENT TUBES each having a diameter of 3m placed equidistant from each other at 5 different points on the torus would join together at the central point(which is open to space) of the torus circle. From here 1 DOCKING TUBE of the same dimensions as that of the MOVEMENT TUBES would head vertically upwards to a height of 100 feet above the point of intersection of the MOVEMENT TUBES. This docking port would be the docking point to the ALPHA CRAFT and would subsist of a radio telescope having a dish (primary parabolic reflector surface) diameter of 500 feet. This vessel would have a radar transmitter for the study of radar signals, a dipole antenna and 2 receiver equipments. The same principle would be applied to 2 optical reflectors telescopes placed at the BETA CRAFT attached to the DOCKING PORT 2 present at the lower torus. Both of them will have a mirror of diameter 30 feet.

A. Operational Scenario -

Wednesday, the 25th of November, 2015. An idea was conceived. A group of 12 'star struck' young scholars played with dreams and visions that have come to shape the world we know today. After 60 years of dreaming, research, technological advancements, planning, sacrifices, hard work, emotional turmoil, monetary investments, and a lot of belief in success, our little intellectual group grew up to give the world a brighter future, a better life, a happier existence named 'Astoria'. Today we stand on the threshold of this new world. And I, the Secretary-General of this settlement, invite and welcome you all to the world of your dreams, the world of Astoria.

Located in the asteroid belt, Astoria will primarily serve as a civilization and mining hub. The charted construction of Astoria will span 15 years from 2078 to 2093 as per proposal. This will be a methodical and efficient process to ensure the highest standards of safety, quality and vitality.

On the 21st of November, 2093, Astoria will open its gates to mankind. The settlement will comprise of three concentric tori. The primary function of these tori will be residential and industrial. Astoria's convenient location and adept technologies will ensure maximum utilization of asteroid, space and human resources. This will provide a plethora of job opportunities, a healthy economy and the resources we humans require for the present as well as the future.

Perfectly maintained weather and other conditions will make Astoria resemble Earth-like environments, only much better.

Residences will be well equipped, luxurious, affordable, and safe and if I may say so, absolutely breathtaking.

A day in the life of an Astorian will involve occupation, recreation and a healthy social and communal life. Religious, ideal and essential freedom, coupled with all community-facilities, recreations such as low-gravity swimming pools and space-trampolines and lucid dreaming sessions, hospitals, restaurants, parks and public spaces, schools and other educational institutions, community halls and places of worship, and state-of-art public transport will make life comfortable.

Maintenance of health and safety will be of primary concern. Hull-breach emergency systems and safety suits and precautions will be set in place. To ensure mental and physical health, regular exercising will be encouraged and regular check-ups will be ensured.

A division of time zones will ensure that our settlement is always functional. However the extent of artificial intelligence and its primary role in everyday life will make all functions much easier and much more convenient. Essentially, Astoria will be the land of union of technology and man at the most fundamental level. Higher intelligence will help humans expand and improve their own capacities to beyond perceivable imagination.

However, Astorians will be deeply connected to their natural human side as well. All green thumbs will rejoice as they gain access to the advanced agriculture facilities of Astoria. Parks and open spaces will be widely distributed. Really, Astoria will just be a finer, cleaner, happier and healthier version of Earth.

The biggest leap in human civilization that Astoria will provide is perhaps its access to the outer solar system and the rest of the universe. With its proficient machineries and technologies, a population consisting of the perfect amalgamation of dreamers and innovators and its unique location, it will provide our species with the ability to access the deepest darkest secrets of the universe. From extra-terrestrial life to a greater understanding of existence, Astoria holds the key to all the locks of the universe and is the first step in many in our endeavor to help humans reach the highest dimension, learn the greatest secrets and spread love in all of the universe, and beyond, if a beyond exists.

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c. Compliance Matrix

Structures

S.No.	Requirement(s)	Fulfillment	Page No.(s)
1	2 Astoria must provide a safe and pleasant living and working Environment for a community of 16,000 long-term residents, and up to 500 short-term visitors. The design must enable residents to have natural views of space outside.	2.0 Structural Design: 2 tori for the residents and visitors of Astoria, 1 torus for industrial activities and 1 concentric torus for agriculture and food processing have been provided. Each torus has smart glass panels for natural views of space	2
2	2.1 On exterior design drawing(s), identify large enclosed volumes and their uses. Show dimensions and construction materials of major hull components and design features.	2.1.0: Description of major hull components and their uses. 2.1.1: Dimensions of Major hull components with properly labeled diagrams. 2.1.2: Salient features of Astoria 2.1.5: Construction materials of major hull components	2,3,4, 5,6
3	2.1(continued) Specify volumes where artificial gravity will be supplied, structural interface(s) between rotating and nonrotating sections, and rationale for selected rotation rate and artificial gravity magnitude(s).	2.1.0: Description of major hull components with diagrams showing pressurized and non pressurized sections as well as sections with artificial gravity. 2.1.3: Structural interface between rotating and non rotating sections has been described. 2.1.4: A table has been provided which contains the rationale for the selected rotation rates and artificial gravity magnitudes.	2,3,4, 5
4	2.1(continued) Specify means of protecting from radiation and debris penetration. The design must show capability to isolate at minimum any two separate volumes in case of emergency.	2.1.6: Description of the radiation and debris protection mechanism has been provided along with a diagram of the protection layer. 2.1.7: A proper emergency evacuation plan has been described which is accompanied by the necessary diagrams.	7

5	2.2 Specify percentage allocation and dimensions of interior ödown surfacesö, with drawings labeled to show residential, industrial, commercial, agricultural, and other uses. Show orientation of ödown surfacesö with respect to overall settlement design, and vertical clearance in each area.	2.2: A map of the primary residential torus along with tables and chart(s) containing the surface area calculations and area utilization of all sections of Astoria has been provided. Proper references have been mentioned to other sections for more information. A diagram of the cross section of the primary torus with the required dimensions has been provided under section 2.1.0.	2,8,9, 10
6	2.3 Describe the process required to construct the settlement, by showing the sequence in which major components will be assembled. Specify when artificial gravity will be applied. Describe a construction technique for interior structures making use of materials from asteroids.	2.3: A step by step construction sequence has been described in a chronological order along with proper explanations.	11,12
7	2.4 Show details of shielding and damage repair methods for frequent impact by small particles, and means for reducing damage due to larger items that can only be detected hours in advance..	2.4: A detailed shielding and damage repair mechanism has been provided along with proper references to other sections for more information.	13
8	2.5 To improve timelines of services for asteroid mining installations in multiple belt locations, over half of Astoria's population will live in the primary settlement, and at least one quarter of the population will be distributed among a collection of secondary settlements.	2.5: Secondary Settlements have been described and diagrams of their structure have been provided.	13

S.No.	Operations And Infrastructure	Provided Information	Page No. and Section(s)
3.1	Orbital Location	Location of Orbit and Asteroid.	Section 3.1. Para 1, Page 14
3.1.1	Sources for Materials	Source of raw materials and construction layout	Sec. 3.1, Para 2, table in the end Page 14/15
3.1.2	Reasons For choosing Asteroid	Some reasons	Para 3, Table 1

		why selected Asteroid is ideal	Page 14
3.2	Basic Infrastructure	Basic layout of infrastructure and operations of each activity in 3.1	Section 3.2 Page 15
3.2.1	atmosphere/climate/weather control	Air composition, quality et cetera	Section 3.2.1 Page 15
3.2.2	food production	Growing, Innovation, Harvesting, Distribution and Storing. Production of dairy products and Meat.	Section 3.2.2 Page 15/16
3.2.3	electrical power generation	Sources and production	Section 3.2.3 Page 16
3.2.4	water management	Layout, sources, management and further detailed references.	Section 3.2.4 Page 16
3.2.5	household and industrial solid waste management	Waste Segregation, Management, Allocation and Reuses	Section 3.2.5 Page 16/17
3.2.6	internal and external communication systems	Personal communication devices and their working. Communication systems with other settlements	Section 3.2.6 Page 17
3.2.7	internal transportation systems	Internal Private and Public transport with diagrams. Inter-tori transportation.	Section 3.2.7 Page 17

3.2.8	day/night cycle provisions	Light cycles and implementation of the same.	Section 3.2.8 Page 18
3.2.9	currency	Type, value and placement of currency	Section 3.2.9 Page 18
3.2.10	Emergency Storage	Sources for storage and revival time	Section 3.2.10 Page 18
3.4	Propulsion System	Working and fuels of propulsion system (along with diagram). Sensing of asteroid and impact on daily life, with frequency.	Section 3.4 Page 19
3.5	Secondary Settlements	Number, purpose, placement and distribution of Secondary Settlements	Section 3.5 Page 20

Human Factors and Safety		
Requirement	Chapter Number where Addressed	Page Number
Provide natural sunlight and views of space	4.1 : Sunlight and Natural Views	21
Provide services expected in modern communities (i.e. housing, entertainment, medical, park and recreation), variety and quantity of consumable goods, and public areas with long lines of sight. List major types of consumables and specify	4.1 : Recreation and Entertainment Health and Medicine Governance Industry Agriculture Food and Distribution Waste Management Water	21, 22, 23,24

means of distribution.		
Map and illustration depicting community design and location of amenities.		
External drawing area and interior floor plan of four home designs. Provide area and number required for each design.	4.2 : Residential Design	25, 26, 27
Provide space suit designs with stowage and donning procedures and air lock designs for entering/exiting the settlement from unpressurized volumes.	4.3 : Space Suits and Clothing Airlock	27,28, 29
Drawings showings examples of handrails, tethers, cages and other systems enabling safe human access in low-g settlement areas.	4.3 : Tethers Handrails Cages Drills, Adhesives and Magnets Vehicles	29, 30, 31
Drawing of means for children to spend time in 1g	4.4 : 1g Environment	31
Drawing of instant move-in home designs	4.5 : Secondary Settlements	31

<u>5.0</u>	<u>Automation Design And Services</u>	<u>Page Number</u>
5.1	Use Of Automation For Construction [Interior & Exterior]	32-34
5.2	Maintenance Systems & Contingency Plans	34,37
5.3	HABITABILITY AND COMMUNITY AUTOMATION	35-36
5.4	Mining Using Automation	36
5.5	Automation For Connectivity Between Settlements	36-37