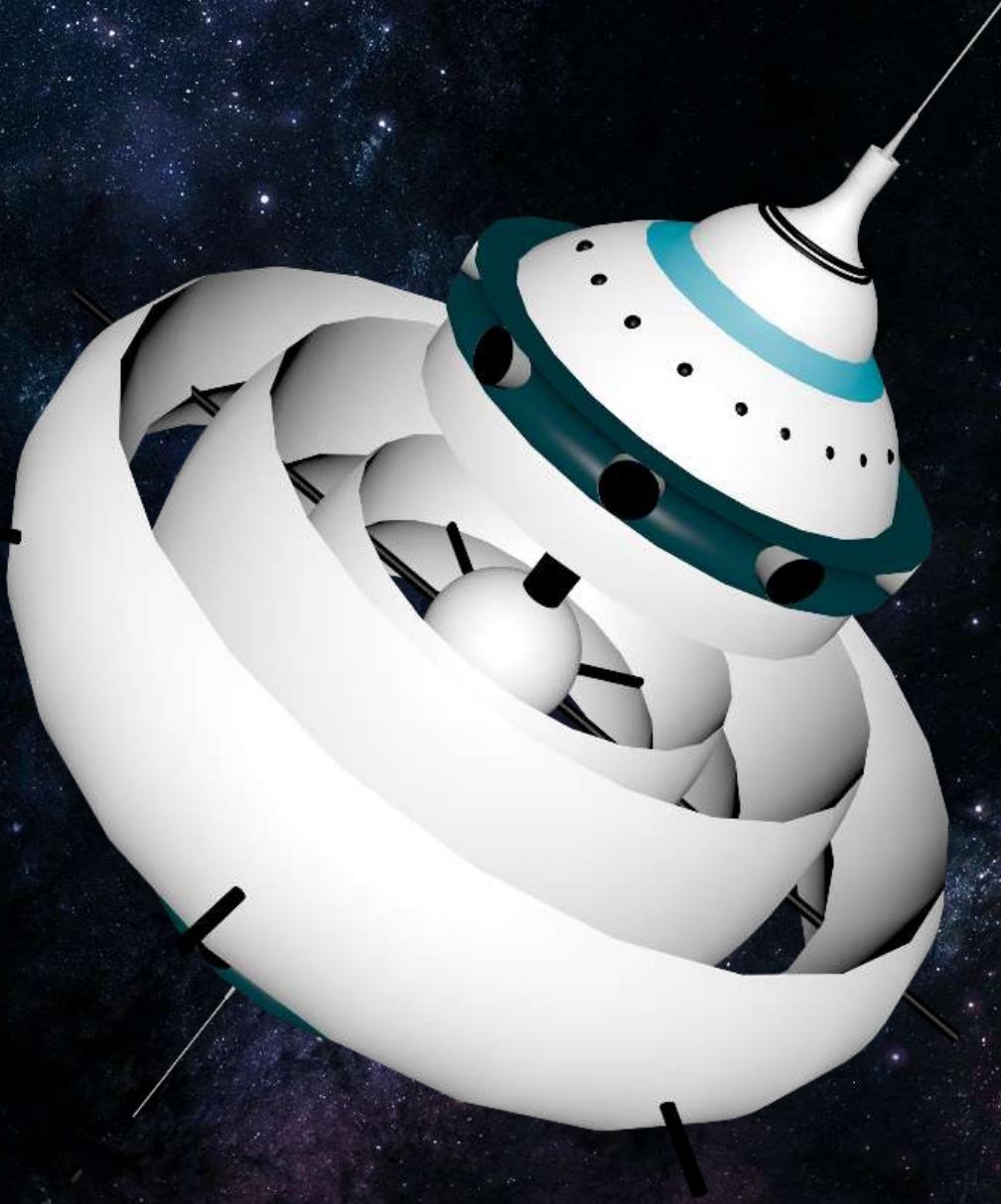


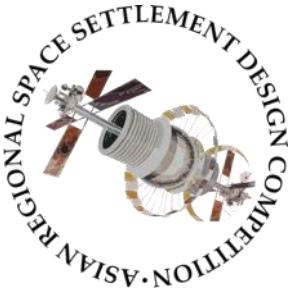
# COLUMBIAT

Hoisting the banderole of eminence....!



## St. Xavier's Sr. Sec. School

Jaipur, Rajasthan, India



## 10<sup>th</sup> Annual Asian Regional Space Settlement Design Competition

### Proposing Team Data

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Names, [grade levels], and (ages) of 12 students currently expecting to attend the Finalist Competition: (we advise that participants be at least 14 years old, and not older than 19)

KARAN AGARWAL [11](16)      VANI AHUJA [11](16)

KINSHUK JAIN [11](15)      LAA-I-BAA TALIB [11](16)

AYUSH AGRAWAL [11](16)      ABHINAV GUPTA [11](15)

HIMESH JAIN [11](16)      SATVIK SINGH [10](15)

MEGHA PALIWAL [11](16)      SARTHAK DIDDI [10](15)

VARUN BANSAL [11](16)      ABHISHEK BANERJEE [10](15)

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

Dilip Srivastava \_\_\_\_\_ Sapna Sharma \_\_\_\_\_

I understand that if our Team qualifies for the Asian Regional Space Settlement Design Finalist Competition January 23 - 26, 2014, 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.

27-11-2013

Responsible Teacher / Advisor Signature

Date

# Executive Summary

“Civilization is a progress from an indefinite, incoherent homogeneity toward a definite, coherent heterogeneity.”

■ Herbert Spencer



Space Settlements being sheer fantasy-related topics times ago, now seem to be taking place in the world today, as an upcoming plinth for human abode. Each element of '**Columbiat**' Space Settlement exhibits the degree of perfection and excellence with which it was envisioned and constructed. The structure of Columbiat indicates the genius of its designers and engineers who built it with utmost flawlessness, proving it to be a worth-while proposal for the Foundation Society.

Firstly, the bots and basic machines will be manufactured on Earth and then, the same will then be transported to the Moon. A Lunar base is proposed to be set up, which will prove to be vital in construction of **Columbiat**, as well as for future Research and exploration purposes.

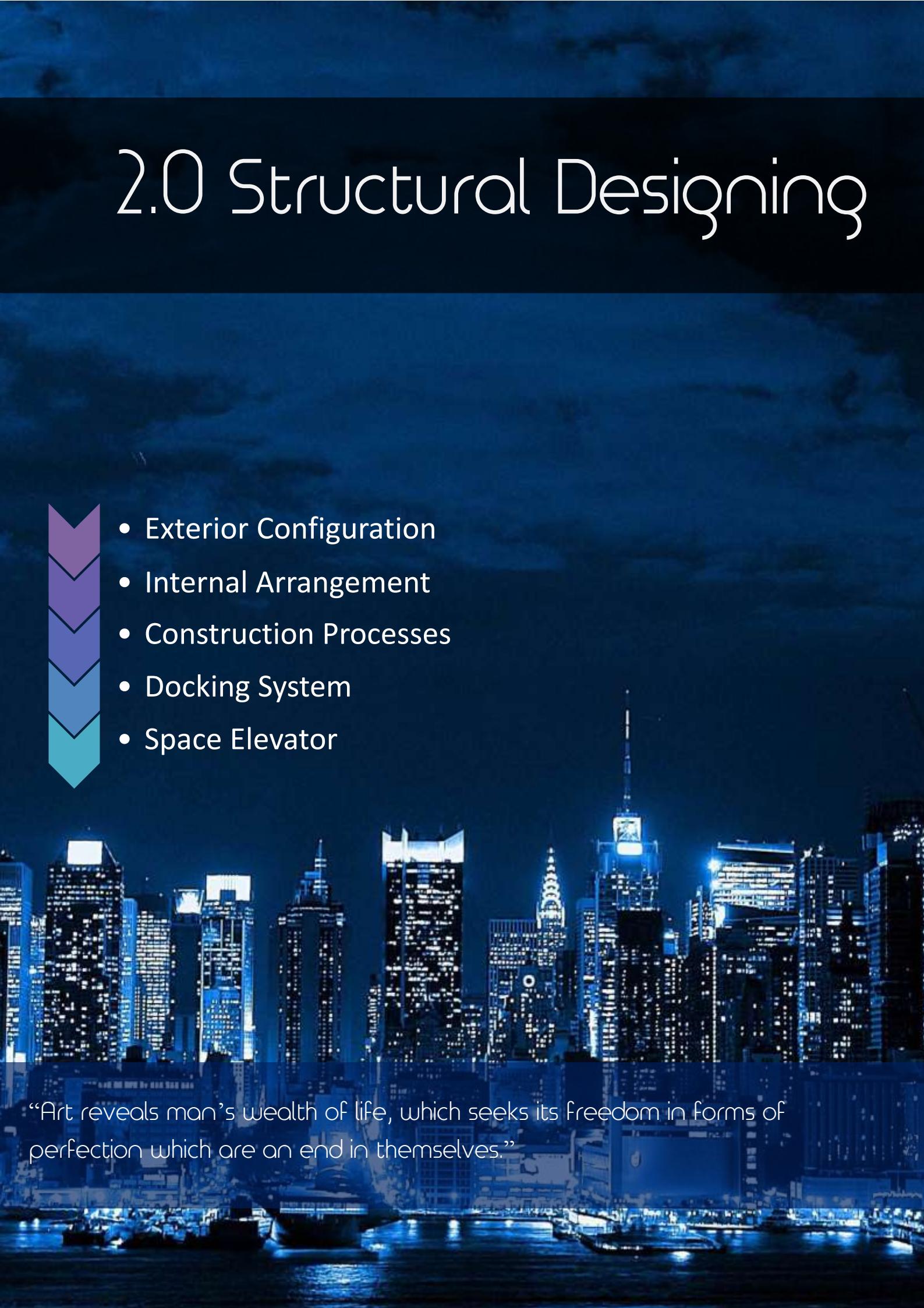
The Operational Engineering Department provides the settlement with the prerequisite of all the basic necessities, as well as other requirements, in order to create a unique habitable environment for the humans. This not just ensures contentment but also a chance to residents of diving deep into the unprecedented space, filled with electrifying leeway of exploring the explicit competence of human mind.

Further on, **Columbiat** has a lot to offer through the latest facilities and cut-edge automation services, which helps the humans to flourish well enough, in an abode that rests in the Space, as a Human Marvel. With almost every imaginable feature of futuristic technology, various bots, most advanced security systems, intelligent data managers, etc. are enough to leave one spellbound. The settlement will be a perfect example of the power of human curiosity and intelligence.

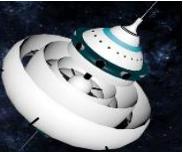
**Columbiat** designed by the students of St. Xavier's School, Jaipur, upholds the motive of 'Hoisting the Banderol of Eminence', to give a glimpse of perfection that lies -- Beyond the Future!

# 2.0 Structural Designing

- 
- Exterior Configuration
  - Internal Arrangement
  - Construction Processes
  - Docking System
  - Space Elevator



“Art reveals man’s wealth of life, which seeks its freedom in forms of perfection which are an end in themselves.”

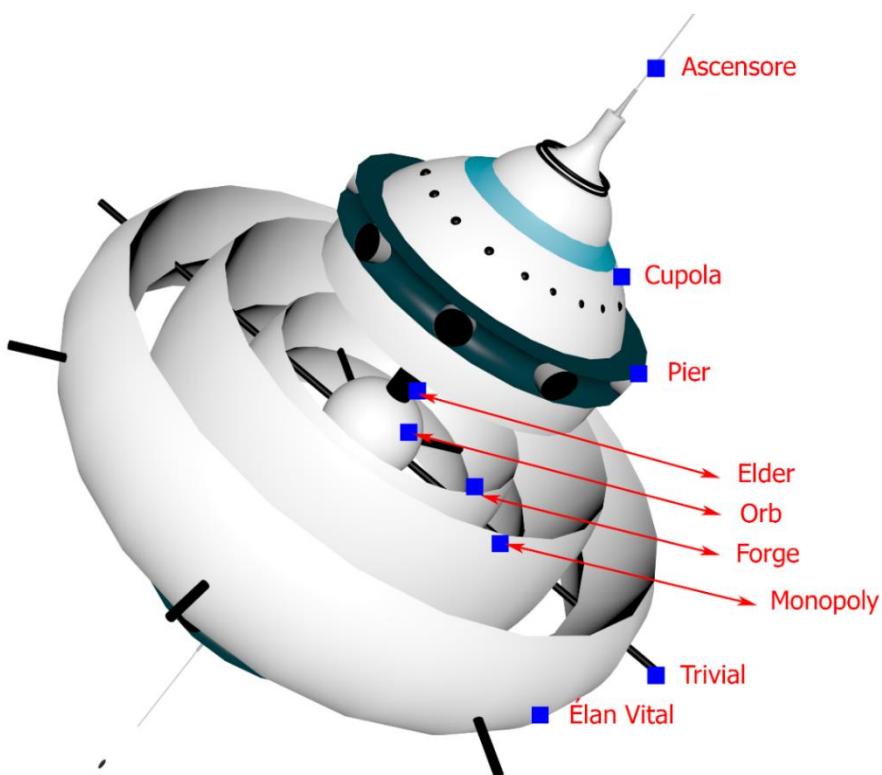


## 2.1 External Configuration

Columbiat is crafted keeping in mind a innocuous and pleasant living and working environment for humans. It will be habited by 23,000 full-time residents, plus an additional transient population, between 2000 and 2500, of business and official visitors, guests of residents, and vacationers.

The design would enable residents to have natural views of Earth and the moon below. To provide this, the Élan vital & Monopoly are kept transparent. The figure shows them white instead of transparent due to artistic render to show the settlement prominent on documents background.

### 2.1.1. Overall External Structure



### 2.1.2. Dimension and Artificial gravity

Names	Minor Radius	Major Radius(in m)	Total Accessible Surface Area (in m <sup>2</sup> )	Artificial Gravity (in g)
Élan vital	150	900	17,76,528.66	1
Monopoly	175	720	16,58,093.53	0.8
Forge	300	450	17,76,528.8	0.5
Orb	180	-	4,07,150.4	0

Names	Major Radius(in m)	Height (in m)	Artificial Gravity (in g)
Elder	50	1620	0
Trivial	10	2000	0
Cupola	250	-	0
Pier	500	100	0
Pier Tunnel	50	550	0



## 2.1.3. Construction Materials

### Building and strength

Material	Properties	Tensile Strength	Areas
Graphene	Exceptionally high tensile strength Transparent Excellent conductor of heat and electricity	130 GPa	Entire Settlement
<u>Silicon Bucky Structure</u>	Exceptionally Strong; Can be formed into flexible strands and cables of unlimited length; Thermal insulating qualities, electrical conductivity	----	Entire Settlement and Ascensore
<u>Carbon Nanotubes</u>	High electrical conductivity, Resistant to extremely high temperatures	63GPa	Internal docking complex

### Insulation

Material	Properties	R-value (per inch.)	Areas
Vacuum insulated panel	Provide better insulation performance than conventional insulation materials transparent	8.8	Entire Settlement
<u>Polyisocyanurate Spray foam</u>	Long service life Recyclable through Reuse	1.46	Elder, Trivial, cupola and pier

### Radiation Shielding

Material	Properties	Areas
<u>RD30</u>	Transparent Excellent shielding and only a thin layer needed	The 3 tori and cupola
<u>BNNT</u>	Strong radiation shield Excellent structural material properties Functional at extremely high temperatures	Elder, trivial, cupola and pier
<u>RXF1</u>	3 times stronger and 2.6 times lighter than aluminum Good against ionizing radiation and cosmic rays	Entire settlement except the 3 tori
<u>Grit-Blasted Screen/Tungsten</u>	Low specular Reflectance i.e. better protection from irradiated heat of order 2000°C ; Very good for electronic devices	Pier, cupola, Forge

Note: - Entire settlement does not include the Ascensore.

## 2.1.4. Functions

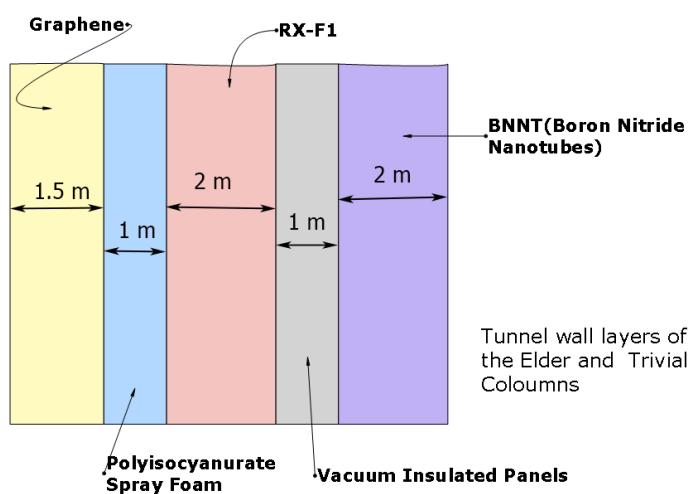
All the parts of the settlement are covered with Organic solar panels which are transparent. Semi-transparent solar panels have already been developed and we have considered that till that time such technology would be developed. They can provide natural sunlight even when producing energy. They also have a low production cost and are very flexible.



As they are abundantly produced by Bellevistat, the entire settlement would also be covered with a 2 m thick layer of Silicon Buckystructure giving it its milky white color and providing it its resilience.

## Elder

Designed for rigidity, this axle will serve as the framework for the settlement. Connected to the trivial rods and the Cupola, this axle would serve as prime pathway connecting the entire settlement. It will be hollow, providing way for the transportation of materials and passengers to and from the piers. The transport pods will function in this axle.

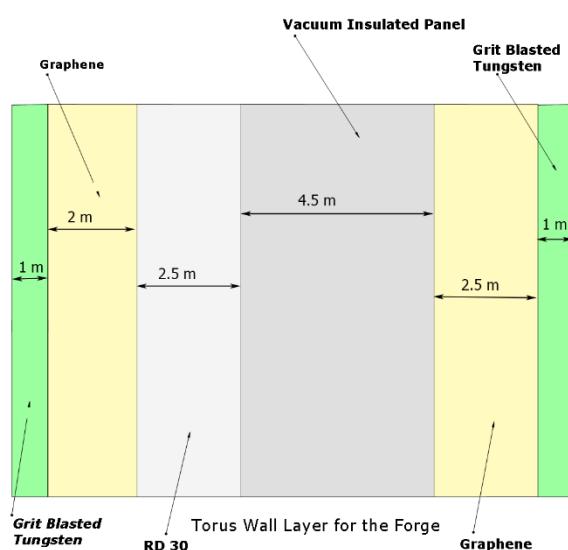
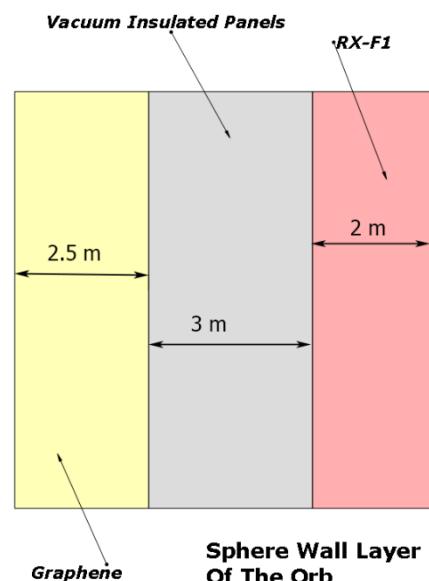


## Trivial

The 8 trivial rods will provide support for the three tori (Élan vital, monopoly and forge) enabling them to rotate with the same angular velocity (0.99 rotations/minute), making transportation between them possible. They will provide protection from the heavenly bodies by launching heavy pods towards them. They will also mark the isolation of colonies. Protruding out of the tori, they will help in any future expansion. They would be the main link between the three tori.

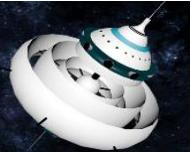
## Orb

Meant for recreation, they will be the impression of the passengers before they actually venture into the residential area. They will have Cave automatic virtual environment (CAVE) which will enable them to see the space along with the earth, moon and other planets. Zero g will enable the people to float around, which will add on to their space experience.



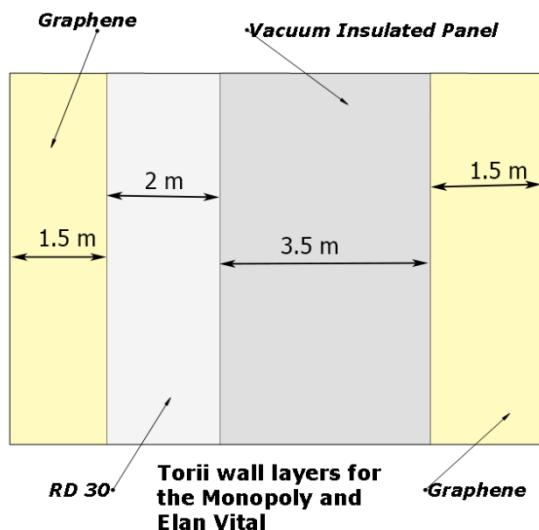
## Forge

Perfected for the 'machineries', it will be the industrial hub. The 0.5 g will provide an environment 'just right' for the robots to work with the machines properly, minimizing the wear and tear without compromising their efficiency.



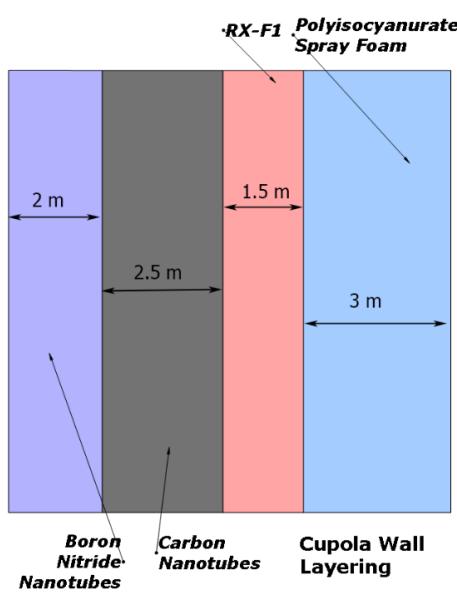
## Monopoly

This torus will accommodate the offices. In view of the future expansion, much of its area is currently kept vacant. Its current set-up includes offices (trade & banking sector, keeping record of the resources of the settlement), control centers (monitoring the functioning of each and every part of the settlement, functioning of the robots and any incoming threats) and research labs (to find new ways to enhance the functionality of the space settlement and deal with the waste).



## Élan vital

A perfect residence! This torus will mainly focus on providing residence and will comprise of apartments, houses and villa. Apart from this, it will also support food processing units (FPUs), hospitals, educational institutes, pathways, landscapes and other recreational units. Also, some area will be left unused keeping in mind the transient population and the future expansion.



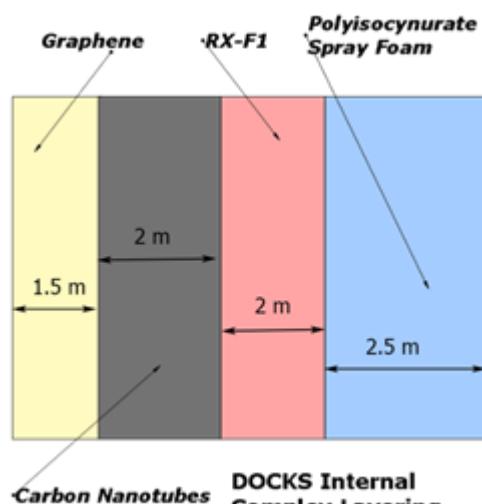
suggests, they will be the port for any incoming space ships carrying people or cargo. Two in number (one on each side), they are situated ideally on each cupola so as to provide easy storage and transportation from the cupola. Nearing the Ascensore, they would provide easy access to them as well.

## Cupola

They are two in number, one on each side of the settlement. The cupola will provide volume for storage of cargo, the ship repair mechanism, the space suits (in case the residents or the passengers need to go in an unpressurised area or space) and the stock of several minerals extracted from the moon or brought from the earth for use which can't be manufactured in the settlement.

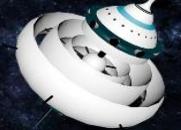
## Pier

As the name



## 2.1.5 Structural Interfaces

Structural interfaces will be placed between orb and trivial making the trivial rotate. Thereby, joint from trivial, all the three tori will rotate with the same angular velocity providing different gravities due to different radius. Apart from this no other structure will rotate so no other interfaces are needed.



## 2.1.6 Exterior Protection

The main concerns also include those phenomena or substances which affect the settlement exteriorly. Therefore, it is a must to protect the settlement against such odds and have measures for Unfavorable consequences. Below is a list of some of the phenomena which can affect the settlement and its inhabitants adversely and suitable measures.

### Dust mitigation

It is the mechanism by which the cosmic dust (or space dust) coming in the path of the spaceship is dealt with. Thankfully, the largest particle possible to collide with the settlement is the size of a grain, but keeping in mind their relative velocities, they can cause significance damage.

Therefore, graphene is used as the outermost layer which is sufficient in protection from such particles.

### Debris Protection

To deal with larger debris, DE-STAR (Directed Energy Orbital Defense System) will be used. DE-STAR is designed to harness energy from the sun and convert it into a massive phased array of laser beams that can destroy, or evaporate, debris posing a threat to the settlement. It is equally capable of changing an asteroid's orbit -- deflecting it away from Earth, or into the Sun -- and may also prove to be a valuable tool for assessing an asteroid's composition, enabling lucrative and rare-element mining.

### Heavenly as well as artificial bodies

Talking about space, the odds of encountering a heavenly body which can collide head on with the settlement are very high, but the threat can't be completely ignored. Keeping this in mind, an Exterior protection unit will be set up at the settlement. Functioning as a fully automated system, it will keep on searching the space for every incoming threat. It will keep the records such as orbital velocity, time period and time as well as calculate any deviations in the path, for e.g. due to gravity, based on the previous experiences and the impacts (if they will have collided) of those which will pass very close to settlement, earth or moon.

Considering that the object will be tracked at least 2 years earlier, the central command system will order every Trivial to launch C-ships parked in it. Now, every celestial body isn't that large, and even if it is, that's not a problem. Many of them contain resources that are valuable. We can harness them to our use. The other can be used to unfold the mysteries of our universe. Track a potential threat by a resource rich object, C-ships weighing a couple of tons will be parked near it as landing isn't safe enough. Now, the object as well as the C-ships will be attracted by gravity. By switching on the ion drive thrusters and applying a very little force, the object can be gently pulled to a safer radius, a change of even a few degrees of the direction will serve the purpose depending upon the distance. Now, side by side research will be carried on to explore the object even further. Depending upon the results, mining will be setup on it. Even its orbit can be shifted using the DE-STAR so that it passes near the earth on a regular interval when we can get the mined resources regularly.

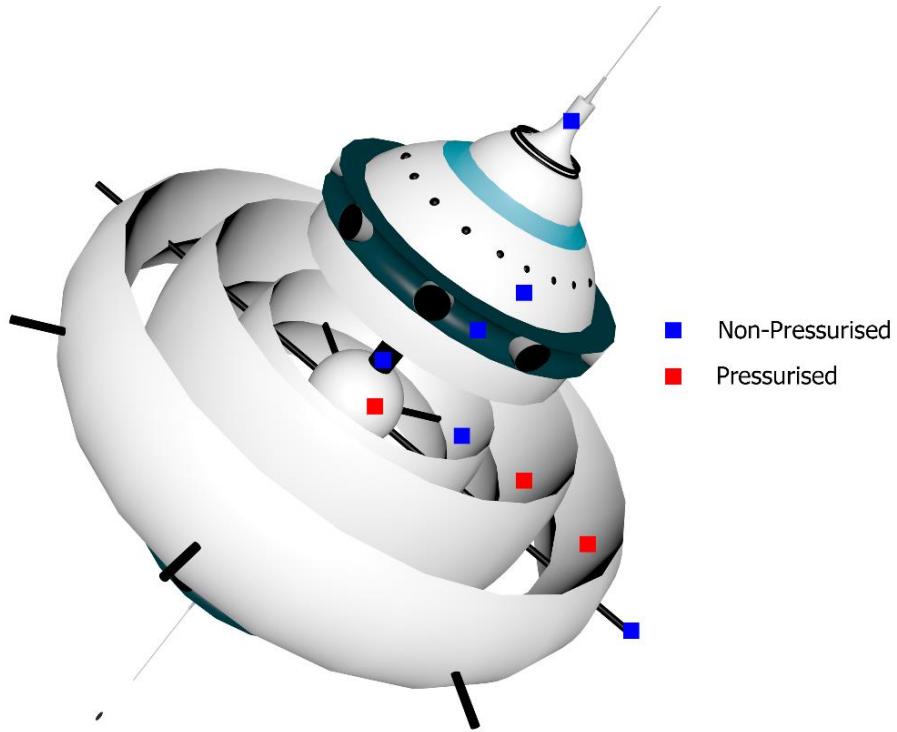
### Radiations

Protection from radiation will be ensured by a newly discovered material, BNNT (Boron Nitride Nanotubes). The BNNT's contain hydrogen, boron and nitrogen. It is a suitable aerospace material as it is light and more effective in preventing radiations than heavy lead and aluminum. Apart from this, it can operate at temperatures higher than 700°C.



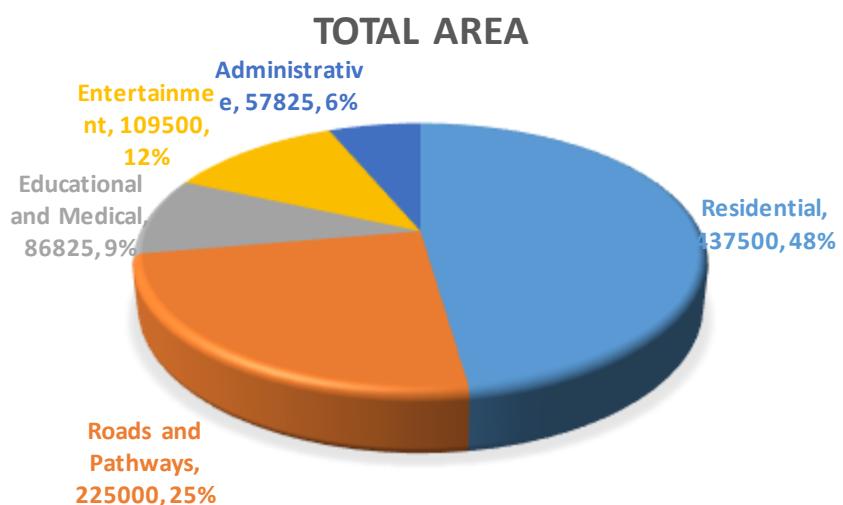
## 2.1.7 Pressurized and Un-Pressurized Areas

There are areas in the settlement which are pressurized due to the human activity in them. In rest of the areas, the people would use bio-suits.



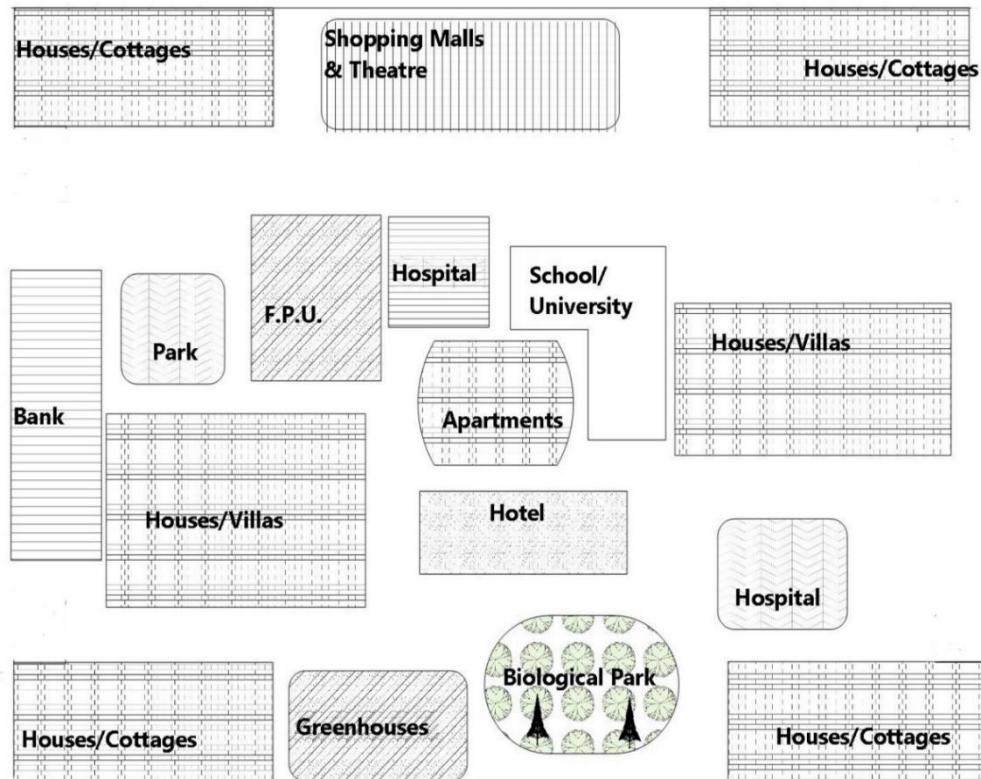
## 2.2 Internal Arrangement

### 2.2.1 Allocation





## 2.2.2 Orientation



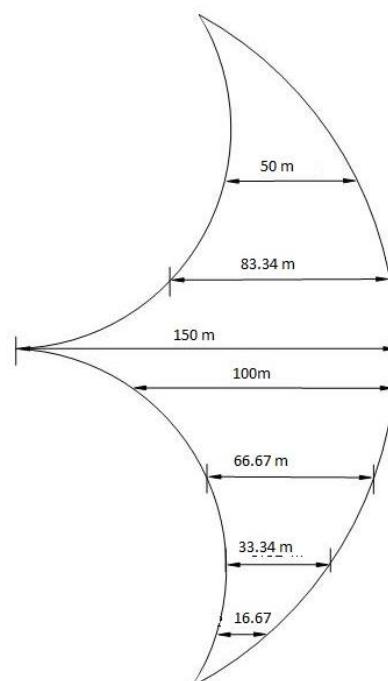
## 2.2.3 Vertical Clearance

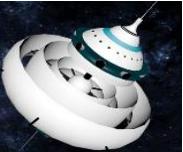
The Residential torus will have a minor radius of 150m. The outer curve will act as a surface for setting up residential areas. The maximum vertical limit will be 125 m in the middle of the sector. As is clear from the figure, the height decreases progressively from middle to the sides.

The Minimum requirements are:-

1. The apartments will have a height of 65 m and an additional space of 5 m will be assigned for 2 layers of aeroponics.
2. The houses and cottages will have a height of 25m including those required for aeroponics.
3. The villas will have a height of 45m including those required for aeroponics.

If after the construction of the residential areas the vertical clearance limit is not crossed further aeroponics layers will be added so as to increase the amount of agricultural produce for the settlement.





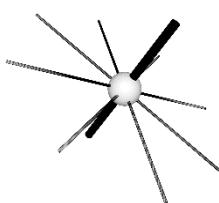
## 2.3 Construction Process

### 2.3.1 Construction Process

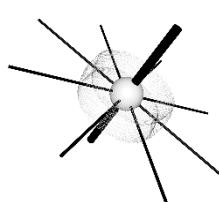
The construction of the settlement will be carried out in 15 years and would involve the following stages:



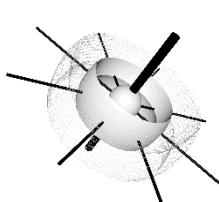
The construction will commence with the setting up of Elder and orb; Time taken to construct these is 1 year.



Then, Trivials will be constructed over a time-span of 1 year.

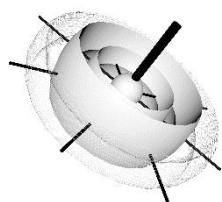


Forge will then be constructed in 1 year.

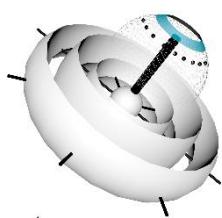


Monopoly will be constructed in 1.5 years.

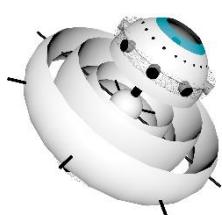
Élan vital's construction will be completed over a period of 2 years.



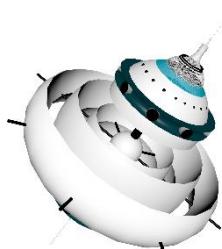
Cupolas' mainframe will then be constructed in 2.5 years.



Piers will then be constructed in 1 year.



Finally, Ascensore and counter weight construction will be triggered whose construction will take another 5 years.





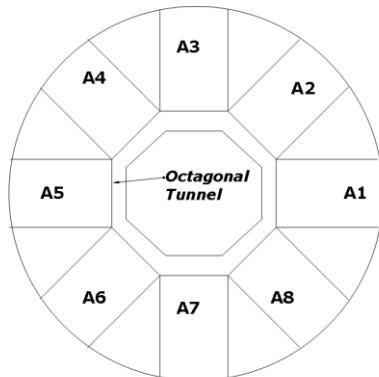
### 2.3.2 Initiating Rotation

During the construction of the settlement, first the "Elder" axle will be set up and then the orb will be constructed. Then the Trivial will be attached to the orb. After the construction of the 3 Tori, at the end of each rod a Lorentz Force Accelerator" will be attached. In order to stabilize the non-rotating sections i.e. The Elder Column, Pier, Cupola, Ascensore "Xenon Ion Thrusters" will be attached providing opposite torque at different positions of the non-rotating sections. They will stabilize the non-rotating sections at the time of construction and also in future.

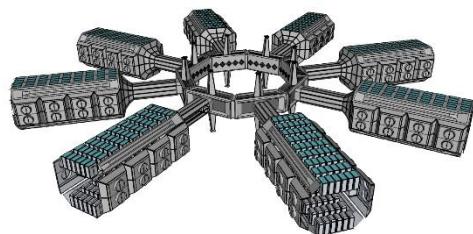
## 2.4 Docking Systems

### 2.4.1 Location of port areas (incoming & outgoing)

Present on both sides of the settlement, the docking system will comprise of a 4-tier system i.e. it will have 4 entry portals for incoming ships and 4 exit portals for outgoing ships. The entrance tunnels will be located at the positions A1, A3, A5 and A7 and the exit tunnels will be located at positions A2, A4, A6 and A8. Each



destination.



Tunnel will have a radius of 50 m and a length of 550m.

The ejection process will comprise of an artificial magnetic field which will be induced at the end of the exit tunnel and the spaceship will be made of metal. The magnetic attraction will provide required force for the movement of the spaceship. When the ship has attained sufficient velocity the induction of the magnetic field will be stopped. This will not only save fuel but also provide an ejection to the ship towards its

### 2.4.2 Long term stay of one ship for emergency repair

The dock for the settlement with its 4-tier system will provide repair mechanisms and long term stay of two ships at a time. The tunnel A1 is demarcated for parking and emergency repair of space ships entering the settlement. The 550 m tunnel provides docking facilities. Each tunnel, one each Pier, will be specially equipped with bots and repair materials to handle heavily damaged ships.

### 2.4.3 Scope for Future expansion

The "Dome" provides further scope of expansion as similar docking complexes can easily be added to both the structures present on both sides of the settlement. This gives us a better opportunity to bring about changes and thereby accommodate large number of ships on both sides of the settlement.



## 2.4.4 Loading/unloading of four cargo ships at once

There would be six ports specialized for loading/unloading, A2, A3 and A4. This system for the docks will be handled in the octagonal tunnel. This will help to compile cargo and passengers from different ships and will allow ease of transportation and distribution of resources to different colonies and offices.



## 2.4.5 Cargo transfer facilities

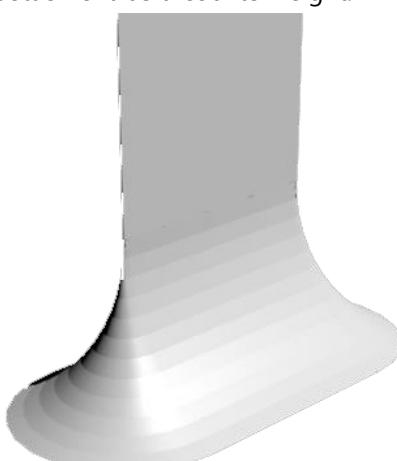
The cargo will first be transported to the Elder from where it will go to the orb which holds the 8 Trivial which will be responsible for further transportation and distribution of cargo and passengers among Communita and the three tori. The passengers arriving from the Ascensore will also be included among them. This not only ensures ease in transportation but also provides better management of incoming and outgoing cargo and travelers.

## 2.5 Space Elevator

The Construction of the milky white, Space Elevator or Ascensore will begin simultaneously at both the terminals of the settlement, stretching equally at both the sides. The length of the elevator will be approx. 58300 km on each side.

On one side, beginning from the docks, it will extend to the Moon's equator. This route will perform easy and cost-effective transportation of residents and cargo. A lunar elevator could significantly reduce the costs and improve reliability of soft-landing equipment on the lunar surface. For example, it would permit the use of mass-efficient (high specific impulse), low thrust drives such as ion drives which otherwise cannot land on the Moon.

On the other side it will extend towards the earth from the settlement as a counterweight. Though very far from earth, it will still reduce the distance by substantial amount.



The cable will be a silicon buckystructure ribbon, 3 feet wide and 1/2 inch thick. They would be constructed by extruding viscous buckystructure feedstock through a catalyzing agent to form ribbons of these dimensions.

The elevator would be attached to the settlement by a parabola formed by thicker length of ribbon at both the sides. Perfected for loading/unloading, the parabola would also serve as dock for the space elevator pods. Its base length would be 4m by 2m, whereas top dimensions being same as the elevator.

# Operations



- Location and Materials
- Community Infrastructure
- Construction Machinery
- Propulsion System
- Space Elevator Cab

“Life like a dome of many-colored glass stains the white radiance of Eternity.”



## 3.1 LOCATION and MATERIALS

### 3.1.1 LOCATION

Columbiat will be located at Earth-Moon L1 orbit [Lagrangian point] serving as an Earth-Moon orbital terminus of a space elevator. The Earth–Moon L1 allows comparatively easy access to lunar and earth orbits with minimal change in velocity and has this as an advantage to Columbiat Space settlement.

### 3.1.2 LIST OF MATERIALS

These Materials are required in the construction and running of Columbiat Space Settlement and they will be procured from Earth, Moon or other Near Earth Objects

Material	Source	Requirement
<b>Silicon</b>	Moon	Electronics and Space Elevator
<b>Graphene</b>	Asteroids & Moon	To provide structural strength
<b>Carbon Nanotubes</b>	Asteroids & Moon	To provide structural strength
<b>Aluminum</b>	Moon	To provide structural strength
<b>Boron Nitride nanotubes</b>	Earth	Radiation protection
<b>RX-F1</b>	Earth	Radiation protection
<b>RD30</b>	Earth	Radiation protection
<b>Vacuum Insulated Panels</b>	Earth	Insulation
<b>Polyisocyanurate</b>	Moon	Insulation
<b>Galium Arsenide</b>	Earth	Resistance to solar heat
<b>Steel</b>	Asteroid	Robotic Framework
<b>Titanium</b>	Moon	Robotic framework
<b>Copper</b>	Earth	Conduction
<b>Aerogel</b>	Earth	Thermal Insulation
<b>Hemp</b>	Cultivated on Moon	Furniture
<b>Bamboo</b>	Cultivated on Moon	Furniture
<b>Concrete</b>	Earth	Providing strength to buildings
<b>Neoprene</b>	Earth	
<b>Oxygen</b>	Asteroids & Moon	Vital for survival
<b>Nitrogen</b>	Asteroids	Major part in atmosphere
<b>Xenon</b>	Earth	Propulsion fuel
<b>Water</b>	Asteroids & Moon	Vital for survival

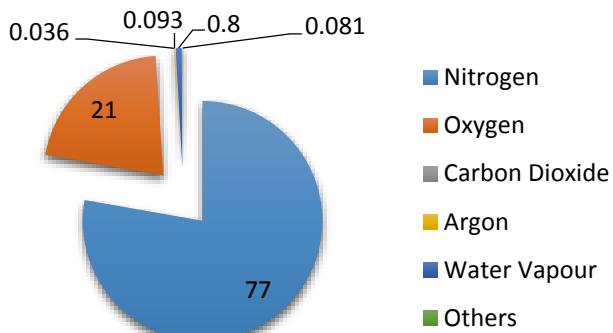
## 3.2 COMMUNITY INFRASTRUCTURE

### 3.2.1 Atmosphere

the residents will be provided with a healthy and pollution free atmosphere which will be similar to that of the Earth. Atmospheric Pressure 1 atm i.e. 1.01325 Bar. Earth like composition is best suited for life, alterations can be fatal.



## Atmospheric Composition



### ATMOSPHERIC REGULATION:

Humidifiers, de-humidifiers, air filters, etc. are installed every 100 Sq. meters to ensure immaculate and hygienic surroundings.

### TACKLING EMERGENCY:

In any case of gas leak or any other mishap, people will have access to Bio-Suits which will have enough oxygen for individuals to help them survive for a couple of days.

### SOURCES:

The gases will be procured mostly from Earth's or Martian atmosphere [Nitrogen specifically from asteroids], and the remaining will be prepared industrially.

Gas	Amount (in m³)	Sources
Nitrogen	77023870	Asteroid
Oxygen	21006510	Electrolysis of Water
Carbon dioxide	36011.16	By product of Combustion and Respiration
Argon	90027.9	Earth
Water Vapour	800248	Transpiration
Others	81025.11	Earth

### 3.2.2 Food Production

Food is a basic requirement for any settlement to flourish. Settlements grow either at places where there is abundance of food or where it's easy to cultivate. In our case, we need to come up with a cultivation solution which does not involve the use of soil or land, for that matter. So we have alternatives: Aeroponics and Hydroponics. To keep the services the best, five aspects have to be maintained:

- Growing & Harvesting
- Moving to FPU's
- Processing, Storing and Packaging
- Delivering and Distributing
  
- ✓ **Aeroponics** is the cultivation of plants in air or mist environment without usage of soil or any aggregate medium. The nutrition in this case is provided by air and the roots are periodically sprayed with nutrient rich water solution.
- ✓ **Hydroponics**, similarly involves the use of water as the nutrient medium for plant growth.

Since Red and Blue light are the most absorbed, the light needed by the plants will be provided by red and blue lights using SOLED's (Stacked Organic Light Emitting Diodes).

#### Location for Aeroponics & Hydroponics:

- Aeroponics will be carried out at the rooftops of every residential unit. In the places of Vertical Clearances of to expedite the production process.
- Since Hydroponics is difficult to set up on rooftops, special greenhouses will be installed in every sector for farming using hydroponics.

Also to ensure healthy plants use of organic disease control techniques is suggested. In these techniques organic materials to prevent the growth of pathogens are sprayed on the plants. Also biological techniques which involve the use of one living organism to inhibit the growth of another living plant pathogen.



<u>Organic control material</u>	<u>Target pathogens on one or more of the product labels</u>
Copper	<i>Alternaria, Erwinia, Pseudomonas, Xanthomonas, Cercospora, Colletotrichum, Cladosporium, Powdery mildew, Downy mildew, Phytophthora, Pythium, Elsinoe, Gnomonia, Fuscladlum, Nectria, Phyllosticta, Diplocarpon, Albugo, Guignardia, Botrytis, Exobasidium, Entomosporium, Exobasidium, Pestalotia, Phoma, Cristulariella</i>
Oils derived from plant extracts	Powdery mildew
Potassium bicarbonate	Powdery mildew
Potassium silicate	Powdery mildew, <i>Pythium, Botrytis, Fusarium</i>
Sulfur	Powdery mildew

### Food Requirements

<b>Crop</b>	<b>Required (gms./day person)</b>	<b>Required (in Kg) (25500)</b>	<b>Kg/25000/season</b>	<b>Production per m<sup>2</sup></b>	<b>Total Area (in m<sup>2</sup>)</b>
<b>Wheat</b>	650	16575	994500	3 kg	<b>331500</b>
<b>Rice</b>	550	14025	841500	0.8 kg	<b>1051875.0</b>
<b>Corn</b>	475	12112.5	726750	1.2 Kg	<b>605625</b>
<b>Maize</b>	50	1275	76500	1.4 Kg	<b>54642</b>
<b>Potatoes</b>	150	3825	229500	2 Kg	<b>114750</b>
<b>Soybeans</b>	25	637.5	38250	2.3 Kg	<b>16630.0</b>
<b>Other</b>	100	2550	153000	5 kg	<b>30600</b>
<b>Vegetables</b>					
<b>Fruits</b>	125	3187.5	191250	3 Kg	<b>63750</b>
<b>Others</b>	75	1912.5	114750	2 Kg	<b>57375.0</b>
<b>TOTAL</b>	<b>2235</b>	<b>56100</b>	<b>3366000</b>		<b>2326747</b>

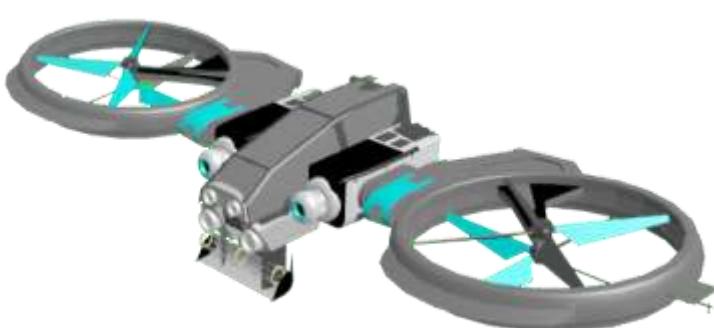


Fig: Aeroponicia

Aeroponicia has rotors on either side, has a spray tank, stores seeds and is capable to manage growing and harvesting on its own.

### Greenery

A green surrounding not only creates an aesthetic environment but also brings a psychological peace of mind to the residents. Thus, maintaining greenery is essential. Greenery of the system will be maintained using a technique known as Zeponics. Ornamental plants will be used for maintaining the beauty and earth like environment inside the settlement, streets, in corridors of apartments and even in malls.

### Meat – Sources

Having limited space and resources makes it difficult to carry animals for livestock purpose. Hence, an artificial method known as Meat Printing will be used as a substitute to fulfill the meat requirements of the settlement.



Some animal cell samples will be taken from earth for this reason. These cells will be replicated and printed onto a gel scaffolding which will later be removed as the cells join together. This 'meat' will later be stimulated so as to develop muscle fibers, as these animals will have no movement to develop it themselves.

## Tackling Emergency

### **Stored Amounts-**

- About 2524500 kg of food will be stored for emergency purposes in order to ensure a healthy population even in times of crisis.
- SCPs like *Methylophilus methylotropus*, *Spirulina* and *Chlorella* can be used as food too in the events of emergency.

**Where?** – In Food Processing Unit (**FPU**)

### 3.2.3 Power Generation

Humongous amount of energy needs to be generated to run a colossal space settlement. Maximum utilization of every possible source is required. Some of the important sources are as follows:

#### SOLAR ENERGY

- Solar panels and paint are present on majority of the external components of the settlement body, including the counterbalancing space-elevator portion. These panels are capable to meet the energy requirements of the settlement.
- Huge Solar panels are located on 'Peaks of Eternal Light' on the lunar surface which absorb energy and then radiate it to the tramway situated 4 kms above the surface of moon. Then, from there they will be transferred using silicon bucky structured substance due to their conductivity i.e using space elevator.

#### ENERGY REQUIREMENT & Storage

Purpose	Power needed (In Watts) [Approximate values]	Storing	7500000
<b>Residential</b>	52500000	<b>TOTAL</b>	150000000
<b>Industrial</b>	27750000		
<b>Transportation</b>	32250000		
<b>Clime Manipulator</b>	30000000		

Energy generated will be stored in the Flywheels. Huge amount of energy will be stored in the form of kinetic energy and when needed it can be converted back into electricity.

### 3.2.4 WATER MANAGEMENT

Water being the most imperative element of life makes the Earth habitable and consequently-peerless. Thus, an efficient Water Management system is one of the basic components of a Space Settlement. Columbiat features an advanced Water Management system **NEER**.

Amount of water required is about 75 litres per person per day -including an individual's personal requirement and industrial usage in the settlement which sums up to 1.875 million litres of water- which will circulate within the settlement to meet the needs of residents.



Purpose	Amount Rqd. (in litres)/ per person per day
Drinking	5
Washroom purposes	3
Bathing	8
Laundry	4
Miscellaneous	15
<b>TOTAL</b>	35 litres

Purpose	Total Water consumption per day
Agriculture	548324.4
Manufacturing Industries	351675.6
Miscellaneous	100000
<b>TOTAL</b>	<b>1000000 litres</b>

### **SOURCES and PRODUCTION:**

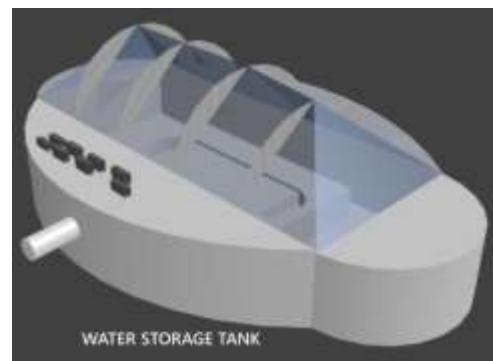
- Majority of Water will be extracted from Lunar Ice Caps and D-type Asteroids.
- Limited amount of water will be procured from the Earth to satisfy preliminary needs before the extraction starts.
- Water will also be generated by Sabatier's Process to replenish the minimal amount rendered waste after recycling.

The monumental task of extracting water from lunar-caps will be performed by mining robots [Further Reference: Section], which will be constructed on moon itself and then transported by the space elevator in the last phases of construction.

### **STORAGE and TRANSPORT**

Water will be stored in two huge tanks, one of which will be modified to work as a purification unit at the commencement of water supply. Water will then spread through channels throughout the residential area and will be cycled again and again, consecutively for years.

As such, an approximate 99.5% reuse of available water will be ensured.



### 3.2.5 Waste Management

Waste Management is important in a space settlement in order to maintain the hygiene and resource availability of the settlement. All of the waste will have to be recycled as it will be essential for survival over a long duration.

Waste generated would be different from the one on Earth, as it'll include industrial byproducts of various processes, e-waste and celestial dust apart from the biotic wastes.

Waste from the residential area will directly be collected through pipelines and will be taken to the sub-processing units where the different types of waste will be separated.

The separated waste will be transported to the Main Processing Units where they will be recycled.

The main categories of the waste will be-

- Non-Biodegradable Waste: Different sub-categories of this waste will be –
  - ✓ Medicinal Waste: It will include used syringes, band-aids and other used precision instruments. The plastic used will be bio-plastic and will be recycled directly along with the other recyclable waste. The rest of the toxic and non-recyclable waste will be shot randomly into the intergalactic space.



- ✓ Industrial Byproducts: Huge amount of industrial waste will be generated as most of the amenities will be prepared with the help of industries. If the waste is recycled then it will be recycled using the respective techniques required and if not so then it will be shot randomly into space.
- ✓ E-Waste: This waste will be composed of electronic devices. Almost all the components of this sector will be recyclable.
- Biodegradable Waste: All of the biodegradable waste including household refuse will be collected through pipelines, stored in a central unit and acted upon by demisted and mega soma beetles, Streptomyces, Penicillium, Bacillus and Aspergillus and then again by saprophytic bacteria, actinomycetians and Slime Moulds. This residual matter will be added to nutrient media in agricultural process. Oil is decomposed by special Oil-eating bacteria. Examples of such bacteria are Pseudomonas and Alcanivorax borkumensis.

### 3.2.6 Internal and External Communication

[Further Reference: Section 5.3.3]

### 3.2.7 Transportation

Columbiat has an internal transport system which facilitates people in saving time and energy. PODs and Mini Conveyors will be the means of transport.

Mini Conveyors are carbon nanotube made motorized two wheelers with an intelligent Navigation System.

Transport Pod are cylindrical aerodynamic vehicles with radius 2.5m and length 12m.

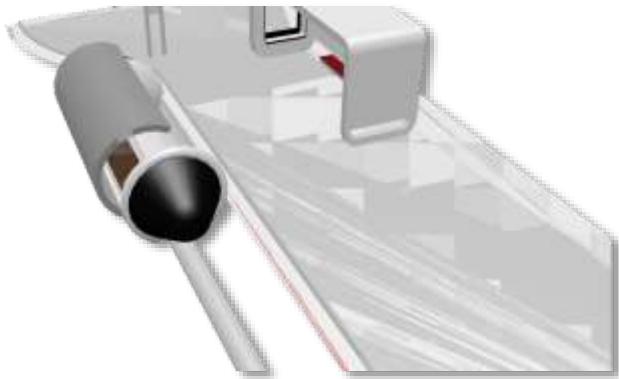


Fig: Transport Pod

- ⊕ Main transportation will be carried out with the help of PODs. Magnetic tracks will be laid throughout the residential area.
- ⊕ There will be one station in each sub-sector and capacity per POD will be fifteen people.
- ⊕ For travelling in these PODs, people will have to commute to particular station, and enter their destination in **Columbiat Routing Executive (CRE)** which will find the most suitable route, the POD and will maintain the main server, plus help in communication between PODs.
- ⊕ Special connections will be established for communication with emergency PODs under the direct control of hospitals, fire department, police and federal agencies.
- ⊕ Entertainment of passengers will be carried out by a **Smart User-Friendly Interface**.
- ⊕ Mini Conveyors will be a more personalized way of transport, they run on electricity.
- ⊕ They would be able to reach out almost everywhere and will have advanced navigation systems which will be under the control of **CRE**. The destination will be selected using a 3D touch interface and the Mini Conveyors will take the resident to the assigned destination.
- ⊕ They will transport one person at a time but portability is their biggest asset. Their main purpose will be to help in transportation of handicapped people. They can be used to move around not only between different places in the settlement but also in offices, malls and even homes.



### 3.2.8 Day-Night Cycles

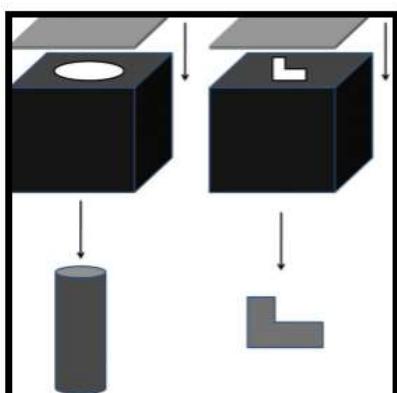
Day-Night cycles have to be stimulated in order to maintain the psychological and physical wellbeing of the residents of Columbiat.

The roof of the residential components contain Nano-blinds on sheets of transparent alumina (many times stronger than steel and transparent) which regulate the amount of light entering: They widen gradually, attain a maxima and then slowly narrow down, Manipulating the intensity and amount of light.

The roof also have advanced air processing machines.

Weather Control and Day-Night Cycles will be controlled altogether by a central unit **Clime Manipulator (CR)** and it will be **CR's** duty to stimulate and manage earth like environment.

The stimulator is designed so as to create an environment as close to earth as possible.



### 3.3 Construction Machinery **CONSTRUCTION MACHINERY**

After mining of raw materials, industries will build up the components of final product in the specific shapes and sizes.

Molten metals will be made to fall on moulds and then beat into final shapes to form the components which attaches to other components of the product just like the parts of a jigsaw.

Further, Intero-Constructo is specialized to assemble and attach various components and give the final touch.

### 3.4 Propulsion Systems

Different propulsion systems on Columbiat are:

1. **Magneto Plasmo Dynamic Thrusters/ Lorentz Force Accelerator:**

- 1.1 Powerful MPD thrusters will be attached at the end of rods (trivial) and will be responsible for initiating rotation of the tori.
- 1.2 Lithium is used as fuel, and is stored in the chamber at the back of the thruster body.

2. **Xenon Ion Thrusters:**

- 2.1 Xenon Ion thrusters are attached on the Non rotatory sections, in order to stabilize the space settlement body in the event of any destabilization because of any external agent.
- 2.2 Xenon is stored with the thruster which in case is entirely used in the event of emergency, then, Xenon will be generated by decomposition of Xenon compounds.

### 3.5 Elevator Cab

[Further Reference: Section 2.5]

# Human Factors



- Community Planning
- Residential Plotting
- Safe Access
- Visitors & Hotels
- Space Elevator

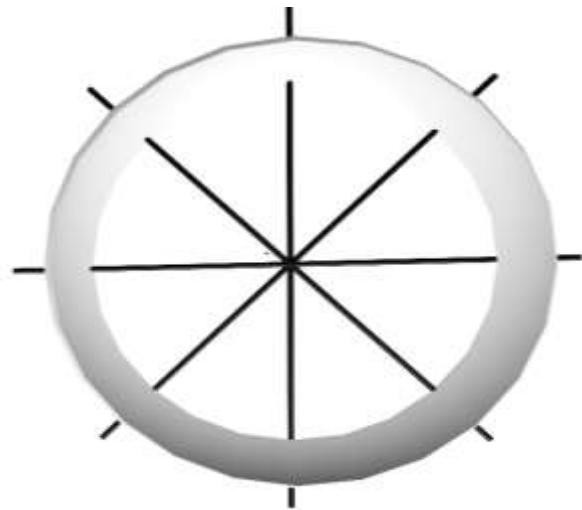
“Civilization means a society based upon the opinion of civilians.”



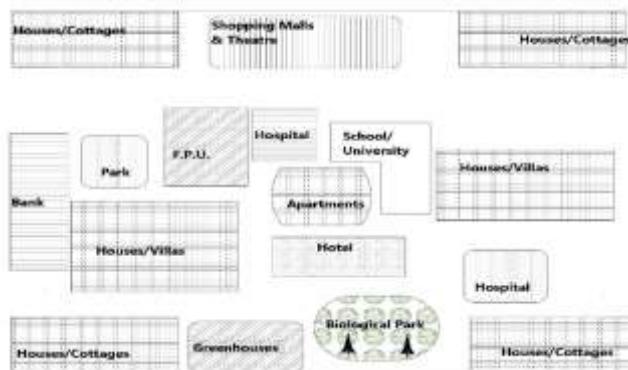
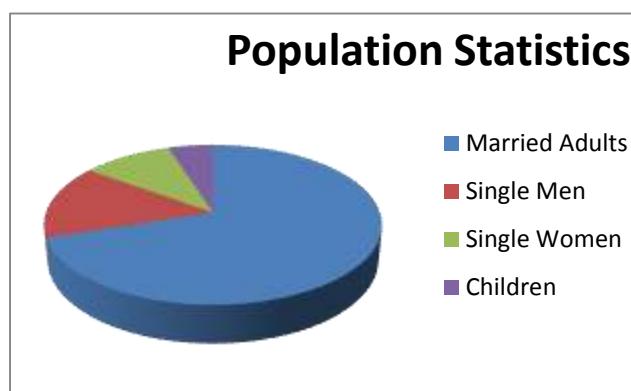
To match the standards, Columbiat will offer its residents with the best available facilities. Each resident will be able to develop a sense of gratification.

## 4.1 COMMUNITY PLANNING

**Columbiat** would offer facilities of a much better stance than those available at earth. The services would be aimed at providing amenity and a sense of convenience to the residents. The settlement would be segmented into eight identical colonies named '**Communita**' which will work as autonomous units. The facilities would include: hotels, hospitals, universities, stadiums, parks, community buildings and other structures. The residential component of the Settlement will be a reflection of modern day cities with a touch of eminent organisation.



### 4.1.1. City Orientation and Demographics



Allocation	Total Units	Total Area (approx.)	Composition (%)
<b>1. Residential Units</b>	1365	547125 m <sup>2</sup>	37.267
<b>2. Roads And Pathways</b>	---	395500 m <sup>2</sup>	26.939
<b>3. Educational And Medical Units</b>	24	132000 m <sup>2</sup>	8.991
<b>4. Entertainment And Other Units</b>	30	165000 m <sup>2</sup>	11.239
<b>5. Administrative Units</b>	20	15000 m <sup>2</sup>	1.022
<b>6. Hotels</b>	8	88500 m <sup>2</sup>	6.028
<b>7. Business and Banking Units</b>	25	125000 m <sup>2</sup>	8.514
<b>Total</b>		1468125 m <sup>2</sup>	100



## 4.1.2. Distribution of Food

### Methods of Food Transportation:-

One of the major activities to be maintained well and steady is the transportation of food around the settlement. The crops will be grown on the roofs of all residential units using Aeroponics and robots will be sent periodically to collect the yield and transport it to the **Food Processing Unit (FPU)**.

**The FPUs:** A total of four **FPU**s will be established in each **Communita**. These will be counted in the Administrative Units and won't be accessible to commons.

The yields will be stored and processed in their respective forms as per the requirements. Superior storages will be established to accumulate the raw materials and processed, surplus food items. Fiber and metal chests will be used for proper security and hygiene. The foodstuff will be further transported by shipping bots on fixed routes to all the colonies and will be further distributed to individual residential division.

**Distribution of Food per division:** After the food items reach the residential unit, the entire stockpile will be kept in "*Root Cellars*" situated beneath the ground surface. The robots will do the work of circulation of the food items within the residential entity.

## 4.1.3. Educational & Medical Facilities

The education system of settlement would exhibit a high degree of functionality. Four colonies will have a school each and the remaining four will have a university each, thus forming an alternate pattern of schools and universities. Overall Growth and Development will be the primary motive of these educational institutes. Activities would be assumed together by all the students, irrespective of age group to ensure better understanding and interaction.

Each **Communita** will have a hospital which would have two departments: one for the treatment of highly infectious diseases and the other for chronic ailments. Each department will support various requirements such as medicines and operational equipment. Eight professionals with medical expertise will be sent from Earth to Columbiat. The hospitals will provide an extremely hygienic and subtle environment.

## 4.1.4. Entertainment and Recreational Facilities

Entertainment forms an imperative part of our lives. Columbiat will take care of the entertainment facilities of its residents with the utmost perfection. Malls, theatres, restaurants, parks, gaming zones, interactive forums, etc. will not only ensure admirable recreational facilities but also a chance of interaction with other residents of the space settlement. S.H.A.I.N. will add a feather to the cap by providing a virtual store enabling the residents to buy their favourite movies, games, songs and everything else. 7D Movies will ensure exceptional experience with full immersion and surround sound, which will create the impression of real characters in the surroundings. Temperature fluctuations and the long anticipated smell-o-vision can be used for this purpose.



#### 4.1.5. Clothing & Paper

Clothing Entity	Source	Per Capita (Kg)	Annual Req.
<b>Organic Cotton</b>	Cotton Plant; Wood of Fir tree	1.2	<b>30000</b>
<b>Lycocell</b>	Wood Pulp	0.5	<b>12500</b>
<b>Jute</b>	Plants	2.5	<b>62500</b>
<b>Ingeo</b>	Plants	0.2	<b>5000</b>
<b>Soy Silk</b>	Soybean Plant	0.2	<b>5000</b>
<b>Hemp</b>	Plants	0.75	<b>18750</b>
<b>TOTAL</b>		<b>5.35</b>	<b>133750</b>

Paper	
<b>Source</b>	Plants, Recycled Paper & other biodegradable materials
<b>Quantity: Per capita</b>	51Kg
<b>Annual Requirement</b>	1300500 Kg (approx.)

#### 4.1.6 Furniture

Item	No. of items (Approx.)
<b>Sitting Arrangements</b>	<b>30500</b>
<b>Tables/Desks</b>	<b>21750</b>
<b>Bed</b>	<b>26000</b>
<b>Sofas</b>	<b>18000</b>
<b>Wardrobes and Cabinets</b>	<b>16000</b>
<b>Others</b>	<b>30000</b>

All kinds of furniture will be made using Hemp and Bamboo which will be grown according to the demands.

## 4.2 RESIDENTIAL PLOTTING

**Columbiat** will exhibit great architectural and structural engineering when it comes to the construction of the homes for the residents.

#### 4.2.1 Construction & Foundation

The construction of all the residential units will be done by using Bamboo and a mixture of concrete, sunlight, water and lunar soil. Strength will be the first preference for the safety of the residents and therefore the frames will be pre-planned using laser technology and then the structure will be built.

**Graphene Groundwork:** Below the base of every building, a plate of Graphene will be constructed which will help in:-



- Rapid Data Transmission
- Electricity Distribution
- Emergency: Since each Graphene plate is interlocked with each-other (like in jigsaw puzzle), in case of emergency, an individual or a group of plates (and corresponding structure) will be shifted as per the free space nearby.

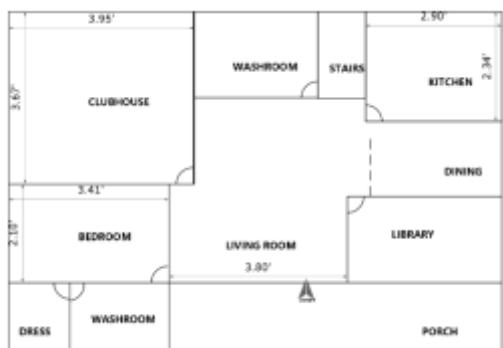
## 4.2.2 Technology

All kinds of gadgets will be made available for the residents and the best technology will be provided by means of S.H.A.I.N. [Further Reference: Section 5.3.4]

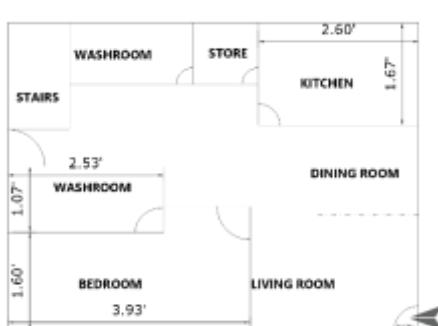
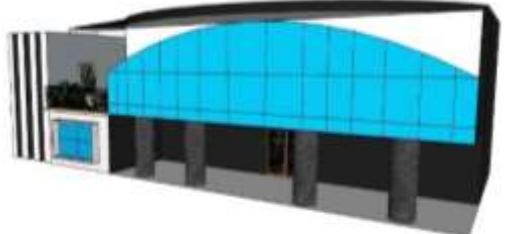
## 4.2.3 Designing & Floor-plans



**Apartments:** Apartments at Columbiat will function as societal units, providing the residents a genial abode. The apartments have been designed to make perfect use of the available space, along with ensuring communal harmony.



**Villa:** Villas at Columbiat will be the epitome of Opulence. One will find all the splendid luxuries in the sprawling villas which have been designed with the utmost perfection to suit all the needs of the residents. Embellished by Jacuzzi and adorned by ornamental plants, Villas will find their admiration among the residents at the very first sight.



**House:** Houses at Columbiat, will exhibit simple but relevant structural design. Residents will find all the requisite requirements in the houses.



"In three words I can sum up everything I've learned a

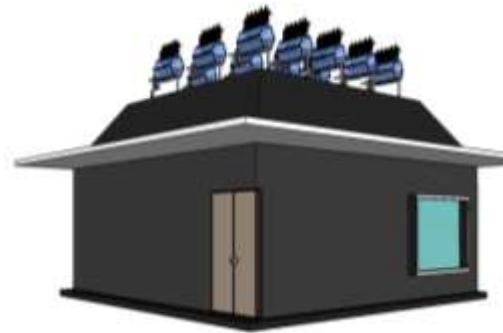


The houses will be furnished with an advanced security system S.H.A.I.N. Some special features are:

- Use of sensors to detect the presence of human beings and automatically switch on/off the electrical appliances.
- Use of dust absorbent materials in paints to ensure cleaner surroundings.



**Cottage:** For the lovers of mythology, traditional looking cottages will be built filled with the essence of royalty with modernity. The cottages will be made in the corner areas having less vertical clearance and will be adjacent to the entry/exit of each Communita.



## 4.2.4 Distribution of various kinds of homes

Type Of Residential Units	Area (m <sup>2</sup> )	Residents /unit	Units	Total Residents	Total Area (m <sup>2</sup> )
Apartment	550	50	450	22500	247500
House	275	2	425	850	116875
Villa	415	4	350	1400	145250
Cottage	250	3	150	750	37500
TOTAL			1375	25500	547125

## 4.3 SAFE ACCESS & BIO-SUITS

### 4.3.1. Systems & Vehicles for low-g areas

All the transport pods will be designed to move freely in all the parts of the settlement. The passengers will wear bio-suits to travel to all low-g areas. [Further reference: Section 3.2.7]



### 4.3.2. Bio-suits

Bio-suits are an ineludible element of any intergalactic venture. Bio-suits protect humans from the unfavorable and strident conditions of outer space. Columbiat will provide the most advanced bio-suits to its residents.

The major features of all the suits is:-

- Pressurized
- Providing Oxygen & Removing CO<sub>2</sub>
- Temperature Control
- Protection from dust/debris and radiation
- Communication



Pressure will be kept using Neoprene-coated fibers. Advanced techniques will include automatic zipping and flexible bending of the joints will be done by careful joint design. A layer of gel and Demron will be applied to provide protection from outside radiation and a thin layer of Aerogels will provide great flexibility, strength and insulation. For normal oxygen concentration within the lungs, pure oxygen will be supplied.

Donning/Doffing: Within the pods, the residents will be made to breathe pure Oxygen for almost half an hour to remove Nitrogen from their insides. Then they will step in the suit, fit in and check the joints. Then the screen and communication system will be checked and finally after covering up, a restart will be done. Remote Zipper Suits will be designed which will stop all the problems in wearing a suit.

The helmet and screen will be fitted with metal rings. The neck region will be slightly sealed for control.

Screen of the helmet will be covered with a thin layer of gold for protection from harmful radiation. The helmet's screen will also display various information such as the present status of an ongoing operation or the composition of surrounding atmosphere or the nearest docking station etc.

Bio-suits will have communication units which will work through wireless networks. Bio-suits will have sensors, which would switch off the units when no communication is being established, to reduce the power usage. Perspiration or sweat will be carried by tiny tubes and will be stored in a removable component of the bio-suit. The water collected during this process may be filtered and used to reduce the temperature of the suit, if required.

### 4.3.3. Bio-suit

#### Requirements & Storage Locations

Storage Location	Units
Pier	1500
Docking Areas	1000
Residential Entry/Exit	500
Transport Pods	1000
TOTAL	4000

The suits will be made available to all the citizens and visitors going to the unpressurized or low-g areas. There



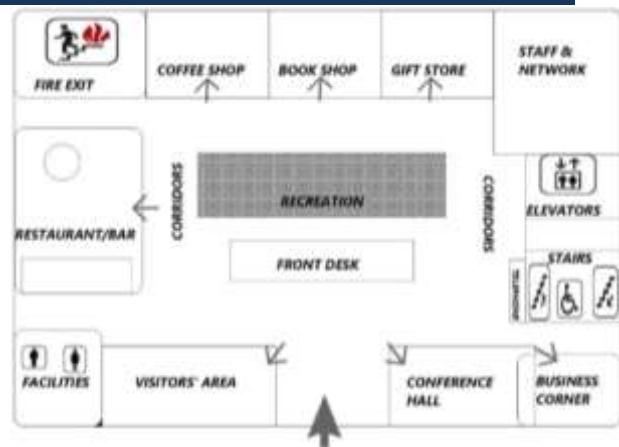
repairing and function will be periodically checked and they will be shifted to the Docking Areas, Residential Entries, and other parts as per the demands. An initial number of 4000 suits will be made available and the number will be increased as per the requirements.

## 4.4 VISITORS & HOTELS

### 4.4.1. Hotels

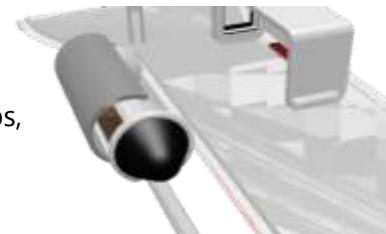
Columbiat will have hotels "Merveilleux" in each Community.

Merveilleux will represent five elements of the Earth. The ambiance in Merveilleux will reflect the geographical features of the Earth. Each of the hotels would have infinity pools at its rooftop. Humans with the help of robots will ensure proper functioning of the hotels and preeminent service to its guests.



### 4.4.2. Passengers' Arrival-Departure Areas

It is important to provide the best of services to all the guests and visitors, and for this purpose, the arrival/departure areas will be equipped with latest technological gadgets, city-map, gift shops, food stores and all means of entertainment and relaxation will be provided.



### 4.4.3. Security Measures to monitor and stop unusual activity

One of the utmost aspect to consider for a successful living in space is the safety and security of the citizens, not only from celestial debris etc. but also internally. For the same, best and latest technology and security measures have been implemented for overall security and comfort living. [Further Reference: Section 5.2.5]

## 4.5. SPACE ELEVATOR



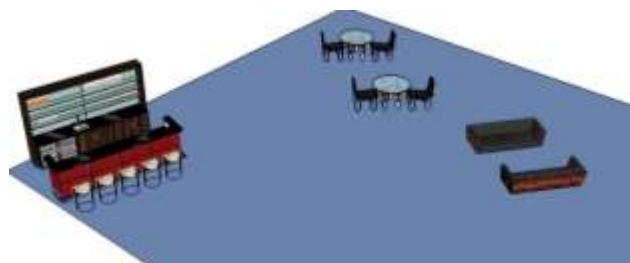
#### 4.5.1. Space Elevator: Design & Configuration

The space elevator will be a small lengthy cuboidal tether-like tower extending from above the docks of the settlement to the Earth's only satellite, the Moon. The cable will be a silicon buckystructure ribbon, 3 feet wide and 1/2 inch thick. They would be constructed by extruding viscous buckystructure feedstock through a catalyzing agent to form ribbons of these dimensions. [Further Reference: Section 2.5 ]



#### 4.5.2. Entertainment & Arrangements

The Space Elevator will not just work as an excellent transport passage for the trade products but will also be a great platform for the citizens to get introduced to the endless, mysterious Universe. The main mode of transport will be the **Space Elevator Cab** which will accommodate 100 passengers at a time. The journey will be spent memorably with a personal visor, a small eating corner, and gadgets-junction for the travellers to enjoy, relax and feel the royalty and modernity of living in a brilliant space surroundings.



# 05 Automation Designing



“Only what's left to be invented yet, Is what' left to be imagined!”



*Imaginations sometimes have to take an unusual path, to express them fully; which in turn are possible, due to technology that we have been able to evolve through developments. Now, time has come, to switch over to even more unique and innovative idea'. The Automation Engineers at the **COLUMBIAT Space Settlement** have tried to design the Systems and networks with detailed sophistications and ideas, yet representing them in a simple way, making the department stand apart.*

## 5.1 Automation of Construction Processes

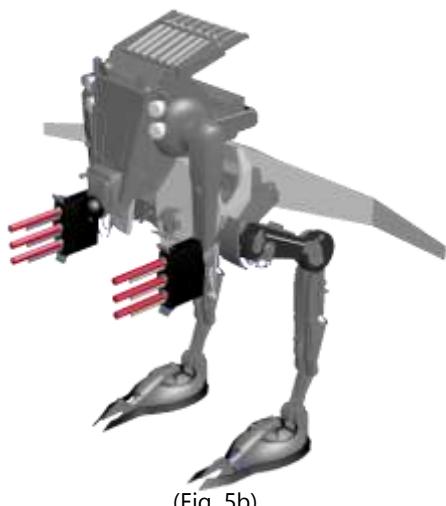
The robot mentioned below is the only robot meant for the construction process. Hence, the rest of the construction will be carried out by the labours in charge and the technicians.



(Fig. 5a)

### Intero-Constructo-

- This robot is meant for the interior construction, assembling and finishing.
- It can do job like welding and furnishing.
- It will help in laying up the interior of each hull component.
- It will be able to change its limb when required and will be able to do the required job done.



(Fig. 5b)

### Exterio-Constructo-

- The robot is well equipped with the welding, cold-welding, screwing, and joining mechanisms needed in construction of the settlement.
- It will be able to construct in both circumstances, on moon as well as the orbital construction. It is aided with interlocking hinges in each limb which will facilitate construction process.

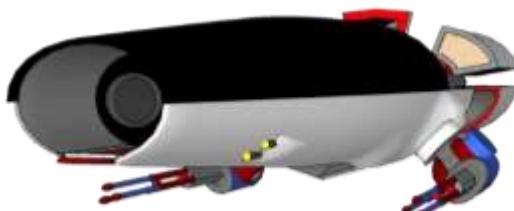
### Protection from Solar Radiation:

Robots working in space would be in consistent threat from solar flares which can pose serious problem to them, so in order to protect from Solar Flares the robots will be coated from stable Titanium Compounds and Gallium Arsenide. These 2 Robots will be built under various plot project with changes in dimensions to facilitate the construction of various things.



## 5.2 Facility Automation

### 5.2.1 Aegis Bot



(Fig. 5c)

It will be equipped with camera sensors that will recognise any suspicious activity and also tranquilizers that will make the target cataleptic. This robot will help in maintaining LAW and ORDER on Columbiat. It will patrol the whole settlement.

### 5.2.2 Data Storage

Method used for storage of digital data would be **Holographic data storage**. It involves the use of laser beams for data storage. The information or the data gets recorded in each and every unit of the recording material i.e. throughout its volume.

- High dynamic range, optical clarity and flatness, non-destructive readout, millimetre thickness, and environmental and thermal stability are some of the characteristics of a suitable holographic storage material. Photopolymer materials can be used for such purpose.
- Holographic data storage enables ultrahigh data storage density, rapid data transfer rates and volume holography which makes it efficient and advanced data storage technology.

### 5.2.3 Back-up Systems

The data backup system in Columbiat will provide an efficient way to restore data in case of data loss event. The data backup system will take care of the Recovery point objective, Recovery time objective and security of the backup data.

- There will be a special backup server which will have backup files of all the data in Columbiat. In case of any data loss the lost file can be very easily restored.
- Each and every data file will be highly compressed in an efficient manner so that they can be easily processed to restore the original data.
- Special encryption techniques will be used to ensure the security of the backup data files.

### 5.2.4 Contingency Planning and Back-up Systems (continued)...



CONTINGENCY	SUSPECTABLE AREAS	DETECTION BY-	RESPONSE TIME
<b>Fire</b>	Public, residential and industrial areas	Fire department- Smoke detectors and sensor systems	<2 minutes
<b>Food or Water contamination</b>	Residential areas	Backup supply and health department	<6 minutes (variable)
<b>Air contamination</b>	Whole settlement	Atmospheric department – sensor systems	<5 minutes (variable)
<b>Power failure</b>	Whole settlement	Electricity department – detectors and robotic devices	<20 seconds
<b>Biological infection</b>	Public areas	Health department – sensor systems	<7 minutes
<b>Data access failure</b>	Whole settlement	Data department – engineers and sensor systems	<5 minutes
<b>Robot failure</b>	Whole settlement	Damage repair department- cameras and sensors	<11 minutes (variable)
<b>Docking accident</b>	Docks	Damage repair department- Robots and cameras	<10 minutes
<b>Hull puncture</b>	Hull of the structure	Damage repair department- Sensor systems	<50 seconds

## 5.2.5 Authorised Access to data

LEVEL	LOCATION	SECURITY MEASURES
LEVEL 1	HOUSES AND RESIDENTIAL AREAS	<ul style="list-style-type: none"> <li>• KEY CARD ACCESS</li> <li>• FINGER PRINTING</li> <li>• Level 1 Security Measures</li> <li>• VOICE RECOGNITION</li> </ul>
LEVEL 2	PUBLIC PLACES	<ul style="list-style-type: none"> <li>• Level 2 Security Measures</li> <li>• IRIS SCAN</li> </ul>
LEVEL 3	DOCKING SECTIONS	<ul style="list-style-type: none"> <li>• Level 3 Security Measures</li> <li>• HEARTBEAT SCANNING</li> <li>• VASCULAR PATTERN RECOGNITION</li> </ul>
LEVEL 4	SERVER ACCESS	<ul style="list-style-type: none"> <li>• Level 4 Security Measures</li> <li>• HEARTBEAT SCANNING</li> <li>• VASCULAR PATTERN RECOGNITION</li> </ul>

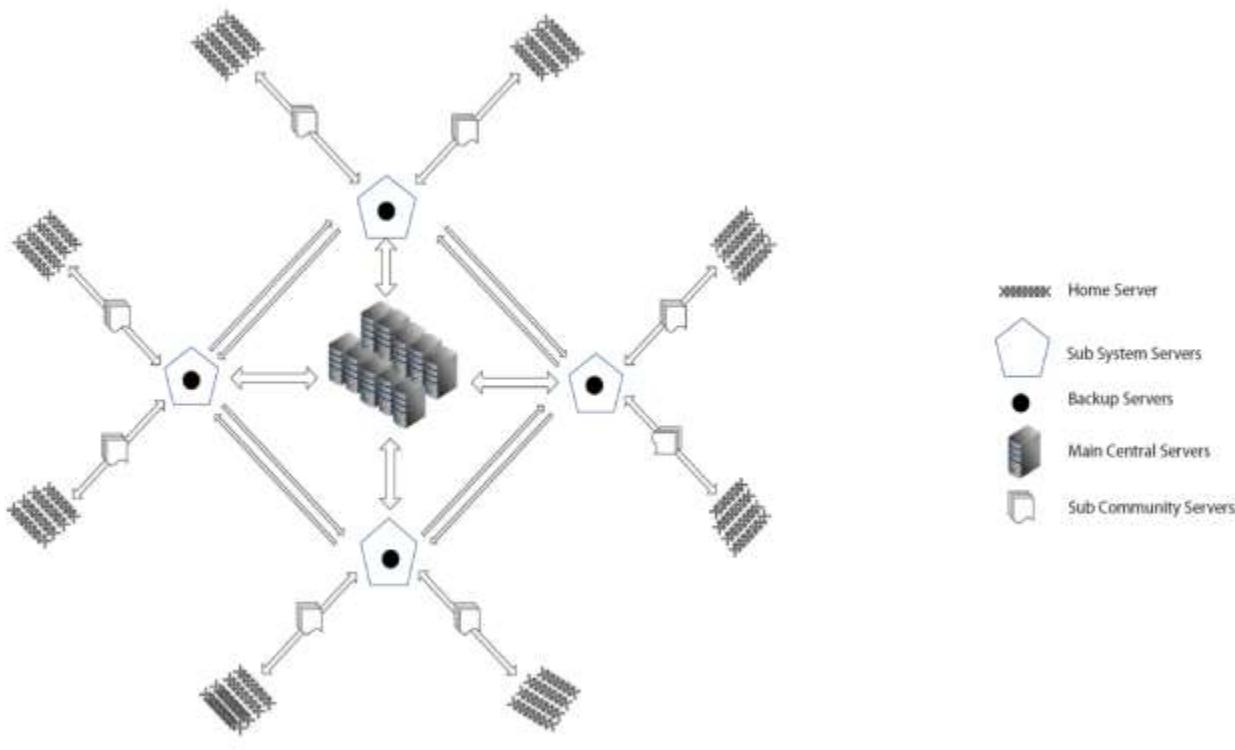
## 5.2.6 Robots Functioning in the Settlement

Name	Purpose	Quantity
<b>Exterio-Constructo</b>	Exterior Construction and Repairing	300
<b>Intero-Constructo</b>	Interior Construction and Repairing	500
<b>Aegis Bot</b>	Security	200
<b>Aeroponica</b>	Maintaining Aeroponics	750
<b>Domilicium</b>	Household robot	1380



## 5.3 Habitability and Community Automation

### 5.3.1 Diagram of Networks



(Fig. 5d)

### 5.3.2 Servers

Server	Name	HDD	Memory	Backups
<b>ICDS</b>	Inter Connecting	4 pb	256 gb	A backup will be available with same specifications
<b>CSS</b>	Central	2 pb	512gb	A backup will be available with same specifications
<b>SSN</b>	Solid State	10 pb	512 gb	Various sub-parts for server will be available and only the smallest damaged part will be replaced
<b>GDS</b>	Government	21 pb	1 tb	This Server will be divided in 16 parts. 2 backups will available for each part.

### 5.3.3 Bandwidth requirements to enable connectivity

In *Settlement* Communication has been categorized as:

- Internal Communication
- External Communication

#### Internal Communication

The internal communication inside *Settlement* will be divided in two categories:-

- a) *Wired Network*      b) *Wireless Networks*



### **Wired Networks:**

Wired network will make use of optic fibres owing to the following advantages:

- High data transfer speed up to 200 gb/s,
- Low Cost & Virtually no signal loss,
- Internet facilities to residents, networking and data swap.

### **Wireless Communication:**

Wireless communication Technology will be '**OFDM**'.

(Orthogonal frequency-division multiplexing through FFT)

Internal wireless communication shall be carried by laser data transfer modem and FFT data due to its following advantages:

- High working frequency that is 2.6 GHz and connectivity speed of at least 4.3 TBps which reaches up to 27.3 TBps & has a very large surface area coverage

It shall be used for wireless conduction of data. For talking hold of Laser rad. Signals modems & decking devices shall be placed at every local area.

### **Communication with Earth and In Space Bodies:**

To have external communication with space ships as well as other settlements, microwaves will be used. The communication system installed on the terminal ends of settlement shall work with a frequency of 20-30 GHz.

### **5.3.4 S.H.A.I.N. (Smart House Artificial Intelligence Network)**

S.H.A.I.N will be installed in each house, making human lives better than ever. S.H.A.I.N. will enhance the living standards in COLUMBIAT by integrating technology and services through home networking.

#### **Main Features of S.H.A.I.N will be:**

Security:-

- A chip will be inserted in every person and object. The system will keep a record of their movements and current position.
- It will ensure the entry of only recognized visitors other than the indigenous residents of the house.

It will take care of the food items, their quantity and other goods of daily use. It will order the items through server, whenever necessary.

This system will have a direct control on all the devices and robots present in the house. It will also manage and control the energy consumption of the house ensuring energy efficiency.

- It will also manage and keep an overview of economy.
- It will be responsible for settling monetary exchanges.
- It will work as a reminder of upcoming events.
- It will manage all the personal needs and will provide suitable advice, if needed.

### **5.3.5 Reducing Requirements for Manual Labour**

Columbiat will be equipped with the finest automated systems and advanced technologies to enhance livability and to provide a fascinating living experience. The flawless operation of the settlement will require a number of automated systems that will reduce the requirement of manual labor. There will be advanced systems for every essential aspect of a modern living habitat –



Therefore, the automated systems in Columbiat will reduce the requirement of manual labor and will provide its Citizens best possible living experience.

- **CONSTRUCTION**

Robots will perform the task of basic construction and finishing processes. This ensures minimal requirement of labour.

- **MAINTENANCE AND REPAIRING**

Robots will be responsible for the maintenance of the settlement and will undertake repair activities in case of damage of any kind.

- **SECURITY**

There will be an advanced security system comprising of special Robo-cops which will help in maintaining law and order in the settlement.

- **LIVABILITY ENHANCEMENT**

Refer to S.H.A.I.N., i.e. Smart House Artificial Intelligence Network. (Section 5.x)

- **MEDICINE**

The Health department will be characterized by advanced robots and nanobots which will revolutionize the field of medicine in Columbiat.

- **AGRICULTURE**

Robots will ensure proper functioning of all the agriculture related processes.

- **TRANSPORTATION**

Columbiat will be equipped with advanced transportation system consisting of special transport pods which will use magnetic levitation.

### 5.3.6 Privacy of Private data and Security of Systems

A significant amount of thought was given during the planning of space settlement, to protect user data as well confidential data in the world which will be entirely bas on Inter-Connected networks and machines. The O.S.P.T will be a piece of code that is injected into a kernel (the thing that bridges applications and hardware-level data processing) without impacting computing speed or device functionality. O.S.P.T is operating-system agnostic, meaning it can run on and monitor any device without being tailored to a specific OS. When it is injected, the O.S.P.T uses firmware evaluation tool, **Firmware Reverse Analysis Konsole (FRAK)** to unpack the device's firmware, replace its signing key (a basic security feature) and repack. Then it runs in the background, and randomly samples executed code at regular intervals to ensure that nothing unusual is going on.

Due to its **Agnosticism**, It will have following advantages:

- It will be functioning for every system, without any need to tailor it for any specific device, so from Homes to Community Servers will be protected.
- Settlements Main servers will be running a Pilot version of this code with more advanced feature sets & to be grouped protected so that each code part keep eye on one-another.
- Government's Organisations and Departments will have their Data be encrypted by using finest codes of Super Computers and protecting their Binaries with the large set of Prime No. rendering it almost 100% protected from threats.



### 5.3.7 Automation for Entertainment

- There will be a 6D movie room in every house where people can enjoy the rich experience of 6D cinema whenever they want. Unique physical effects that occur in synchronization with the movie can provide a very good way for amusement. Movies will ensure exceptional experience with full immersion and surround, which will create the impression of real characters in the surroundings. Temperature fluctuations and the long anticipated smell-o-vision can be used for this purpose
- In the 6D movie room can also turn into a 6D gaming room where people can play their favorite games in 6D. People can also join to the gaming network where they can enjoy community gaming and can take part in various gaming tournaments going on.
- The domestic household robots can help people lift up their moods if in case they are feeling low. The robots can act as their personal entertainers and companions.
- There will be a PARADISE complex which will be a site of various climatic condition stimulation to provide people with an enriching experience. For e.g. In Coastal climate stimulation people can enjoy surfing, scuba diving, swimming, sun bathing and other related activities. Similarly there will be climatic stimulations like the Frigid Zone and Tropical Forest zone etc.

### 5.3.8 Robot Resourcing

- a) Basic Materials for Robot Construction
- b) Maintenance and Repair of Robots

## **MATERIALS**

### COMPOSITE MATERIALS

These materials have a very high strength to weight ratio. They are very lightweight and extremely strong. Thus they will be used in robot building. Materials Used:

- FRP's (fiber reinforced polymers) like carbon-fiber, reinforced plastic.
- MMC's (metal matrix composites).

### SYNTHETIC MATERIALS

Synthetic materials like polycarbonate, PVC etc. will be used because of their ability to get molded into the required shape.

### PREVENTIVE MAINTENANCE

Preventive maintenance is very useful in reducing the possibility of breakdown and thus decreases the need of emergency maintenance.

- Efficient cooling systems will be installed in robots working in conditions above 120F to ensure their proper functioning.
- Special protection from shock, vibration and dust will be provided.
- Electrical components of robots will be secured from liquid sprays.



- It will be looked upon that a robot does not contribute to fire or

explosion due to electric sparks and excessive heating.

**ALUMINIUM:** Being a lightweight strong, durable, cheap and corrosion resistant aluminum becomes an appropriate alternative. It will mainly be used in medium sized robots in non-load bearing parts.

Its alloy duralumin will also be used.

**STEEL:** It is an alloy of iron and is very strong. Being heavier than aluminum, it will be used in bigger sized robots, to ensure proper functioning in rough conditions

**TITANIUM:** It will be used in construction of robots because of its high strength to weight ratio. It will mainly find its use in construction robots.

**COPPER:** Being a very good conductor, Copper will extensively be used for making special parts and wiring. Bronze and Brass can be used for bearings.

## LUBRICATION

Lubrication ensures high performance, accuracy and efficiency of robots and thus it is necessary that a robot must be continuously lubricated over its lifetime. Silicate esters and ionic fluids will be used as synthetic lubricants. PTFE (polytetrafluoroethylene) will be used as a solid lubricant.

## GENERAL ROUTINE MAINTENANCE

General routine maintenance will be done on a monthly basis or as per required by various robots. These routine maintenances will include basic inspection of robots for obvious problems like leaks, clogged air vents, circuit breaks etc. Other steps will include changing fluids, changing filters, and cleaning surface, making adjustments and measurements and replacement of parts if needed.

## EMERGENCY MAINTENANCE

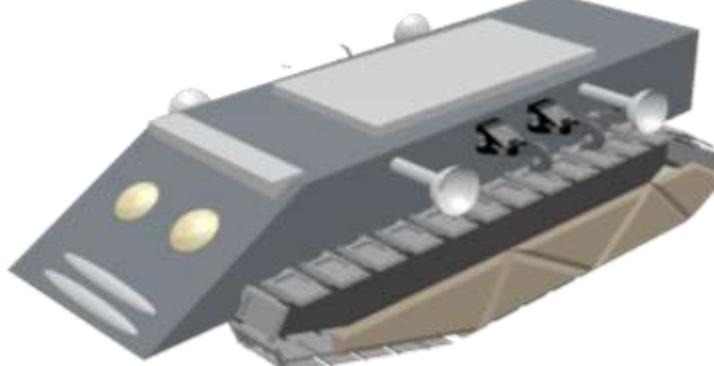
- In case of a robotic breakdown, the engineers will initiate a diagnostic program to look for the cause of breakdown.
- This diagnosis will include the inspection of robot considering it as a combination of three separate systems: power supply, controller and manipulator.
- If the cause of breakdown is a minor one, the robot will be repaired on the spot by the repair team consisting of engineers and other repair robots.
- In major breakdown cases, the malfunctioning or broken part will be replaced and the robot will be checked for proper functioning.
- The broken robot may also be replaced by another one which is on standby if all other measures fail.

## 5.4 Refining and Mining Processes

### 5.4.1 Unloading of Containers



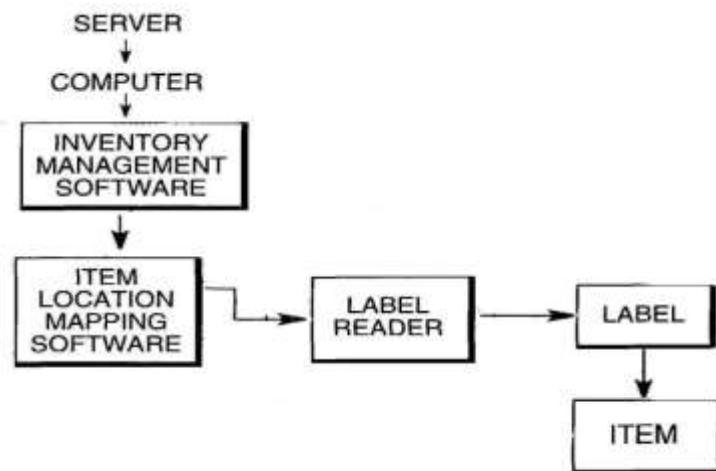
Robots (fig. below.) will unload shipping containers from ships using electric vacuum pump which will pump out the air & create the desired vacuum level and will then transfer them to Refining facilities. Same Robot will also unload containers in 0g and vacuum using Hooks.



(Fig. 5e)

### 5.4.2 Warehousing and Inventory management:

Warehouse will be located in the Cupola as it is the nearest possible location for the incoming and outgoing cargo so that it will be cost efficient. A unique label will be provided to every item. This label will contain the information about the package. The inventory management system will be like this:-



Server will receive the information about the required item and by inventory management software, item location mapping software will be switched which will recognize the label on the required item and then will transfer it to the desired location.

## 5.5 Visiting Ships Maintenance

Columbiat will have a dynamic docking facility. The docking stations in Columbiat will pay heed to the visiting ships effectively and efficiently.

### 5.5.1 Maintenance and Overhaul of Visiting Ships

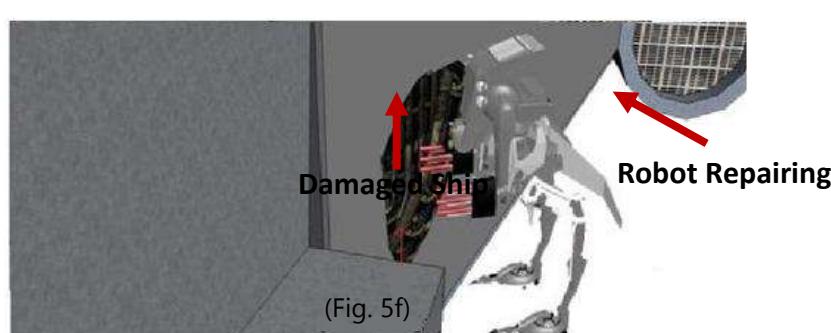
- Each docking station will have inspection teams consisting of human engineer supervisors and robots that will be equipped with all the necessary sensor systems.



- This inspection team will inspect each and every part of the space crafts with utmost precision and will spot defects, if any. By investigating the underlying causes of procedural failures, the inspection unit will make sure that the space craft is ready for its next flight.

### 5.5.2 Robot Repair Facilities

Robots will be employed in the ship repairmen areas to repair the damaged sections of the space ships, below is an artistic render of a robot (Pilot version of Exterio Constructo robot) repairing the ship.



### 5.5.3 Prevention of Spread of Dust and Contamination

- Highly efficient Laser Cleaning Technology will be used for cleaning the space crafts in docking stations of Columbiat. This technology will provide a unique way of cleaning surfaces with unmatched perfection.
- The Laser Cleaning Technology is environment friendly and extremely precise. The cleaning will be done by means of powerful, short length, rapid and moving laser beams. These powerful laser beams will be focused at the target surface which will lead to micro-plasma bursts, shockwaves and thermal pressure due to which any dust particles or contaminants will get precisely vaporized. Thus the contaminant will get sublimated and ejected and the target surface will get cleaned.

# 6.0 Costing and Scheduling



The key is not to prioritize what's on your schedule, but to schedule your priorities.



## 6.1 Schedule

Preliminary construction studies	Research	1 year	15 May 2050	
Construction of Automated construction Systems	Research	6 months	15 Nov. 2050	
Construction of The Orb And The Elder Column	Construction	1 year	15 Nov. 2051	
	Research	6 months	15 May 2052	
	Construction	1 year	15 May 2053	Construction of Interface between Rotating and Non-Rotating section
Construction Of The 8 Trivial Columns	Research	6 months	15 Nov. 2053	
	Construction	1 year	15 Nov. 2054	Construction Of Thrusting Sections Begins
The Forge Torii Construction	Research	6 months	15 May 2055	
	Construction	1 year	15 May 2056	Installation of Solar Panels & Installation of Industries begins
The Monopoly Torii Construction	Research	6 months	15 Nov. 2056	
	Construction	1.5 years	15 May 2058	Interior Finishing of the Torii Begins
The Élan Vital Torii Construction	Research	6 months	15 Nov. 2058	
	Construction	2 years	15 Nov. 2060	Installation of Life Support System Begins Interior Finishing of the Torii Begins Rotation Initiated
Thrusting Sections	Construction	1 year	15 Nov. 2055	
Upper and Lower Docks mainframe	Research	6 months	15 May 2061	
Docking Stations	Construction	2.5 years	15 Nov. 2063	
Construction	Research	6 months	15 May 2064	
Space	Construction	1 year	15 May 2065	
Elevator and counter weight construction	Research	1 year	15 May 2066	
Interface between Rotating and Non-Rotating section	Construction	5 years	15 May 2071	
Installation of Life Support System	Construction	1 year	15 May 2054	
Installation of Solar Panels	Research	6 months	15 May 2061	
	Construction	2.5 years	15 Nov. 2063	
	Construction	1 year	15 May 2057	

Cost and Scheduling



Installation of Industries	Research & Preliminary construction	6 months	15 Nov. 2056	
	Construction	1.5 years	15 May 2058	Usage Begins
Pressurization of Volumes	Equipping	6 months	15 Nov. 2071	
	Laying Out Of Plans	3 months	15 August 2058	
Interior Finishing of Monopoly	Construction	1 year	15 August 2059	
	Laying Out Of Plans	3 months	15 August 2060	
Interior Finishing of Élan Vital	Construction	1 year	15 August 2061	
	Laying Out Of Plans	3 months	15 August 2062	
Testing Of Settlement Movement Of Residents	Testing	6 months	15 May 2072	
	Final Settling	1 year	15 May 2073	
<b>TOTAL</b>		<b>24 Years</b>		

## 6.2 Cost

Name	Quantity	Cost	Total Cost (in \$)
Research & Development	-	-	27,500,000,000.00
Planning	-	-	2,500,000,000.00
		<i>Structural Engineering</i>	
Construction phases:			
Orb	1	15,000,000	15,000,000.00
Trivial	8	5,000,000	40,000,000.00
Forge	1	10,000,000	10,000,000.00
Monopoly	1	15,000,000	15,000,000.00
Élan Vital	1	20,000,000	20,000,000.00
Cupola	2	13,000,000	26,000,000.00
Pier	2	16,000,000	32,000,000.00
Ascensore	1	30,000,000	30,000,000.00
Materials	-	-	15,000,000.00
Other	-	-	1,000,000.00
		<i>Operations</i>	
Electricity Generation	-	-	10,105,000.00
Waste management	-	-	8,406,000.00
Water management	-	-	8,870,000.00
Transportation	-	-	1,550,000,00.00
People transportation from earth	25,000	25,000	625,000,000.00
Aeroponics	206250	200	41,250,000.00
Other	-	-	750,000.00
		<i>Human Factors</i>	
Residential Units	1375	3,200,000	935,000,000.00
Hotels	8	4,562,700	36,501,600.00
		-	



Clothing	142250	-	900,000.00
Furniture	-	100	14225000.00
Paper	4000	-	750,000.00
Bio-Suits	-	10,000	40,000,000.00
Other		-	1,000,000.00
		<i>Automation Design</i>	
	300	<i>and Services</i>	
Exterio-Constructo	500	8000	2,400,000.00
Intero-Constructo	200	10000	5,000,000.00
Aegis Bot	750	6000	1,200,000.00
Aeroponica	1380	4000	3,000,000.00
Domicilium	150	5000	6,900,000.00
Laboral Bot	150	7000	1,050,000.00
Unloading machine		11000	1,650,000.00
		<i>Business</i>	
		<i>Development</i>	
Salaries	55	-	218,500,000.00
Office		2,097,400	115,357,000.00
Total			32,283,364,600

Personnel	Employed	Salary per year(in \$)	Total(in \$)
Engineer	450	95,000	42750000.00
Technician	560	75,000	42000000.00
Labour	725	50,000	36250000.00
Office Employees	1500	65,000	97500,000.00
Total	3235		218,500,000.00

**TOTAL COST-32,283,364,600**

Cost and Scheduling

# 7.0 Business Development



There are no secrets to success. It is the result of preparation, hard work, and learning from failure.



Columbiat will function as the chief business hub, thus catering intelligently to the commercial business needs. In order to become primo business centre, Columbiat will accomplish the following necessities:-

## 7.1 TRANSPORTATION NODE AND PORT

The various different sections of PIER would be serving to the Transportation needs of Columbiat as an ideal Transportation Node and Port.

### 7.1.1 Docking and Cargo-Handling Capabilities

PIER will act as a docking port of the Columbiat. Its five Dome entrances consists CCCS(Columbiat Cargo Clamping System) capable of clamp all the cargo and passenger ships visiting the settlement, thus providing obstruction free transportation of cargo and humans. It is highly automated, thus helping to clamp the ship accurately. After a secure docking, freight would be transported to warehouses and storage area located in CUPOLA (For more details refer to sec 5.4.2).

### 7.1.2 Terminal Facilities for Passengers Trafficking

Passengers at port terminal will have to pass through PHS (Passengers handling system) installed at PIER itself, used for docking passenger ships. This is fast and simple system which would help in trafficking control. After getting down from ships passengers will head for the Rest Centres constructed in Élan Vital. All of movements in the docking area would be controlled and managed by the Docking Control Unit located in PIER.

### 7.1.3 Rest and Recreational Provision for visitors

-Rest and recreation centres will be situated in Élan Vital (Residential Torus) i.e. in city environment near Theatres, amusement parks. These centres features rooms and suites, a conference center, 4 restaurants with a variety of dishes, and a fitness center including sauna and pool and various sports.(For more details refer to sec. 4.1.4 and 5.3.7).

-When the Foundation Society initiates operations of settlements near and on Mars and number of visitors in transit may temporarily reach 5000 at that time no. of rooms will be increased and more Resorts will be constructed at Élan Vital.

## 7.2 Commerce and Financial Centre

As different companies have shown interest shown for establishing their businesses on Columbiat we have provided them the facilities that will take their business to new altitude.

### 7.2.1 Office facilities for business establishment

Offices at Columbiat will have the following facilities for its employees –

-Conference rooms and workstations:



Well furnished conference rooms will be constructed, with a networking system and a projector. Workspace will depend on the number of employees. Offices will have Computerized Workstations. Materials' flow, handling and storage will be designed to elevate job performance. The offices will be provided with lounges, gymnasiums, refreshment areas and cafeterias.

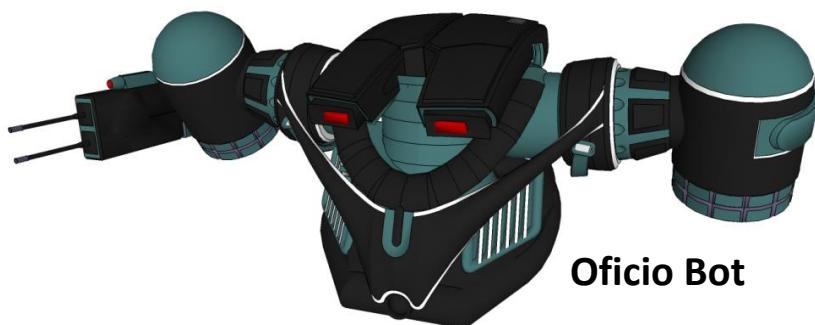
-Network and communication system:

Company's intrinsic communication system will be set up which will allow Internal and External Communication. A high speed networking system will also be established in offices and will be connected to ICDN (Inter-Connection Database server).

### 7.2.2 Advanced Head Office Facilities

Three major Banks and Foundation society headquarters will be set up in Columbiat catering to the financial needs of space-based companies, space settlement's residents, and ships' crew. The banks at Columbiat will have easy access to the latest technology, data and control units, space resources, networks, thus improving research facilities. The main offices will have almost all the facilities conferred upon the other business companies and other facilities like:

- Special research labs for the formulation of new settlement opportunities.
- All the modern computers and facilities required will be provided.
- Advanced Communication Systems will enable the operation of far-flung business easily.



Oficio bot will help the office workers to communicate in well.

- It will have a camera which will enable the Boss to have a nice look on its employees.
- It is also aided with an inbuilt speaker which notifies the employees about important announcements.
- It will act as Computing center enabling secure networked internal communications for each company while providing interconnectivity for transferring data between companies as it is aided with a Wi-Fi router.

### **7.3 Space Elevator Operations Center**

Space Elevator Operations center will be situated at MONOPOLY and will be highly automated resulting in smooth functioning of Space elevators.

# Appendices



# Operational Scenario

## ➤ Cases of Fissures/Ruptures in Exterior-hull parts

- The moment the fissure occurs, sensors and beams will detect it using the temperature, pressure and volume change. Simultaneously, repair bots will be sent to the scene and the possible treatment will start.
- At the same time, the affected zone is emptied, and is isolated till the task ends.
- If in any case emergency breaks out, the industries and residential society will be alerted and emergency controls will be started.
- The robots, along with the experts' team will successfully treat any kind of obstacles.
- A restart of all the systems will be done and a record will be kept for future.

## ➤ Inner Disasters

- First of all, for the purpose of utmost safety, no industries will be established within the residential area.
- The case maybe of leakage, irregular flows, overheating or non-functioning.
- For all the cases, a team will be instantaneously formed and the robots will be also brought for the task to begin.
- The systems will be shut-down and nearby areas will be isolated.
- After the restoration is done, a check will be done and all the systems and devices will be restarted

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- Image Editing: Photoshop
- Designing: SketchUp, Blender

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