

Columbiat



A space settlement proposal by Apeejay School Sheikh Sarai, New Delhi, INDIA.





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1.0 Executive Summary

1.1 Introduction to Columbiat

Our company visualizes and dreams of reaching the stars, with an insatiable thirst for excellence and a passion to explore the unexplored horizons of space. Mankind has already moved from the cradle of the Earth and, going to the nursery of the moon, and we aim to help humanity to spread its wings, to bring about a new era in the modern world.

Our company realizes the vision of the Foundation Society and pursues it with thoughtful zeal, zeal not only to create a space settlement in the L2 orbit but also to mark the beginning of an era of mankind's maturity. While building the settlement, we kept in mind that it shall cater as a business and banking hub to the people, so we built it in such a manner which helps to maximize the manufacturing capabilities and minimize manufacturing costs. The Space Olympics will be one of the major sources of tourism and revenue. We ensure the FS members that awarding SA the contract will be one of their most well placed and secure investments as we boast an impressive and awe-inspiring structure as well as a strong commercial value.

Description of Design	
Component	No.
Torii	2
Docking Ports	8
Inter-connecting spokes	4
Central Hub	1
Industrial Hub	1

1.2 Description of design and construction: Spartan Avionics hereby proposes Columbiat, a double-torii system. The first torus will serve residential purposes and the second for accommodation of agricultural and mining activities. One look at the structure of Columbiat is sufficient to reveal that this settlement has been designed to serve as the backbone of trade and the thighbone of commerce throughout the solar system. Eight separate docking ports and special torus for agriculture and tourism have been provided. The constructional materials have been chosen so as to ensure maximum safety and also to reduce the costs as they are already available on the moon. The resources of various sub-contractors and already existing settlements will also be roped in.

Plans for operations	
Activity	System
Life support	PLSS
Water	From Earth
Thruster fuel	Hydrogen and Helium
Electricity generation	Solar panels & S.P.S
Climate	Mediterranean shirtsleeve climate
Temperature	25-30 °C
Humidity	45-50%

1.3 Description of development: The structural development of Columbiat will be done in 7 phases. After the structure has been fully developed, the interior and the operations of the settlement will be installed. The settlement will be handed over to the members of the Foundation Society **13.5 years** after the contract has been awarded. This settlement will cost the Foundation Society around US \$288 billion.

1.4 Description of operations and maintenance: The maintenance of the settlement will be done mostly by robots e.g. Solan-20, Solan-32, and Boruc etc. The overseeing of all these robots will be done by the robot management server (refer to 5.1.2.1). The annual maintenance cost comes out to be US \$1 billion. The operations of this settlement have been designed so as to facilitate trade and commerce and to provide an infrastructural base for the present and the future of the Space Settlements Program.

Residents of Columbiat will not only enjoy the unique features of a space settlement but also get all the comforts of an earthly metropolis.

We feel that we offer the FS members just what they are looking for and more. All the requirements listed in the RFP have been met by our engineers showing their capability. We offer the Foundation Society realism, practicality and inventiveness.

Plans for maintenance	
Tasks	Robots
Cleaning	Lithlea
Internal maintenance	Lavange
External maintenance	Solan-20

We submit this proposal to the FS members and hope that we will get the chance to make this project into reality. SA awaits the approval of the Foundation Society and hopes that its engineers will get the chance to work for the settlement of the cosmos. To end with a statement that summarizes our vision for the future: "We have a dream, a dream that one day the solar system will be the playground of all earthlings, in that galaxial order we envision Columbiat to be the backbone of commerce and the node of transportation."



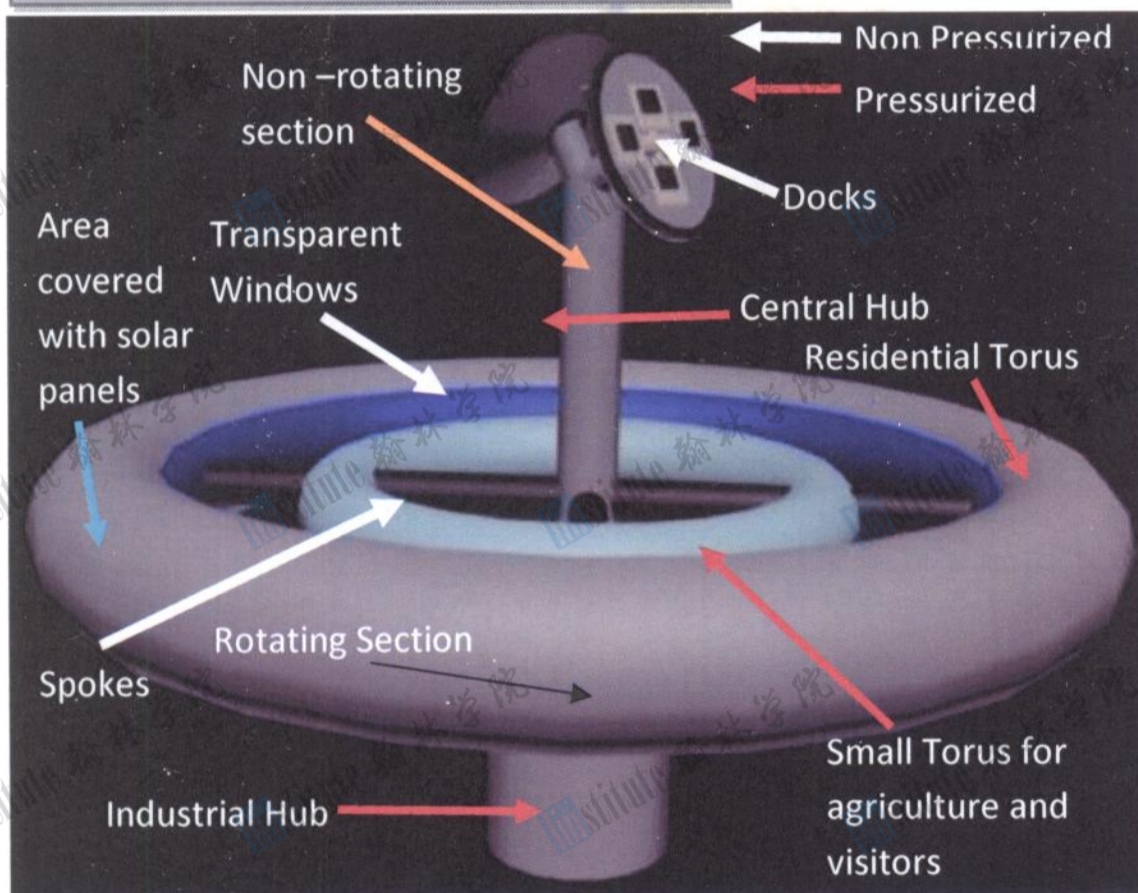
2.0 Structure and Design

Columbiat has been designed with safety and comfort of the inhabitants as the prime consideration. Another important design consideration has been to make the settlement commercially active even before the completion of the full structure. This has been done by making the inner torus habitable on its completion. This ensures that the commercial and outer torus construction activities start together.

2.1 Design overview

Columbiat consists of the central hub, industrial hub, small torus, main torus and docking stations. Every component and structure has been designed to be fully redundant and has self healing mechanisms in place. Most components and assemblies used have self diagnostic technology inbuilt into it and inform the maintenance department and team of robots about the impending failure much before the failure actually happens. An ever alert space monitoring system takes precautionary measures much before the possibility of major asteroids and debris damaging the settlement. These precautionary measures may involve rotating, repositioning the station for some time till the debris/asteroid moves past the settlement. The torus is divided into four self sustaining units. In case of damage to a section of the torus shutters isolate the damaged quadrant and the safety mechanisms come into place to ensure safety of all aspects of the settlement.

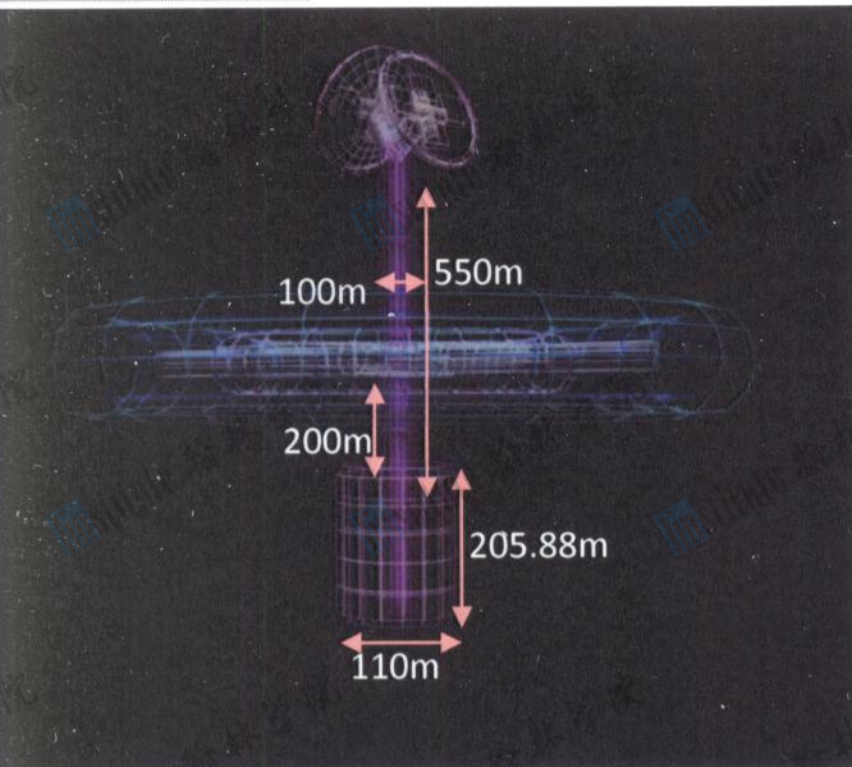
2.1.1 MAIN DESIGN – Exterior View



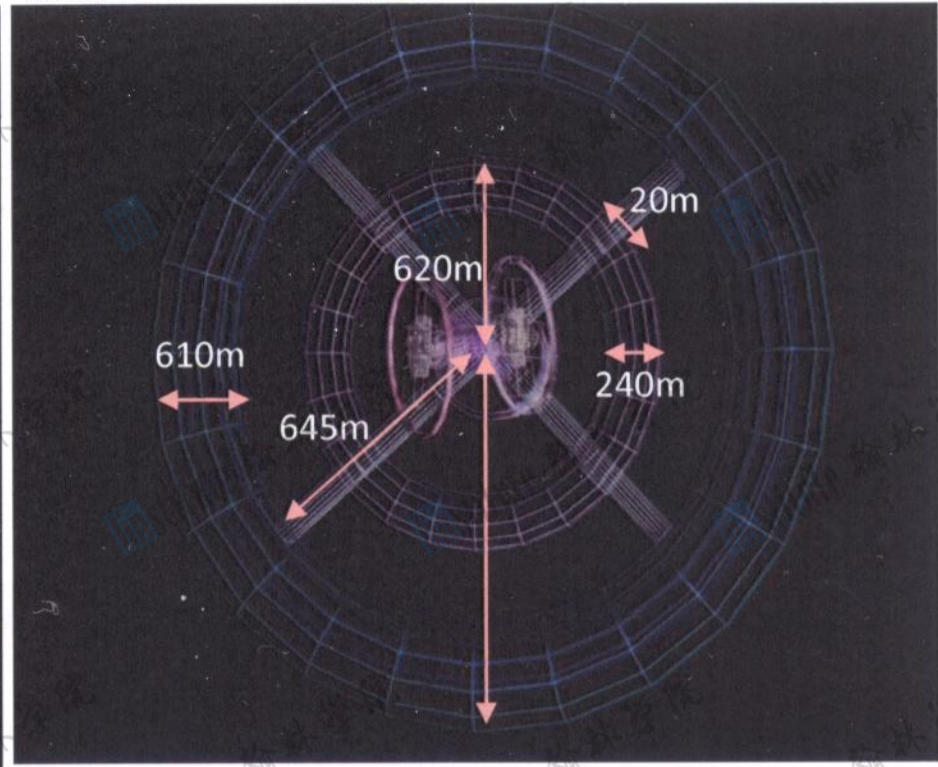
Design Features

- Main Torus For residential purpose
- Small torus for agricultural purpose and to provide adaptation of half-g environment to visitors
- Utmost shielding for radiation and debris penetration
- Non rotating docks and central hub
- Eight widely separated docks.
- Antennas will be located on the Industrial sector and Docking Ports.

2.1.2(A) Side View



2.1.2 (B) Top View



2.1.3 Dimensions





Structural components	Dimensions					Down Surface Area (m ²)	Surface Area (m ²)	Volume (m ³)	Primary Use
	L	B	H	Major Radius	Minor radius				
Main Torus(1)	-	-	-	1305m	695m	3,832,743.04	12,040,917.37	1,836,239,899	Residential Area and Business Development.
Small Torus (2)	-	-	-	620m	380m	753,982.24	2,368,705.06	142,122,303.4	Agricultural Production
Connecting Spokes (horizontal)	-	-	405m X4	10m	-	32,400	101,787.60	508,938.01	Transport
Central Hub	-	-	550m	75m	-	-	259,181.4	9,719,302.28	Support for docks & industries (micro-g activities)
Conical structures	-	-	20m	50m	-	-	-	-	Docking systems
Tubes connecting to cones	-	-	10m	20m	-	-	1,257.14	12,571.49	Connecting docks to Central Hub
Industrial Hub	-	-	205.88m	110m	-	10x38,013.271=380,132.71 (Floor wise)	142,294.041	7,826,172.233	Industrial Sector



2.1.4 Major structures and their uses

Dual torii system	Uses
Main Torus	Residential, banking and commercial centre
Small Torus	Agricultural area and half – g training facility
Central Hub	Storage, transportation and micro – g entertainment facility.
Industrial Hub	Industries, maintenance, manufacturing and repair centre.

2.1.5 Construction Materials

Material	Properties	Cost(\$)/unit
Super adobe	<ul style="list-style-type: none"> High tensile strength Low thermal conductivity High service temperature 	115/lbs
Kevlar – 49	 <ul style="list-style-type: none"> High tensile strength Excellent curing properties Capable of sustaining minor impacts without damage 	140/lbs
Aluminum Titanate	 <ul style="list-style-type: none"> Excellent corrosion resistance Light weight, high thermal and electrical resistance Extremely low magnetism 	100/lbs
Octra 2020	 <ul style="list-style-type: none"> High tensile strength Ozone resistance, thermal resistance 	100/lbs
RTV3145	<ul style="list-style-type: none"> Resist UV rays Ozone resistance Thermal resistance 	187.9/lbs
Sealant Gel	<ul style="list-style-type: none"> Temporary fixation 	7/lbs
Polyethylene Foam	 <ul style="list-style-type: none"> Withstanding high temperature Dispersing the radiations 	7/lbs

Newer materials with collapsible molecular structure will also be used.

2.1.6 Radiation and debris protection:

All the materials shall be compiled together hermetically using adhesives and gels such as **RTV-3145** adhesive and **sealant gel** shall be used for the temporary fixation of the materials in case any penetration occurs in the settlement by the fast moving debris in space. **Polyethylene foam** shall also be used for it is capable of **withstanding high temperature** and helps in **dispersing the radiations**. These materials shall be put together in form of tiles in order to make replacement easier in case of any disturbance to the settlement. The **Glass** shall be constructed at in space to improve its maneuvering ability at the micro – g space.

2.1.7 Layer Concept

The adjoining table shows the layer concept of the main enclosed volumes and the materials used in our settlement for construction.

Part	Layer Concept	Explanation
Main Torus	8 Layers (13 m)	Super adobe(2m), Polymer M5(1.5m), Spectra-2000(2m), Polyethylene Foam(1.5m), RTV-3145 Adhesive(1m), Aluminum titanate(2m), Kevlar-49(2m)
Small Torus	8 Layers (9.7m)	Super adobe(1.5m), Polymer M5(1m), Spectra-2000(1.5m), Polyethylene Foam(1.5m), RTV-3145 Adhesive(1m), Aluminum titanate(1.5m), Kevlar-49(1.7m)
Central Hub	8 Layers (11m)	Super adobe(1.5m), Polymer M5(1.5m), Spectra-2000(1.5m), Polyethylene Foam(1.5m), RTV-3145 Adhesive(1.5m), Aluminum titanate(2m), Kevlar-49(1.5m)
Connecting Spokes	8 Layers (7.7m)	Super adobe(1m), Polymer M5(1m), Spectra-2000(1m), Polyethylene Foam(1m), RTV-3145 Adhesive(1m), Aluminum titanate(1m), Kevlar-49(1.7m)
Docks	8 Layers (6.2m)	Super adobe(1m), Polymer M5(0.3m), Spectra-2000(1m), Polyethylene Foam(0.2m), RTV-3145 Adhesive(1m), Aluminum titanate(0.7m), Kevlar-49(1m)
Industrial Hub	8 Layers (7m)	Super adobe(1.5m), Polymer M5(0.5m), Spectra-2000(1.3m), Polyethylene Foam(0.5m), RTV-3145 Adhesive(1m), Aluminum titanate(1m), Kevlar-49(1.2m)



2.1.8 Pressure & Gravity

The table listed below shows the rationale for gravity and pressure in various sections of the settlement.

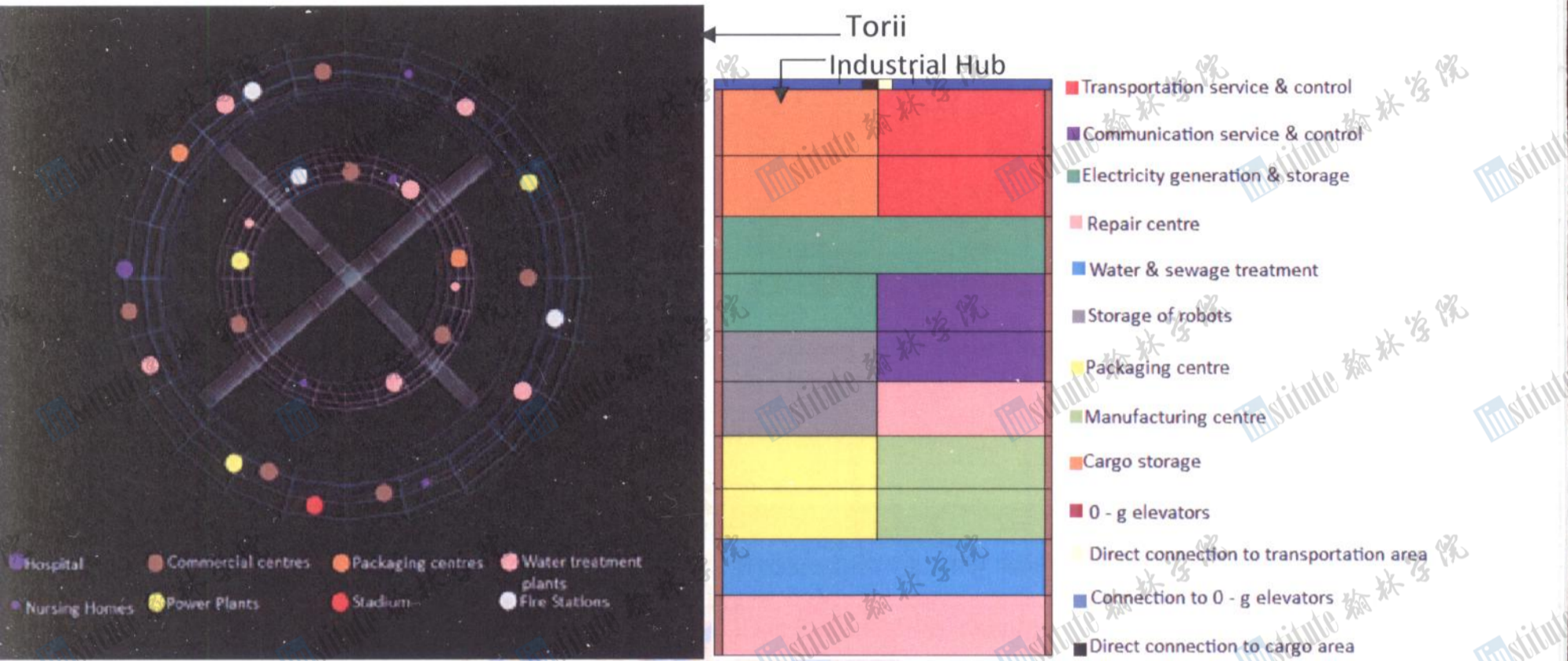
Structural Components	Pressure	Gravity(m/s ²)	Justification
Main Torus	.82atm	9.8	It's best suited for overall human development and performance.
Central hub	.82atm	0 (approx)	Easy storage, transportation and great entertainment in zero - g
Docks	-	0 (approx)	Saves fuel
Industrial Hub	.82atm	0 (approx)	Manufacturing and storing is done very easily.
Small Torus	.82atm	4.9	Half - g training facility for visitors

Gravity shall be generated by rotating the settlement with a tangential velocity of 100m/s that gives 0.95 RPM to the torii giving 1G experience to the main torus and half - g experience to the small torus.

- The formulas used here are : $F = mv^2/r$ and $F = mg$
- Shall prevent the coriolis force
- Due to possible degradation of spin, the thrusters shall provide the necessary thrust.

2.2.1 Allocation of areas in the settlement

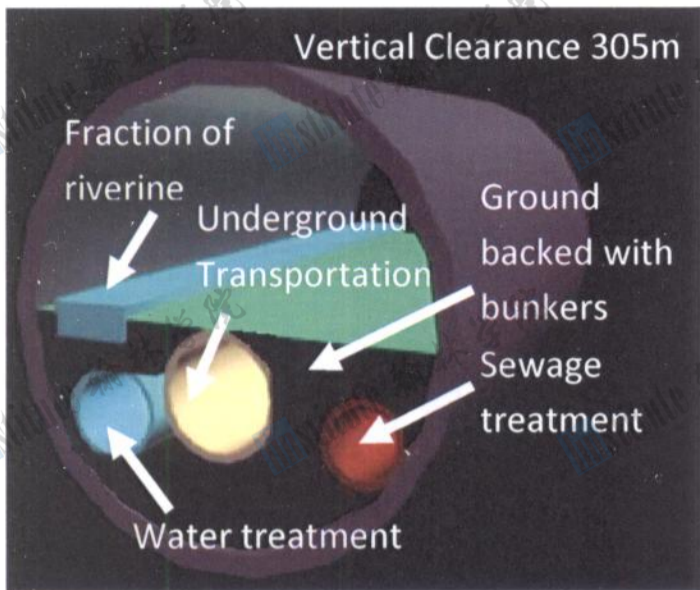
Knowing the fact that the area in the settlement shall be limited, we have tried to make sure that adequate amount of land is allotted to all the community attributes in the settlement to utilise the space efficiently and effectively.



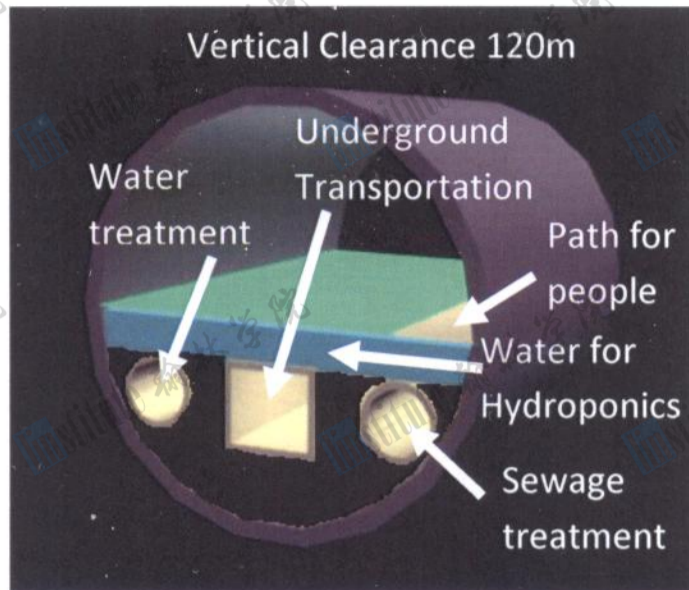
Spaces to be used	% of area to be utilized	Total Area Utilization (m ²)
Residential	29.5	1,465,223.11
Offices & Banks	8.1	402,315.50
School	2.1	104,304.02
Shops	2.0	99,337.16
Hospitals	1.1	54,635.44
Half - g accommodation	2.9	144,038.88
Meditation centres	0.9	44,701.72
Recreation and Entertainment	7.4	367,547.49
Public open spaces	5.2	258,276.62
Industries/Storage	10.2	506,619.51
Communication	1.5	74,502.87
Roads and Paths	7.5	372,514.35
Waste & water management	3.8	188,740.60
Agricultural land	12.2	605,956.67
Animal Husbandary	0.65	32,284.58
Ponds & riverines	0.5	24,834.29
Miscellaneous	4.9	243,376.04
Total	100	4,966,857.99



2.2.2 Cross – sections



Down Surface Area in Main Torus



Down Surface Area in Agricultural Torus

Unpressurized structural component	Utilization
Central Hub	Storage, micro-g entertainment, transportation
Industrial Hub	Base for industries, maintenance and repair centre.
Docks	Base for docking of space shuttles, cargo ships, passenger ships etc.

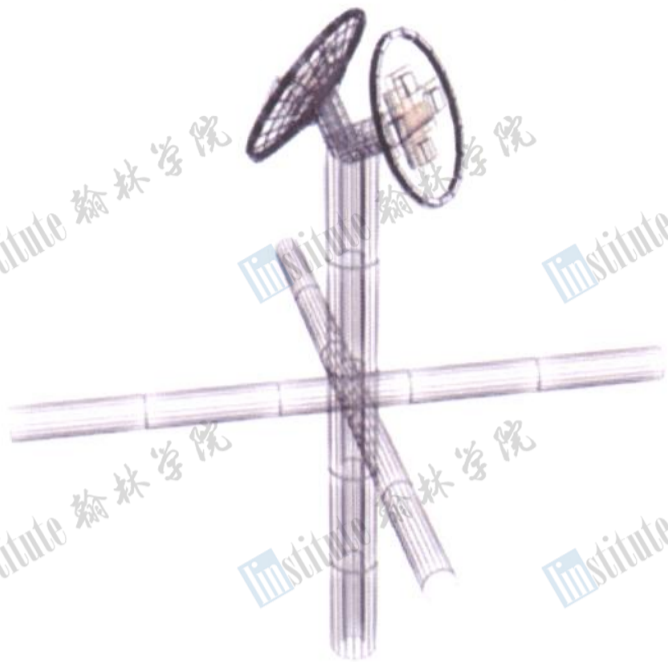
2.3 Structure Sequence



Phase1: It'll commence by 15 Aug 2044 with the construction of Central hub. Time 2years

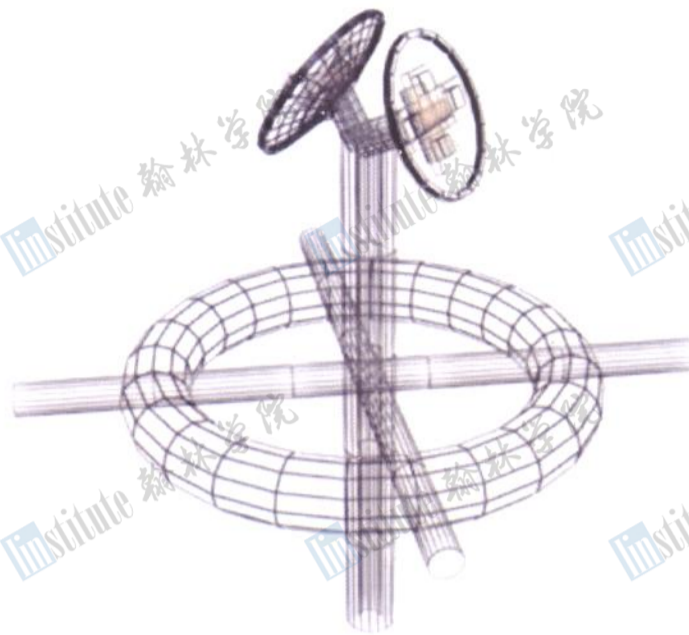


Phase2: The docks shall be constructed and shall be overlapped with solar panels. Time 1.5years



Phase 3: The spokes that would provide support and transportation shall be constructed in a year.

Time: 1 year

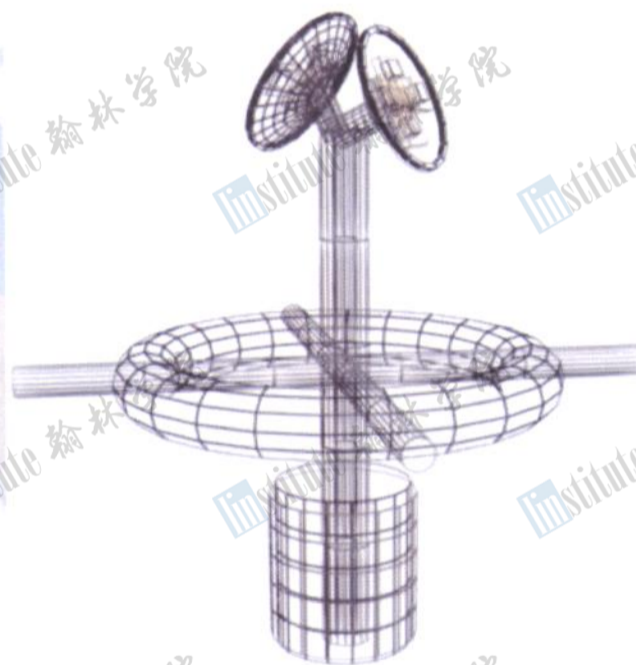


Phase 4: The agricultural torus in its initial stage shall provide residence for initial visitors and employees.

Time: 2.5 years

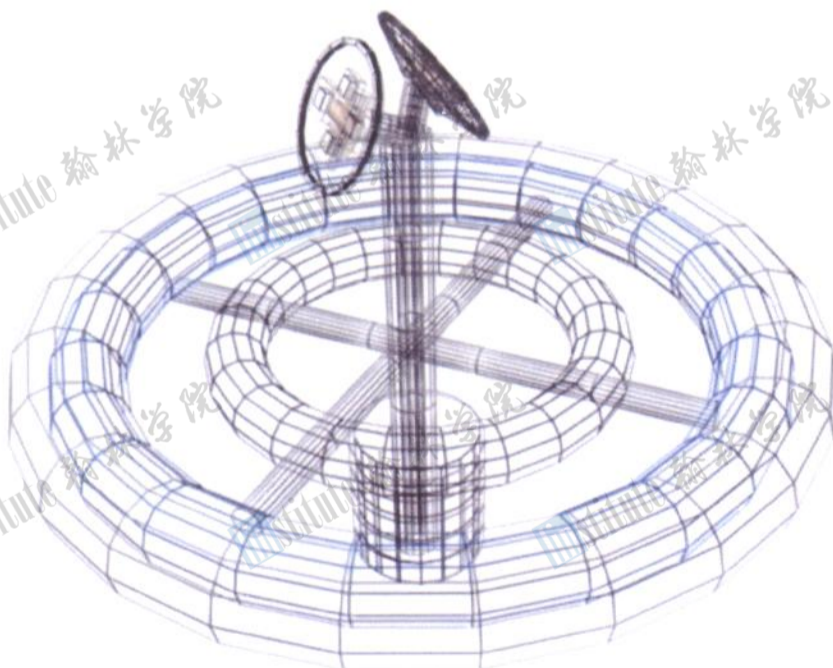
Phase 5: The industrial sector will be constructed under the central hub.

Time: 1.5 years



Phase 6: Finally the main outer torus will be constructed along with a transparent window for a view of earth.

Time: 3.5 Years.



Phase 7: The torii and the industrial cylinder will be overlapped with solar panels.

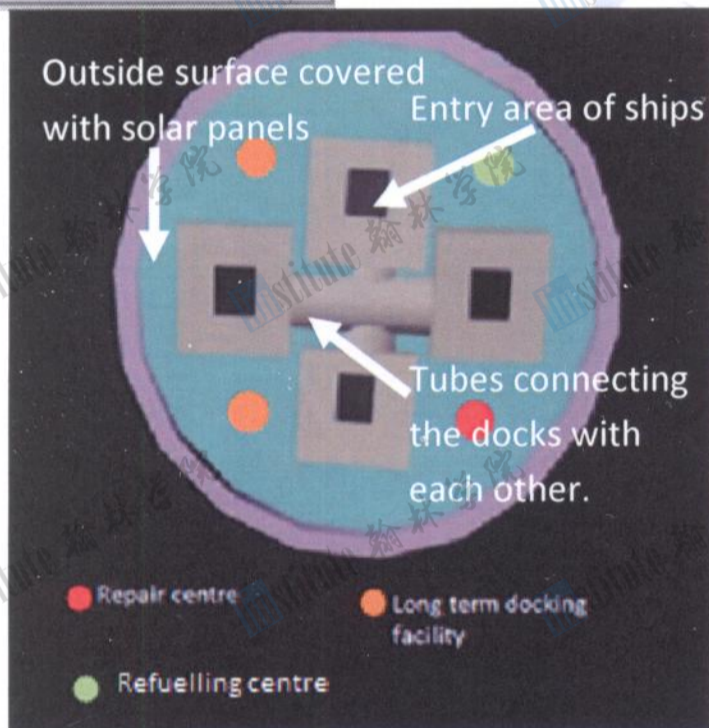
Time: 1.5 years



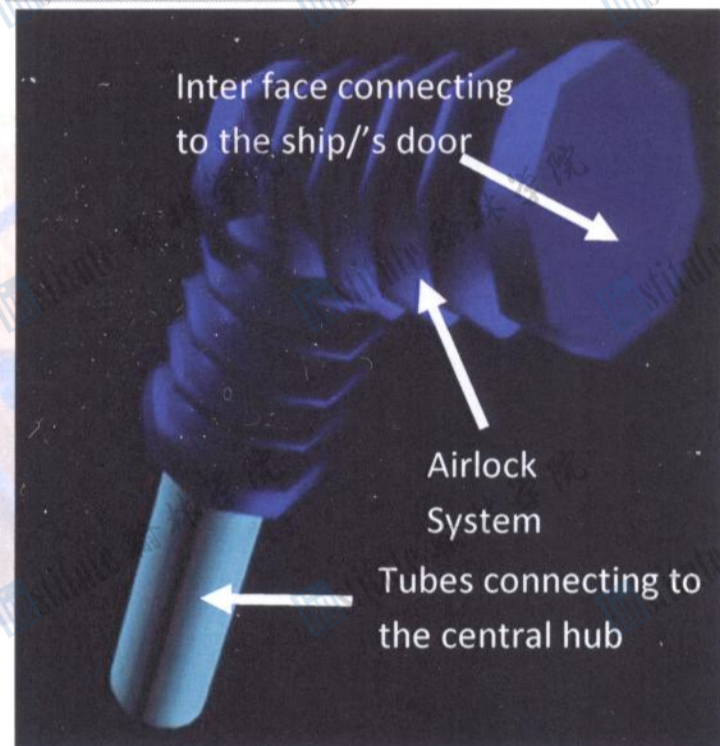
2.4 Port facilities

2.4.1 View of docks

Hawk eye view



Inside Cut View



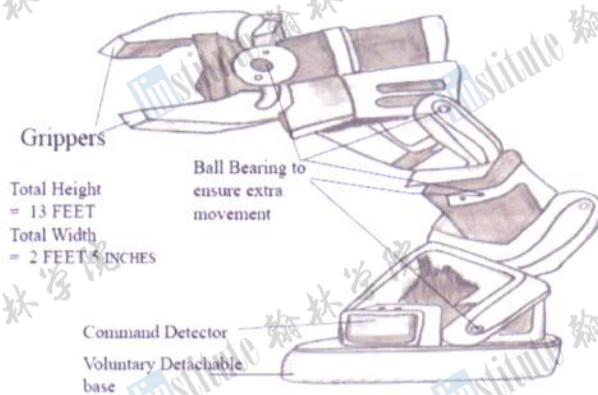
2.4.2 Design features

- Four widely separated docks each for cargo ships and passenger ships.
- Because of good angle towards the sun, the outside surface of the docks is covered with solar panels to make the docks self – sufficient.
- Specially designed airlock system for making the passengers have a good feeling in the docks.
- Docks providing facilities like repairing and long term docking facility for at least two ships.
- Easy access to fuel storage area.

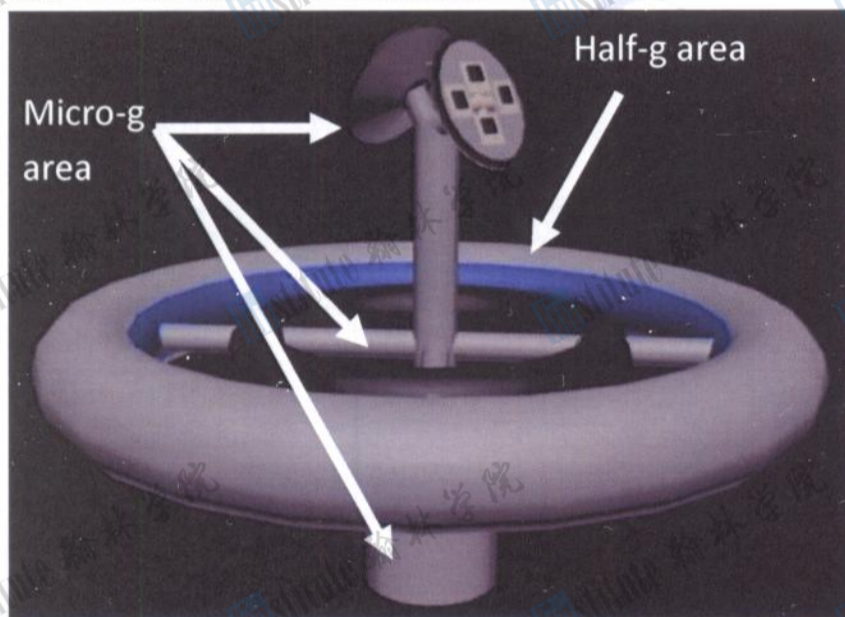


2.4.3 Functioning

There shall be two docking centers – One for cargo transportation and one for passenger transportation. These are designed in such a way that at least four cargo ships and four passenger ships can load and unload simultaneously. The docking ports shall provide services like long – term docking facilities, refueling, maintenance and repair services. After the ships have entered the docks, automated gripping mechanisms like **bionics arms** shall grip the shuttle. Then the airlock system connected with the central hub shall extend to connect to the shuttle's door. The passenger's airlock system shall be different from that of cargo. The cargo airlock system shall have electromagnetic conveyer belts which shall help cargo to reach its desired destination, whereas in the passenger airlock system the passengers shall be given Velcro boots to reach their destination.



2.5 Half – G accommodation



2.5.1 Low – G areas

Columbiat is designed in such a way so that the half – g accommodation for visitors as well as the agricultural area is provided in a separate torus and the residential area for 1g accommodation is provided in a separate torus.

2.5.2 Rotation rates

Rotating section

Area	Radius	Tangential Velocity	RPM	Gravity
Main Torus	1000m	98.9m/s	0.95	9.8m/s ²
Small Torus	500m	49.5m/s	0.95	4.9m/s ²

Non rotating section

Area	Radius	Gravity
Central Hub	50m	0(approx)
Industrial Hub	110m	0(approx)

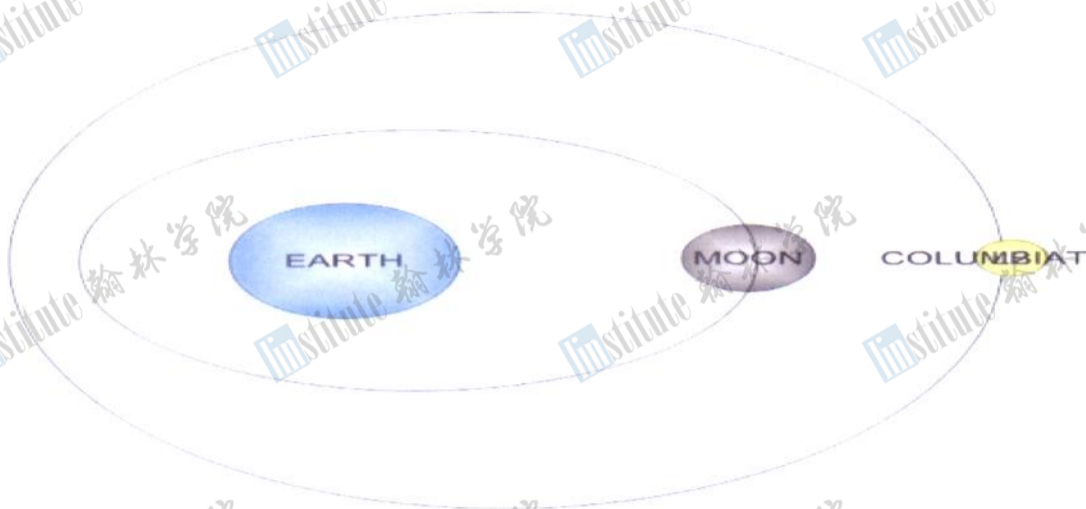
We assume that our proposed structural design along with its unique features and qualities will make it possible for humans to sustain life in a unique and comfortable manner and experience a completely different lifestyle from what they faced at earth and other stations.



3. Operations and Infrastructure

3.1.1 Orbital location

EARTH-MOON L2 ORBIT



Columbiat will operate at the Earth-Moon L2 libration point, enabling future conversion to serve as the orbital terminus for a lunar space elevator.

3.1.2 Construction Materials

SOURCES AND TRANSPORTATION METHODS

Materials	Source	Composition	Method of Transportation
Kevlar 49	Earth	Polyparaphenylene terephthalamide	Titan
Aluminium Titanate	Alaskol	Aluminium and titanium	Calypso
Octra 2020	Luna	-	IO
Polyethylene foam	Earth	Carbon and hydrogen	Titan
Super adobe	Earth	Propylene sand tubes	Titan
Sealant Gel	Earth	-	Titan
Other Materials	Earth		Titan

3.2 Community Infrastructure

Atmosphere

Parts per million by volume

Estimated total volume of Atmosphere=90% of the volume of Columbiat = 90% of 1987556564.85=1788800908.365 m³

Gas	Volume	Source
<u>Nitrogen</u> (N ₂)	780,840 ppmv (78.084%)	Earth
<u>Oxygen</u> (O ₂)	209,460 ppmv (20.946%)	Moon
<u>Argon</u> (Ar)	9,340 ppmv (0.9340%)	Bellevistat



Carbon dioxide (CO₂)	383 ppmv (0.0383%)	Columbiat
Neon (Ne)	18.18 ppmv (0.001818%)	Earth
Helium (He)	5.24 ppmv (0.000524%)	Earth
Methane (CH₄)	1.745 ppmv (0.0001745%)	Moon
Krypton (Kr)	1.14 ppmv (0.000114%)	Alexandriat
Hydrogen (H₂)	0.55 ppmv (0.000055%)	Earth
Nitrous oxide (N₂O)	0.3 ppmv (0.00003%)	Earth
Xenon (Xe)	0.09 ppmv (9x10 ⁻⁶ %)	Alexandriat
Ozone (O₃)	0.0 to 0.07 ppmv (0%-7x10 ⁻⁶ %)	Earth
Nitrogen dioxide (NO₂)	0.02 ppmv (2x10 ⁻⁶ %)	Earth
Iodine (I)	0.01 ppmv (1x10 ⁻⁶ %)	Earth
Water vapour (H₂O)	~0.40% over full atmosphere, typically 1%-4% at surface	Earth

Atmosphere/Climate/Weather

The composition of the atmosphere will vary based on the photosynthesis, combustion and other activities. Atmospheric control system comprising of sensors to monitor the composition of the atmosphere and release and absorption mechanism for the various components of the atmosphere will be maintained using sophisticated control computers linked to liquefied atmospheric component containers. The oxygen, carbon dioxide contents will be adjusted in such a way so that the rate of photosynthesis and the rate of respiration of humans and combustion of fuels balance out. The climate will be controlled by varying the atmospheric temperature and humidity on a cyclic basis. By varying the duration and intensity of the solar lighting system the temperatures will be controlled. Humidity will be increased by addition of steam to the atmosphere using solar boilers and reduced using dehumidifiers. Summer/Winter/Rains/Snow will be simulated using artificial means on cyclic basis.

Food Production

The food production is an integral part of the Columbiat. Since photosynthesis results in production of oxygen, the plants also form a mechanism for automatically controlling the availability of oxygen and reduction of carbon dioxide. To reduce transportation of soil for cultivation, hydroponics based plant cultivation would be used. Accurate control of lighting, water and nutrients will result in fast production of food items. Agricultural waste will be converted to fodder for animals which will in turn provide, milk and meat products. Excess food production will be sold off to other space stations and visiting space ships. All residential and commercial building will have terrace gardens producing food items. The balconies will have ornamental plants for aesthetic reasons. The open spaces will have medicinal plants and fruit trees.



3.2.1 STAGES	METHODS
Growing	The food shall be grown by using BHAS (Bernoulli hydroponics and aeroponics systems). This method not only increases the yield but also reduces the area and water consumed. In this method, the plants not only pull water through capillarity but are artificially made to do so in a shorter period of time. The pressure shall be lowered by using air suckers and velocity of water increases. In case of any disaster in the agricultural torus that would prevent food from being utilised, there would be a small production area with every house for backup. The plants will form an important component of the oxygen generation process and will balance out the carbon dioxide generation caused by respiration and combustion.
Harvesting	AGRICULTURE Robot shall monitor the harvesting of the crops. A round of human examination shall ensure the prevention of malfunctioning of BHAS.
Packaging	HCVP (high capacity vacuum packs) shall be used for the storage of crops and different food items.
Delivering	Delivery by PSP (Pascal split pipeline) system shall be done so as to generate pressure for faster delivery. This system shall function between the production units and retail markets via underground. Since pressure at both ends shall be uniform (Pascal's law) so no damage to the food is possible.
Selling	Selling shall directly be done in the markets to which the people have full access.

Food Items available on Columbiat

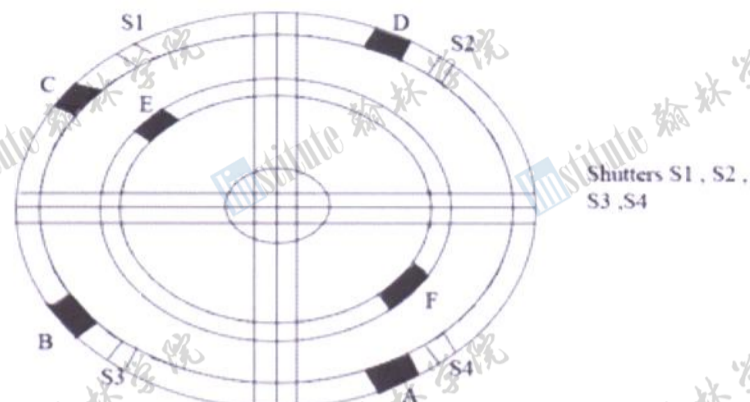
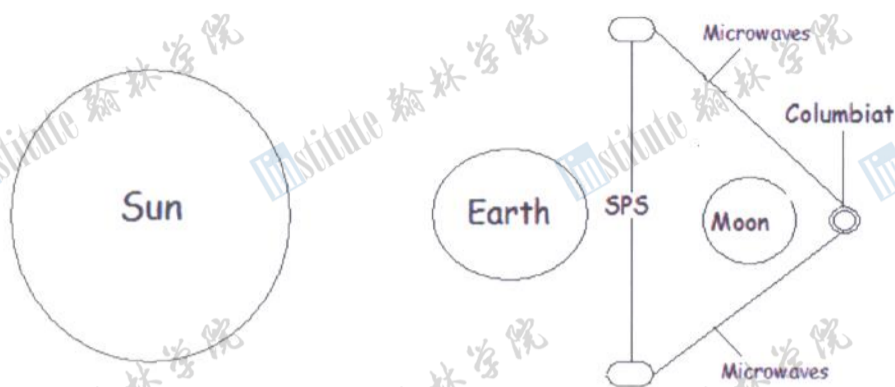
A balanced diet is essential for all living objects, which is true for residents of Columbiat as well. Various items available on Columbiat will be adequate for a balanced meal. For reference of daily requirements of the vitamins and minerals, refer to Human engineering

Electricity Production

Solar Power Satellite- Two 75MW SPS's dedicated for Columbiat will be placed at Earth-moon L-4 and L-5 Liberation Points and will be a major source of energy generation. A rectenna disk to convert microwaves received from the SPS's will be constructed on the settlement. Parts of the settlement will also be covered with receiving panels. The tendency of microwaves to diverge will be suppressed by using materials to focus electromagnetic waves into a narrow cone. Solar panels will act as a backup source in case of any mishap. The panels placed near the docks will produce energy of 10MW. Stored electricity will be utilized during some shortfall.

Estimated Power Consumption

Applications	Estimated Power consumption
Domestic	73.5 MW
Robots	5 MW
Commercial	20 MW
Artificial Lighting	22 MW
Waste and Water Management	8 MW
Data Centers	10 MW
Industrial	20 MW
Transportation	5 MW
TOTAL	163.5 MW



Power collection main torus, distribution transformers A, B, C, D
Power collection Small torus E, F
Circular power grid containing protection and failover circuits

Water Production

Water is the minimum need for a person to survive. So we would fetch water from the Mars. The water available in Mars has the same mineral composition of that on Earth. So it will be edible for humans. As the planet doesn't have an atmosphere thus it will be possible to get water easily.

Figures per year

Water Requirement Table

Water needed per person	150 liters
Water needed for the whole settlement	1,000,000 gallons

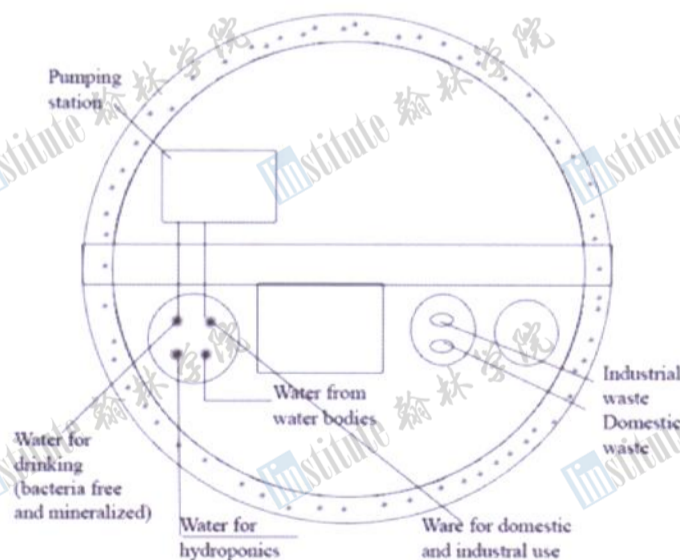
Water and Solid Waste Management

The solid waste will be divided into primarily into 2 parts:

Recyclable Waste – It will be graded by grading robots into various components. These components will be sent to recycling plants for recycling

Organic- Organic Waste will be recycled by Organic Waste Management System. Waste generated from various sources such as:-Food waste, waste water, human waste and dead plants and animals that are organic in nature will be mixed together in sealed grinders, mixers and centrifuge to generate waste slurry. This waste slurry will then be exposed to high heat and pressure inside the container as a result around 60% of the material will be converted into ammonia and acetic acid. These are filtered from the residual waste into separate chamber. The residual waste is then passed over catalytic converters which convert the residual material into water and carbon dioxide. This mixture is passed through a condensation chamber to separate the water from carbon dioxide. In effect the organic waste using this process has been converted to:

- Water
- Carbon dioxide
- Acetic Acid
- Ammonia



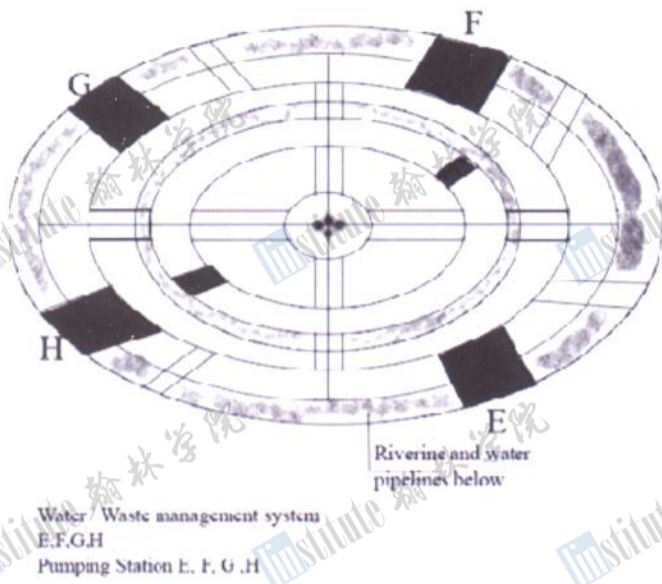
The water pipeline will travel up and down the central hub
The waste water pipeline will carry water in two pipelines



Carbon dioxide is required for the photosynthesis process and produces oxygen. Adequate Spirulina and other highly photosynthetic plants will be used to convert the carbon dioxide into oxygen.

Day/night cycle provisions

We will be using artificial lighting to provide Day and night cycle. There shall be PHOLED bulbs which shall illuminate the whole settlement. These bulbs shall be synchronized in such a way so that we will have dawn, dusk, morning, evenings etc.

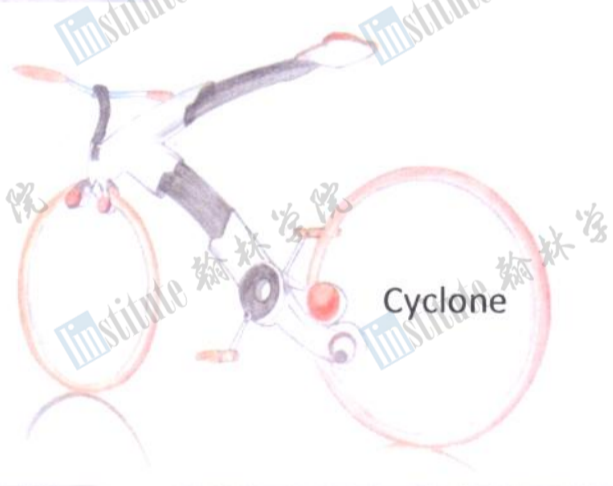
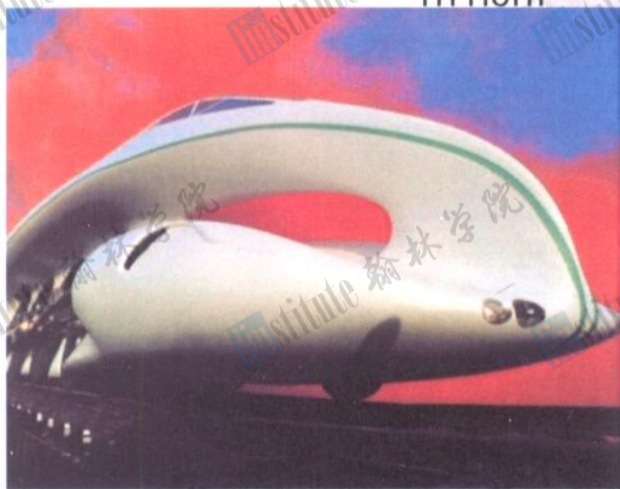


Internal Transportation

The internal transport system will cater to the needs of transportation of goods and people. The Tri Horn trains will carry passengers and goods everywhere within the torii and spokes. The central hub will have elevators for transportation of goods and passengers. Conveyer belts will connect the central hub to the Tri Horn Train System. The Tri-horn systems will be produced in the internal hub and will be available for sale to other space stations. Magnetic levitation and magnetic braking system will form the technological base of the system. This magnetic system will allow the Tri-horn Trains to operate in low G areas as well as hi G areas efficiently and safely. Computerised control of the movement and scheduling will ensure that passengers will have to wait at the most 2 minutes for a train and the maximum journey time will be 15 minutes to any part of the space station. Transportation of cargo will be through the underground conveyer belts running throughout the torus and spokes.

RFID devices containing the destination address of the cargo will ensure that the cargo will be unloaded from the conveyer belts at the correct location/station. Residents will be encouraged to use the cyclone for movement within the settlement. This will allow the residents to exercise while saving on the transportation costs. The cyclone will have variable loading options so that the amount of effort / exercise can be controlled. It will also allow the rider to travel without cycling using the battery mode.

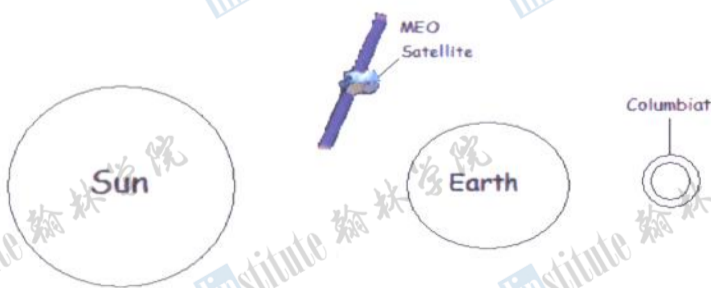
Tri Horn



Internal and External communication

Internal communication will be done using Artemis

For external communication these satellites will play an important role. We will establish a radio communications setup on Alaskol to lower the strain on existing communications and serve as a communication 'transit' for greater communication speeds of transfer and data transfer rates





3.3 On orbit infrastructure for sustaining operations

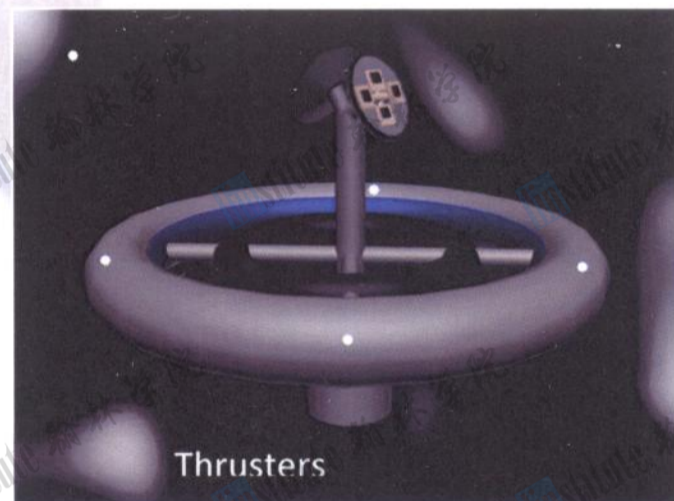
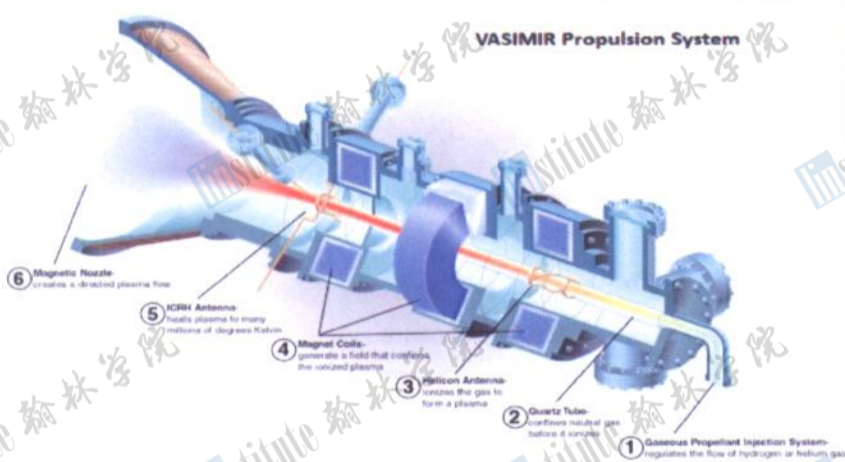
Before the structure is operational we will use tools and equipment from existing space stations. This will cut down on costs and time. Once the basic settlement is operational the commercial and other activities will increase. This will necessitate the production of advance vehicles fine tuned to the needs of the inhabitants, travellers and neighbouring settlements. Facilities for more sophisticated power plants, new storage and distribution technologies will allow for evolution of Columbiat. It is also expected that the risks from debris will increase and special vehicles that will track and remove the debris before collision will be developed. Miniature Life saving torroids capable of sustaining life for a few months will be developed within Columbiat that will serve as life stations (similar to life boats on ships) in case of major catastrophic damage to Columbiat.

3.4 Propulsion

Propulsion systems will use Variable Specific Impulse Magnetoplasma Rocket (VASIMR).

Not only would VASIMR allow for faster space travel, it would have some pretty incredible side benefits, as well. This will allow travel to L2 much more quickly than chemical-powered rocket, and then, once there, to refuel on L2 for the return flight to Earth. The VASIMR engine will also even help protect astronauts from the dangerous effects of radiation during their trip. VASIMR will keep the Columbiat in orbit without requiring extra fuel to be brought up from Earth. VASIMR is a plasma-based propulsion system. An electric power source is used to ionize fuel into plasma. Electric fields heat and accelerate the plasma while the magnetic fields direct the plasma in the proper direction as it is ejected from the engine, creating thrust for the spacecraft. The engine can even vary the amount of thrust generated, allowing it to increase or decrease its acceleration. It even features an "afterburner" mode that sacrifices fuel efficiency for additional speed. Possible fuels for the VASIMR engine could include hydrogen, helium, and deuterium. Electrical power sources for the VASIMR engine will have solar panels.. While Columbiat orbits the Earth, atmospheric drag gradually pulls it closer to the Earth.

Every so often, the Station has to be boosted back into a higher orbit. This is done by a variety of means, but all of them require fuel launched into orbit from Earth. The VASIMR engine, however, will change that, since it would use hydrogen, which is already generated as a waste product on the Station. By using waste hydrogen and electricity from the Station's solar panels, VASIMR could maintain Columbiat's orbit without requiring any additional fuel. The diagram below shows the propulsion system.



3.5 Provisioning and Maintenance

Major source of revenue on Columbiat will be due to the excellent facilities for visiting space ships. Columbiat will have docking facilities for space ships of various sizes and types. The visiting ships can replenish food supplies, get their engines serviced and overhauled, refuel and get their waste products recycled. Columbiat will have provisions for maintenance of satellites and other equipment being carried aboard visiting ships. It will be the ULTIMATE transit point beating the likes of Singapore and Istanbul Provision and maintenance services provided to the Spacecrafts:

- | | |
|------------------------|----------------------------------|
| 1. Cabin maintenance | 6. Flight Programming Check |
| 2. Air pressure checks | 7. Interior/ Exterior Cleaning |
| 3. Airlock checks | 8. Audio/Video service check |
| 4. Debris cleaning | 9. In Flight entertainment check |
| 5. Suction pad check | 10. Electrical Wiring Check |



4.0 HUMAN ENGINEERING

Human beings are very demanding creatures by nature wanting only the best of everything. All basic comforts, amenities, quality of life being at a higher level than what they are used to on earth is what has been our endeavor to build into the new settlement at Columbiat. The basic psychological and social needs having been met, we have also tried to ensure that the day-night cycle, seasons and other natural elements that contribute towards the happiness and well being of human beings on earth are either replicated or compensated for at the settlement keeping our limitations of a space settlement in mind.

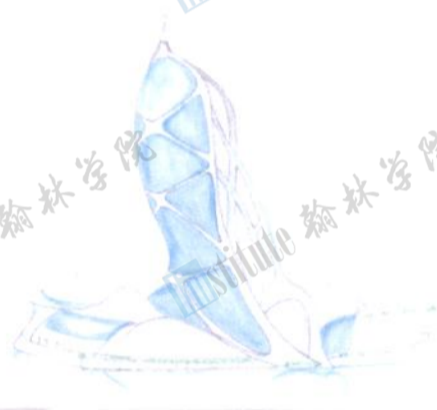
4.1.1 Community Comforts

Housing -Variable housing will be provided for meeting differentiated needs of the community. e.g.: High rise apartments, Plotted development for families, Single apartments etc. Pre fabricated blocks and knock down furniture will provide options for building personalized homes. Further, to decorate living spaces wall papers maybe used. Microwaves, solar energy and electricity will be used for cooking and heating purposes.

Tourists and business visitors will stay in hotels and resorts built especially for them, without compromising on their experience of life on a space settlement.



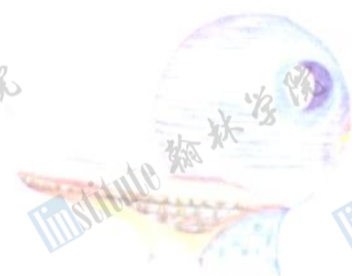
(A hotel near the river side for tourists)



(Another design of a hotel)

4.1.2 Education

- One school shall be built on Columbiat to accommodate 1200 students to begin with, this area could be expanded later.
- Robots will be used as teacher assistants to enhance quality of education. Curriculum will be varied and provide options for science, commerce or human studies administered through e-books and a centralized evaluation system. Space studies and developing a temperament for exploration shall be encouraged. Physical activity through ample playing fields will also be taken care of.
- Scientists from earth will be invited to organize seminars and lectures on a regular basis.
- For higher studies, the university at Alexandriat shall be used.



A design of a school

4.1.3 Entertainment and Recreation

Entertainment and recreation will be of utmost importance at the settlement to ensure residents have a healthy and balanced lifestyle. To ensure adequate physical exercise, the inclusion of a SPORTS STADIUM with varied sporting facilities tailor-made for **micro g conditions** is being proposed. E.g., A Basketball court will have the baskets placed proportionately higher to compensate for lower g values. A Velcro floor will provide anchorage.

Similarly, arenas will be constructed for a Harry Potter type game sequence, where players practically fly to play, or a Star Wars simulation, Squash, Darts, Billiards, Chess with magnetic pawns will be made available. A community Olympics and other mini tournaments are proposed to be held on a regular basis to foster



competition and skill enhancement. A gym with magnetic weights in place of normal ones may also be included. Apart from sports, other recreation will be provided through cultural programs like concerts, plays, dance recitals etc. The CITY HALL with an auditorium will cater to such needs. MALLS & CINEMAS: To cater to other needs malls having all kinds of shops for different shopping purposes and food joints will be setup. Cinemas having multiple screens presenting simple, 3D, 4D movies and holographic shows will also be built. Further, festivals will be celebrated, carnivals will be organized, beaches and river cruises developed. Yoga centers, meditation centers and observatories shall also be provided.



- Columbiat will have a unique feature known as “space safari” in which the people shall be taken for tours of the nearby space colonies and over views of earth, moon and visible outer space.
- A holographic space safari will also be developed within the station to simulate a “back in time” experience.
- The settlement will have open spaces, beautiful gardens and play grounds to be used for different purposes such as playing, jogging, walking and holding picnics.

4.1.4 Medical

For catering to small and big medical needs of residents, one main hospital will be built with 150 beds serviced by 45 doctors, both general physicians and specialists. Smaller clinics, four in number will be scattered throughout the settlement for easy access in times of minor needs.

One Veterinary clinic will cater to all the animal related medical needs, including vaccination.



A design of a hospital

- Chemist shops and pharmacies will facilitate 24/7 service.
- The hospital will be well equipped with Laboratories, X-ray units, CTC scan Units, Pathology, Nursing care, ICU, Coma CCU etc. In-patient and Out-patient services will be provided.
- The hospital will also have decontamination units, sterilization units, quarantine wards etc.
- Adequate protective devices for doctors and patients will be supplied in ample quantity.

4.1.5 Banking

Residents and visitors at Columbiat shall be provided with pre-loaded credit cards with credits for each basic need. Every time a transaction occurs, the cards will be swiped and credits deducted. In case there is requirement for extra credits, special permission will need to be taken. Any left-over credits may be

Category	Number of credits issued
Entertainment	25 credits
Health care	50 credits
Clothing	30 credits
Food items	35 credits

exchanged for favors or used for vacations etc. No physical transaction of money will be required or take place. Even for commercial purposes, all banking shall be done electronically. The Artemis shall also provide access to one’s account. The table listed below shows the number of credits allotted to different categories-



Visitors will get their cards on arrival and will have to submit them on leaving. Their cards too will be preloaded as per the amount they pay at the time of purchasing their passage ticket. In case they wish to extend their stay/avail of extra facilities, they can electronically transfer money from their earth accounts.

The people will require all the basic and daily needs for living in the settlement comfortably. Supermarkets for groceries and other food stuff, hospitals for first aid and medicines for health care are such examples.

Following is the table showing some consumables and their distribution-

4.1.6 VARIETY AND QUANTITY OF CONSUMABLES

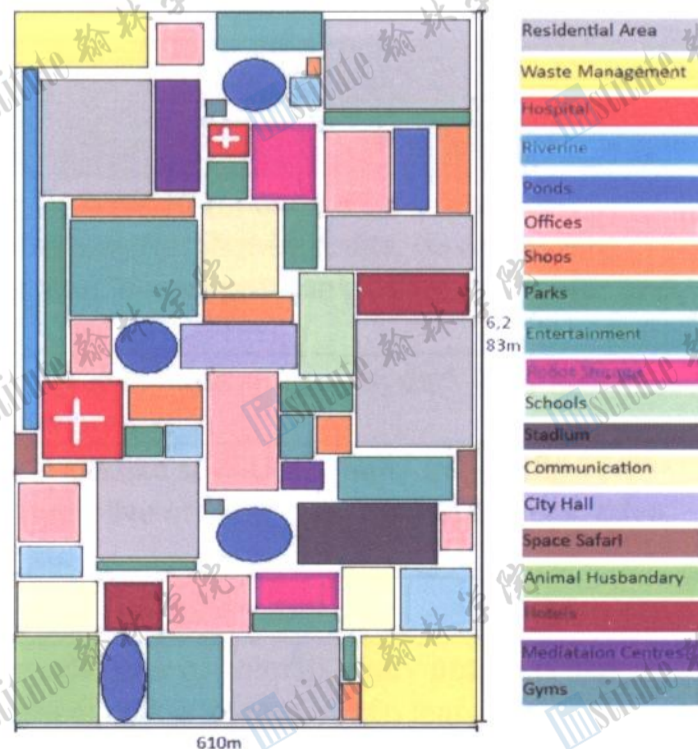
Consumables

Consumables	Quantity (per person per year)	Distribution
Medicine	0.5kg	Through hospitals and clinics
Kitchen ware	44units	Through malls and shops
Electrical appliances	10units	Through malls and shops
Stationary	64units	Through shops
Toiletries	8.4kg	Through malls and stores
House ware	5units	Through malls
Cloth	50m	Through malls
Cosmetics	1.2kg	Through malls and stores
Office equipments	72units	Through stores
Food	876000kcal	Through grocery stores and food marts
Paper	20units	Through shops

Need	Source of consumable
Food	Will be grown mainly in the agricultural ring through aeroponics and hydroponics. Alternately, personal and community gardens may also grow smaller quantities.
Clothing	It will be made of materials produced in the manufacturing center
Toiletries	Synthetically and organically made toiletry products will be produced in operations center
Medicines	Medical products will be produced synthetically or assembled in the operations center
Appliances	They will be made of silicon provided on moon

We have tried to design Columbiat in such a manner that the people don't have any complaints or problems with the lifestyle of the settlement. However, living in space might have different impacts on a person who will be living there. They might feel insecure or depressed. In the tables listed below we have listed out some such problems with their remedies.

Community Layout





4.1.7.1 Psychological symptoms and their remedies

Home Sickness	Excellent telecommunication facilities to be in touch with loved ones back at home, regular trips/vacations.
Isolation	Provide social activities
Boredom	Entertainment facilities
Depression	Meditation and festivities
Development of various types of phobias	Regular breaks, talks by experts, group discussions
Development of destructive tendencies	Isolation and consultative therapy
Solipsism syndrome	Recreational Activities
Insomnia	Cognitive Behavior Therapy, medication, physical exercise
Stress	Meditation & Yoga

4.1.7.2 Physiological symptoms and their remedies

Problem	Remedy
Reduction of Bone Mass	Enhanced Gravity
Weightlessness	Regular Medical Checkups
Osteoporosis	Regular Exercise
Asthenia Syndrome	Space Suit for Extra Vehicular Activity
Loss of sense of taste/smell	Exposure to near earth like atmosphere
Asphyxiation/ Breathlessness	Isolation to lower g chambers, exposure to hi-oxygen areas, provision of pure oxygen tanks in homes, recreational areas

4.1.8 Good Food

Fine food options will be made available to residents through restaurants serving select but nutritious meals. Standard menus will be rotated to provide variety. A good diet, low in fat, cholesterol, sodium and sugars; and high in vegetables, fruits, beans, nuts and whole grains will be necessary to maintain health and longevity at Columbiat.

Nutrients	Requirements /day		Sources
	Children 1200-2100 kcal	Adults 1900-3900 kcal	
Carbohydrate	40-60g/100g of calories	50-70 g/100g of calories	Glucose (its basic form) and sweets, biscuits, chocolates, pastries, honey, fruits, cereals, grains, pulses, bread, beans, potatoes, other vegetables and fruits.
Protein	20-33g	45-55g	Legumes, grains, nuts and seeds; dark leafy greens; eggs; dairy products
Fat	15g	15g	Vegetable oils like soya bean, mustard, sunflower, ground nut, olive etc and corn, peanuts, seeds, olive, oily fish etc
Vitamins			
Vitamin A			Fish liver oils, liver of animals, dairy products like butter, ghee, milk and eggs, green leafy vegetables, red palm oil, carrot, pumpkin and ripe mango
Vitamin A Carotene	300-600µg 1200-2400µg	750µg 3000µg	

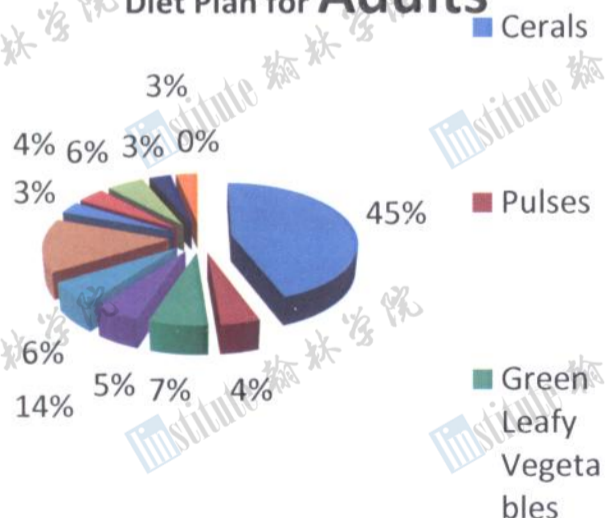


Vitamin D	400 I.U	200 I.U	Fish liver oils (of cod, halibut, shark), fat fish (sardine, salmon, Herring), egg yolk and dairy products(butter, ghee, milk).
Vitamin E	10-20mg	20-25mg	Wheat germ oil, corn germ oil, vegetable oils (Soy bean, cottonseed, sunflower, ground nut, mustard, coconut etc) cereals and eggs.
Vitamin K	Not known	Not known	Green leafy vegetables (spinach, cabbage, kale), vegetables (cauliflower, soybean, carrots, potatoes), wheat bran, wheat germ etc
Vitamin B			Apple, bananas, coconuts, ginger, sugar and jaggery will be transported from earth. Sugar will be transported in powder form
Thiamine Riboflavin Nicotinic Acid Vitamin B6 Vitamin B12	0.3-1.1mg 0.5-1.2mg 12-17mg 0.8-1.4mg 0.5-1.0µg	1.2-2mg 1.3-2.2mg 19-26mg 2.0mg 1µg	Dried yeast, rice polishing, wheat germ, whole cereals, liver, fruits, vegetables, milk, peanut, meat, fish, eggs, legumes (pulses) and dhal, leafy vegetables.
Vitamin C	25mg	40mg	Citrus fruits and green leafy vegetables (drumstick leaves, coriander leaves, cabbage), Gooseberry, Guava, Pineapple, ripe mango, papaya and tomato.
Vitamin P	Not known	Not known	Fresh fruits (orange, apple, blackberry, cherry, plum) and vegetables (spinach, tomato, lettuce, cabbage, carrot, cauliflower, pea etc.).

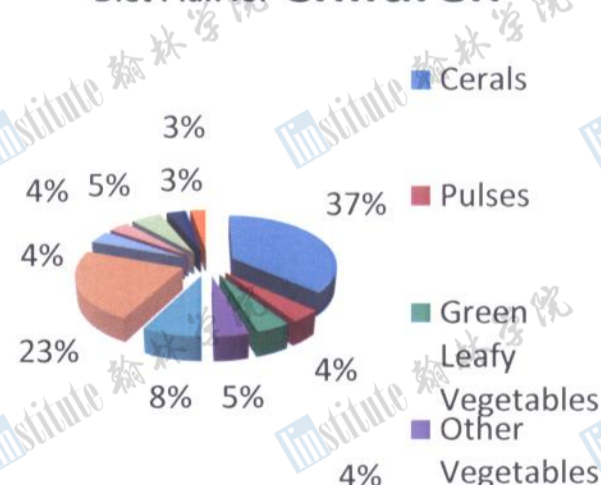
Minerals

Calcium	400mg	600mg	Dairy products; dark, leafy greens, legumes; most nuts and seeds; molasses; figs, apricots; dates
Iron	20-28mg	28-30mg	Legumes (especially soybeans and soy products other than oil); dark, leafy greens; dried fruits; whole and enriched grains; molasses
Zinc	10-15 mg	15mg	Eggs, cheese, legumes, nuts, wheat germ, whole grains, some kinds of brewer's yeast
Sodium	5-10g	10-15g	Salt

Diet Plan for Adults



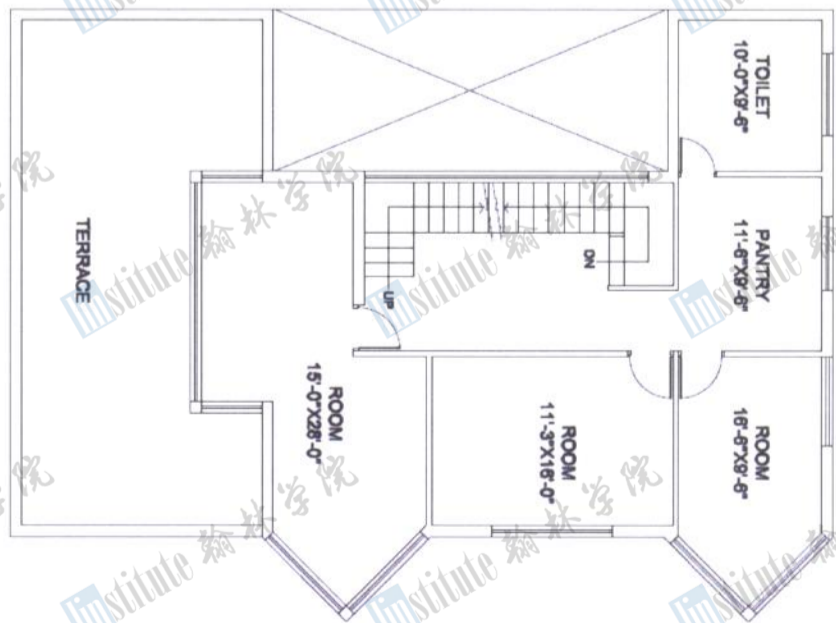
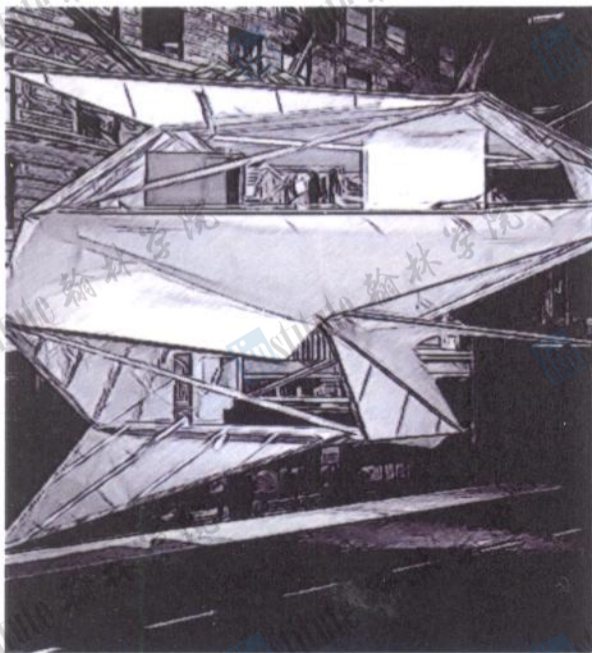
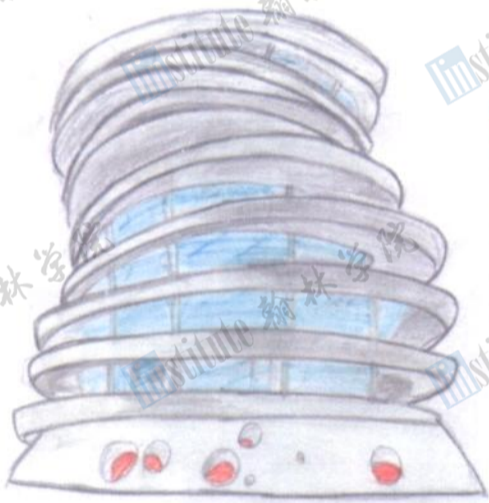
Diet Plan for Children

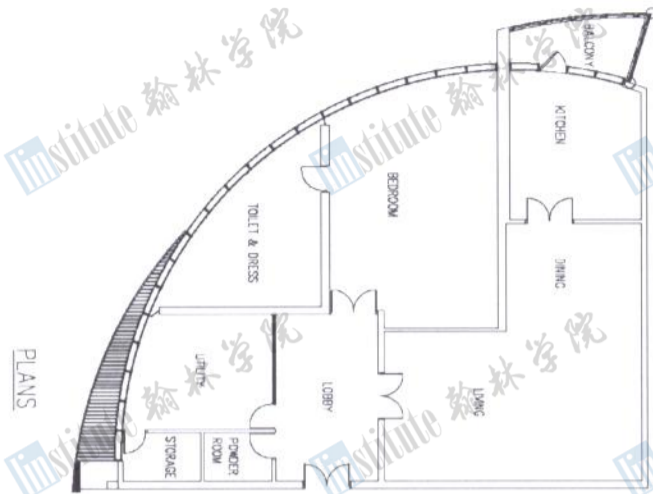




4.2.1 House and Floor plans

People living in this settlement will lead a luxurious life. The houses built will have attractive home décor and all amenities needed by the people according to their needs. Keeping in mind the different requirements of people, Columbiat will render different kinds of houses for different people. The following are some different kinds of Houses with their floor plans.





4.2.2 Differentiated neighborhoods

The population that comes to Columbiat is going to be a very varied one. Keeping that in mind we have differentiated neighborhoods. Hip and happening ones for the younger generations, mellow ones for the middle-aged ones and peaceful and serene for the older generations. The older ones will not like to be disturbed by the head-banging songs of the young generation and the young generation will not like to be disturbed by the bawling kids of the married couples. We will offer knockdown houses and furniture so that if people find our designs distasteful (not that it's possible) they can simply knock it down and make it according to their taste. We will not give them any chance to complain. They will have bricks of every possible color known to man. We ourselves will offer our best designers and engineers to help our less enlightened customers. We will offer our whole vast arsenal of construction materials for designing the houses as they want it.



Not to forget, we have also made sure that different colonies have different community attributes according to the needs of the people. For example the residential area for the younger generation will have all entertainment facilities nearby such as Cineplex, pubs and discos. The houses of the married people will be near parks and gardens with playground. Houses will be built near the river side as well for the people who enjoy natural beauty and peace. The residents living at Columbiat might not like being disturbed by the tourists and their daily activities. Thus they will be allotted a different colony for living which will have all entertainment facilities and basic amenities. The tourists will be given a chip which will act as an identity of them being an outsider. This will make sure that they do not enter the residential areas and disturb the local people.



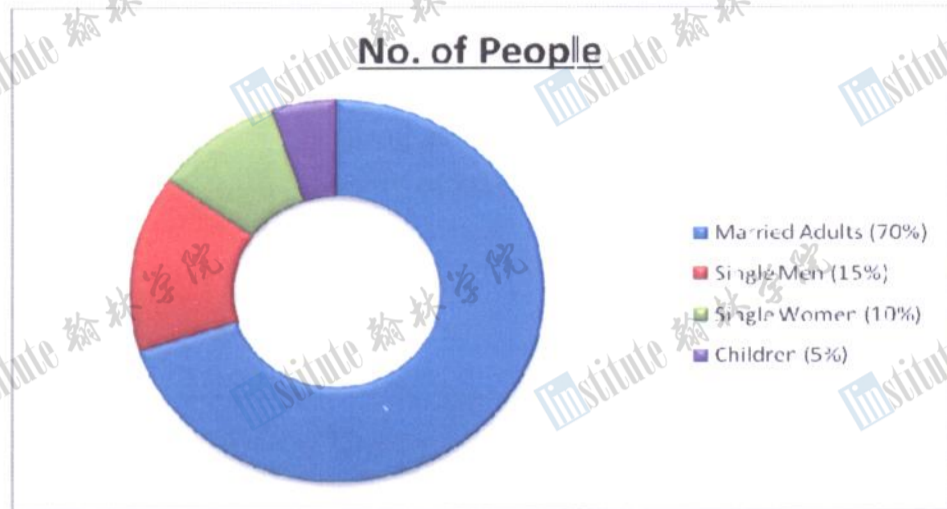
Drawings depicting differentiated neighborhood





4.2.3 Demographics

Following is the anticipated demographics of the original population given.



Demographics	No. Of People
Married Adults (70%)	16800
Single Men (15%)	3600
Single Women (10%)	2400
Children (5%)	1200

4.2.4 Source of the Furniture

We have tried to make sure that the houses and offices built at Columbiat will have all the furniture required by the people at their homes, offices and other places for carrying out their tasks and for their daily uses. The source for the main materials (like wood) used to make the furniture shall be Columbiat itself. Following is a table showing the estimation of furniture required in the houses and hospitals by the people-

Furniture

Items	Office (requirement per room)	House (for 1)	House (for 2)	House (for 3-4)	Apartments	Total requirements
Dining table	0	1	1	1	1	12000
Chair	3	4	6	8	3	127000
Sofa	1	1	1	2	1	30000
Bed set	0	1	2	3	1	42000
Desk	1	1	1	1	1	25000
Study table	1	1	1	1	1	25000
Total	6	9	12	16	8	261000

4.3.1 Air locking

The docks will have specially designed airlock system for making the passengers as comfortable as possible in the docks. The airlock will provide a proper breathing environment for the people. There will be micro-g in the docks due to the non-rotating central hub so we will be providing the passengers with Velcro boots with would keep them from floating. Elevators in the passenger corridors will allow safe transfer to the passengers. From there the passengers will be transported via the spokes to the small central torus where they will undergo decontamination from space debris and will be transferred into the torus where the transients will be living in their respective hotels and motels. The decontamination chamber will be a clean room where the visitors will enter and cleaned by various gases before entering any chamber. There is possibility of minor air loss at the time visitors will enter/exit the pressurized chamber.

$$V = l \cdot b \cdot h$$

$$= 4 \cdot 10 \cdot 4$$

$$= 160$$

$$\text{Percentage of air lost} = 5/100 \cdot 160$$

$$= 8 \text{ cubic meters}$$



4.3.2 Tethers and handrails



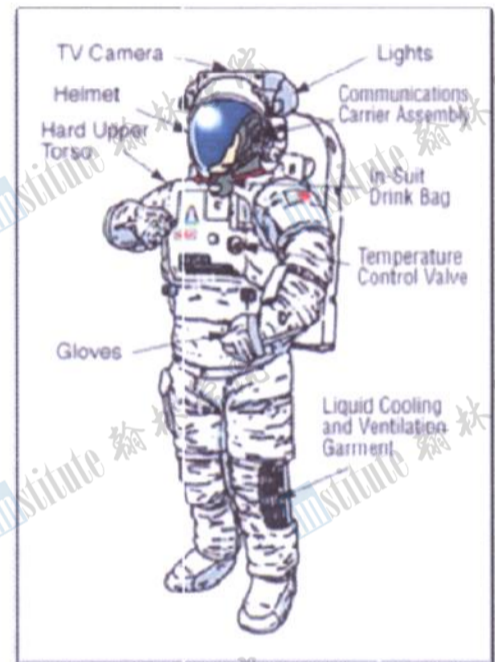
Tethers, cages and handrails will be used as a precautionary measure to keep a person at a desired fixed place while the person will be playing micro-g games. This will prevent the possibility of the person floating away from the desired area. This will also ensure that other moving objects do not injure the person.



4.4.1 Space suit designs

Pressure suits will be used for specialized tasks such as high altitude reconnaissance flight. Bio suit will be a specialized space activity suit which will fit each wearer, using laser body scanning. List of materials used in space suit are:

- Kevlar 49
- Nickel titanium layer
- Nylon-spandex
- Elastic
- Urethane painted foam



4.4.2 Space Boots

Technical Details:

Upper: Leather

Lining: AIR TECH breathable

buckles: 4 polyurethane buckles with quick release system

Protections: inside suede heat protector; shin plate, steel toe cap, rear polyurethane heel protector and ankle protector

Colors: White, Black

Sole: dual compound rubber sole, oil and petrol resistant

4.4.3.1 Donning of a Spacesuit

1. Pressure in airlock system is increased
2. Person to Pre-breathe 100% oxygen for 30 minutes
3. Put on MAG and LCVG
4. Attach DCM to HUT
5. Attach arms
6. Rub helmet with antilog compound
7. Place EVA on helmet
8. Connect ECA
9. Step into LTA and pull it above the waist
10. Squirm comfortably into upper torso portion of suit
11. Attach cooling tubes of LCVG to PLSS
12. Lock LTA to HUT
13. Put on CCA and eye glasses
14. Wear gloves





15. Lock the helmet, EVA and outer gloves
16. Check EMO for leaks by increasing pressure to 0-20 ATM above airlock pressure
17. Suit is tethered to airlock door
18. Door is opened
19. SCU is disconnected from EMU
20. Step out of the airlock

4.4.3.2 Doffing a Space suit

1. Step into airlock
2. Connect SCU to EMU
3. Close the door
4. Unlock helmet, EVA and outer gloves
5. Remove CCA and eye glasses
6. Unlock LTA and HUT
7. Disconnect EEH electrical connection to PLSS Detach cooling tubes of LCVG and PLSS
8. Take off upper torso portion of suit
9. Step out of LTA
10. Disconnect CCA
11. Detach arms
12. Detach MAG and LCVG

4.4.4 Space suit storage

The space suits will play a vital role as they will help in repairing and transportation outside the space settlement as we can go to outer space safely if we wear them. Therefore they will be stored near the docking ports. A chamber near the airlock systems will be provided as well for storing the space suits. They will be used in order to enter or exit the settlement as well. Biological suit with unique features will be used in unpressurized and will consist of:

- Skin tight body suit and pressurized helmet representing clothes
- Hard torso & Chest shell and electromagnetic gecko boots with thrusters for sleek and simple movement
- Portable life support system having oxygen tank, cooling water system and carbon filters.
- Piezoelectric pumps.
- Easy to don and doff taking only 20 minutes and weighing 7 kg.
- Digital display in helmet and control panel on hand with a health monitoring system.



Material for Bio suit:

1. Electric alloy mesh
2. Thermal gel
3. Electric gel
4. Stretch alloy band
5. Electric alloy zipper
6. Nickel-titanium alloy
7. Nitinol



4.5 Security

We will have to provide security scans to keep away the activities of the visitors from normal routine lifestyle and for security of people living in the space station. We have provided the following scans:- Electronic Access Control Solutions

Anticipated security issues	Security response
Mutation in plants	The plants will be sought out and quarantined for study
Dormant viruses in animals/plants	Animal put to sleep and incineration of carcass
Contamination of water supply	Immediate shutdown of primary water supply. Secondary supply started after checking
Contamination of air	Immediate curfew imposed in houses with secondary air supply coming into effect after checking
Plot to blow up Foundation Society HQ	Foundation society HQ has blast proof structure and is situated in the utmost secure area
General lawlessness (including extreme acts like arson, assassination, etc.)	NIGHTCRAWLER will apprehend the culprit. Culprit sent to earth to be tried by judiciary
Riots	NIGHTCRAWLER is equipped with riot gear to disperse unruly crowds
Forced entry into docks and sensitive areas	XYZ will immediately stop the intruder and confine him till a punishment has passed

Anticipated security threats	Cause of threat	Solution
Theft	Unauthorized access to restricted areas	Surveillance systems
Fire	Due to excess heat generated due to various activities	Hydrant and suppressant sprinklers, smoke detectors
Unauthorized access to data	System hacks and fake identities	(Iris, vein, laser) Scans
tourists can interrupt in the functioning of the settlement	Disruption of normal living environment of permanent residents	They will be staying in a different torus
Excessive and differentiated data in servers resulting in overloading	Excessive amounts of vast data in security checks, communication	Differentiated servers
Epidemics of unknown diseases	New diseases which haven't been faced before	Medical quarantine(isolation) Treatment performed in isolation to prevent the spreading of diseases

Access control systems provide exclusive security by providing access only to authorized personnel to enter & leave the premises. These access control solutions are based on Biometrics, Smartcards, RFID Tags etc, thereby making the System more reliable & fool proof. Regular but unobtrusive security robots will be constantly moving around the settlement. These will be equipped with hi end sensors as well as stunning/temporary confinement weapons. These will be ...in numbers. They will be connected to the master security server which will send out alerts at time of any attacks, general misconduct of residents. These will be in addition to CCTV cameras installed all over and will be used to move in quickly in times of crisis.

Upon entry to the settlement, each permanent and visiting person will be given a rule book and orientation film will be shown alerting them to various rules and do' and don'ts expected of them while in residence.



Misbehavior and anti social activities shall be discouraged and punished by way of confinement in higher g areas. For major offenses, they will be sent back to earth for trial by existing judicial systems.

4.5.1 Aerial Surveillance Solutions

Surveillance done with a bird's eye view is the most effective form since it offers a complete picture of the activity area & its surroundings. Our offering includes a wide variety of aerial surveillance solutions that can add value to security & surveillance measures.

4.5.2 Baggage Screening Solutions

This will be deployed both for in coming as well as outgoing traffic. X-ray based baggage screening will be deployed to detect explosives, weapons, narcotics & other contraband items that may be concealed in objects. Strictly no firearms or weapons or technology or material to produce them on the settlement shall be allowed. In coming residents will also have to undergo full body scans.

4.5.3 Fire Detection & Suppression

Fire detection is done through special sensors that detect smoke & fire even before they spread. Once detected, Suppression solutions will be activated which could be hydrant based, dry suppressant based extinguishers. High end sprinklers will ensure that the fire is under control & extinguished. Each torus shall be divided into 6 sections so that in a worst case scenario the people of the particular section would be evacuated and the shutters would enclose the particular section to stop the fire from spreading. The fire caused by electrical or fuel based sources would be controlled by hydrant & suppressant based sprinklers.

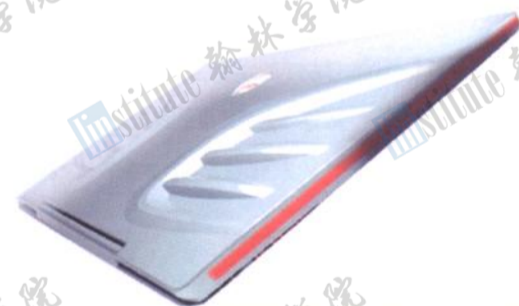
5.1 AUTOMATION DESIGN AND SERVICES

To meet requirements of maximum comfort and advanced technology to run Columbiat efficiently, we propose to provide automated systems and Hi-end computers. Construction, security, maintenance and day-to-day running will be greatly aided by robots and other automated services.

5.1.1 TYPES AND NUMBER OF COMPUTERS

Columbiat will depend on computers for a large amount of work and functions. Large capacity, ability to switch between multiple networks, fast servers, back-up systems will be built in to all systems.

Types	Processor	Numbers
Servers	3.98 GHz (24-32 cores)	20
Nodes		192
1.Administration desktops	4.2 GHz (16-20 cores)	22,000+1500 variants
2.Artemis	3.8 GHz (10-14 cores)	
3.Touch Screen Laptops	3.8 GHz (13-19 cores)	



5.1.1.1 TOUCH SCREEN LAPTOP

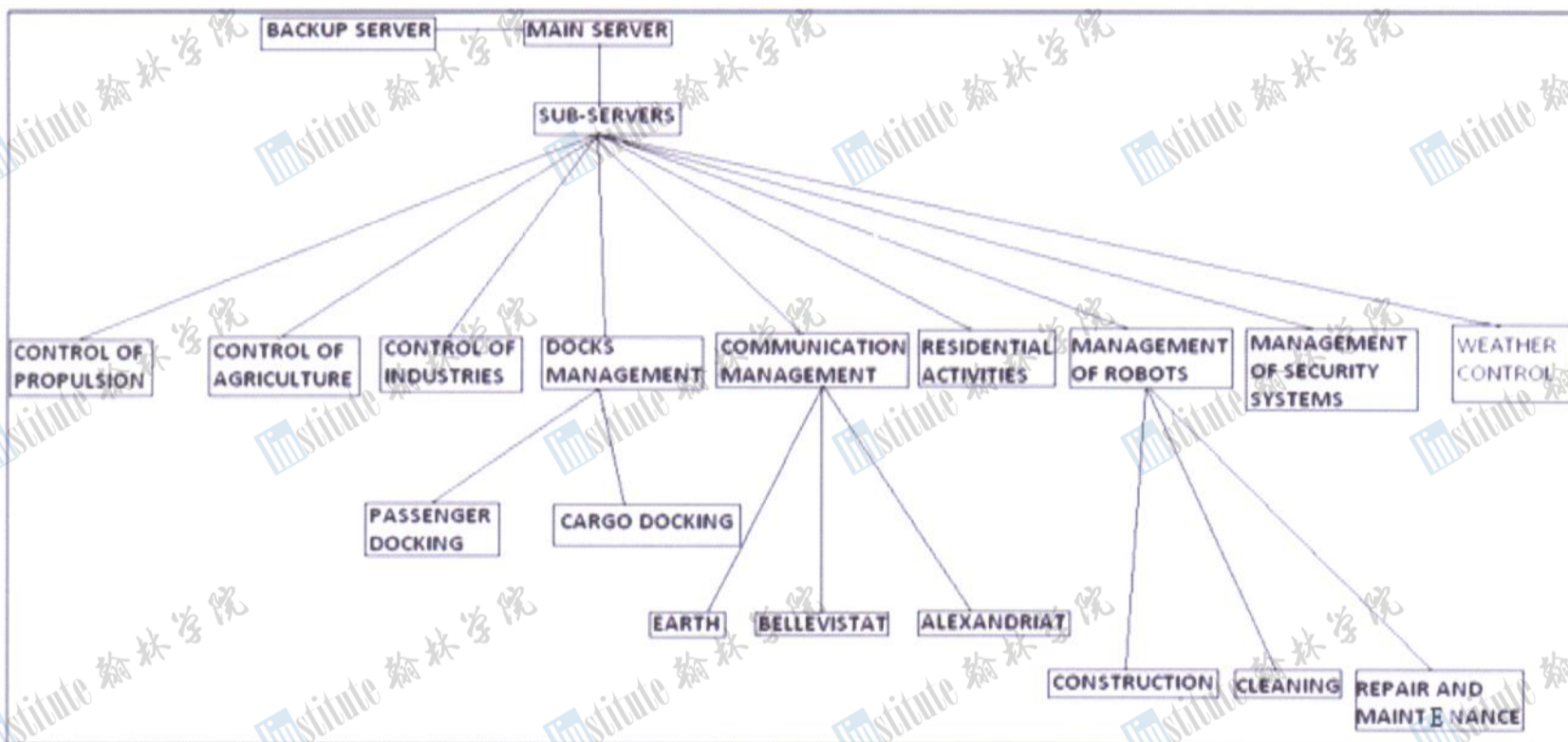
5.1.2 NUMBER AND TYPES OF SERVERS

These servers placed at the central hub will be responsible for various functions from rotation to agriculture, hence will have no or minimal chances of failure. Only authorized personnel will be allowed access and control of the servers as they will be the "brain" of the settlement.



Purpose	Processing Speed	Storage	RAM	#
Control propulsion, rotation and revolution	18 PFLOPS	38 PB	1.42 PB	1
Control of Agriculture Activity	10 PFLOPS	9 PB	512 TB	1
Control of Industrial Activity	9 PFLOPS	9 PB	640 TB	1
Management of docks and communication facility	18 PFLOPS	34 PB	1 PB	4
Residential Activities	11 PFLOPS	18 PB	768 TB	1
Controlling of Robots	15 PFLOPS	34 PB	1.32 PB	6
Controlling of Security Systems	9 PFLOPS	8 PB	640 TB	1
Management of Cargo Transportations	18 PFLOPS	8 PB	768 TB	2
Inventory Management	11 PFLOPS	10 PB	1.00 PB	1

5.1.2.1 SERVER HIERARCHY



5.1.3 NUMBER AND TYPES OF SOFTWARE

The main software, **EASYNAT** will control the propulsion and rotation of the settlement. Easynat also has the ability to predict and detect any threat up to one year in advance. The **ASTRANET** and the **OPTIMUM WEATHER CONTROLLER** will serve needs of internal communication and weather modifications.

Name of software	Purpose of the software
RETRO	Personifies the domestic robot and controls the house wirelessly.
EASYNAT	Controls the rotation, propulsion and revolution of the structure.
ASTRANET	Controls the network devices and network connections.
OPTIMUM WEATHER CONTROLLER	Controls the weather conditions, atmospheric pressure, and other climatic factors.
HEFTILE	Protects the system against spywares, adware and viruses.
HASTEX	This is the operating system used in the nodes at the settlement.
UPKEEPER	This software backs up all the critical data to the MEO satellites



5.1.4 NETWORK DEVICES

In order to connect people of the earth and the other settlements with the people of the Columbiat we will produce excellent internet facilities to run WI-FI enabled laptops, remote signal catching UHF towers , WI-max routers and WI-FI enabled artemis. The UHF towers would be the main networking devices and would catch signals and transfer signals to and fro. The satellites which would be rotating the settlement would be used to direct the cargo ships and transfer signals for communication. The signals emitted by the satellite would be caught by the UHF towers, and further transferred to the WI-max routers; WI-FI enabled laptops, and Artemis.

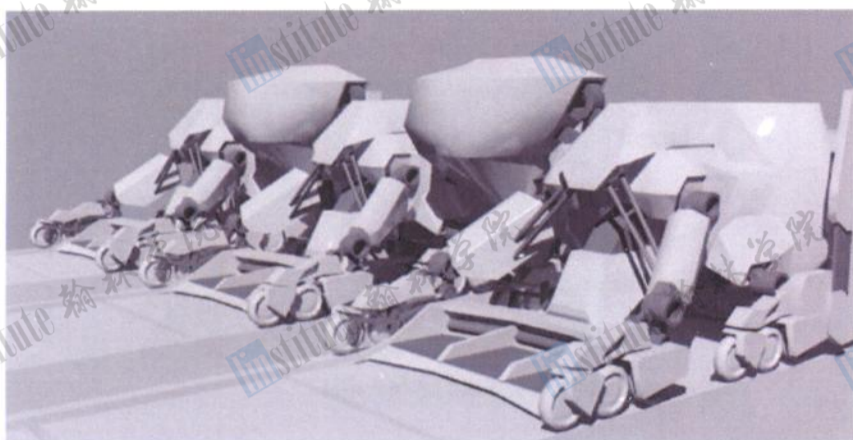
Wireless	Specification
UHF's Towers(Ultra High Frequency Devices)	3.8 GHz speed of data transfer
WI-FI enabled laptops	4-8 GBps transfer speed
WI-max routers	15 GBps transfer speed
WI-FI enabled Artemis	3-5 GBps transfer speed

5.1.5 DATA STORAGE AND DISTRIBUTION

Exchange of data between the earth and the settlement being of prime importance, critical data stored in the server needs robust backup, for which an **auto backup system** for all servers and private users will transfer data at regular intervals to the MEO satellites.

Data storage devices	Amount of data storage
MEO satellite	1 TB storage in each inch
Super PD	Can store up to 8-16TB
Frequency	Purpose
2.4 GHz to 4.8 GHz	Internal communication of the residents
8 GHz to 9 GHz	Data exchange between servers of the Columbiat and other settlement
25 GHz to 28 GHz	Communication of high security servers.

5.2 ROBOTS FOR SETTLEMENT



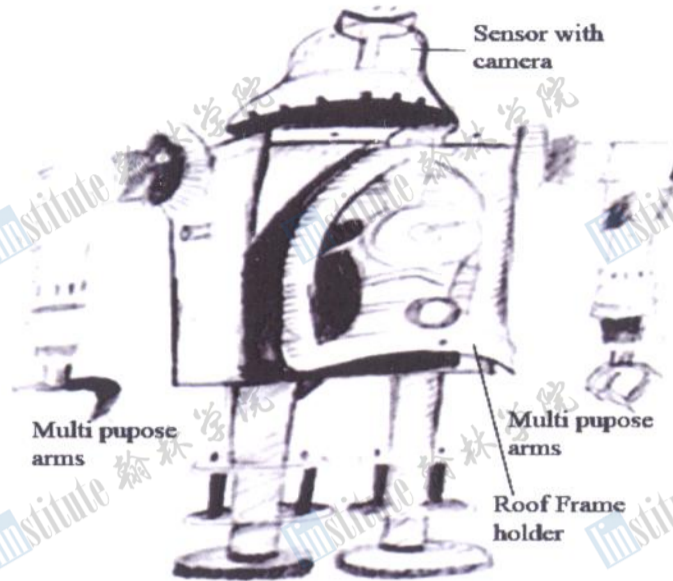
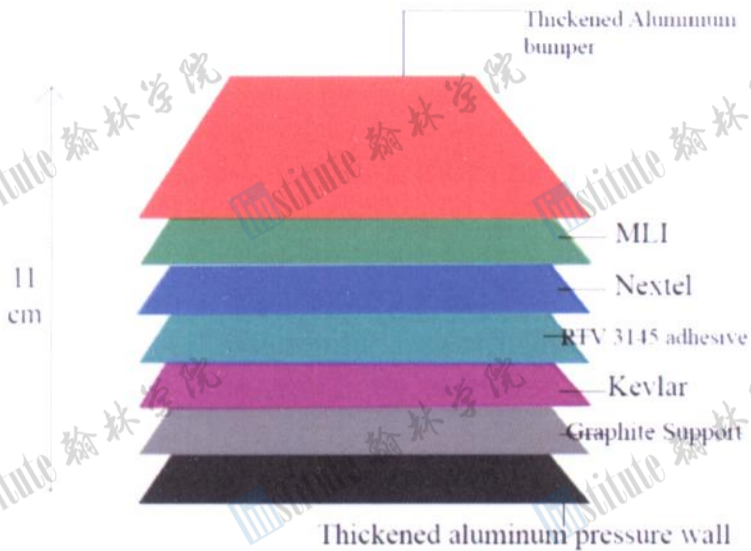
5.2.1.1 DONNEL (EXTERIOR CONSTRUCTION)

5.2.1.2 Donnel - 2
(INTERIOR CONSTRUCTION)

Name of Robot	Purpose	Dimension	Quantity
Donnel	Exterior construction	7ft*4ft*3ft	745
Donnel-2	Interior construction	5ft*3ft*1.5ft	575
Assembleox	Assembling	5ft*4ft*1ft	370
Welfer	Welding	4ft*2.6ft*1ft	290
Nutox	Roof frames	4ft*3.5ft*2ft	170
Derigible	Maintenance and repair	4ft*2.5ft*1ft	450
Bionic Arm	Cargo transportation	(13*2.5) feet ²	40
Damas	Mining	4ft*1.7ft*2ft	115
IMP	Sterilization	Size of a blood cell	345

(TOTAL ROBOTS-10,200)

Physical construction of the settlement will be undertaken solely by robots. These construction robots will have a coating of aluminum, zinc, conglomerate, and chromium to protect it from direct radiation and sunlight.



5.2.1.3 MATERIAL TO PROTECT ROBOT FROM SOLARE FLARE

5.2.1.4 NUTOX (Roof framing)

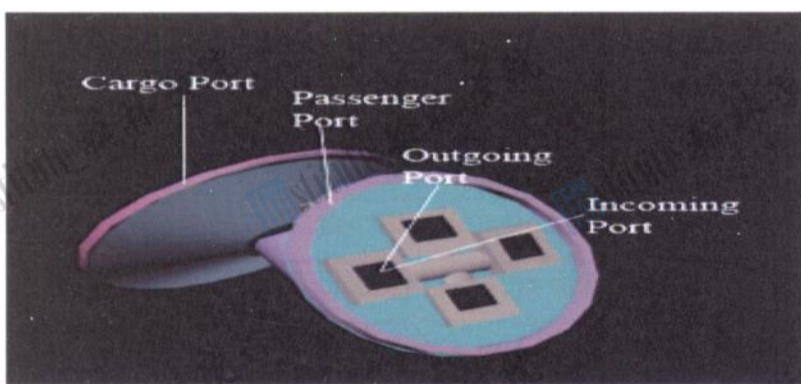
5.2.2 TRANSPORTATION AND DOCKING SYSTEMS

High technology vehicles running on efficient energy derived from hydrogen and solar energy would be used for transportation. Transportation of goods from one part of the torus to the other would be done by special rail systems placed at each end of the spokes. Spokes would be utilized as support as well as for transportation of goods. The docking systems of the settlement are so inclined that it makes it easy for the incoming ships to cope up with rotation speed of the settlement and then land on it.

The docks are divided into two types and then they are further divided into two categories:

- Passenger docking : Incoming docking; outgoing docking
- Cargo docking: incoming cargo ; outgoing cargo (refer locations of docks)

The docks will be equipped to accommodate visitors from earth, moon, Alexandriat, Bellevistat, Alaskol and other near earth asteroids.



Name of Ship	Destination of Cargo
Marid	Earth
Ashton	Moon
Afrit	Alexandriat
Trooper	Bellevistat
Tangent	Alaskol

5.2.2.1 DOCKING SYSTEM

5.2.3 TRANSPORTATION OF MATERIAL AND EQUIPMENT

During the early stages of construction, material and equipment would be transferred from earth to Columbiat via Marid. Batch ships will transfer cargo and engineers from earth through external ships to the construction site.

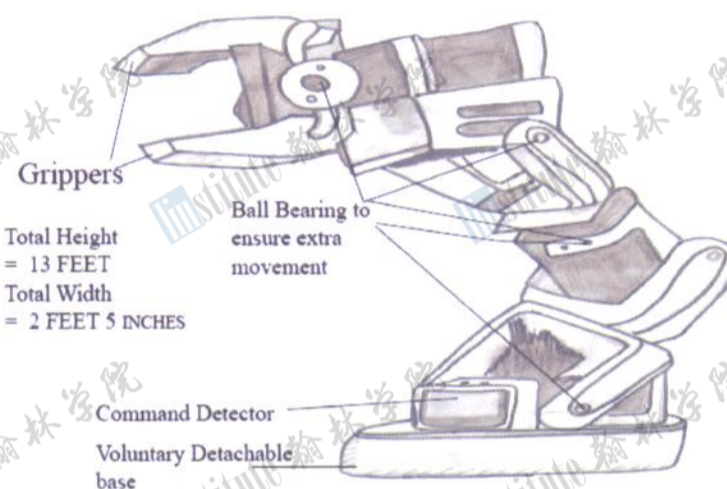
5.2.4 Security system

Security being a paramount concern at Columbiat, a high security system called NANOCHIP is being proposed. This system will be equipped with sensors and warning systems, with the ability to predict and detect threats.

NANOCHIP LEVELS	SECURITY PROVIDED TO AREAS
LEVEL-1	Used in residents, each person would have barcode encrypted on his NANOCHIP.
LEVEL-2	Used in industrial hub, in the offices. Each person will have three NANOCHIPS in his body to ensure extra security
LEVEL-3	Used in the industrial hub for access to the servers. Each person has at least six NAOCHIPS in their body. It ensures protection against any unauthorized access of data

5.3 AUTOMATION OPERATION

Name of Robots	Purpose
Repair Robots	
SOLAN - 20	Emergency exterior repairing
SOLAN - 32	Interior repairing
Maintenance Robot	
BORUC	Exterior maintenance
LAVANGE	Interior maintenance
Construction Robot	
DONNEL	Exterior construction
DONNEL- 2	Interior construction
ASSEMBLEOX	Assembling of construction material
WELFER	Welder for interior and exterior
NUTOX	Construction of roof frames
DERIGIBLE	Maintenance and repair of construction robots
Cargo Transportation Robot	
BIONIC ARM	Cargo handling
ACOUSTIC	Emergency mass evacuation
ASAPHALT	Loading and unloading cargo
Sterilization Robots	
IMP	Space dust cleaning and medical help
Mining Robot	
DAMAS	Mining the moon and other bodies for construction material
DAMAS-2	Ore extraction
Domestic Robot	
LITHLEA	Household Robot



5.3.1.1 BIONIC ARM- Cargo Handling



5.3.2.1 SOLAN-32(Interior Repair)



5.3.2 Robots for maintenance, repair and safety

Robots for Repair , Maintenance and Safety	
SOLAN - 20	Emergency exterior repairing
SOLAN - 32	Interior repairing
BORUC	Exterior maintenance
LAVANGE	Interior maintenance

1. REPAIR ROBOTS-

will be used for repairing of damaged exterior and interior parts in case of failures, caused due to major debris penetration. For this we have **SOLAN - 20** and **SOLAN - 32**

2. MAINTENANCE ROBOTS-

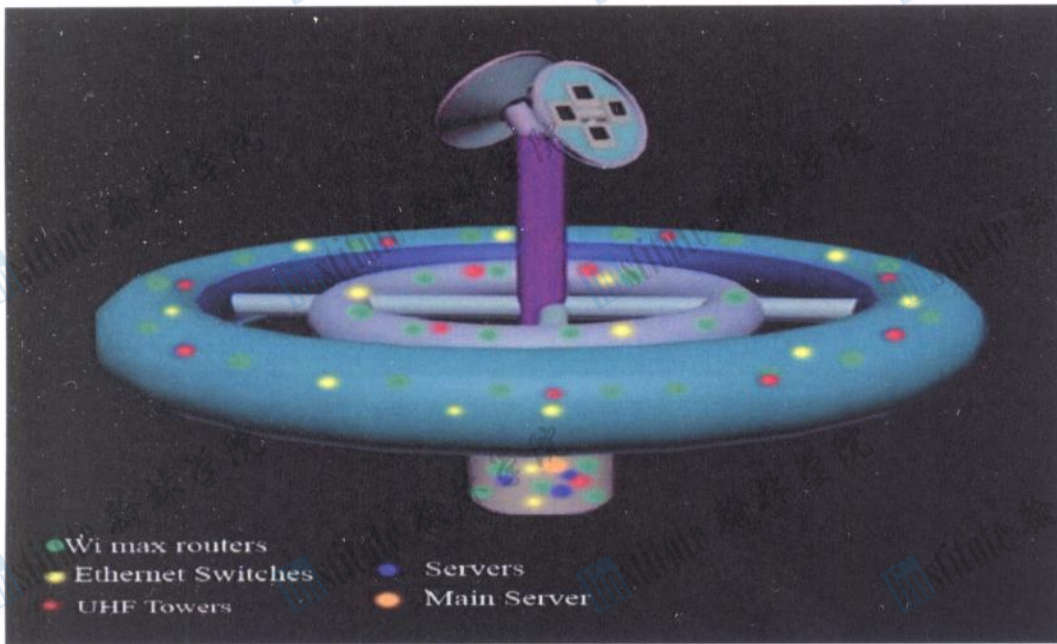
will function on a constant and regular basis repairing faulty robots, machinery and settlement simultaneously. These will be **BORUC** and **LAVANGE**

5.3.3 CONTINGENCY PLANS AND SERVICES

The contingency plans described in the table below are ultra high efficiency and quick response methods to enable the settlement to work in a safe and secure manner at all times, safeguarding from malfunctions or accidents.

Contingency	Actions to be implemented		Response Time
Asteroid Penetration	Minor Debris Penetration	Major Asteroid Penetration	
	Walls of the settlement shall be temporarily sealed with Polyethylene foam	We will be having gravitational tractors to prevent asteroid from colliding with the settlement (3)	30 min – 45 min
	Walls repaired by the SOLAN-20 and BORUC using RTV 3145 Adhesive as soon as possible to avoid in inconvenience		<2 hours
Misbalancing of Climate	The OPITMUM CLIMATE CONTROL server would make necessary changes through climax		<5 min- 15 min
	Purifiers would be used to purify contaminated air		3min - 7 min
Fire	The area would be evacuated and people be removed to a safer place		< 45 min
	Mono ammonium phosphate along with dry ice would be sprinkled		< 5 min
Solar Flare	The polyethylene layer of the settlement acts as a shield.		5-10 seconds
	BORUC shall be sent to the exterior, to check and repair any damaged parts.		< 5 min
Settlement Collapse	The people would be transported to Alaskol, Alexandriat, Bellevistat, Earth via Tangent, Afreet, Trooper, Marid.		< 4 hours hours
Docking Accident	The route traffic shall be diverted to other docks		5 min - 7 min
	Repair robot shall come into play and repair sooner possible to avoid inconvenience		< 1 hour
Network/ Server Failure	Backup server shall start functioning and control other sub servers a period of time		20 seconds
	L AVANGE shall repair the server and bring it back into operation.		<17 min
Unauthorized access of data	System or network shall be jammed by the HEFTILE and trap the culprit		8 min – 7 min
Disaster in main torus	Immediate isolation via shutters and evacuation via escape pods.		<17 min

5.3.4 PHYSICAL LOCATION



5.3.5 ENHANCING LIVABILITY

To enhance the livability aspects of the settlement and to compensate for loss of earthly pleasures, hi tech gadgets will help make routine tasks easy and life enjoyable, leaving inhabitants with leisure time to enhance quality of life. **ARTEMIS** and **LITHLEA HOUSEHOLD ROBOT** are examples of such tools.

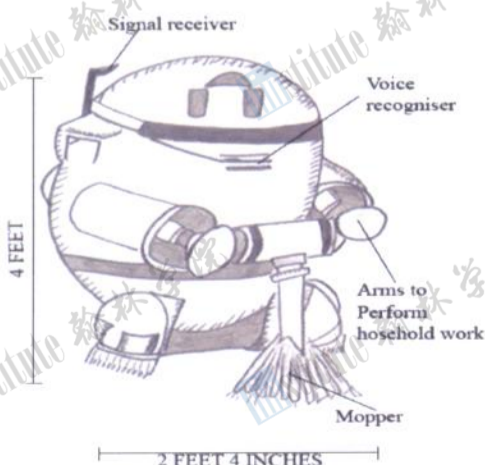
5.3.5.1 FEATURES OF ARTEMIS



5.3.5.1.1 ARTEMIS

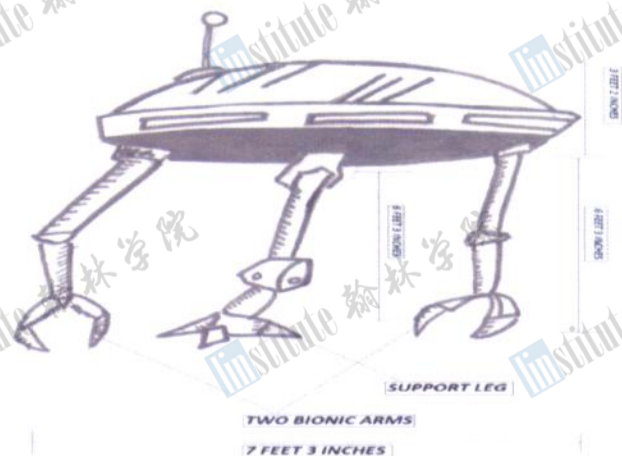
Wi-Fi enabled , Provides high speed networking , Wirelessly controls the house and the robot ,Video conferencing , High speed data transfer, has 10-14 cores to do given tasks faster, Can connect to the servers on the earth, Emits waves that can travel without medium, People can talk to each other on phone between settlements and earth, Durable battery life lasts up to 3 months , Can withstand extreme climate, water, electricity and vacuum resistant , access to computing and robot resources from any part of the settlement.

5.3.5.2 FEATURES OF LITHLEA



5.3.5.2.1 LITHLEA

Does all the household work , Can be controlled wirelessly through Artemis, Acts as a security robot for the house, User friendly voice recognition programmed to do all given tasks, Already installed household tools to make work faster, Automatically does pending work, Easy



5.3.6.1 ASAPHALT

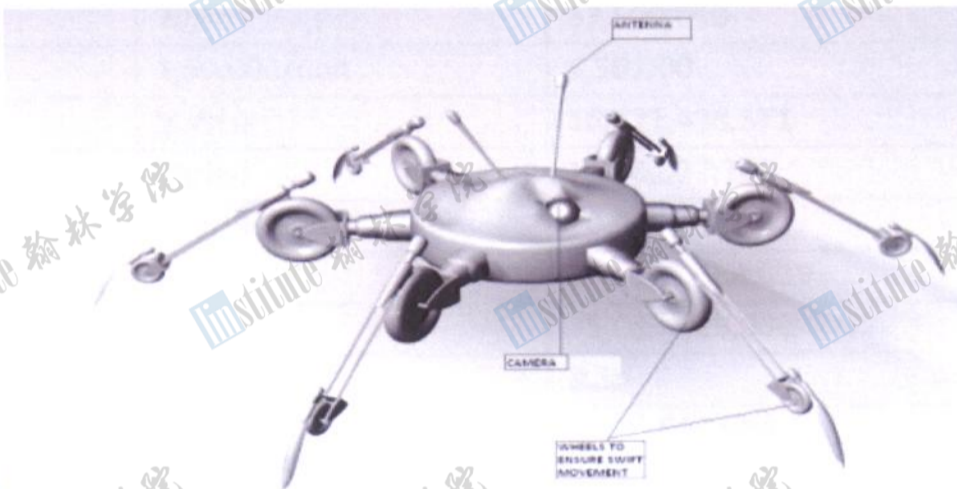


programming for handicapped users, perform routine tasks and perform all the manual activities without their presence.

ASAPHALT- this robot is used to load or unload cargo material from the ships entering the settlement. This robot is a little big and has two huge arms and leg. Each arm can lift up to 150 tons. This robot will mainly be seen in the docking area.

5.3.7 ROBOTS TO PROTECT SETTLEMENT FROM DUST

IMP- A multi-purpose robot is actually a Nanorobot. 100 of these will be placed at the airlock system to clean and decontaminate people and materials entering the settlement, apart from providing cleaning services to visiting ships. IMP will also double up as a medical assistant, to penetrate into the patient's body and look for and cure any type of minor diseases. It would also prevent dust contamination and the entry of foreign particles into settlement via people coming to settlement and goods arriving at cargo ports. The docking system consists of such a prevention method that decontaminates the ships arriving either of the two ports.



6.0 Cost and Schedule

Phase - 1

Material	Quantity	Cost\$/Qty.	Total Cost\$
Research Studies	1575	37500/unit	59,062,500
Construction Materials	15210411.8 kg	Varied	1,690,492,880
Shielding Materials	5204060kg	Varied	634,442,455
Robots	2860	Varied	403,182,869
Transit Cost	27172760kg	1000\$/kg	27,172,760,000
Miscellaneous	Varied	Varied	5b
Delay cost	Varied	Varied	2.5b
Total Cost			\$37,459,940,704

Phase - 2

Material	Quantity	Cost\$/Qty	Total Cost\$
Research studies	2425	15000/unit	36,375,000
Construction Material	21,473,618.975kg	Varied	2,261,172,078
Shielding Material	6361695kg	Varied	775,554,237.5
Mirror	1	700,000,000	700,000,000
Robots	1300	Varied	335,424,930.541
Transit Cost	61795612.5	1000\$/kg	61,795,612,500
Miscellaneous	Varied	Varied	4.5b
Delay Cost	Varied	Varied	5b
Total Cost			\$75,404,138,746.041



Phase - 3

Material	Quantity	Cost\$/Qty	Total Cost
Research Studies	2640people	15000 per unit	39,600,000
Docks	8	1b/unit	8,000,000,000
Warehouse	5	1b/unit	5,000,000,000
Water Management System	3	8.3m/unit	24,900,000
Waste Management System	3	10.5m/unit	31,500,000
Thrusters	6	47m/unit	282,000,000
Solar Panels	1875000	20/m ²	37,500,000
MEO Satellites	3 Units	1,50,000/unit	4,50,000
Space Ships	150	Varied	16,821,428,571
Agriculture	7,53,982.24m ²	Varied	1,130,973,360
Day/Night Cycle	140 PHOLEDs	500/PHOLED	70,000
Robots	4,500	Varied	548,115,064.039
Transit Cost	75,083,025kg	1000/kg	75,083,025,000
Miscellaneous	Varied	Varied	3.5b
Delay Cost	Varied	Varied	2,000,000,000
Total Cost			\$112,499,561,995

Phase-4

Material	Quantity	Cost\$/Unit	Total Cost(\$)
Research Studies	1375 people	20,000/person	27,500,000
Houses	13375 units	Varied	2,233,625,000
Tethers	22500m	25/m	562,500
Handrails	8000units	77/unit	616,000
Hospitals & Nursing Homes	1 & 4 respectively	Varied	3,392,280
Roads	422368m ²	75/m ²	31,677,600
Recreational centers & theatres	36units	Varied	638,179,472.5
Spacesuits	25000	21000/unit	525,000,000
Schools	1 unit	380,700/unit	380,700
Bionic Arms	40	500,000/unit	20,000,000
Hotels	3 units	438,300/unit	1,314,900
Training Centers	1unit	7.3m/unit	7.3m
Stadium	1 unit	2.4b/unit	1.5b
Offices	250 units	176250/unit	44,062,500
Robots	1500 units	Varied	371,835,470
Transit Cost	31366695 kg	1000\$/kg	31,366,695,000
Miscellaneous	Varied	Varied	3b
Delay	Varied	Varied	2.75b
Total			\$ 39,774,891,422



Phase - 5

Material	Quantity	Cost\$/unit	Total Cost(\$)
Research Studies	985 people	16000/unit	15760000
Internal Communication System	Varied	Varied	18.5m
Servers	20 units	Varied	12.6b
Desktops	192 units	1250/unit	240,000
Softwares	88036 units	Varied	13,248,600
Robots	40 Units	Varied	13,980,000
Transit Cost	13,114,167.5kg	1000/kg	13,114,167,500
Miscellaneous	Varied	Varied	2b
Delay Cost	Varied	Varied	0.5b
Total Cost			\$ 22,675,896,100

Grand Total = \$287,814,428,967.041





Scheduling

Event↓ Year→	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Contract awarded														
Definition and construction of material source bases														
Construction of central hub														
Construction of Docks														
Construction of spokes														
Construction of agricultural torus														
Installation of Power System(Solar Panels)														
Construction of industrial cylinder														
Construction of Outer Torus														
Addition of Thrusters														
Addition of Atmosphere														
Installation of Water Management System														
Installation of Mirror(for directing sunlight to solar panels)														
Construction of Agricultural Systems														
Waste management														
Construction of external and internal communications														
Construction of interior of the permanent residential torus														



7.0 Business Development

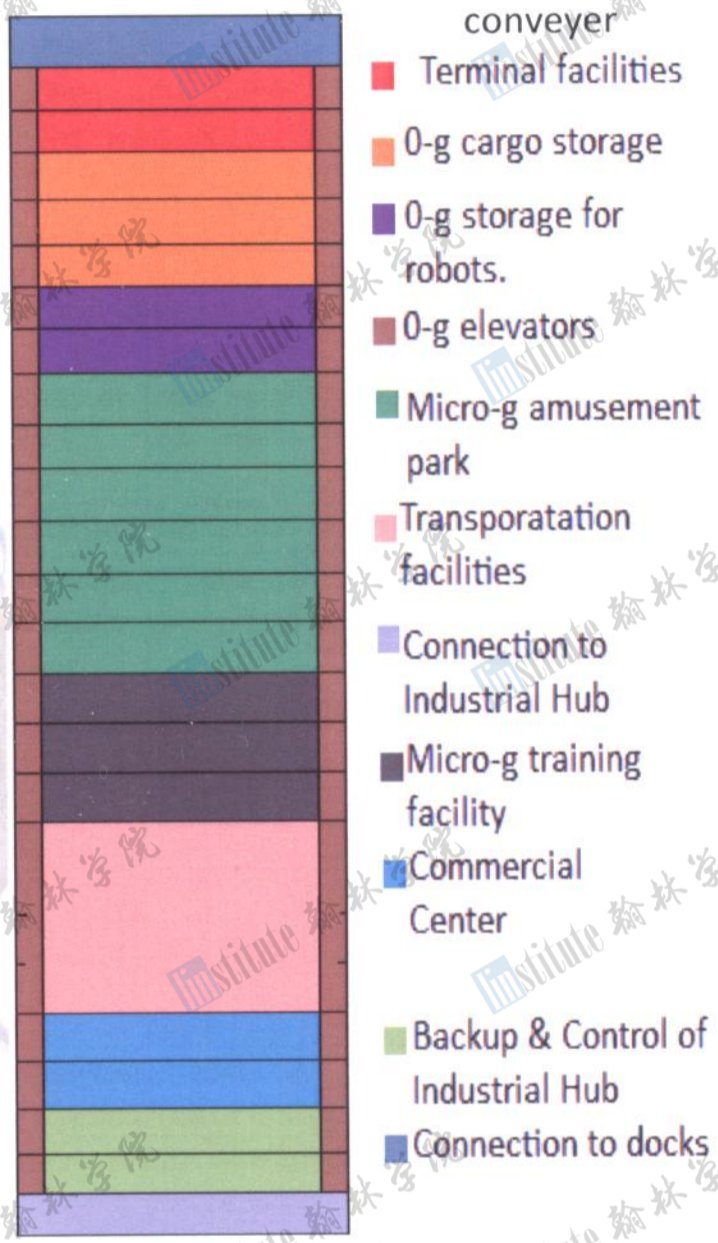
Docking Port

- Passengers : Elevators in the passenger corridors allow safe transfer
- Hotels and communities where passengers will stay allows passengers to enjoy their time at Columbiat before their next flight departs
- Cargo Facilities : Large docking port allows ships of all sizes to port
- Cargo is transported through electromagnetic belts in between ships and dock ports
- Ware housing and bulk provided beneath loading and unloading areas which will hold cargo for ships which have not yet arrived
- Docking base provides:
 - Fuel
 - Repair And Maintenance
 - Docking port for out of service ships

Terminal Facilities

- The Central Hub shall be directly connected to the ports and shall provide a whole lot of recreation, and entertainment for passengers waiting for their flight.
- There shall be an A-class help facility for passengers to help out with their problems and to handle the passenger traffic along the ports.
- Medical facilities shall work 24/7 along the ports for quick service.

In future, the settlement is even capable of sustaining about 5000 of transient population along the agricultural and residential torus.



Cross section of Central Hub

Commercial Facilities

- Since the settlement is a business hub, 9 commercial centers including a headquarter (in the outer torus) with utmost financial facilities are provided all over the settlement.
- Since the approximate time for the construction of the settlement is 12 years but the business shall commence within 6 years with the construction of the small torus.
- The connectivity all round the settlement and even outside shall be totally secure and quick. Every PC shall be provided with an anti – virus program so that there is no problem of viruses and hacking.
- In case of any crisis in any other settlement, there shall be an emergency transportation of required cargo from the storage to the docks and then to the desired destination.



8.0 COMPLIANCE MATRIX

Structure and Design

Pt. No.	SOW Requirements	Fulfillments	Page No.
2.0	Settlement to ensure safe living for 22,000 full time residents and 2500-5000 transient population.	Outer torus for residential and commercial purposes, inner torus for agriculture and half – g residing, and a separate industrial hub.	5-6
2.1	Exterior view, uses, radiation protection, rotating & non-rotating sections, pressurized- unpressurized section, dimensions, and artificial gravity provisions.	Labeled diagrams and tables, multi-layered shielding with properties, and tables for dimensions and artificial gravity.	6-9
2.2	Overall map layout of interior allocation of settlement, orientation of down – surfaces with vertical clearance, usage of micro – g areas..	3 labeled diagrams, and a table showing allocation of the settlement area, labeled diagrams of cross sections with vertical clearance, table for usage of micro – g areas.	10-11
2.3	Construction sequence	7 – Step construction sequence.	11-12
2.4	Location and functioning docks	Labeled diagrams, rationale for functioning and description and labeling all the provisions.	12-13
2.5	Half – g accommodation and provision.	Overall labeled drawing of settlement showing the low – g area and a table for rotation rates.	13

Operations and Infrastructure

Pt. No.	SOW requirement	Fulfillment	Page no.
3.1.1	Identify sources of materials and equipment to be used in construction and operations	Labeled diagram and 2 tables explaining the sources of materials	14
3.1.2	Means for transporting those materials to the Columbiat location, and storage between arrival and use.	Tables defining means of transport	14
3.2	Elements of basic infrastructure required for the activities of the settlement's residents	Clearly labeled diagrams and tables showing locations and uses of basic infrastructure	14 – 18
3.3	Existing or new on-orbit infrastructure required to develop and sustain settlement operations (e.g. vehicles, satellites, and power plants)		18
3.4	Propulsion systems required on Columbiat, for establishing and maintaining rotation of artificial gravity volumes, and station-keeping at Earth-Moon L2.	Thoroughly researched propulsion systems. Diagram showing placement of propulsion systems	18 -19
3.5	Provisioning and maintenance services for on-board systems of visiting ships	Diagrams clearly showing provisioning services, storage and paths showing direction of travel	19



HUMAN ENGINEERING

Pt. No.	SOW Requirements	Fulfillments	Page No.
4.0	Provision of natural sunlight & views of earth readily along with high standards of living.	Artificial light and viewing galleries with transparent windows.	20 & 4
4.1.1	Adequate and ample education, medical and recreation facilities coupled with comfortable and modern housing	Labeled drawings and tables mentioning layouts of community attributes	20 – 22
4.1.2	Consumables including clothing, medicines and paper	2 tables mentioning consumables & their sources	22
4.1.3	Psychological and physiological factors.	2 tables mentioning psychological and physiological factors and their remedies.	23-24
4.2	Drawings of homes, differentiated neighborhoods, demographics	Labeled drawings, tables as well as floor layouts.	25-27
4.3	Designs of systems, devices, vehicles and safety measures.	Labeled diagrams and various tables on safety of the residents at each point in the settlement.	27-28
4.4	Spacesuit designs, donning & doffing procedures and airlock designs.	Neat drawings of spacesuits, airlocks and systematic procedures for donning & doffing	28-29
4.5	Designs of hotels, accommodations for visitors and quarantine safety measures for them.	Labeled designs of hotels and table for safety measures.	30-31

Automation and Design

Pt no.	SOW requirements	Fulfillment	Page no.
5.1	Specify no. and types of servers, computers, network devices, software, data storage and data transfer devices.	5 tables describing all types of data storage and distribution devices, servers, computers and softwares used for the settlement.	32 – 34
5.2.1	Types of construction robots	All types of robots constructing the settlement are specified in the table.	34
5.2.2	Transportation of passengers and construction material and docking systems.	Transportation of construction material and passengers to the settlement by the cargo and passenger transportation ships.	35
5.2.3	Security systems that are to be used in the settlement	Nanochip system is used in the settlement as security system.	35
5.3.1	All the robots used in the settlement.	Table describing all the robots in the settlement.	36
5.3.2	Repair and emergency robots and contingency plans.	Repair robots and maintenance robots described in a table. Required contingency plans needed for the settlement specified in a table.	36 – 37
5.3.3	Physical locations of the servers and the network devices and how to enhance livability in the community?	Labeled diagram. We are using ARTEMIS phone and Lithlea a household robot to enhance the quality of living.	37 – 38
5.3.4	Protection from dust contamination.	Labeled diagram of robot and procedure.	38



9.0 Bibliography

- Google groups
- Wikimedia groups
- Yahoo!
- Howstuffworks
- Discovery channel
- National geographic channel
- D&K space encyclopedia

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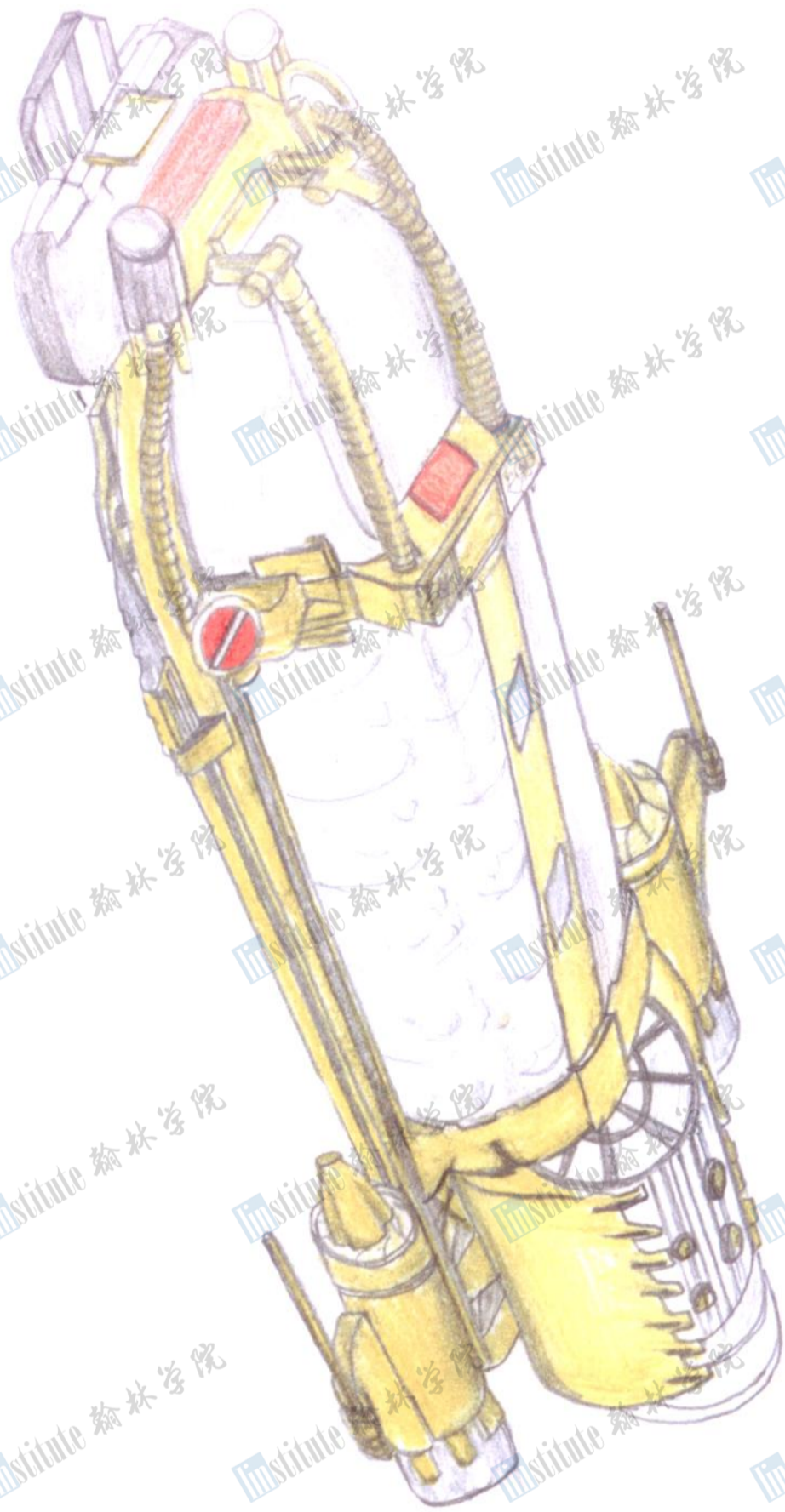
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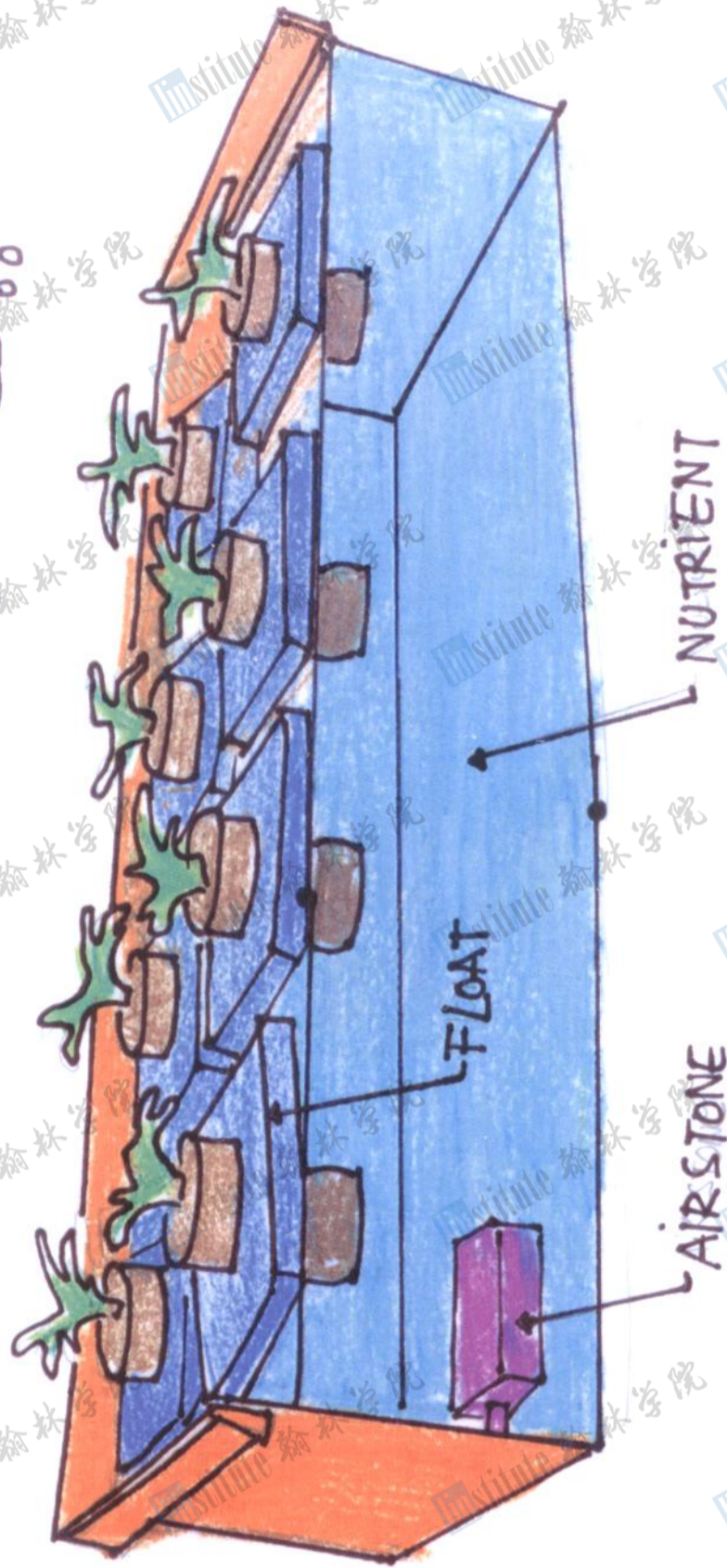
Last but not the least Skippy (my dog) for being the most understanding creature







HYDROPONICS



NUTRIENT

FLOAT

AIR STONE

