Northdonning

Needwell

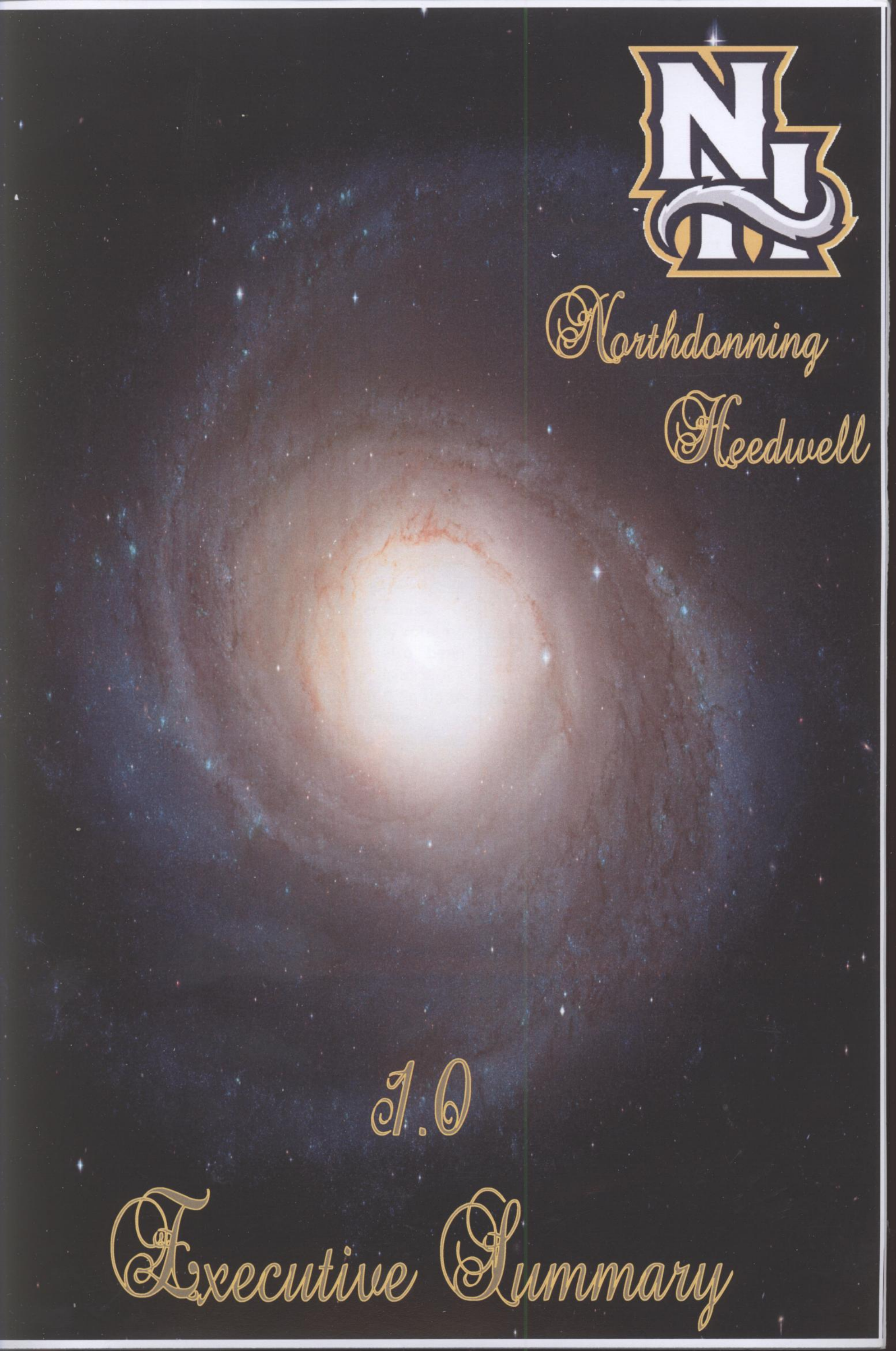
Columbiat

"City that never sleeps"

INDIA

B.C.M. ARYA Model Sr. Sec. School

Shastri Nagar, LUDHIANA, PUNJAB



Northdonning Heedwell

1.0 Executive Summary

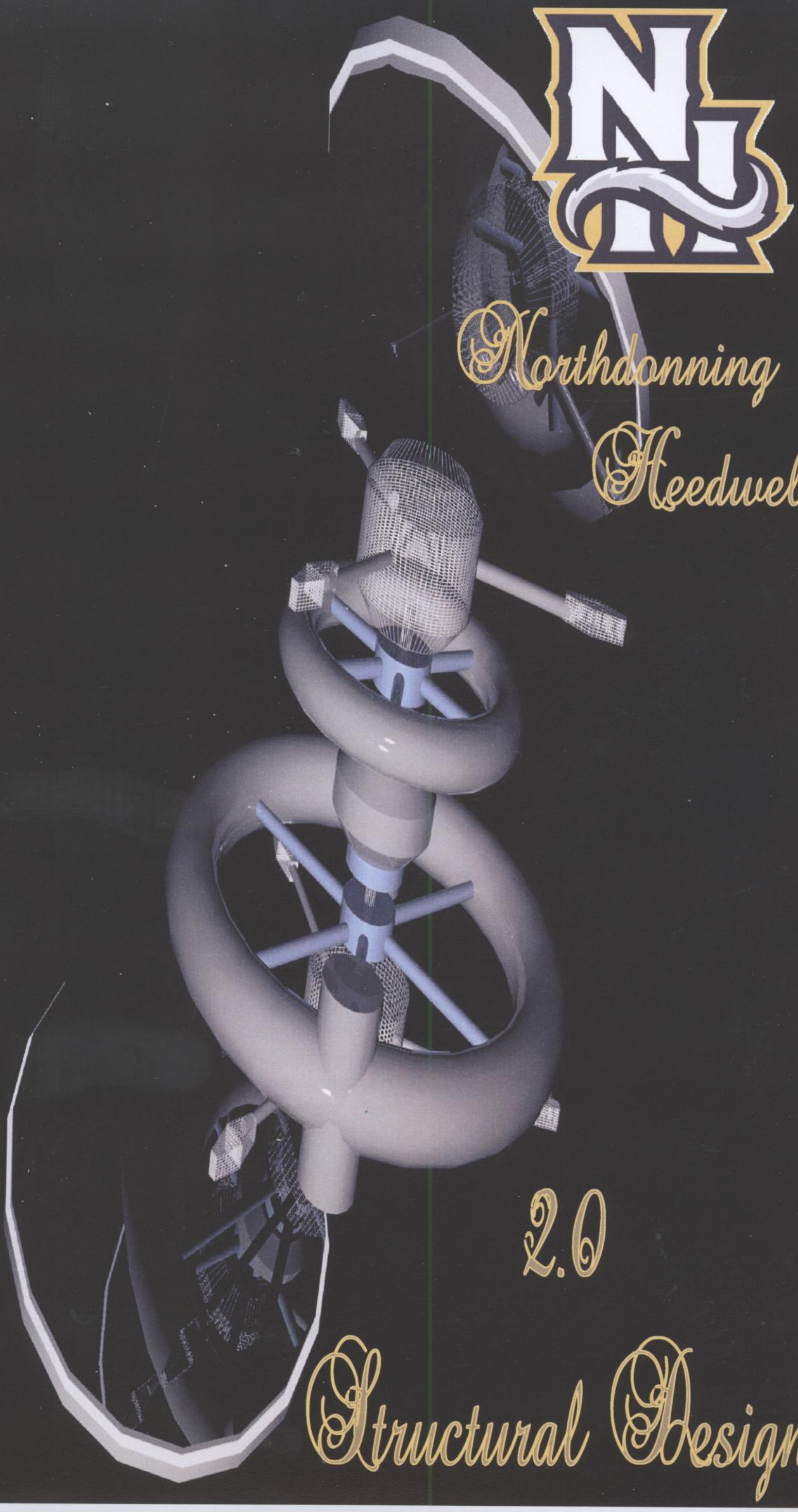
As the endeavour of humans to explore new avenues for expansion of human civilization and to enrich the legacy for our future generations continues. Settlements like Bellevistat & Alexandriat have glorified and brought about successful results in the space expansion program. Now the time is ripe for a full fledged and huge space settlement which will serve not only as harbinger of new scientific era in research but also be the business centre in space. So to satiate humans' insurmountable thirst to create extra terrestrial settlement ; under the steward ship of experts in Northdonning Heedwell , an immaculate plan for settlement colony **"Columbiat"** at L2 point has been presented.

- Columbiat is dubbed as **"Singapore in space"** due to its commercial importance and **city that never sleeps**.
- "Columbiat" as envisioned by The Foundation Society will serve as a major extra terrestrial business hub of all other space ventures.
- It will serve to divert bustle of commercial and tourist traffic away from Alexandriat and Bellevistat.
- It will also have a big space ship repair center.
- Settlement shall be availed by lunar space elevator and serve as the orbital terminus.
- Artificial gravity shall be generated by rotating the structure, half g level has also been provided for suitable adaptation of visitors.
- Agriculture facilities are provided at 0.5g up to 0.62g at which growth of plants is more.
- A major eminence of Columbiat is that it has zero g industrial sector which will provide cent per cent efficiency.
- The docking facility has capability to load–unload 6 minor ships and 2 major ships handling and a ship repair facility adjacent to docking port.
- Innovative and sumptuous community plans and residential designs gasconade of proper allocation of area based on intensive.
- Vehement consideration to food and its types, production, storage, distribution, and consumption has been given.
- Totally Automated house construction by contour crafting. Nano-bots and construction ships shall do the construction work.

Features	
LOCATION	**L 2**
POPULATION	**Permanent: 22,000 Transient: 1,500-5,000**
MASS	**4.059×10^{10} kg**
MOMENT OF INERTIA	**2.06084×10^{17} kgm^2**
DOWN SURFACE IN MICRO-G	**1.17×10^{6} (~24%)**
INTERIOR VOLUME(MAIN)	**$3.37 \times 10^{10} m^3$**
VERTICAL CLEARANCE	**200m**
RPM	**.901**
PSEUDO GRAVITY (ACCELERATION DUE TO GRAVITY)	**Main Torus- $9.8 m/s^2$ Low g Torus-5-6m/s^2**
DATE OF CONTRACT	**7th May 2044**
DATE OF COMPLETION	**7th Nov 2054**
TOTAL COST	**$ 155.3 bn**

Construction will initiate on May 8, 2044 and involve a net cost of $155.125bn. A harmonious balance between quality time and expenditure has been provided only by our expertise at Northdonning Heedwell.

We express our heartfelt gratitude to The Foundation Society for making us a part of this esteemed and coveted project. We sincerely hope that our nisus will satisfy demanding requirements of 'The Foundation Society' & we'll be deemed competitive enough to be a permanent part of this historical endeavour.



Northdonning Heedwell

2.0 Structural Design

Northdonning Heedwell is proud to present a station that can serve as a Business centre as well as a home to over 22,000 permanent residents, and more than 5000 transient population plus enough space for accommodating many times this number in future. Window panels will provide the residents with natural views of space and Earth. Although safety and function always come first, Northdonning Heedwell has managed to craft a station that is a comfortable and pleasant environment for its occupants. The configuration and the facilities provided in Columbiat shall enable it to develop sufficient commercial opportunities for the space frontier justifying the name selected for it.

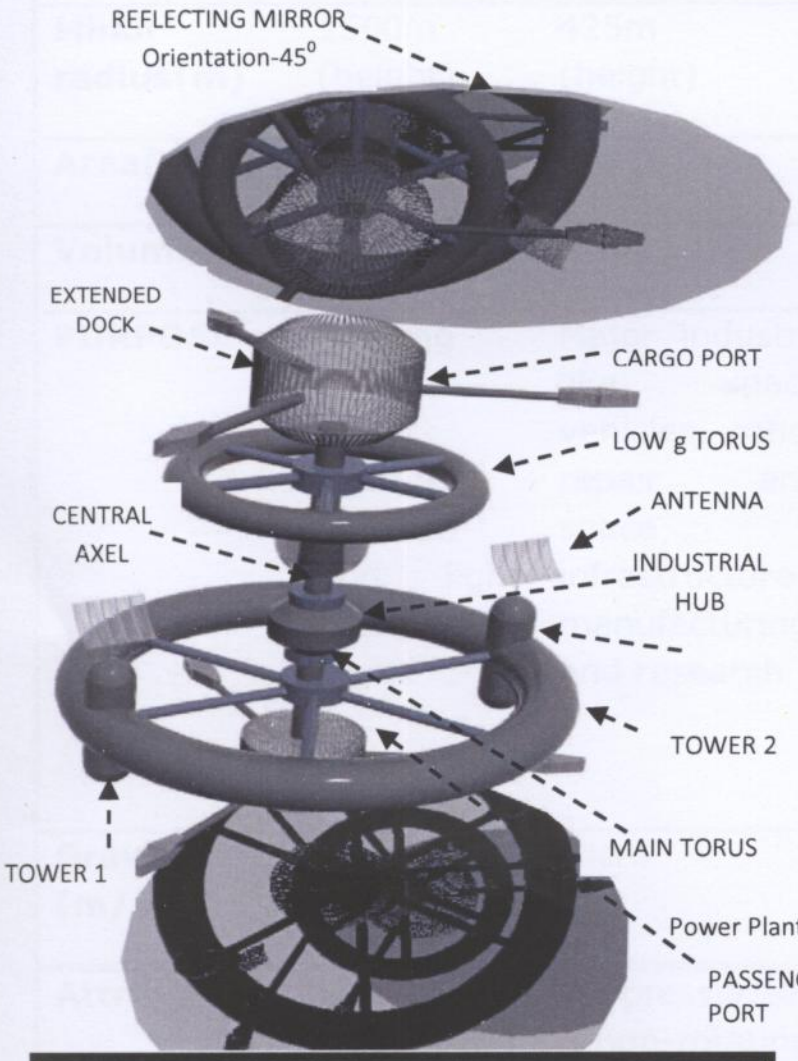
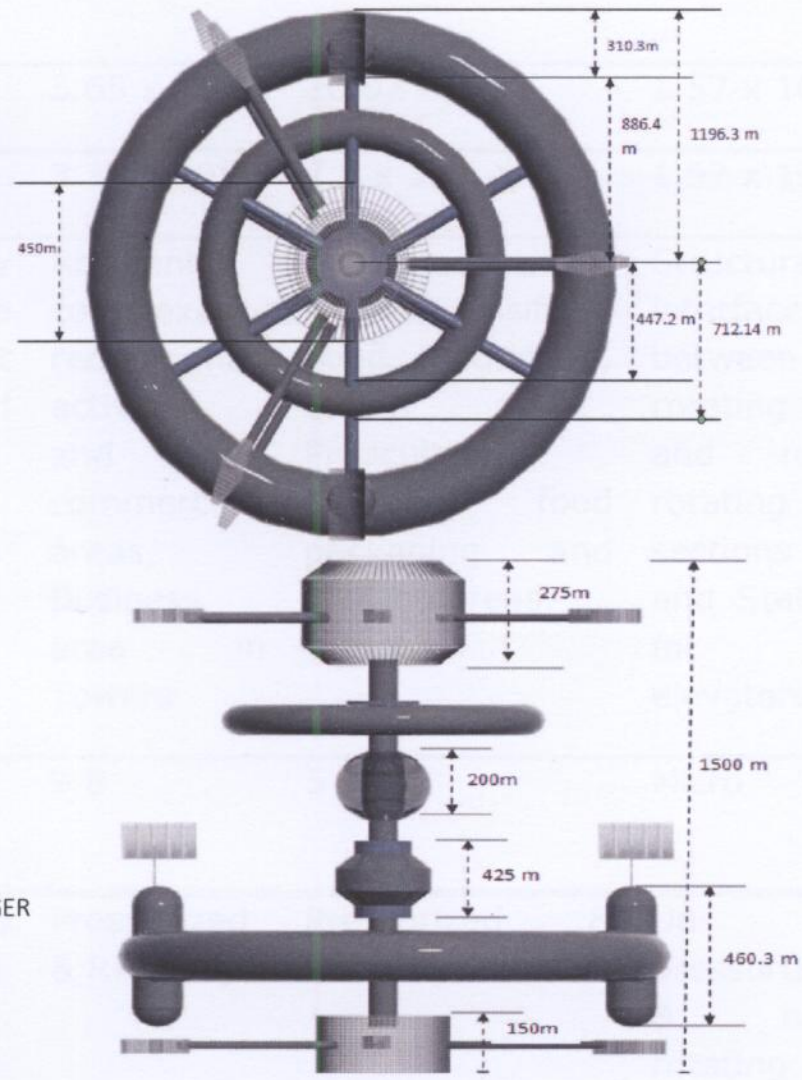


Fig 2.1.1 Exterior view of COLUMBIAT

2.1 Exterior Structural Design:



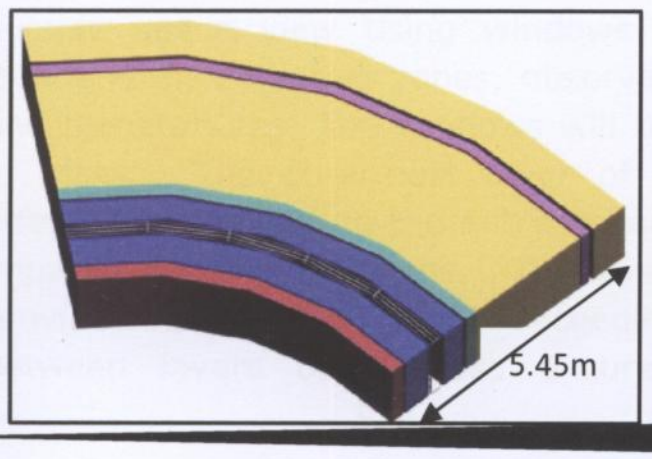
2.1.1 Basic structure: Columbiat is composed of two rotating tori and a centre axle (fig2.1.1). Main torus is used purely for residential and commercial purposes; Low g torus holds the visitors as well as agriculture. Two cylindrical towers (together called as the **Twin towers**) are provided on Main torus these will be host all the commercial activity these have been chosen in remembrance of **Twin towers of Manhattan, New York**. These are called tower 1 and tower 2**. Foundation society Head Quarters** will be located in the tower.

The tori rotate at the rate of 0.901 rpm with help of **Nano-FET** propulsion to generate an artificial gravity of 9.8 m/s^2 in main torus, $5m/sec^2$ to 6 m/sec^2 in low g torus, and a non rotating section is attached to it for industry and research. Two space ports are provided on central axle on which 6 small ships and 2 large ships can dock simultaneously. Platforms are provided, one for each torus, which act as structural interface between rotating and non rotating sections and also serve as stations for the elevators that come from the torus as

well the central axle. These platforms are also supporting points for the industry structure and the mobile modules during the construction stages.

Structural component	Central axle	Industrial sector	Main torus	Low g Torus	Platforms
Major radius(m)	125m (radius)	225m	1196.3m	712.14m	200m
Minor radius(m)	1500m (height)	425m (height)	886.4m	447.22m	125m (ht)
Area(m^2)	1.17×10^6	6×10^5	5.65×10^7	20.02×10^6	1.57×10^5
Volume(m^3)	7.35×10^7	6.7×10^7	3.37×10^{10}	7.1×10^9	1.57×10^7
PURPOSE	Docking ports, major storage facilities and light industry	Major industry like space vehicles, robot repair and space infrastructure manufacturing and research	Residential complexes, recreational activities and commercial areas, Business area in Towers	Accommodations for the visitors, Food production, animal, Pisciculture facilities, food packaging and storage areas.	Structural interface between rotating and non-rotating sections and Station for elevators
Gravity (m/s^2)	Micro	Micro	9.8	5 to 6	Micro
Attributes	Un-pressurized non-rotating	Un-pressurized & non-rotating	Pressurized & Rotating	Pressurized & Rotating	Un-pressurized & non-rotating

2.1.2 Construction material: Most of the material required for the construction of outer structure of Columbiat will be easily available on the NEOs (near earth objects) like asteroids and majorly on the moon where they are present in raw form and will be refined at same place. The settlement walls will be Regolith derived from MOON has properties of



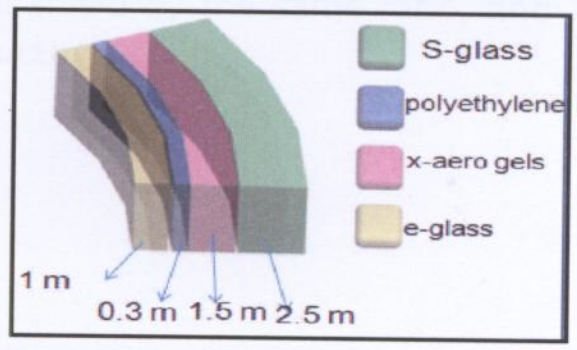
WALL COMPOSITION
Ceramic Tiles (0.3m)
Cage like Honey Comb Structure (0.2m)
Lunar Bricks (1.25m and 3m)
Silica Aerogels (0.2m)
Kevlar (0.1m x 2)
Alumina Silicate Glass (0.1m)

radiation protection. A layer of Ceramic tiles which will provide corrosion resistivity.

MATERIALS	SOURCE	PROPERTIES	Utilization
Lunar Regolith	Moon	High resistance to solar flares, cosmic and ultra violet radiation.	Radiation protection Debris protection
Ceramic tiles	Alaskol	Very high melting point	Thermal shock resistance
Silica aerogel	Moon	Very low heat capacity	Thermal insulation
Kevlar	Moon	High tensile strength	Structural support
Cage like structure (titanium)	Moon	Strengthens the settlement Increases the stability of structure	Debris protection
RTV adhesive	C–type asteroid	Good binding material	To join different layers of the settlement
Alumina-silicates glass	Moon	Thermal insulation Thermal shock absorption	Will form Innermost layer
S glass	Moon/Earth	Tensile strength	Outermost layer for windows
Polyethylene	Moon/Earth	Good radiation shielding	Protect settlement from radiation
X aerogel	Moon	Transparent, Low thermal expansion	Controls thermal expansion
Electro-chromic smart glass	Moon/Earth	Light intensity	Controls the amount of light entering the settlement

WINDOW MATERIAL: The wall will have a provision of outside space view using windows installed at special locations in recreation zones, observatories, visual centers and planetariums. The windows will be comprised 4 panes of glass. The outermost layer of Polyethylene will be effective in preventing the entry of radiations and it resists impacts of micrometeorites. The layer of X-Aero gels shall provide transparency. The succeeding layers of e-glass between layers of S glass ensure safety along with

Fig 2.1.2(b) Windows material



providing radiation protection. E-glass will control the intensity of light entering the settlement using suspended particle device technology.

2.1.3.1 Debris penetration: To safeguard our settlement completely, we propose a 3.5m thick Whipple shield of Titanium in the form of honey bee structure which acts as Shape Memory Alloy (SMA), so that if any part is ruptured, the structure gains back their shape. This Kevlar layer will cause the incident particles to release their kinetic energy and split into smaller, lower-velocity particles that harmlessly splatter against the hull.

2.1.3.2 Radiation Shielding: Measuring radiation levels**:** The detection and measurement of radiation is one of the most important functions the colonists will perform in determining if radiation and/or radioactive contamination is present inside or outside the settlement. **(1)Portable ion chambers (2) Geiger-Mueller (G-M) counter (3) Dosimeters**

Specific to various types of radiation will be placed in the areas of major interest, such as residential and industrial areas. Two types of radiation are particularly significant and must be reduced as possible.

Solar flare protons: Electromagnetic shielding is the most convenient way of protecting against ionizing radiations in space. The principle is in fact simple: the magnetic shield is based on the fact that a charged particle's trajectory in a magnetic field is curved. When the particle enters the region of high magnetic field, its trajectory will be curved away from the region we want to protect from radiation. For obtaining a more intense electromagnetic induction using the same amperage and without having to increase the length of the coil systems we are using multi-layered coils, which consist in a number of concentric common coils. We will be able to generate a more intense electromagnetic field with almost the same use of energy.

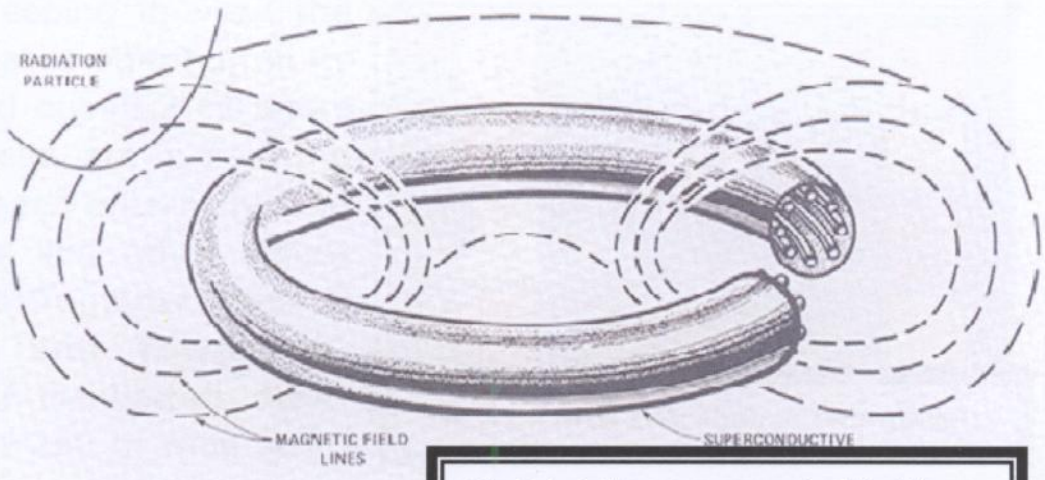


Fig 2.1.4 Electromagnetic Shielding

High-energy galactic cosmic rays (GCR): An electrostatic charge is applied to the settlement's shell to repel the positively charged radiation a magnetic field then prevents the plasma electrons from discharging the vehicle. At large distances the shield is charge neutral, since the magnetically confined electrons exactly neutralize the charge on the shell. Since electrons are lighter than protons by a factor of 1860, the magnetic field required for the plasma shield is reduced over that for a simple magnetic shield by the same ratio, and hence the weight associated with the field generation and structure.

2.1.4 Artificial gravity: Refer to section 3.5

2.2.1 Main torus: Northdonning Heedwell has adopted an innovative internal

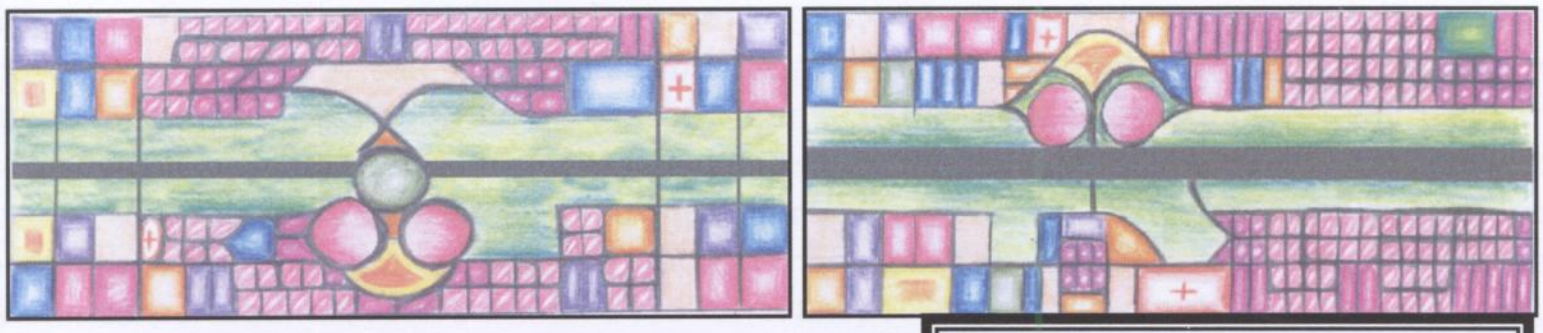
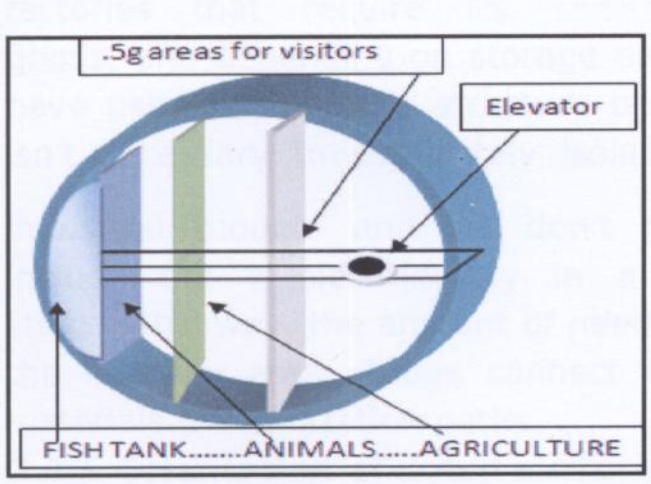


Fig 2.2.1 Internal Layout Main torus

arrangement design in its plan for Columbiat. The lower torus will serve primarily as a residential and commercial zone. The division has been planned keeping in mind various factors including quality of life, living standards, trade, transport and communication, recreation and entertainment etc. The down surface will be a **250 m wide strip with a ceiling of 200** m in the torus and the towers amounting to a total down surface area of 1705052.80 m^2. Columbiat inhabitants would also avail the serene and tranquil touch of a lake.

2.2.2 Commercial towers: Keeping in view the business prospects that Columbiat is offering, all its business activities will be carried out in 2 cylinders of dimension 310m*460m. These are called the towers as they appear so when seen externally. The Foundation Society Headquarter and other offices will be located in these towers. Together these 2 towers will be called as the **Twin Towers** in remembrance of twin towers of Manhattan, New York. The down surface will be a 250 m wide strip with a ceiling of 200 m in the torus and the towers amounting to a total down surface area of 115000m^2.

Fig 2.2.2 Area allocation in Twin-towers



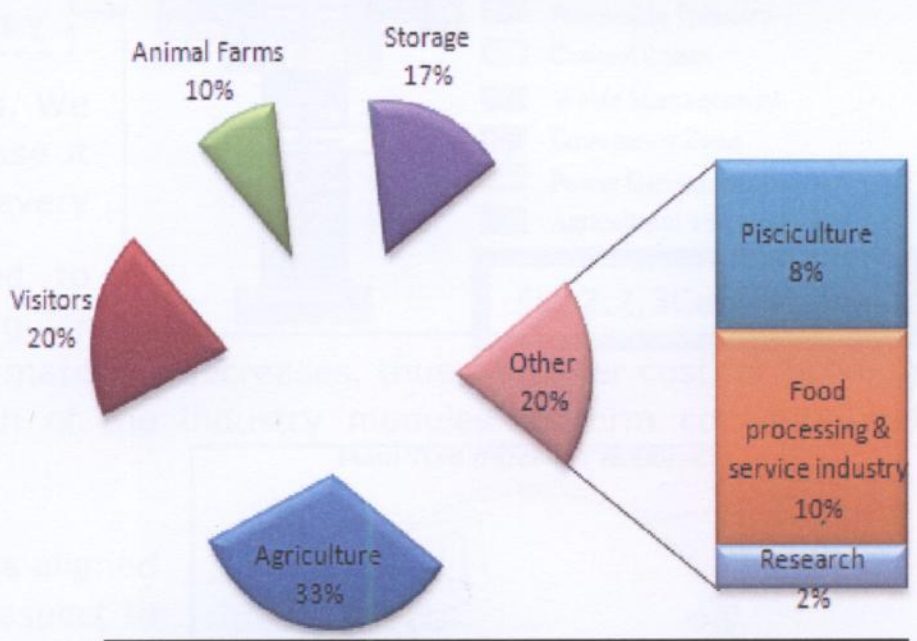


Table 2.2.3 Description of layers in Low g Torii

2.2.3 Low g torus: The low g torus (with down surface area of 2411881.11m^2) will predominantly function as an agricultural zone sustaining Astoria's population with its inventive food production and storage techniques. It will also provide areas for **adaptation of the visitors at half g**. Its main components will include food processing units, warehousing units, secondary industries (assembling and

manufacturing units), research, animal farms, storage etc. Agricultural zone will consist of **3 different layers (layer 1(100m), layer2 (54.96), layer3 (40m))** stacked vertically above each other and cultivated by Aeroponics technique. Animal farms will be maintained where genetically modified micro-livestock animals (for greater productivity) will be reared for milk products, food requirements and maintaining ecosystem inside the torus. At the bottom of the torus a Fish tank is included to carry on Pisciculture. Pioneered water, waste management and bio mass systems (utilizing the waste to produce energy via bio gas) have been incorporated. Elevators will be used for Transportation between different layers.

Layers	Width(m)	Area(m^2)	Usage	Gravity
Layer1	232.29	820139.33	Agriculture, research, accommodation to visitors, medical, quarantine facilities	5 m/sec^2
Layer2	222.65	862951.33	Agriculture, Food Processing, secondary industries, storage, agriculture drying areas	5.5 m/sec^2
Layer3	176.59	728790.46	Micro livestock rearing, Food processing, secondary industries, storage, agriculture drying areas and Pisciculture	6.0 m/sec^2

2.2.4 Central axle: The central axle has the shape of a cylinder, which serves as a support pole for the spaceports, the platforms and the industry structure. All the structures that need 0 g are attached to this axle, for example factories, hospitals, decontamination rooms and even space shuttles. The link between the central axle and the sectors of torus is made through the spokes. The industrial zone is modular; each factory attaches to the metallic structure, and places itself depending on the other factories that require its goods, and depending on storage areas. We have used the metallic structure because it isn't necessary to completely isolate every industrial module and we don't need to include the whole industry in a regular shape. This way, the amount of needed materials decreases, thus a smaller cost for building the industry area. Tubes connect each of the industry modules to form corridors and materials transportation paths.

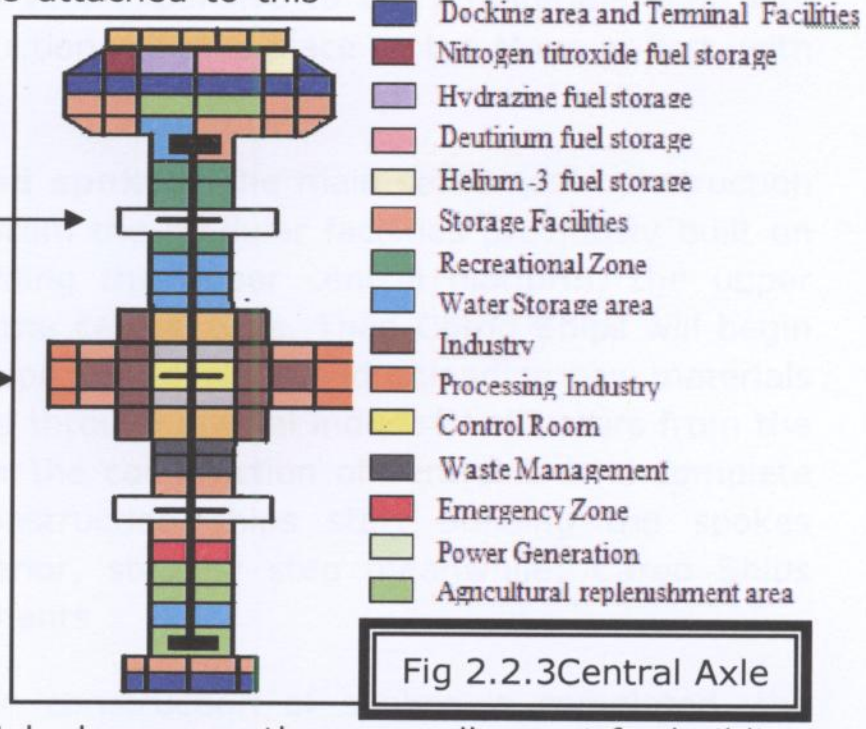


Fig 2.2.3Central Axle

2.2.5 Orientation of down surfaces:

The down surface in case of Main torus is aligned an angle slightly higher than 90^0 with respect to spoke, leaving the ceiling of 200m. In case of Low g torus the three layers are stacked as shown in figure2.2.3

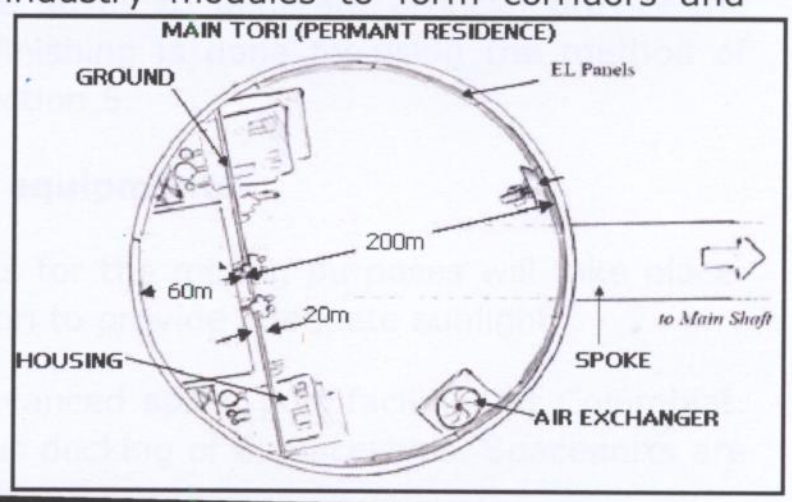
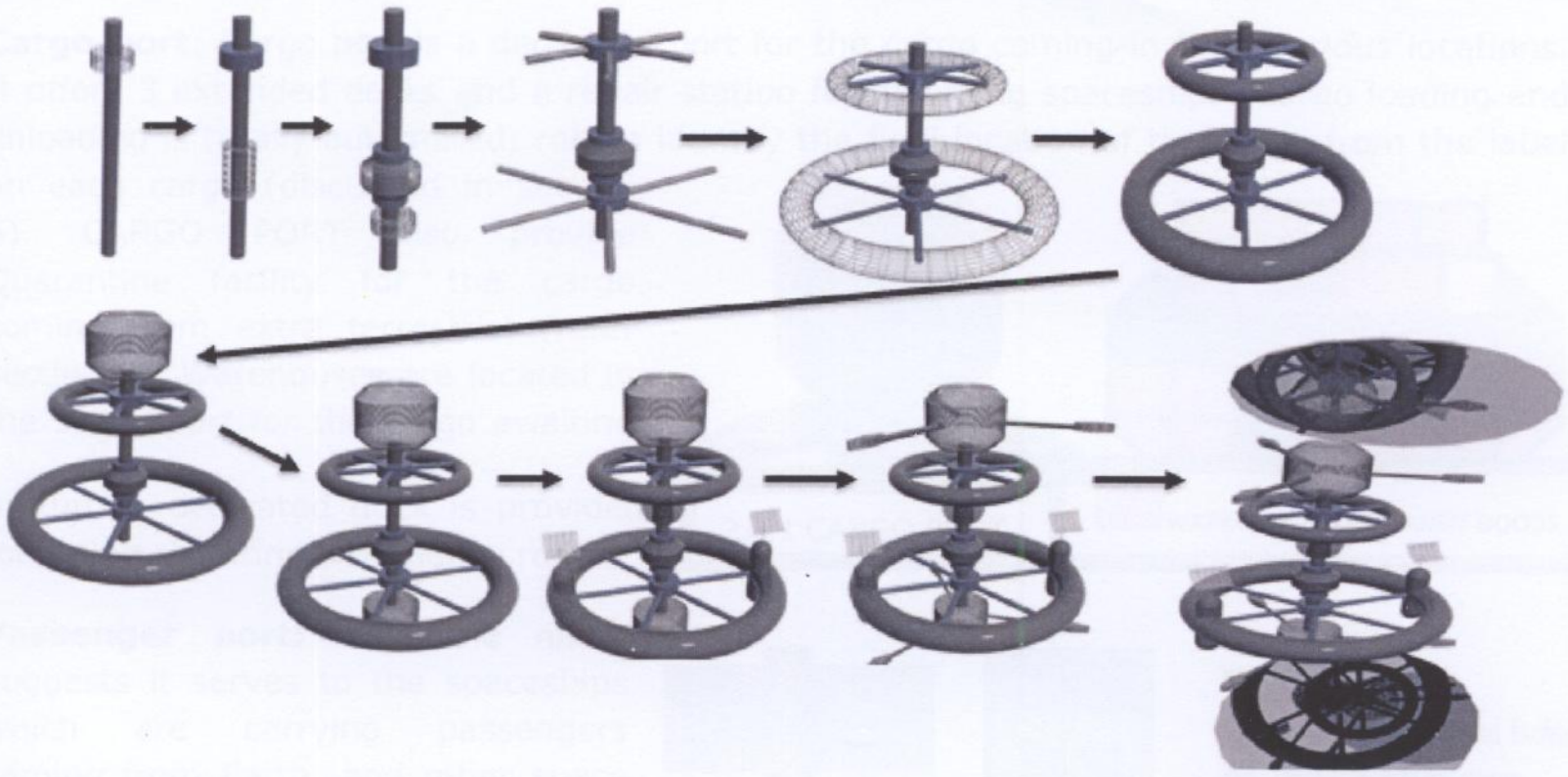


Fig 2.2.5 Orientation of down surface

2.3 Construction Process:

Fig 2.3 Construction Process



Stage 1: Initial construction: Since it is very expensive to carry materials deep into space, a significant portion of the main construction will take place on the Moon at first, with help from ALASKOL operations will commence.

Stage 2: Construction of central axle and spokes: The main settlement construction begins with the arrival of construction ships from the modular facilities previously built on Moon. The construction ships will start building the upper central platform, the upper spaceport and the corresponding segment of the central tube. Then Cargo Ships will begin to arrive from the Moon, using the upper spaceport for docking and unloading new materials for construction. The materials are transported through special industrial elevators from the upper space port to the upper platform. After the construction of central axis is complete construction of the spokes starts. The construction ships start building the spokes symmetrically, from the interior to the exterior, step by step meanwhile; Cargo Ships continue to bring modular construction components

Stage 3: Construction of tori: After the construction of spokes is completed, the construction ships, assisted by nanobots begin constructing the torus segments. After the construction is over the tori are made to rotate so as to generate artificial gravity the automated construction of houses and interior finishing is done by using the method of **contour crafting** and robots discussed later in section 5.

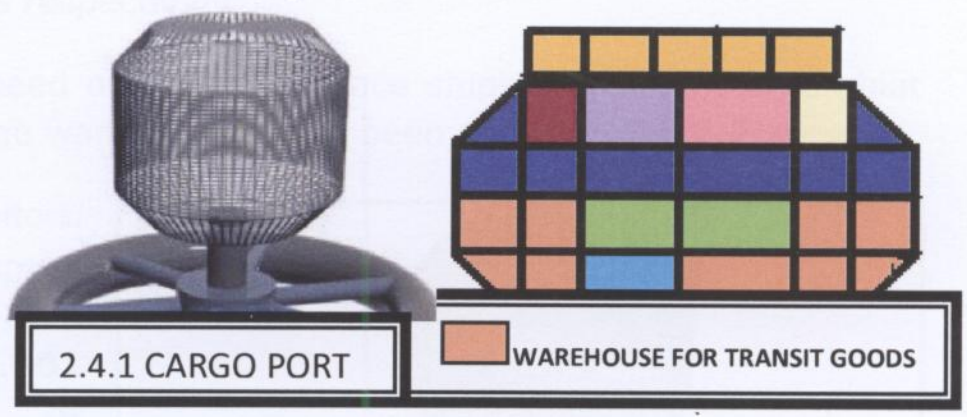
Stage 4: Construction of Mirrors and mining equipments

Simultaneously construction of mining equipments for the mining purposes will take place. Mirrors will be constructed and placed about the tori to provide adequate sunlight.

2.4 DOCKING PORT: We provide the most advanced space port facilities at Columbiat. There are 2 space ports which offer a simultaneous docking of 6 spaceships. Spaceports are

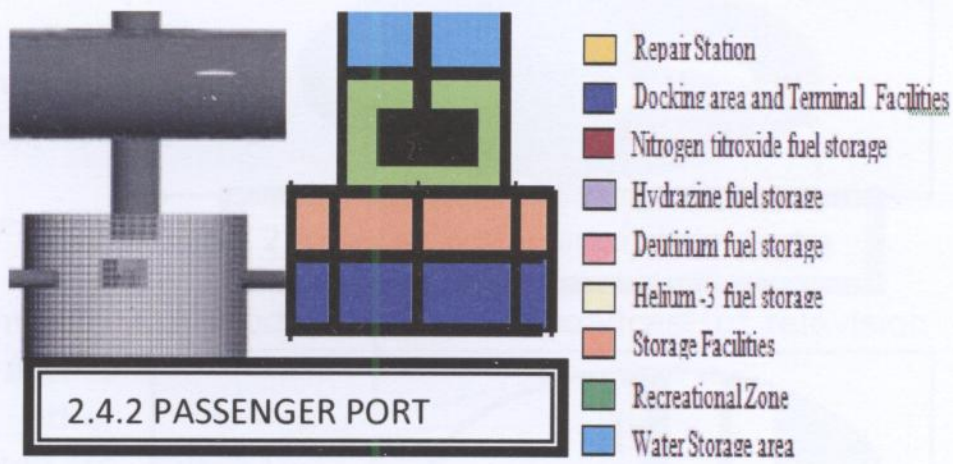
located on the 2 ends of the central axle and are non-rotating, ensuring safe docking of spaceships. The spaceports are named Cargo port and Passenger port.

Cargo port: Cargo port is a dedicated port for the cargo coming in from various locations. It offers 3 extended docks and a repair station for incoming spaceships. Cargo loading and unloading is totally automated; robots identify the final location of the cargo from the label on each cargo (discussed in section 5). CARGO PORT also provide Quarantine facility for the cargo coming from extra terrestrial (refer section 4). Warehouses are located in the space port for the cargo awaiting pickup. A dedicated dock is provided for a ship requiring emergency repair.



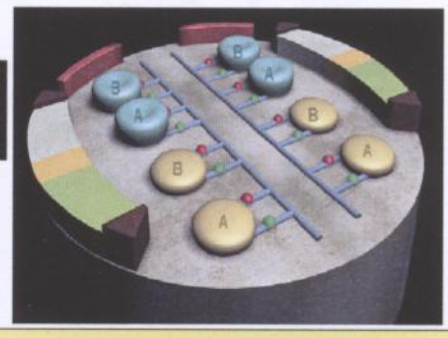
2.4.1 CARGO PORT

Passenger port: As the name suggests it serves to the spaceships which are carrying passengers coming from Earth, and other space settlements. It allows attachment of 3 spaceships through its extended dock facilities. It has a special cargo handling facility, the cargo of the tourists are transferred to the residential tori. Cargo of transit passengers is directly loaded on to their respective ships. Passengers coming from long voyage are first sent into quarantine facilities (discussed in section 4) for a check-up and then sent to the low g torii having half the g level for adaptation.



2.4.2 PASSENGER PORT

2.4.3 DOCKING AREA



The primary features of the Docking area include: **Unloading of cargo and passengers:** The incoming space ships will be docked at different terminals where unloading of passengers and cargo will take place.

Maintenance and repair: After unloading the space ships will undergo a series of checkups.
Discrepancies if any will be repaired at a separate terminal.

Hangars: Those space ships that are going to be on Columbiat will be placed on specially designed HANGARS.

REFUELLING: Those ships that will need to return to Earth or other space settlements will be refueled accordingly.

Agricultural needs will also be also provided so that they don't run out of food needs.

Launching: Launch pads provide a safe and hassle free launching from Columbiat to different destinations.

Elevators: Elevators provide transportation of cargo and passengers from the docking station to storage facilities and terminals respectively

Docking stations more than fulfill the need of incoming space ships and makes Columbiat self sufficient in docking facilities. Storage warehouses have been shown in **fig 2.4.1**

2.5 Location of half g areas for the visitors: Visitors coming from micro gravity space ships will be provided accommodation at **5 m/sec^2 and the rotation rate of .901 m/sec^2** for the adaptation. **Area of 310000 m^2** will be allocated on the on the layer 1 in the Low g tori. To cater psychological needs & entertainment of visitors, Columbiat provides a variety of entertainment options. The gaming zones, music, hubs, multi-cuisine restaurants, bars, shopping malls, cinema halls etc will aid the complexity of modern lifestyle. Broadcast of television channels of earth and easy internet access add to the enjoyment of residents. Other major public areas are parks, space watch (to view outer space), science city, virtual driving bays. All these provide the visitors a unique and supreme level of recreation.

2.4.3 Location of Accommodation at .5 g

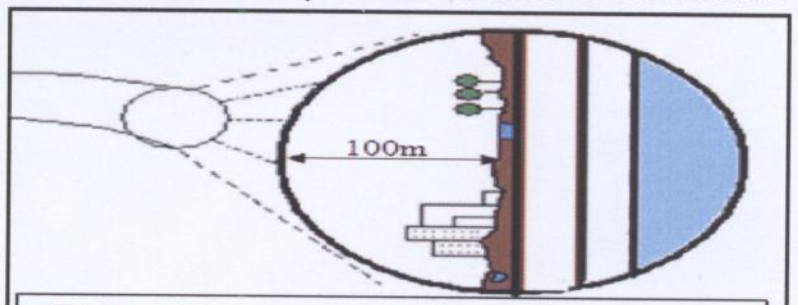
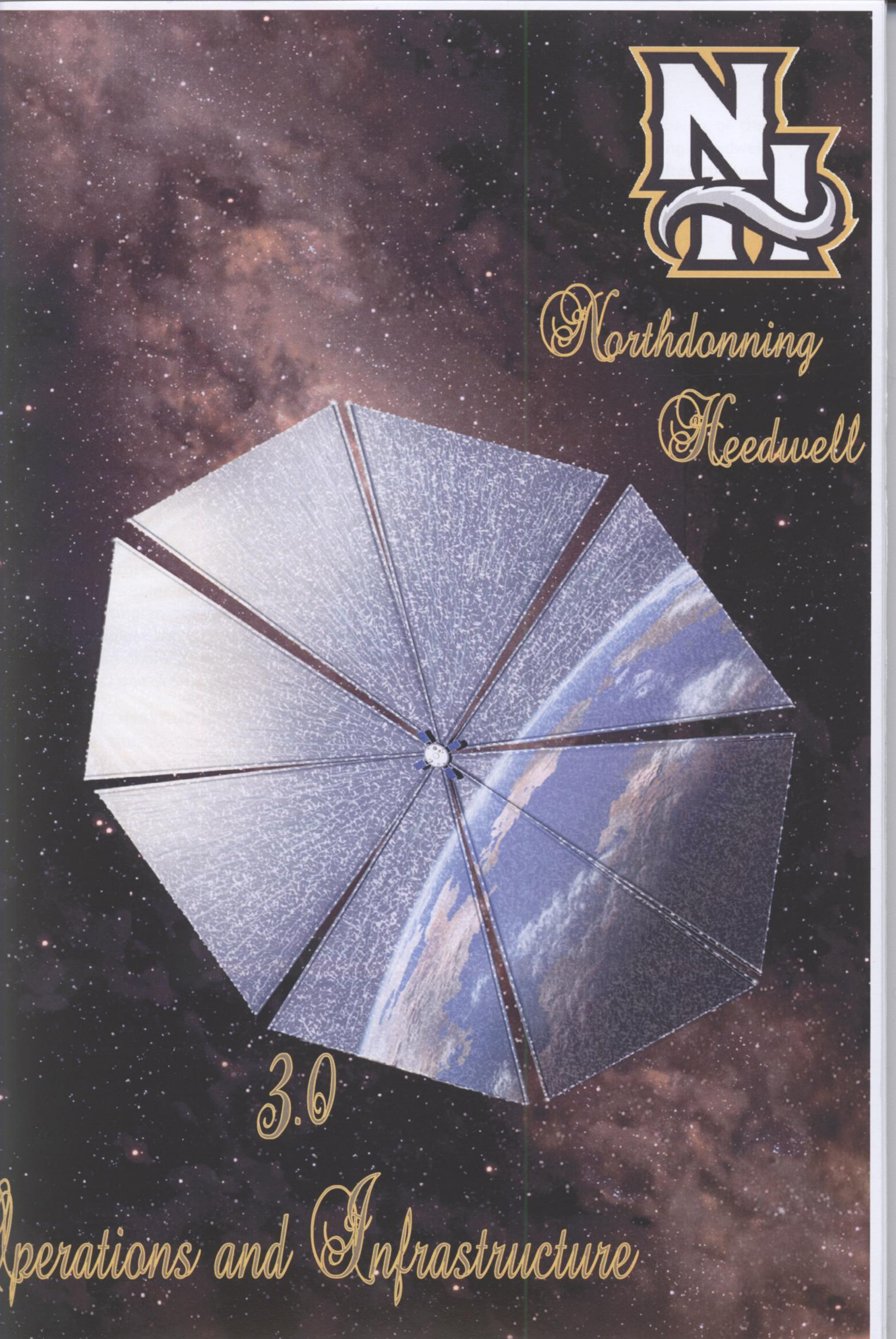


Fig 2.5 Cross-sectional View of Low g torus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3.0
Operations and Infrastructure

An effective infrastructure is a crucial component of maintaining the well-being of the 27,000 residents that live aboard the Columbiat space station. Northdonning Heedwell has harnessed both innovation and practicality to produce such an infrastructure. Revolutionary designs, like the combined pneumatic and fibber optic power supply system and the pneumatic elevators, work seamlessly with systems like the highly functional climate control system to create the exceedingly efficient framework upon which the station operates.

3.1.1 Columbiat as Orbital Terminus in L2: Columbiat's location has been chosen strategically on the Earth moon L2 liberation point. L2 is 64,517 ± 3539 km from the centre of the moon away from the Earth. The variations are due to the 0.055 eccentricity of the lunar orbit. L2 points enable the conversion of Columbiat into an Orbital Terminus for the lunar space elevators (LSE), once the material for conversion is available after 15years. The L2 LSE is slightly better for launching masses into Earth and lunar orbits, and can communicate with lunar far side outposts and ALASKOL. Solar-powered vehicles will climb the space elevators to take payloads beyond the Lagrangian points with excess orbital energy. From there, small robotic space tugs will complete the cis-lunar transportation system, taking lunar materials to COLUMBIAT. And from there it will send to different destinations for use in construction, shielding, habitats, and solar power satellites.

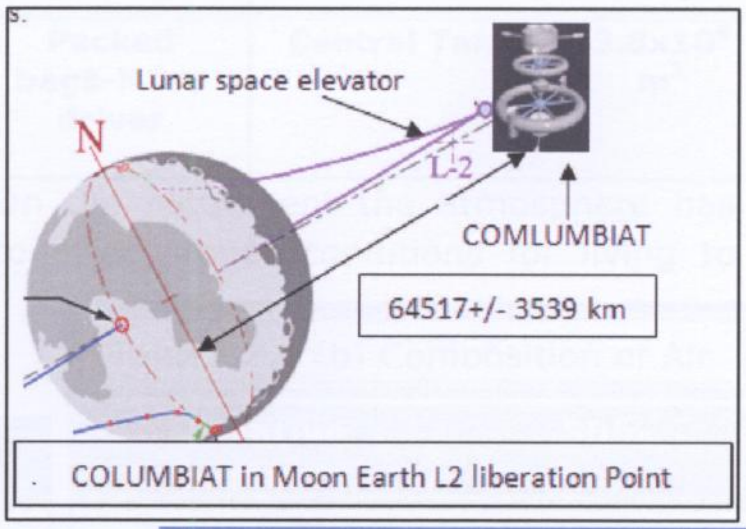


Fig.3.1.1 COLUMBIAT ACTING AS AN ORBITAL TERMINUS IN L2

3.1.2 CONSTRUCTION MATERIALS AND EQUPIMENT: The moon is our primary mining site. Oxygen, silicon, aluminium, iron, calcium, magnesium and many other minerals exist on the moon in various amounts. These materials can be mined from ALASKOL.

Table3.1.1 Usage, Source, Transportation and Storage of Material

Material/Equipment	Usage	Source	Transportation	Storage	Amount
CONSTRUCTION OF THE CENTRAL AXIS					
Lunar Regolith	Radiation protection Debris protection	Moon	Mass driver	Not required	$1.3x10^8$ m^3
Ceramic tiles	Thermal shock resistance	Moon	Mass driver	Alexandriat	$1.7x10^7$ m^3
Silica aerogel	Thermal insulation	Moon	Mass driver	Alexandriat	$2.7x10^7$ m^3
Kevlar	Structural support	Moon	Construction ship	Not Required	$6.9x10^7$ m^3
Cage like structure (titanium)	Debris protection	Moon	Mass driver	Not required	$1.7x10^7$ m^3
RTV adhesive	To join different layers of the settlement	C–type asteroid	Mass driver	Central axel	$6.9x10^6$ m^3

Alumina-silicates glass	**Will form Innermost layer**	**Moon**	**Mass driver**	**Central**	**$2.9x10^6$ m^3**
S glass	**Outermost layer for windows**	**Moon/ Earth**	**Mass driver**	**Central Tank**	**$4.9x10^6$ m^3**
X aerogel	**Controls thermal expansion**	**Moon**	**Mass driver**	**Central Tank**	**$2.2x10^6$ m^3**
Electro chromic smart glass	**Controls the amount of light entering the settlement**	**Moon/ Earth**	**Packed bags-Mass driver**	**Central Tank**	**$3.8x10^6$ m^3**

3.2.1 ATMOSPHERE/WEATHER CONTROL: On the settlement the atmosphere has same composition as on the earth in order to offer proper conditions for living to residents, animals and plants.

Table3.2.1 (a) Quantity of Air

Air Composition		Quantity (K mole)
Nitrogen	78.0842%	$6.5657*10^{11}$
Oxygen	20.9463%	$1.6835*10^{11}$
Argon	0.93422%	$.1683*10^{11}$
Carbon dioxide	0.03811%	-
Water vapor	1%	-

Table3.2.1 (b) Composition of Air

Relative humidity	50%
Temperature	22 degrees C
Atmospheric pressure	p0=101.325 Pa.
Partial pressure of oxygen (pO2)	(~13.4 kPa or ~100 mm Hg
Carbon dioxide	less than 0.4 kPa

Carbon Dioxide Elimination: Air Revitalization System: The air revitalization module will consist of several subsystems. The Variable Configuration CO Removal System (VCCR) using molecular sieves will take air from the residential atmosphere and store it in a CO store from where the CO

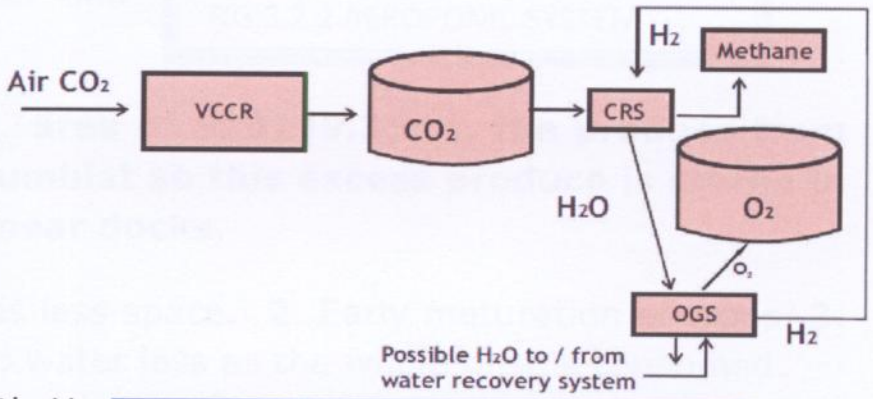


Chart 3.2.1 Air Revitalization System

Reduction System (CRS) will react CO with H to make H_2O. The methane (CH_4) will be used as fuel and H_2O will be passed to the third system, the O_2 Generation System (OGS), which will break down the H_2O into H_2 and O_2 according to the reaction:

$$H_2O\ (1) \xrightarrow{\delta} H_2\ (g) + 0.5O_2\ (g)$$

The O_2will be stored in an O_2store and H_2 goes back to the CRS .H_2O from the Air Revitalization Module will be put into water recovery module. In addition, an O_2 accumulator extracts O_2 from the biomass atmosphere and places it in the O_2 store. Injectors will be available to take gases from the stores and inject them into the atmosphere.

Thermal control: Temperature control and other functions including control of humidity, air-borne particulates and airborne micro-organism will be done with the help of Temperature and Humidity Control System (THC). These systems utilize Condensing Heat Exchangers (CHX) to remove water vapours and heat from the residential atmosphere. Condensate contains trace levels of water-soluble contaminate which is present in the air. Water reclamation system is used to purify condensate for the production of drinking water. **Humidity Control:** Humidity levels will be controlled within the residential area using condensing heat exchangers.

Some of the Station's **oxygen** will be generated in different way except the above mentioned, from two different types of substances from lunar and asteroid ores that contain metal oxides, using the separation methods. **Hydrogen** generation is made from thermal extraction and electrolysis. **Wind** will be an important component on this station, in parks and gardens where the wind has the purpose to reproduce the conditions of Earth; wind will be produce through processes like pressure differences and temperature between different bodies of air.

3.2.2 Food Production:

Food production is done in the low g torus on 2 lower layers. Lower g helps reduce the gravitational resistance and plants grow faster and longer. The agriculture will be done both by Aeroponics and land farming. We are also using micro livestock to obtain meat and milk products.

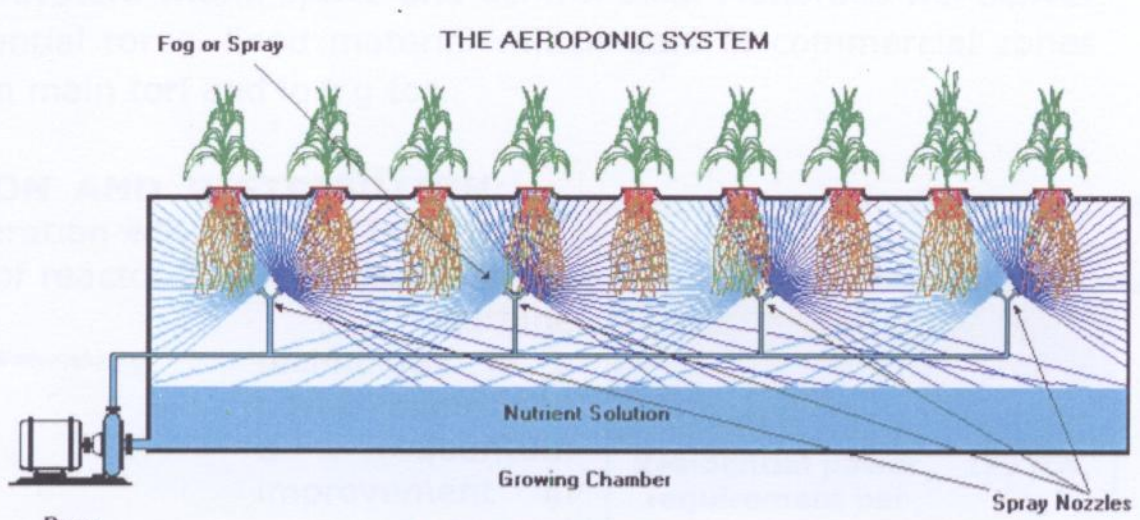


FIG 3.2.2 AEROPONIC SYSTEM

Food is Produced here is produced in area of 820139.33m^2, the produce from this area is more than required at Columbiat so this excess produce is stored in warehouses in central axis as well as near docks.

Advantages of Aeroponics: 1. Consumes less space. **2**. Early maturation of crops. **3.** More resistance to pests and weeds. **4.** No water loss as the whole mist is consumed.

MICRO LIVESTOCK AND PISCICULTURE: The third layer holds around 3000 micro livestock animals like goats, pigs, cows and sheep, because of these layer's strong floors and high structural integrity. Goats and cows are relied upon to provide the bulk of the milk for the station. Fish are held in three large tanks. Each tank is maintained at a different temperature in order to satisfy the needs of the many varieties of exotic fish offered on the station. Fish are harvested by large, permanent nets that sweep a large enough area to feed the station. Northdonning Heedwell has made a great humanitarian effort to ensure that large animals such as sheep and goats are raised free range in large "pastures" in order to minimize the negative physical effects of keeping them in small areas.

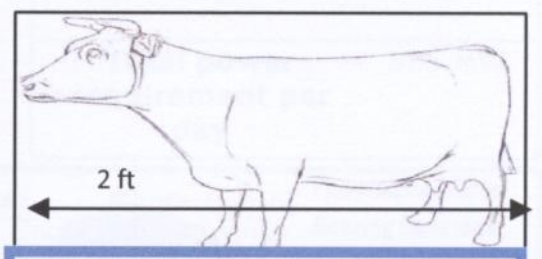


Fig3.2.4 MICRO-LIVESTOCK

Packaging: Modified Atmosphere Packaging (M.A.P) will be used for packaging of all food materials. This method involves modifying the atmosphere around the food product allowing chemical, enzymatic or biological reactions to be controlled and therefore reducing or eliminating the main processes of deterioration of the product. All the packaging would be done in biodegradable plastics and nylon bags. The entire packed foodstuff will then be stored in the containers made up of aluminium sheets.

Storing: Food will be stored in the storage area of 111847.4 m^2 in agricultural torus with the help of following techniques of preservation:-

Preservation of Food: It will be majorly carried out using irradiation, while the term irradiation pertains to all forms of treating food products with ionizing radiation, specific types of radiation treatments will be used in the food industry.

1) **Radurization** 2) **Radicidation 3)Radappertization:**

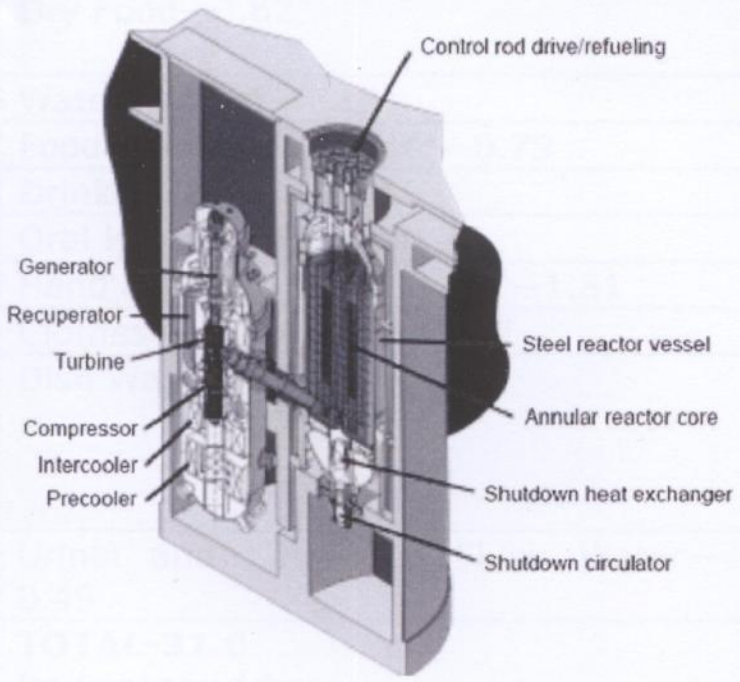
Delivering and Selling: Processed and raw food will be delivered to commercial centre and warehouses using the elevators within spoke and central axis. Monorails will deliver food items within the residential torus. Food material will be sold in commercial zones located in residential areas in main tori and low g tori.

3.2.3 POWER GENERATION AND DISTRIBUTION:

Main Sources of Power generation will be the **GT-MHR**, it combines a meltdown-proof reactor and advanced gas turbine technology in a power plant with a quantum improvement in thermal efficiency, approaching 50%. Conventional, low temperature nuclear plants operate at about 32% thermal efficiency. GT-MHR power plants can achieve thermal efficiencies of close to 50% which means 50% more electrical power from the same number of fissions. Dramatically lower high-level radioactive waste per unit of energy. As generating electricity in space would be very costly so we have presented power savers for this purpose.

Table3.2.3 Power Requirement

Power required per person per day	10 KW
Residential power requirement per day	120 MW
Industrial power requirement per day	235MW
Docking port & control centre requirement per day	165 MW
Agricultural power requirement per day	65 MW
Total power requirement per day	585 MW



Secondary sources of Power Generation

Backup: Flywheel used to absorb electric energy from a source, store it as kinetic energy of rotation, and then deliver it to a load at the appropriate time.

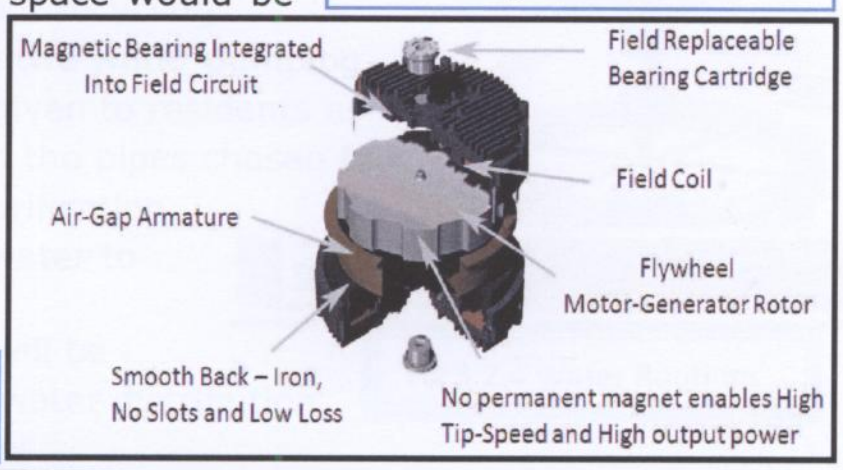


Fig3.2.4 Fly Wheel

Knee Power: This knee brace generates electricity when a user is walking. The knee generator uses the motion of the knee breaking itself before the next stride begins to capture that expended energy the device requires less than 1W of metabolic energy to generate 1W of electricity. The device is placed closer to the hips where the user would not notice the weight as much. It is used to power the LED head lamp, radio, recharge batteries, electrical gadgets etc.

3.2.4 WATER MANAGEMENT: Water is the key for existence of life, so we have to be very careful on what and how we use it. A certain quantity of water will have to be 'imported' from Earth initially. At a later stage, water will be taken from **C type asteroids and Themis family of asteroids** in the main asteroid Belt. It is present on these asteroids in frozen form and will be processed in the water treatment plant in the central cylinder. Here it will be made potable and then made available to the inhabitants.

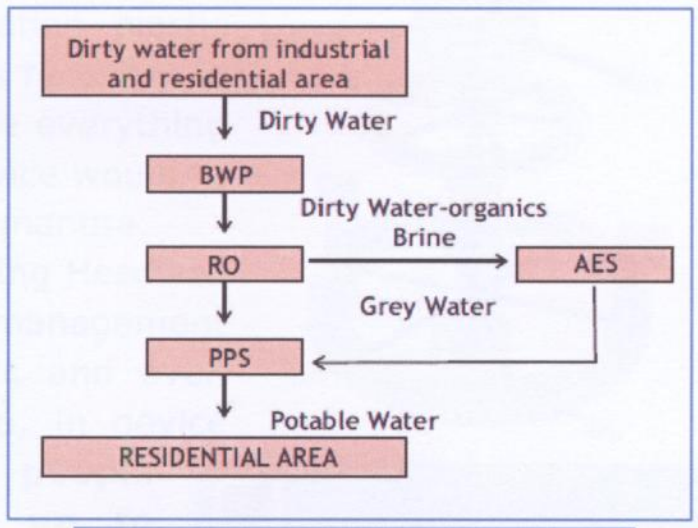


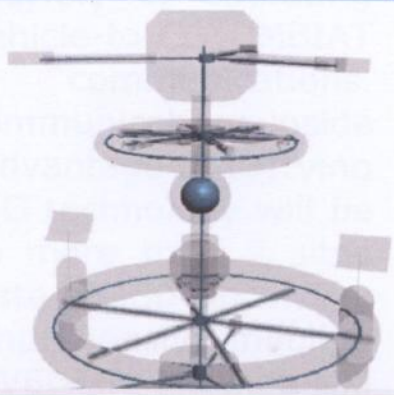
Chart 3.2.4 Water Management

Table 3.2.4 Water Input - Output

INPUTS-kg/person /day	OUTPUTS-kg/person/day
Oxygen—0.83	Carbon Dioxide—1.00
Dry Food—0.62	Water from Respiration and Prerespiration—2.28
Water in Food—1.15	Urine—1.50
Food Preparation Water—0.79	Urine Solids—1.50
Drinking Water—1.61	Hygiene Water—7.18
Oral Hygiene Water—0.36	Latent[evaporated] Hygiene—0.44
Hand and Face Wash Water—1.81	Clothes Wash Water—11.87
Clothes Wash Water—12.47	Dish Wash Water—5.41
Dish Wash Water—5.44	Latent [Evaporated] Dish wash Water—0.03 Feces Solids—0.03 Feces Water—0.09 Swear Solids—0.02
Urinal and Commode Flush Water—0.49	Urinal and Commode Flush Water—0.49
TOTAL-31.0 kg/person/day	**TOTAL-31.0 kg/person/day**

Storage: Water will be stored in a quartz sphere on central axel. UV light falling on the sphere helps to kill any contaminating micro organism. It has a volume of 6181875 m^3 which can easily sustain Columbiat's requirement for 1.1 years without recycling.

Distribution: The residential area will have two water pumping centres from where supply of water will be given to residents as well as to agricultural torus. The diameter of the pipes chosen for this purpose will be 1.8m. There will be a purification plant, which ensures the supply of purified water to the tori. Pipes will run under the roads and will be connected to each house at one end and to water distribution plant at another end.



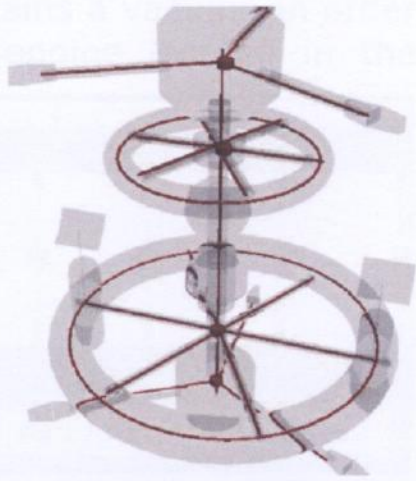
- Water lines and water Chamber

Fig 3.2.4 Water Routings

3.2.5 Household and solid industrial waste management:

(Household waste = 2kg/person/day)

Organic waste: Materials such as cloth, paper, plastic, aluminium and glass would be deposit in special places, collected and melted and recycled. Waste plastic would be recycled by non-incineration plastic disposal technology using TiO2 high grade materials recovery to recycle old home appliances. As we have to recycle everything up in space, so a self-sufficient waste-treatment device would fit the conditions in best way. And even could produce manure.



- Sewage lines & waste management plant

Fig 3.2.5 Sewage Routings

For the **non recyclable waste** material Northdonning Heedwell propose exclusively a self efficient organic waste management system. In this system we can treat all organic and even inorganic waste (chemicals) with help of bacteria, in device known as microbial fuel cell. **If we had 25,000 people and we treat their sewage, we can get up to 0.75megawatts of continuous Power.** This involves Desulfitobacteria, which breaks down and detoxify all the problematic environmental pollutants, including PCBs and some chemical solvents.

Inorganic Waste: Some of the inorganic waste (chemicals etc) could be treated by using the above given method .While some (metals and etc) would be refined, recycled and used in industries. And other would be incinerated by using microwaves.

INDUSTRIAL WASTE: Industrial waste is divided into two parts: **1) Metallic 2) Non-metallic:** Metallic waste will be removed using magnetic separators and aluminum magnets. Glass would be removed using optical sorting. Rest of the waste would be melted down to original elements. Melted metallic waste would be recycled into sheets. Non-metallic waste left after recycling will be incinerated using microwaves at 1473K.

3.2.6 Internal and external communication: 1) External communication: We are likely to rely heavily on Ka-band frequencies (20-40 GHz) for communications traffic. In addition to providing relief from frequency congestion, Ka-band technologies offer potential size, weight, and power savings when compared to lower frequency bands. For communication between earth and moon, earth and COLUMBIAT we will put to use the 37.0-37.5 (return link) and 40.0-40.5 (forward link) GHz frequency bands. We will also develop preliminary communications concepts for a space-to-space system operating at near 26 GHz. Space-to-space applications can encompass a variety of operating conditions, like vehicle-to-vehicle communications, vehicle-to-COLUMBIAT communications, and COLUMBIAT-to-OTHER SETTLEMENT communications.
2) Internal communication: Free space optics will be used for communications inside the two torii, docks and the central hub. This technique holds the advantage of carrying multiple signals at any particular time irrespective of the load the 4G technology will be able to support interactive services like video conferencing (with more than 2 sites simultaneously) wireless Internet etc. Data will be transferred at a rate of 150 Gbps. The transfer cost of the data would be comparatively very less and comprehensive mobility would be possible. The networks will be all IP networks based on IPV6. The antenna will be much smarter and improved access technologies like OFDM (Orthogonal Frequency Division Multiplexing) and MC-CDMA (Multi Carrier Code Division Multiple Access) will be used. Also the security features will be much better.

3.2.7Internal Transportation A remarkably efficient transportation infrastructure on board Columbiat allows for effective human transportation. Columbiat will utilize the following transport systems for the comforts of its inhabitants.

Columbiat Monorail Line Service: Columbiat will have an elevated metro train system utilizing pneumatic levitated trains. Each monorail line includes 3 trains capable of carrying 500 passengers each, with the capability to load or unload at least 200 persons at each stop. The train travels through an airtight tube that maintains a vacuum in order to minimize air resistance increasing efficiency. A pneumatic engine located in the bottom of each train powers the trains. These trains travel at a maximum speed of 100 Km/h in order to minimize travel time and avoid greatly fluctuating levels of gravity exerted on the train and its passengers because of variations in rotation speed. **Elevator:** - Within every sub ring a series of small elevators exists to get occupants to and from the main rail and the ground below. Each elevator is made up of two pods (each pod capable of holding 200 persons) functioning as counterweights for each other.

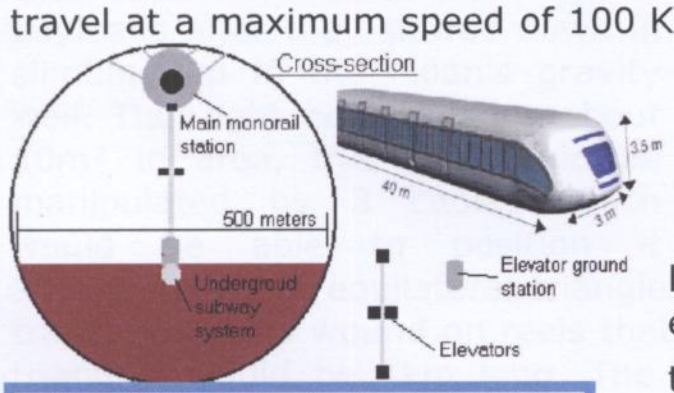


Fig 3.2.7(a) Columbiat Monorail line facility

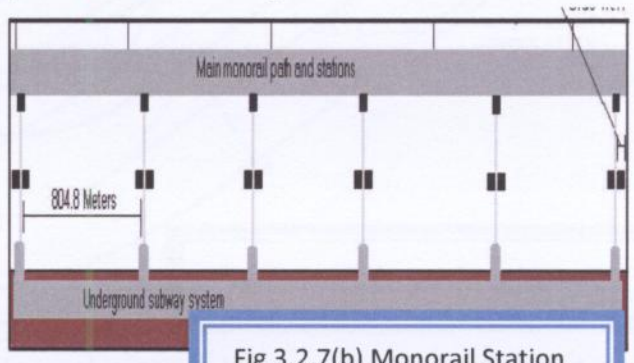
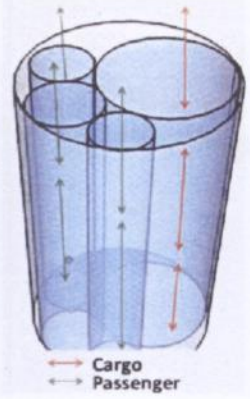


Fig 3.2.7(b) Monorail Station

Personal Transport: - For maintaining a clean and spacious environment on Columbiat personal vehicles will be limited to bicycle. But keeping in mind the business prospect of the settlement we will provide cab facilities in hotels. Patients and disabled people will be provided with Automated Wheelchairs.



Transportation in Central Axis and spokes: Elevators are used for transportation within central axis and spokes. The elevator itself acts as a stopper with the conduit acting as a pneumatic hose. Above the elevator there is constant air pressure of 0 bars. Below the elevator there is .225psi (.01551bars) when it is at the bottom, or at 1g, causing the pressure to neutralize the weight of the elevator. Thus, when the elevator is in the center of the conduit the pressure underneath is far less, yet the gravity is also far less, causing the movement to remain neutral wherever the elevator is located. With the weight being neutral, it is only required that a small pneumatic powered engine lift the elevator up and down with minimal energy expended. The elevator will be capable of carrying a maximum of 200 persons and 3000m3 of cargo on each trip. Each spoke elevator will be able to carry 12500m3 of cargo to ease transportation clogs.

3.2.8 Day and night cycle: A mirror angled at 45º to the plane on which the settlement will lie will be placed (fig.2.1.1). This will rotate about its own axis, centred above the axis of rotation of the torus, once every 24 hours thus giving day/night cycles. However as natural light need only be supplied to the torus and the central sphere, a full mirror, covering the entire settlement. This will bring light into the settlement all 24 hours. The effect of darkness will be made by the changing the transparency of the variable transparency glass. It is based on suspended particle technology. Light absorbing microscopic particles is dispersed within a specially formulated liquid, which is suspended, between layers of film. This film, in turn, can be enclosed within a variety of transparent materials, ranging from glass to plastic. The particles are activated by an applied electrical voltage, forcing them to align at various angles, resulting in a range of controllable transparencies. It is as durable as the glass or material within which it is enclosed. So by using foamed glass as the outer cover, its strength can be drastically increased.

3.3Space Infrastructure: Mass Driver: The "mass driver" is a "catapult" tube which launches materials from the lunar surface to a Catcher/Collector, perhaps near a factory in orbit near the Moon. It is powered by electricity, producing magnetic fields to accelerate cargos through an accelerator tube.

Mass Catcher: An orbital-based Catcher/Collector would be located in lunar-stationary orbit (the "L2" in this case), where it would collect the stream of numerous small payloads after they slowed down in climbing up in the Moon's gravity well. Thin light net, probably about 10m² in area, this net would be manipulated by 3 cables which would be able to position it anywhere within equilateral triangles. These triangles would travel on cables wound on reels that move on three close looped traps. Each side of the triangles would be 1km long. The triangles would move on the cables in the same direction as the payloads to provide counterthrust when they enter the catcher.

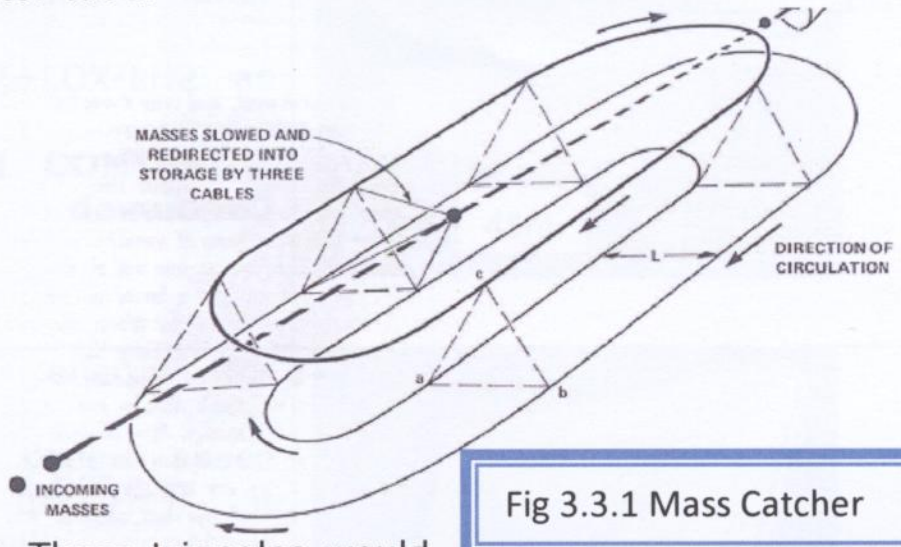
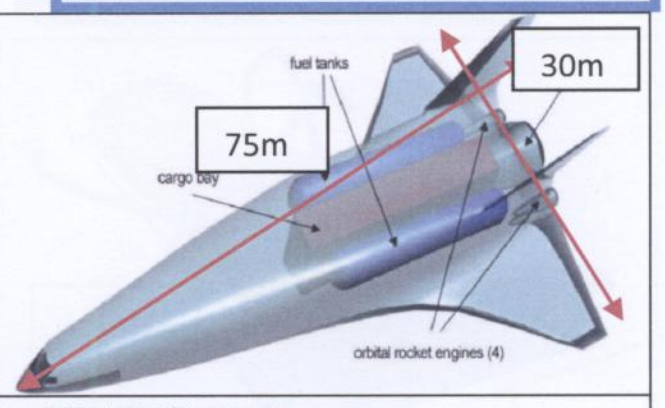
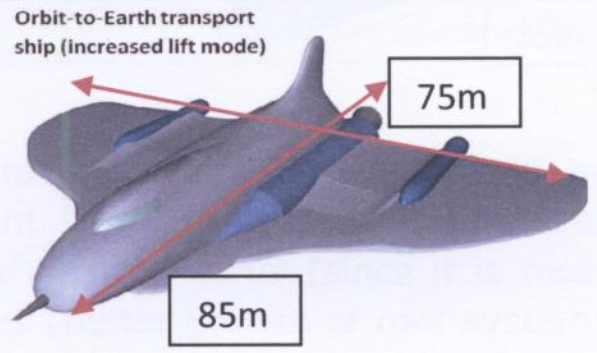
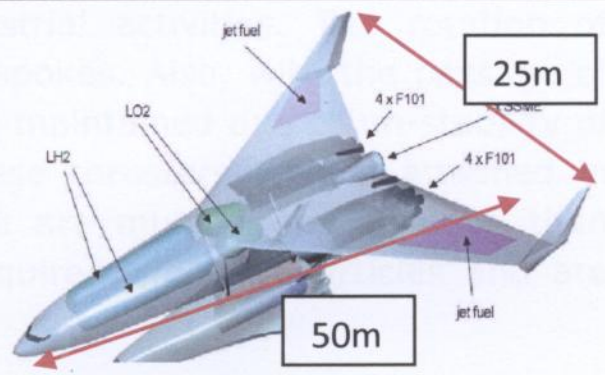
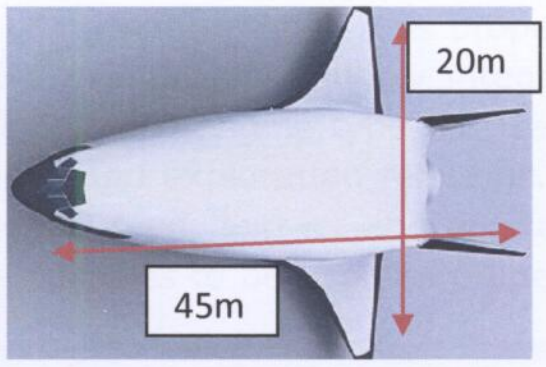
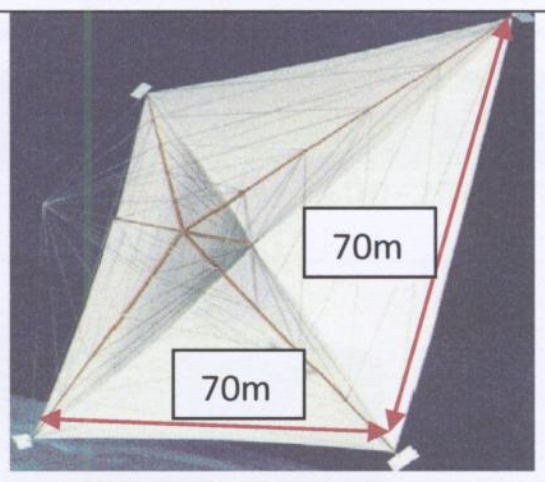
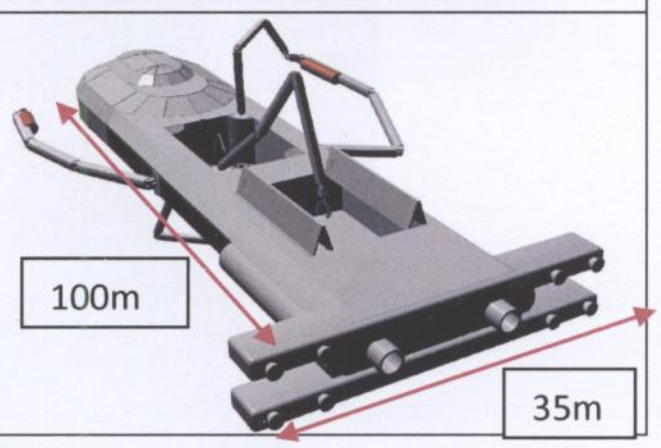


Fig 3.3.1 Mass Catcher

Table 3.3.1 Space vehicles

Cargo Ships	÷ Propelled by VASIMR engines,LOX-LH2 thrusters ÷ Used for transportation of materials from lunar facilities during construction sequence. ÷ **STATUS IN CONTRACT: Included**	
Orbit to Earth Ships	÷ Use only LOX-LH2 thrusters. Used for transportation of people and material from settlement to earth ÷ **STATUS IN CONTRACT: to be developed individually**	
Earth to Orbit Ships	÷ Use LOX-LH2+Canisters as fuel to leave earth. ÷ After reaching orbit it can be used as, orbit to earth ship. ÷ **STATUS IN CONTRACT: to be developed individually**	

On-Orbit-Small-Transport ships	Used for transportation of people and other components. ÷ Used for transport between settlement and lunar facilities. ÷ Use VASIMR+LOX-LH2 as thruster. ÷ **STATUS IN CONTRACT: to be developed individually**	
Space Drone	÷ Uses solar energy for propulsion ÷ Used in deep space missions because it provides small constant acceleration ÷ **STATUS IN CONTRACT: to be developed individually**	
Construction ships	÷ Used in construction of major settlement components. ÷ Use both VASIMR and LOX-LH2 engines. ÷ **STATUS IN CONTRACT: included**	

3.4.1 Artificial Gravity: The source for artificial gravity in our settlement will be centrifugal force provided by the rotation of settlement. The settlement will rotate at 0.901 rpm to generate a gravitational pull of 9.8 m/s^2 in main torus (since it is most favourable for human habitation), 5-6m/s^2 in inner torus (better growth of root systems of plants in this gravity and for visitor's adaptation. Micro gravity environment in the central cylinder will favour transportation and industrial activities. The rotation of settlement will be initiated during the construction of spokes. Also, with the passage of time the rotation rate of the settlement will have to be maintained due to un-stability of L2 by the use of NanoFET Thruster periodically. These thrusters will be attached in balanced pairs around the structure. These thrusters are much more effective than ordinarily used chemical rocketry. The propellants required are nanoparticles and are available easily

3.4.2 Propulsion Systems: Incorporating a propulsion system in Columbiat's structural configuration is of extreme importance. Serving purpose of maintaining artificial gravity and station keeping on an unstable Earth-moon L2 orbit. For this very purpose the **NANOPARTICLE FIELD EXTRACTION THRUSTER** (nano-FET propulsion system) capable of exhaust modulation at constant power. In addition, the advantages offered by nanoFET's potential for high efficiencies, lower thruster specific mass and longer operational lifetimes are both mission enhancing and enabling.

NANOPARTICLE FIELD EXTRACTION THRUSTER

Principle: A new electrostatic thruster technology is using nano-particles as propellant with micro- and nano-electromechanical systems (MEMS/NEMS). This highly integrated propulsion concept is a high efficiency, variable specific impulse engine type that can be readily scalable for a large range of future space science and exploration missions. The nanoFET utilizes highly scalable MEMS/NEMS structures to feed, extract and accelerate nanoparticles through micron-sized thrusters. The nanoparticles to be used as propellant can be of various geometries and materials.

Technical specifications:

Table3.4.1 Technical specification of NanoFET

Fuel used	Power	Specific impulse	Efficiency	Thrust
Nanoparticles	1-10 MW	100-1000 sec	<90 %	100-200 KN

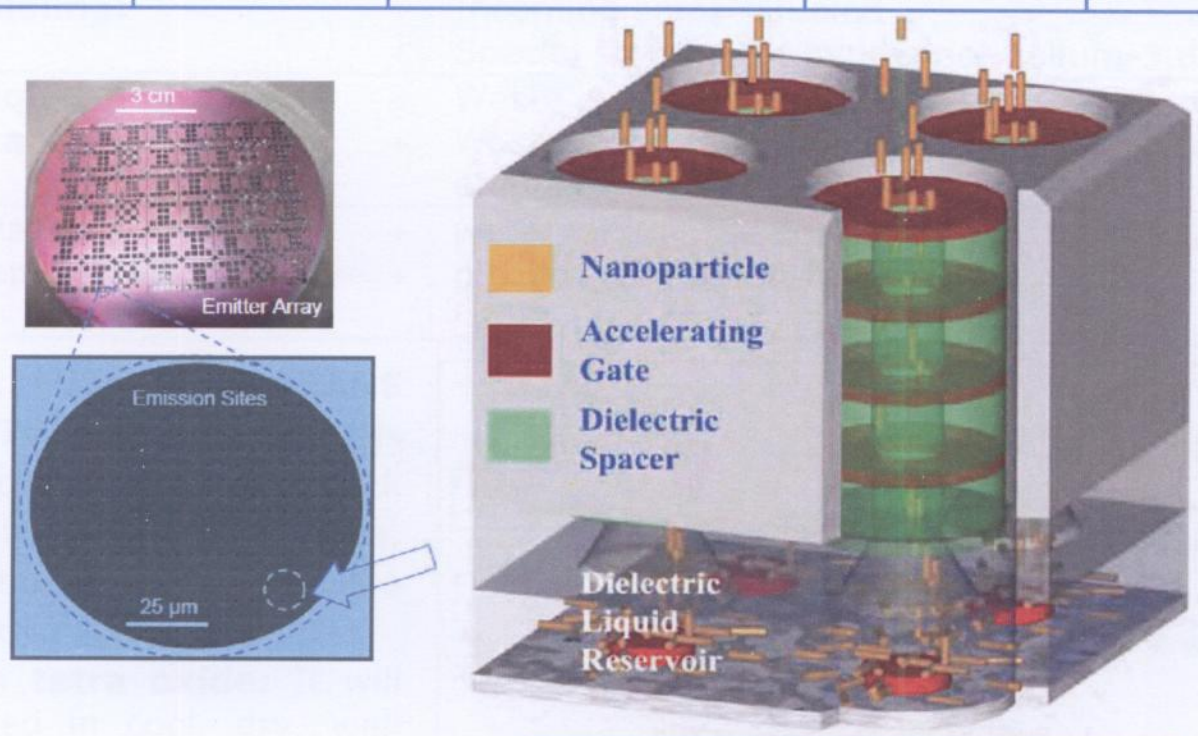


Fig 3.4 NanoFET Propulsion System

One intriguing aspect of nanoFET is that it uses MEMS/NEMS technology to enable a "flat-panel" thruster design that incorporates power processing as well as nanoparticles manufacture, storage, feed, extraction, and acceleration. This results in a modular and geometrically scalable propulsion system, from watts to megawatts.

LOCATION OF PROPULSION SYSTEM: Such engines, sixteen in number, will be strategically placed ensuring swift evacuation of the settlement into nearby safer orbit. Eight of them would be placed on either side of the transverse cross section of the central cylinder at axial positions along their circumference at equal distances. All the sixteen engines will not be operated at one instant. Upon threat of debris approach the engines will be launched one after another creating sufficient thrust required to perform safety manoeuvre taking Columbiat to a safer location more than one mile away. Consequently Columbiat will be highly sufficient and efficient in its shielding methods making it pleasant and risk free for its inhabitants.

3.5 Provisioning and maintenance services for visiting ships:

Table 3.5 Showing Provisioning & Maintenance Services

SERVICES	Description
1. Food and agriculture replenishment:	÷ Warehouses of agricultural products located in spaceports ÷ Robots present in docking area replenish the food items of incoming ships
2. Livestock veterinary services:	÷ Pre examined animals brought from earth and other settlements ÷ Facilities of feed, 2 veterinary experts and vetobot (robot) always available
3. Engine overhaul	÷ Engine scanned for any discrepancy ÷ Damaged parts replaced, Engine repair for any wear/tear
4. Fueling:	÷ Incoming ships refueled ÷ Special storage for hydrazine, helium-3.deuterium
5. Liquid and solid waste disposal	÷ Waste collected in a tank in the spacecraft ÷ Waste collection line run through all ports and tank emptied
6. Water replenishment	÷ water tank of the spacecraft ÷ pipeline for replenishing water

3.5.2 FUEL STORAGE FACILITIES: Storage of fuels will be done in the cargo dock above the docking area, Special storage facilities are listed below:

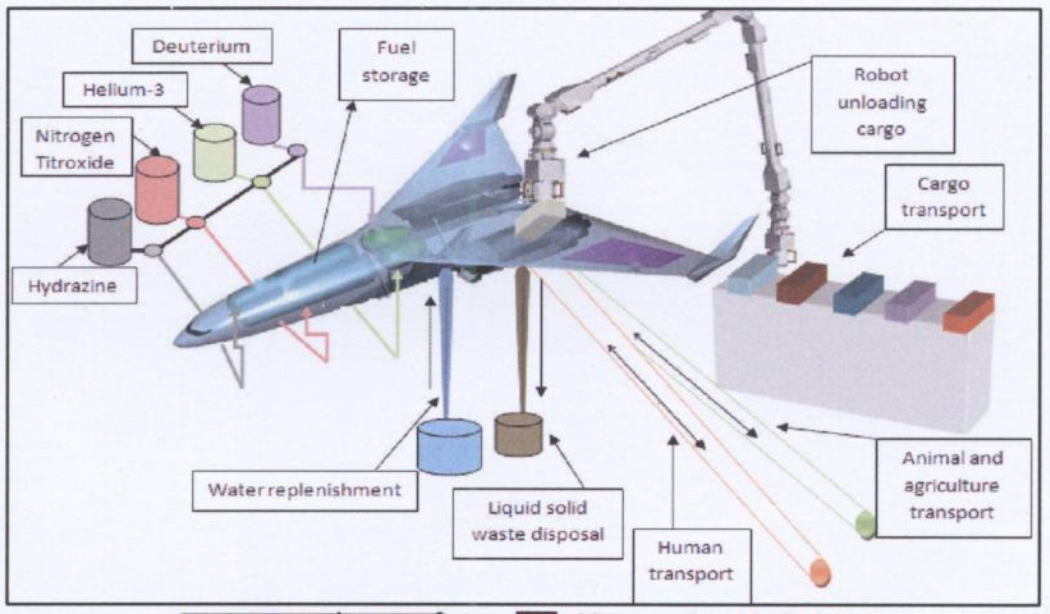


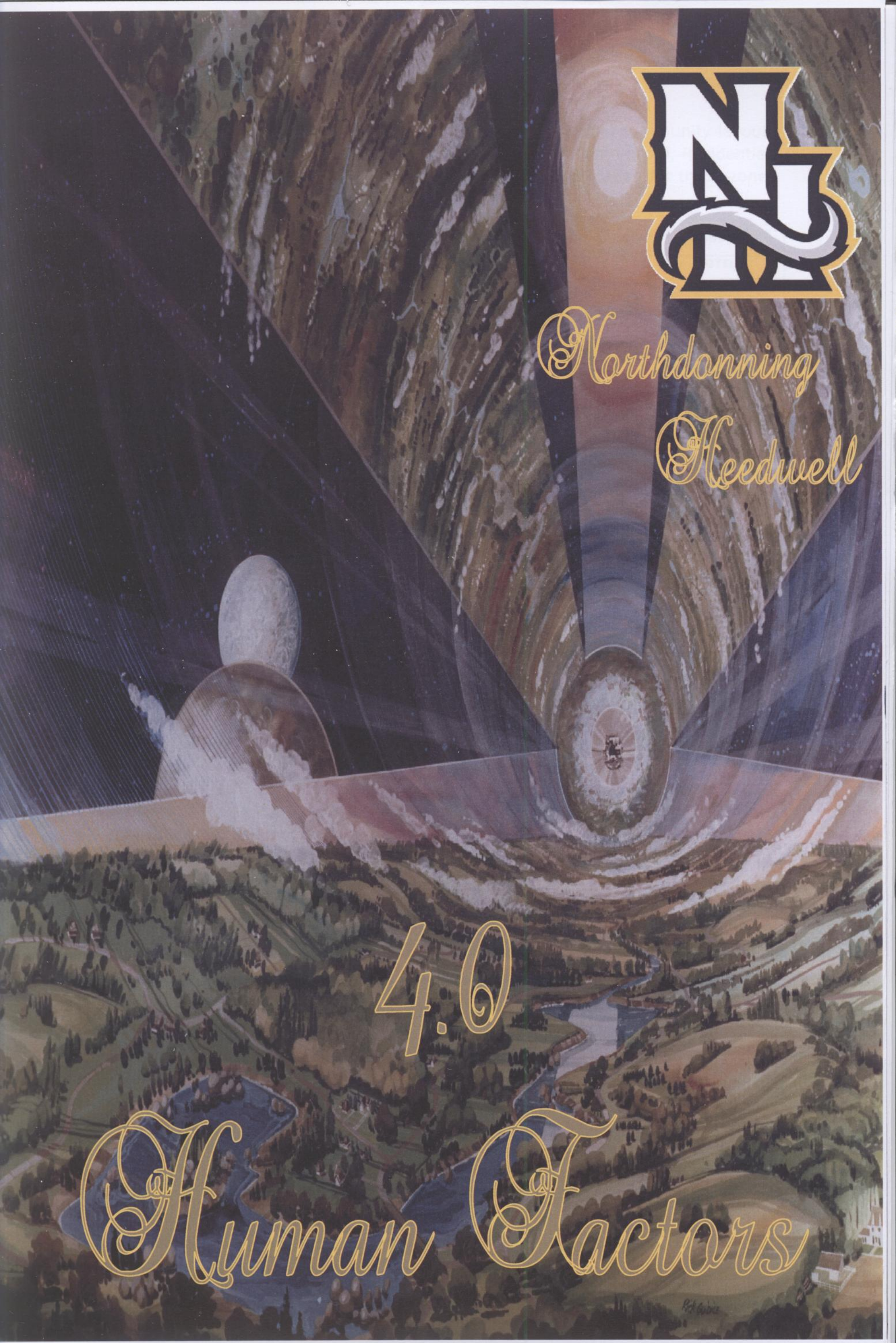
Fig 3.5 Showing Fuel Storage Services

÷ **Nitrogen tetra oxide:** It will be stored in cool, dry, well ventilated location, separate from oxidisable materials. Outside and detached storage to be provided for this fuel.

÷ **Deuterium:** Electrical equipment used will be non-sparking and explosion proof. Check valve or trap to be used in the discharge line to prevent hazardous backflow into the cylinder. Fuel to be stored in cool and dry, well ventilated area of non combustible construction away from heavy traffic areas and emergency exits.

÷ **Hydrazine:** Storage containers will be type 304L and 347 stainless steels with less than 0.5wt% molybdenum. Hydrazine solution will be transferred by pressurizing with nitrogen at a safely regulated pressure. For extended bulk storage, stainless steel tanks, piping and valves will be employed.

÷ **Helium-3:** It will be stored in glass or quartz vessels coated with cesium. Transportation will be guided by a magnetic field of a few gauss. To provide this transportation boxes will be made out of soft iron and mu metal. By means of permanent magnets a field region with dB/dr/B<10-3/cm will be provided in a volume of V=6l which is about 15% of the transport box volume.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Human Factors

4.1.1 Community plan: The main torus will be divided into 4 equal community layouts 2 of each type, with further divisions into specialized zones viz. Commercial, Residential, Business centre and Recreation centre. The area and distance allocation for these zones will be based on utility, connectivity and comfort factors.

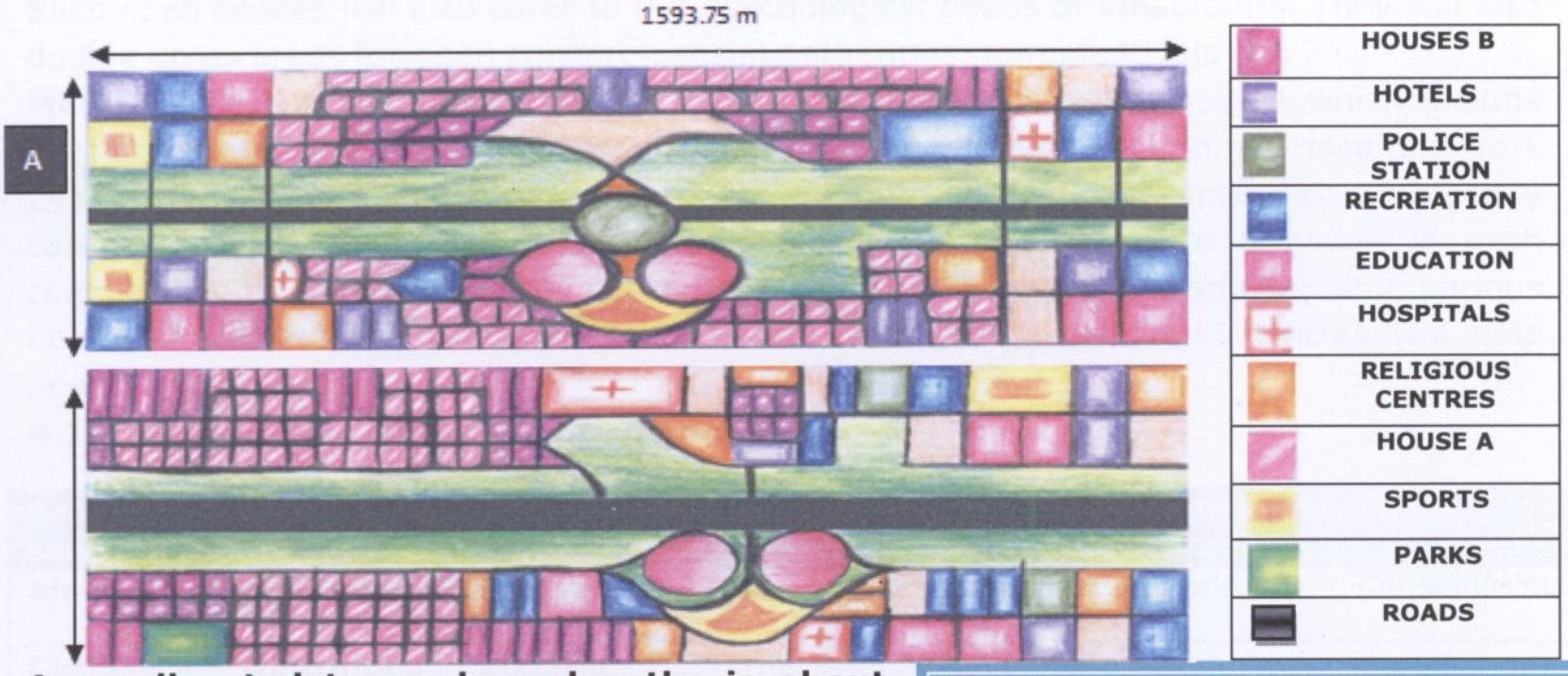


Figure 4.1.1 (a), (b) Community Plans

Area allocated to roads and paths is about 23%.Housing: The housing scheme for Columbiat will lay equal emphasis on traditional comforts of homes as well as modern amenities, techniques & gadgets. It will be planned with optimal provision for space within & outside, community lawns, utility areas & close proximity to public and commercial areas as well as proper allocation for utilities like parks etc. Houses are designed to suit the needs of residents. They even have provision of backyards for cultivating crops and plants. Household robots are provided to carry out day-to-day work.

Education & Research: The 'Columbiat central school' provides basic education to the children. **Pre-school education (3-6 yrs old)** aims at building the very basic mental level and play-way schools will be provided for this age group involving games and activities in which they get to know more about the settlement. **Secondary education (6-12 yrs)** takes into account basic arithmetic and knowledge of languages. **High level education (12-17 yrs)** lays stress on scientific subjects. **Higher education** is provided by the Columbiat central university which offers a variety of scientific and theoretical courses. The university will also run specialized short time term courses for inhabitants of Earth and other space settlements. This university is a research hub and co-ordinates the zero-g processes and research in central cylinder. Well qualified teachers carry on their work with the assistance of robots and electronic media.

Recreation and Entertainment: Recreation will be an integral part of any plan for humans on Columbiat because of the complexity of the modern lifestyle involved. Special care will be taken to provide entertainment facilities for each and every age and interest group. Multiplexes, shopping malls, cinema halls, gaming zones, discotheques, bars, and multi-cuisine restaurants will cater to this need. Broadcast of television channels of earth and easy internet access adds to the enjoyment of residents.

Recreation facilities will be hosted by lakes, theme parks, visual centres, sports centres, public parks, science city, amusement parks, religious and community centres. The serene environment of gardens and the surrounding woods along with the accompanying theme park and visual centre will provide a luxurious retreat to the residents and the visitors. Theme park includes roller coaster & other rides and Visual centre will provide

views of space and will run shows of documentaries based on "Columbiat's Concept and Construction", space, asteroids etc. to provide a unique form of intellectual recreation.
All these provide the residents a unique and supreme level of recreation. Public parks will add to the recreation modes as well as provide an aesthetic touch to the settlement. Such open spaces will also cater to the psychological needs of inhabitants. They will also double up as areas for open concerts, social gatherings, fairs, festivals etc.

Medical: The medical infrastructure constitutes well-equipped hospitals which include fully automated pharmacies, labs, and emergency and operation rooms. Hospitals work 24X7 and use latest technology with robots assisting all medical procedures. Emergency care centres respond rapidly to medical emergencies. Clinics are provided in each community for regular medical checkups. Nano-robots will regularly monitor various health characteristics of the respective individuals. Yoga and reiki centres will help people maintain their health.

4.1.2 Variety and quantity of consumables

Spices/oil seeds	Fruit	Vegetables	Vegetables	Vegetables	Animal products	Flowers
Almond	Pineapple	Onions	Peas	*Broccoli*	Pork	*Chrysanthemum*
Cashew nut	Watermelon	Zucchini	Turnip	Tomatoes	Fish meals	Roses
Coconut	Strawberries	Leek	Garlic	Taro	Goat meat	Ferns
Walnut	Melon	Sweet potato	Eggplant	Sweet corn	Egg, hen	*Anthurium*
Black Current	Blueberry	Silver beet	Celery	Spinach	cows	*Begonia*
Cardamom	Red Currant	Radish	Carrots	Pumpkin	Milk	Palms
Ginger	-	Potatoes	Cabbage	Pepino	Beef	*Gladiolus*

Table4.1.2 (a), (b) Variety & Quantity (Req./person/day in gm) of Major food items

Non consumable	Quantity/person/year	Non Consumable	Quantity/person/year
Textiles	30m	**Kitchenware**	2 sets
Hygiene/Toiletries	5kg	**Electronics**	3
Footwear	3 pairs	**House application**	1
Furniture	1sofa set, 1dining table	**Tool/ hardware**	1 tool kit
Sporting Equipment	1kit	**Biodegradable plastics**	1kg
Stationary	8sets	**Polymer**	1.2 kg
Cosmetics	4Kg	**Medicines**	.4kg

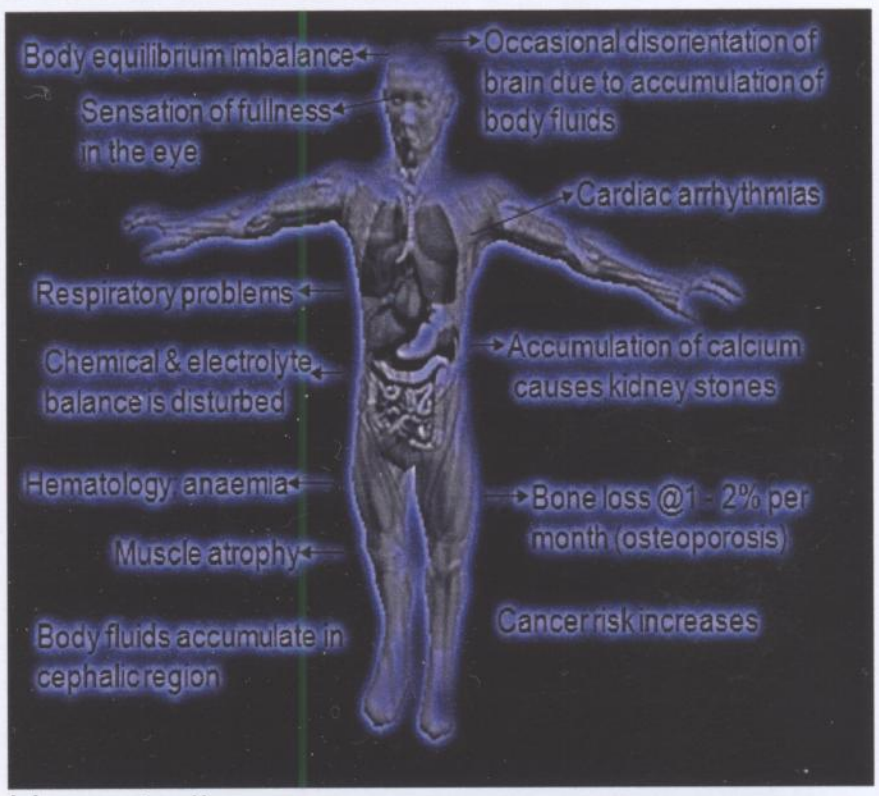
4.1.3 Psychological problems solved :

Problems	Remedies
Acrophobia(fear of flight)	✓ **Systematic desensitization (consecutively exposing of phobic things)**
Auto-phobia(fear of being alone)	✓ **Earth like environment**
Aviophobia(fear of flying)	✓ **Open space areas**
Claustrophobia(fear of confined spaces)	✓ **Line of sight more than 64km**

Keno phobia(fear of empty spaces)	✓ **Proper physiotherapy** ✓ **Meditation and yoga** ✓ **Maintenance of day and night cycle** ✓ **Entertainment and recreational activities**
Lipsism syndrome(person feels everything is dream)	
Insomnia(sleeplessness)	
Isolation and Boredom	
Depression	✓ **Active role by Astro-Sociologists with frequent community gatherings as to create a coherent social structure.**
Anxiety	
Violent Social Environment	

Table 4.1.3 various psychological problems solved

4.1.4 Sources of cloth and paper and annual replenishment: Major source of cloth and paper will be agriculture. Areas have been allocated for the growth of plants which are processed in industrial module. Around 85% of the paper and cloth will be replenished and reused.



4.1.5 Means of Public Distribution System:

Pubic distribution system (PDS) involves the delivery of materials to commercial centres and warehouses using internal transportation system (discussed in 3.2.4) within the spokes and central axle. Monorails will deliver the food items within the residential torus. Food material will be sold in commercial zones located in residential areas in main torii and low g torii.

4.2.1 Design of residential homes: Columbiat provides differentiated neighbourhood types in the four different communities, giving its people to choose the location as well as different kind of architectural design and life style choices which sooths their eyes.

Type of Accommodation	Targeted group	Size	Number
Apartments	Low single	600 ft^2	675
Apartments	Mid single	750 ft^2	675
Medium Houses	High single	900 ft^2	800
Apartments	Low couple	1200 ft^2	910
Apartments	Mid couple	1800 ft^2	910
Large Houses	High couple	2100 ft^2	1500

Table 4.2.1 Details of Accommodation

TYPE A (I): Architecture Style: Split Level, Traditional

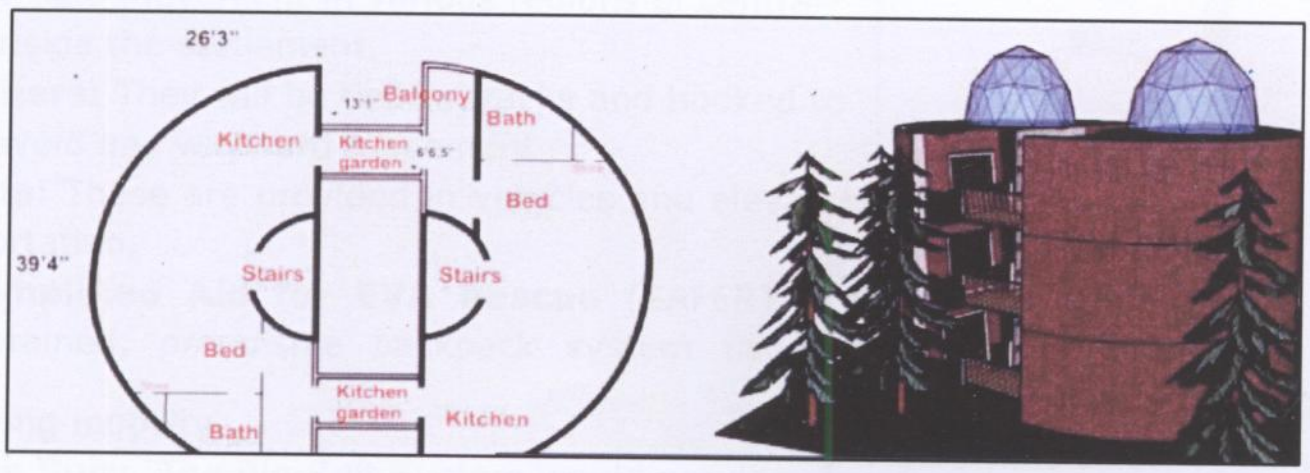
A

TYPE A (II): Architecture Style: European, Country

B

TYPE B (I): Architecture Style: Modern

C



TYPE B (II): Architecture Style: Apartment

D

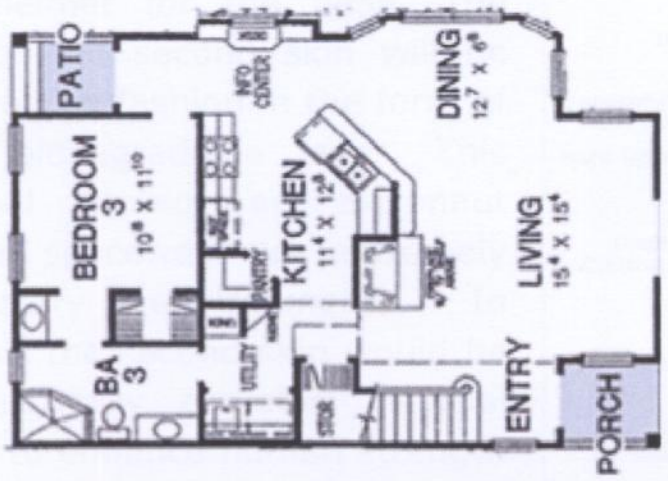


Figure 4.2.1 (a),(b),(c),(d) Floor plans of different Neighbourhoods

Furniture Items	Chair	Table	Sofa	Desk	Bed
Residential	72856	32956	26964	32956	22470
Offices	3365	2784	1256	2834	Nil

Table 4.2.2 Furniture Requirements

4.2.2Furniture Requirements: Different types and number of furniture that will be required by each unit in residential and official area have been shown in table 4.2.2

Source: To conserve resources we will use the agriculture waste to make WHEAT or STAW boards. To make the boards, wheat-straw fibres are bounded with resins that create both physical and chemical bonds. It can be painted and stained like wood and can be used for interior applications such as cabinetry, furniture and decorative wall applications. The resin do-not uses formaldehyde, so the finished boards emit no unpleasant fumes. Weighing about 20 percent less than standard particleboard, a board made from wheat or straw has a superior ability to hold screws and nails and is more resistant to moisture penetration. The lighter weight also makes it easy to transport.

4.3.1 Design of vehicles: Design of vehicles have been shown and explained in 3.2.

4.3.2 Safety measures for movement in low gravity regions

(1)Padded walls: Walls of the low gravity areas are padded with a soft material to reduce the impact of any accidental collision.

(2)Elevated Ceiling: The use of elevated ceiling ensures the availability of enough space to reduce the chances of collision.

(3)Recessed hand holds and foot holds: They will be provided for the safe movement in various regions of central cylinder and outside the settlement.

(4)Safety Tethers: They will be tied to tracks and hooked to person's back avoid any wayward movement

(5)Safety belts: These are provided in vehicles and elevators used in transportation.

(6)SAFER: **Simplified Aid for EVA Rescue** (SAFER) is a small, self-contained, propulsive backpack system used to provide free-flying mobility.

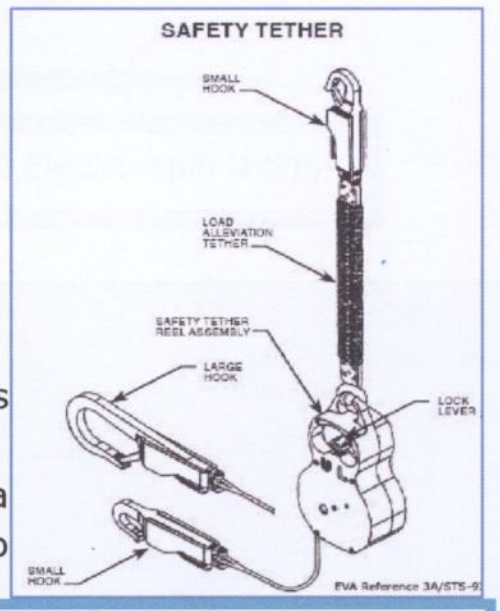


Figure 4.3.1 Safety Tethers

4.4.1(a) Space Suit: The Bio-Suit System would provide life support through mechanical counter pressure where pressure is applied to the entire

body through a tight-fitting suit with a pressurized helmet for the head. The "epidermis" or the second skin will be applied in spray-on fashion in the form of an organic, biodegradable layer. This coating would protect an astronaut conducting a spacewalk in extremely dusty planetary environments. In addition to this the second skin would be made of electrically actuated artificial muscle fibres to enhance human strength and stamina. Top most layer of this suit is a protective restraint layer with the Kevlar fibres incorporated into it for radiation shielding. Underneath this skin lies the open cell foam (a cellular structure consisting of a solid metal containing a large volume fraction of glass fibre pores forming an interconnected network) surrounded by the airtight bladder, such that the combined set up augments person's biological skin by providing mechanical pressure. For the temperature and moisture control, a layer of tiny tubes is used which channelize perspiration away from the body to a remote collection point. Tiny piezoelectric pumps powered by energy produced through the body motion moves the perspiration through the tubes. For the movement of joints the mechanism of flexible convoluted joint with pressurized self sealing gel will be used. The Bio-Suit System will embody communications equipment, biosensors, computers, even climbing gear for Extra Vehicular Activity (EVA). The suit will have facility of electronic check list for additional security and they will also have the provision for servicing and resizing.

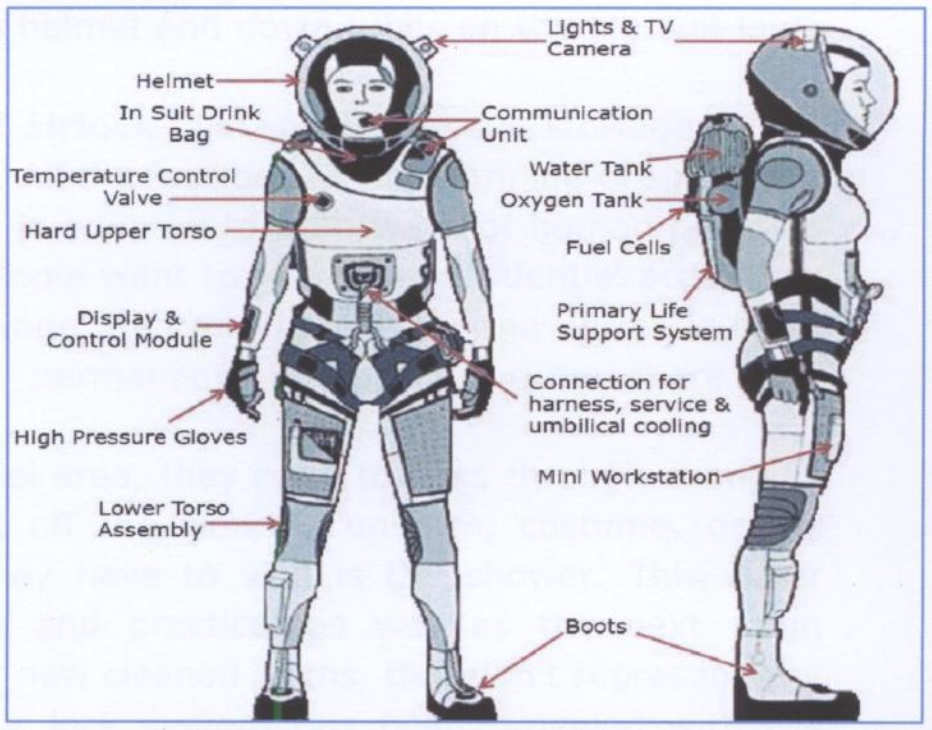


Fig 4.4.1 (a) Bio Space Suit

4.4.2 Donning and doffing of space suit: The first step in the donning procedure is putting on of bio-suit layer. The bio-suit layer is lightweight and easy to don and doff. It is custom fitted to each astronaut using a 3D laser scanning and electro-spinlacing process. **Electrospinlacing** involves charging and projecting of tiny fibres of polymer directly onto the skin. Kelvar fibres are applied over the cell bladder along the lines of non extension. Then a hard torso shell would be slipped on, sealed via couplings located at the hips. A portable life support system is then attached mechanically to the hard torso shell which provides gas counter pressure. Gas

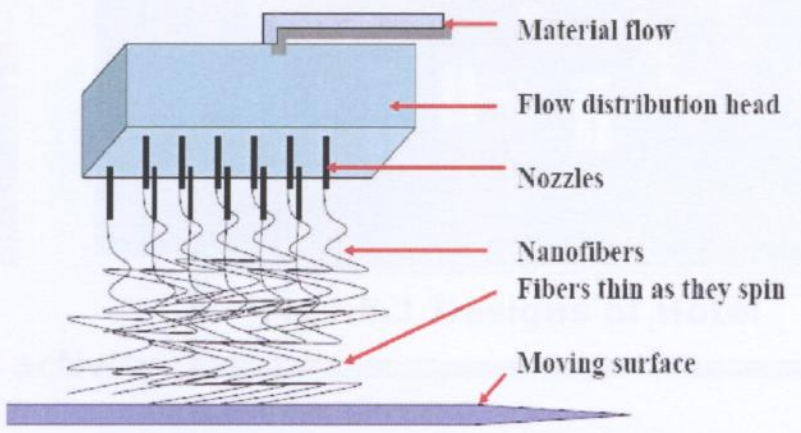


Fig. 4.4.2 Electro-spin lacing

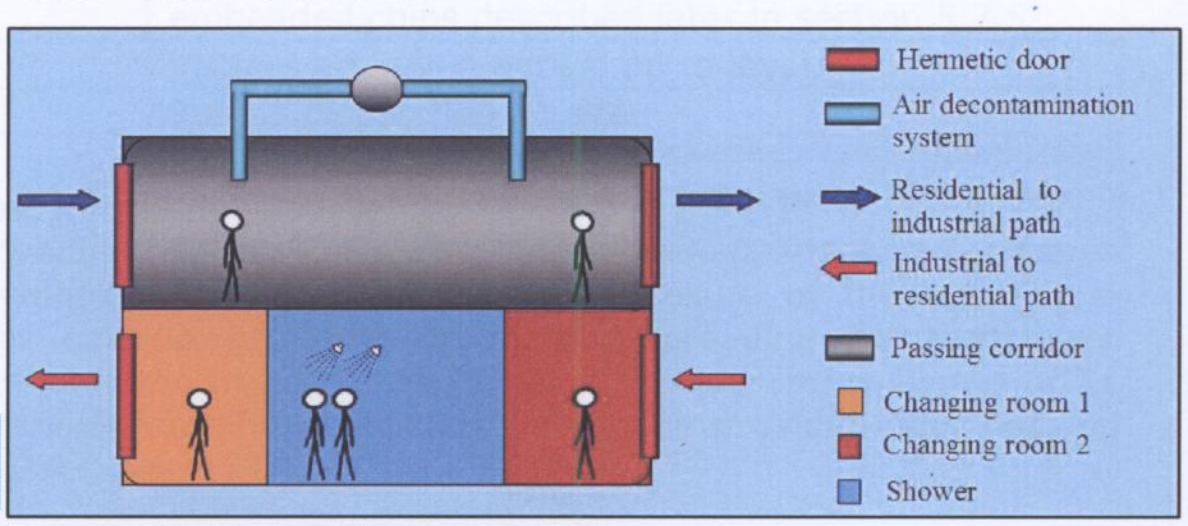


Fig. 4.4.3 Air Lock Design System

pressure would flow freely into the wearer's helmet and down tubes on the bio-suit layer to the gloves and boots.

4.4.3 Space suit stowage and design of airlock system: Space suit stowage will be in the room attached to the air lock system. All the facilities for the donning of space suit will be provided there. The air lock system is adapted to both ways of human direction transport and has hermetic doors. When people want to leave the residential area, they get dressed with the space suit in the stowage area and then enter the hermetic door, pass through a sterile air room that permanently filters its atmosphere (air decontamination system).

When the person has to enter the residential area, they have to pass through changing room number 1, where they have to get off the working uniform, costume, or the unsterilized cloths. The next room that they have to visit is the shower. This water decontamination technique is very useful and practical as well as the next room changing room number 2, where people get new cleaned cloths, that don't represent any danger for the Columbiat's community. Air lock system has been provided with the hermetic doors through which no leakage of air takes place and the door are provided with the sensors and they get closed immediately as soon as the person enters the air lock system. This system minimises the air loses in each cycle which is around $4m^3$.

4.5.1 Location of the hotels and other accommodations: Visitors arriving on the vehicles will be provided accommodations at $5m/sec^2$ in the low g torus for adaptation. Besides these accommodations visitors are also provided with the hotels in the main torus. Locations of the hotels are shown in the figure 4.1.1 in the community design.

Fig4.5.1 Designs of Hotel

4.5.2 Security measures to monitor the activity of visitors:

Security risk	Measures taken
Movement in restricted areas	Monitor the activity of the visitor using the embedded chips described later in section 5.2.5
Unauthorized access	Visitors are given access up to level 1.
Indiscipline	Robots dispatched on site

Table 4.5.2 Security Measures

4.5.3 Quarantine facilities: Terrestrial disease agents are capable of invading a host and causing evident disease symptoms within 21 days after exposure of the host. Most disease agents capable of causing epidemic or rapidly spreading diseases were sufficiently virulent to be transmitted in less than 21 days. So quarantine period of 21 days have been decided. Various quarantine facilities have been provided near docking ports which have been discussed below:

Quarantine of the personnel: The quarantine facility consists of an airstream trailer shell built on a special platform, living and sleeping quarters, a kitchen, and a latrine. In addition to having its own internal backup power, air conditioning, and communications systems, it is equipped with a medical diagnostic capability. Quarantine was assured through the maintenance of negative internal pressure, filtration of effluent air, internal capture and storage of waste material, and a transfer lock system.

Quarantine of spacecraft: The spacecraft room will contain all equipment required for decontamination of the Command Module. It consists of communications and closed circuit television for monitoring and supporting cleanup and decontamination activities.

Quarantine of lunar samples: Boxes containing samples of lunar rocks and soil from early missions were opened in a unique vacuum chamber. The chamber was designed to ensure sample sterility and to provide a method for preliminary examination without compromising sample integrity by exposure to air.

Quarantine of the flight equipment: All flight equipment exposed to lunar surface materials was placed under quarantine restrictions. The equipment included films, data tapes, logs, and other flight equipments.

4.5.4 Passenger Terminal Facilities:

With so many different types of space transients passing through Columbiat every minute, a highly capable and efficient passenger terminal is located on docking port. This terminal is designed to fully accommodate space tourists, business executives, construction workers, scientists, colonists, and Foundation Society members.

The main passenger terminal is capable of docking with three different space cruisers. Since the terminal is not rotating the passengers will use handholds and moving poles to move within the terminal. Once the passengers have decided their final location, whether it is a departing space flight, a hotel or resort, or residential housing for permanent residence, the passengers' luggage and belongings are transported via robot corridors for the passengers' convenience.

Other facilities for passengers include:-

- Disaster management personnel including fire officers and health experts.
- Transportation facilities for the transportation of travellers to the torii.
- Terminals for passengers to be equipped with fully computerized self explaining guide robots using which visitors can get any information related to rest, recreation, transportation and other such activities at the terminals itself.
- Banking facilities will be offered at all such terminals.
- Terminals will be divided into different sections for traffic to different destinations.
- Terminals will have facilities like food joints, recreation i.e. gaming areas, cinemas and comfortable lounging for passengers who have to stay for long durations.
- The visitors coming from low g space vehicles are provided with accommodations where gyms and rehabilitation centres shall provide facilities like vibration zones to counter the effects caused on the passengers during their stay in the low gravity regions.

4.5.5 Rest and recreation facilities

Visitors will be provided with various recreation and the entertainment facilities in the main torus. These facilities have been described in 4.1.

4.5.6 Medical facilities:

Various medical facilities are provided at the docking ports for the visitors. Automated first aid rooms with the assistance of qualified doctors will be provided at the docking ports to handle the emergencies like nausea, food poisoning, blood pressure, indigestion, injuries, and heart and skin problems. Besides this various decontamination rooms have provided for the visitors with the facility of HEPA filters and proper showers to minimize the risks of infections. Well equipped hospitals have been provided in the major torus. Other medical facilities in the main torus have been discussed in 4.1.1

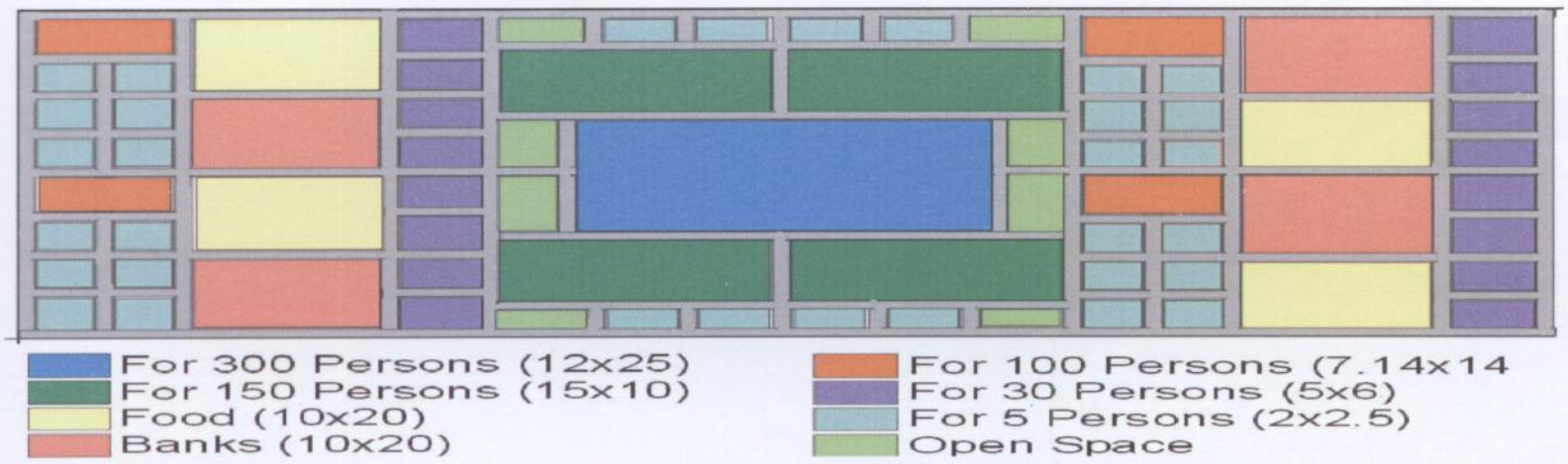


Fig 4.5 Layout of twin towers, area allocation (in meters)

4.5 Business centre:-

1) Office facilities

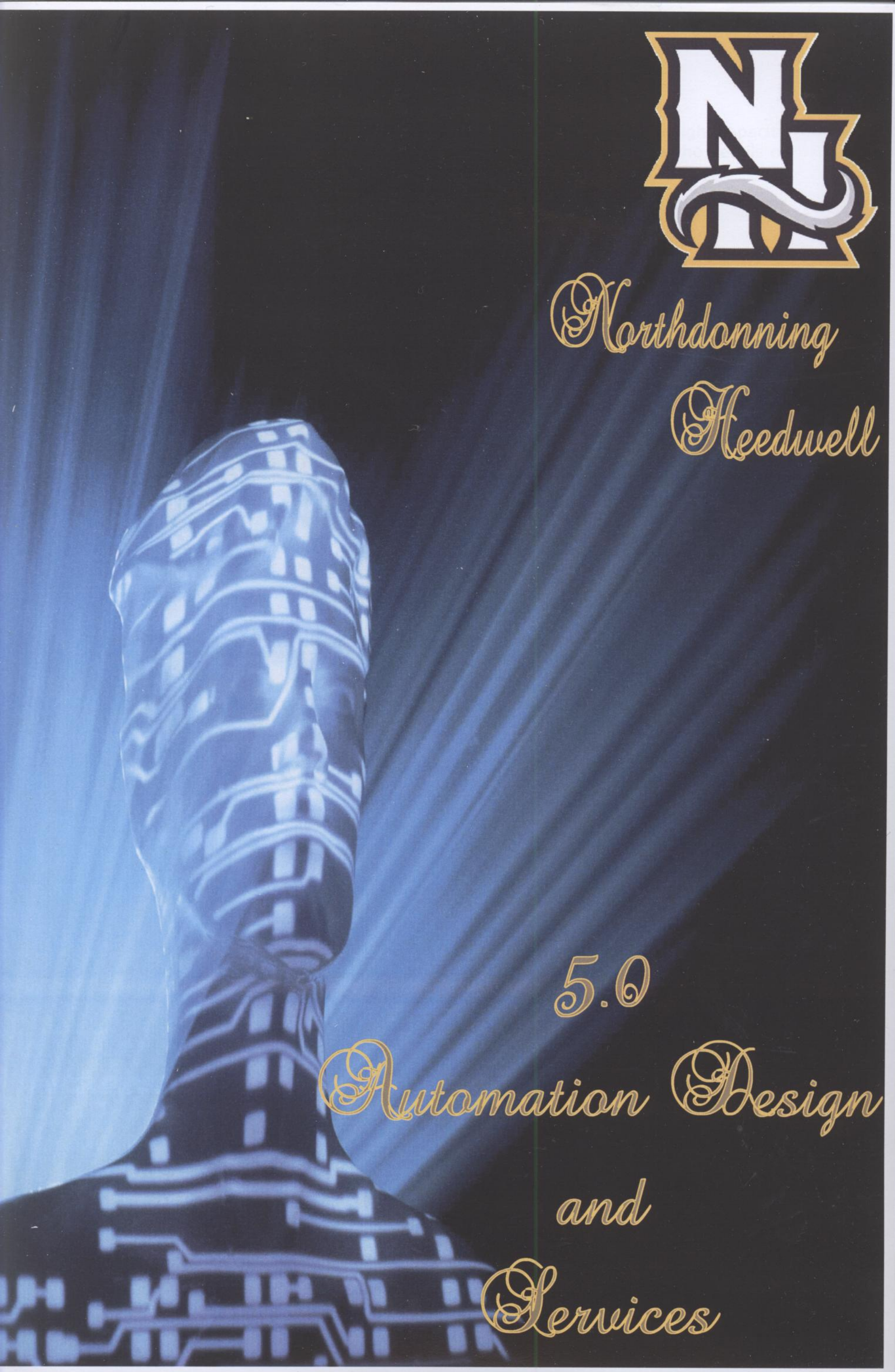
- All offices to have satellite linkage throughout the settlement, with other settlements in space and on the moon and with the earth to provide quick and efficient audio and visual communication. This facility shall greatly boost business capabilities.
- Various offices to be situated together in the same business complex ensuring availability of similar and related business types at the distance of a couple of floors.
- All offices to be provided with latest technologies of their respective fields.
- Separate emergency vehicles for offices which require quick transportation to other parts of the settlement such as storehouses or other offices.
- Research facilities to be provided in offices so as to facilitate development of technology.
- 150 person offices to be provided with systems linking the entire building so as to ensure access to any part of the office at the touch of a button.
- **Customization facility** to be provided to all companies i.e. companies can get their offices customized and get the facilities of their choices added at their own expense; this shall greatly help in earning profits for the settlement and shall also ensure the satisfaction of the customers.

2) Facilities for banks

- Bank offices to include all the above listed facilities.
- Special facilities for banks to include separate passages and vehicles for the transfer of confidential materials, documents, money etc.
- Banks to be linked with major banks of the earth, so that people who want to come as tourists to the settlement can arrange for credits on the settlement from earth and receive those on their arrival at the settlement.
- Offices to be configured in a manner that would allow maximum members to operate their accounts at the same time.
- Banks to provide easy loan facilities for space based companies so as to allow them to establish their business with little inconvenience.

3) Facilities for Foundation Society Headquarters

- Special chamber of the society in microgravity zones for research purposes as research can be done better in micro gravity.
- Foundation society headquarters to have all normal office facilities listed above.
- Also included would be a high tech observatory so as to facilitate space research for future development in space.
- Separate bank branch to manage the financial enterprises of the society.
- Foundation society headquarters to include all sorts of recreational facilities, foods of various cuisines, lounging facilities and instant access to transportation.



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5.0

Automation Design and Services

Each house, office, person onboard Columbiat will be connected by high capacity computers to maintain connectivity and communication. Table 5.0.1 gives the details of computers used.

Table 5.0.1 Number of computers required

Names	Quantity	Place	Configuration
Persona	5300	Houses	3.8Ghz 16core Processor,512Tb storage,32Tb RAM
Professiona	2600	Offices	4.0GHz 32core Processor,640Tb storage,64Tb RAM
Multicana	1000	Others	3.8GHz 16core Processor,512Tb storage,32Tb RAM

5.0.2 Smooth functioning of Columbiat will be ensured by mainly five servers i.e. V1, V2, V3, V4 and V5.

- V1 is a Heavy Load Industrial Server
- V2 and V3 are Residential & Agricultural Server
- V4 and V5 are Docking servers.

Specifications	Main Server V1
Speed	4.8Ghz
Hard Disk	100 Exabyte
Processor	120 Core Processor
Memory	256 Tb
Power	2000 watts(110 volts)
Bus Speed	240 Gb/sec
Cache	2.6 Gb

Specifications	V2 & V3
Speed	4.5GHz
Hard Disk	80 Exabyte
Processor	64Core Processor
Memory	256 Tb
Power	2000 watts(110 volts)
Bus Speed	190 Gb/sec
Cache	2.4 Gb

Specifications	V5 & V4
Speed	4.5GHz
Hard Disk	80 Exabyte
Processor	64Core Processor
Memory	256 Tb
Power	2000 watts(110 volts)
Bus Speed	190 Gb/sec
Cache	2.4 Gb

5.0.3 List of Software to be used by Columbiat Residents:

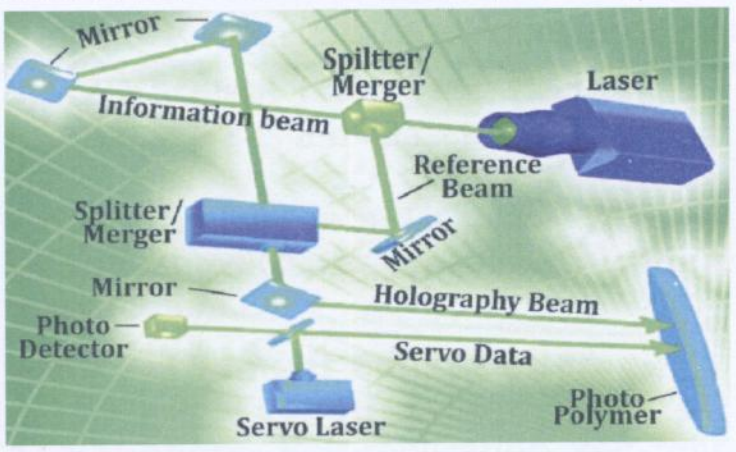
SOFTWARES	FUNCTION
AR-rotato	Monitoring rotation-rate, placement and orbit of the settlement
Stellar Shield	Detection of debris and radiation
AR-Robonic	Monitoring and controlling the Robotic activities, maintenance and repair of robots
AR-CMFM	Detection, maintenance, repair of constructional and mechanical faults
AR-Alert	Alerting evacuation robots and residents during emergency conditions
SLK-propeller	Monitoring the propulsion system, close check on amount of fuel available and condition of propellants.
AR-data	Collection, distribution, protection and backup of critical data
FKL-SOS	Operating and monitoring severs within the settlement as well as linking them with Alexandriat, Bellevistat and Earth
ARK-AM	Monitoring air pressure, temperature and weather in various zones of Columbiat.

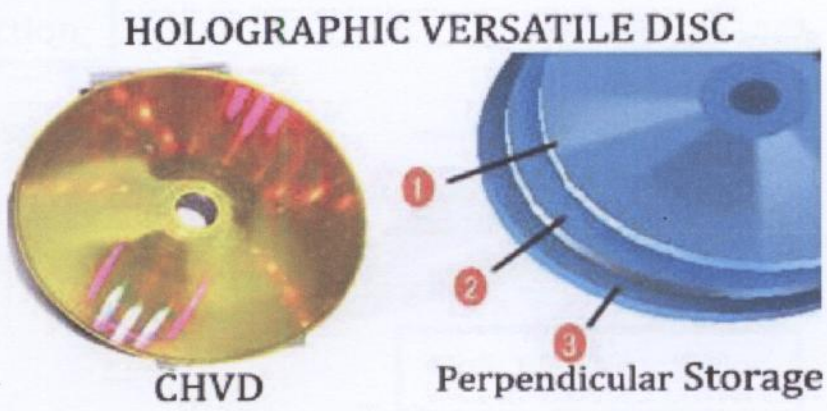
5.0.4 Types of network devices for Network Planning

Network Devices	Specifications	Usage	Number
MULTI-NET	45-ports industrial Ethernet ring switches.	Industrial, residential, agricultural areas.	60

DOCKNET	8-Gb ports, 30 fibre ports, 940 gabs matrix.	High networking areas of DOCKING.	30
INDUSNET	50 industrial Ethernet ports, ultra reliable temperature from -40^{0}C to 75^{0}C.	High networking areas of industrial section.	50
RESINET	2-port Ethernet media converter, 1Tb/sec (access point).	High networking zones of residential torii	100
X-CRYSTAL	900 Gigabit Ethernet switches with 1Tb/sec matrix.	In the control rooms of Arial.	150

5.0.5 Data storage: Holography will provide means for storing enormous amount of data in few cm^2 with density of 4 TB per cm^2.





5.0.6 Data Collection & Distribution: Major data Collection takes place at the V1 server in control centre located in industrial hub.

- Ka band enables strong signal data transfer.
- Frequencies between 27.5GHz and 31Ghz for uplink
- Frequencies between 18.3 and 18.8Ghz and between 19.7 and 20.2Ghz for downlink
- Inside the settlement the data will be distributed by optic cables

5.1 Automation for Construction: Construction will be carried out in a highly automated manner through various mining robots, systems and construction robots. Our settlement provides high tech facilities to its residents. In agricultural and in residential region, everything is monitored using highly advanced computers and robotics systems.

5.1.1 Automation for construction of Columbiat

DEVICE/ TECHNIQUE	FEATURES	PURPOSE
NANO ROBOTS	Nano-scaled construction (10 nm3)	Assembling framework ,Air tight sealing, Electrical pathway construction
CONSTRUATION SHIPS	4 robotic, 4 welding arms, 2 VASIMR engines	Core Construction for settlement
MINNER	Suits various terrains ,Laser drilling system	Construction of base control centre Transportation on moon and asteroid
TRANSPORTER	High storage, Robotic arm, sensors	Used for transporting cargo
CONTOUR CRAFTING	Layer by layer construction	Building major and minor components of house.

INTERIOBOT	Vacuumed feet, sprayer, camera, sleek hands.	Painting, welding, carrying boards
ROLLER360	Good storage of raw material, programmable for prescribed path	Laying roads at rapid rate.
FLEXIBOT	360^0 movement, multiple tasks, Material handling, Assembly, Arc welding	Construction of industry and other infrastructure at zero g.
MULTI-TASKER	2Robotic arms, 2Blade cutters	Cutting, welding, joining, Machine tool Load and Unload functions

Table 5.1.1 Devices/techniques for construction

5.1.2 Material Transportation:

÷ Cargo is transported to the orbit using mass derivers and mass catchers retain it there.
÷ Cargo ships transfer the construction material to the settlement.

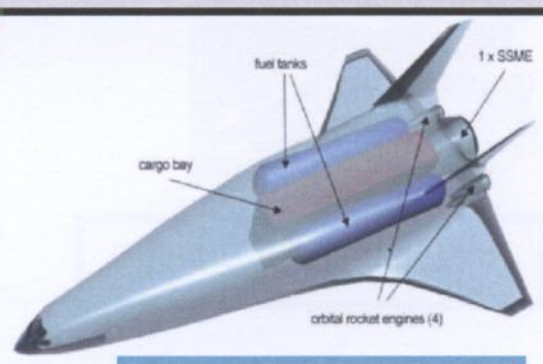


Fig5.1.2 Cargo Ships

5.1.3 Settlement Construction

(i) External construction

a) Nanobots- Self-replicating, self-reproducing, and self-assembling, super-tiny machines, which build themselves up from individual atoms and molecules.
÷ Used for the construction of exterior hull components of the settlement. Making an air-tight seal
÷ Placing solar panels, laying electrical circuits
÷ Repairing small cracks and fissures in pipes, walls etc.
÷ Embedded in the seals, enter a dormant stage, re-activated during repairs.

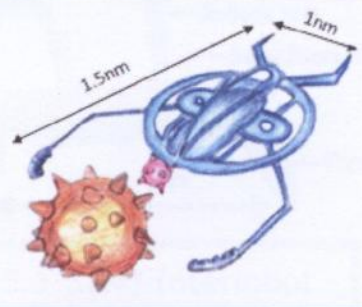


Fig5.1.3 (a) Nanobot

b) Construction Ships:
÷ **Command room** for 6 working people
÷ An **empty assembly space**
÷ **Depositing space**
÷ **4 robotic arms-M**anoeuvring and **F**ixing components
÷ **4 welding arms** for assembling
÷ Propelled by two **VASIMR** (Variable Specific Impulse Magneto-plasma Rocket) engines for long distances, 4 mobile LOX-LH2 thrusters for short distances.

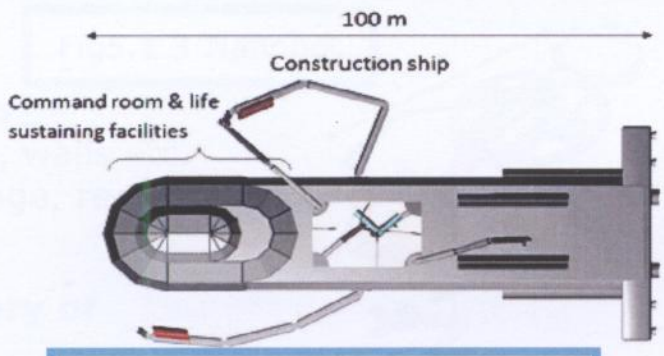


Fig5.1.3(i)(b)Construction Ships

c) Xerobot
÷ 2 telescopic arms for easy access of materials
÷ Electron beam welder for joining
÷ Solar panels, Ion propulsion system
÷ Storage for Kevlar mesh sheets

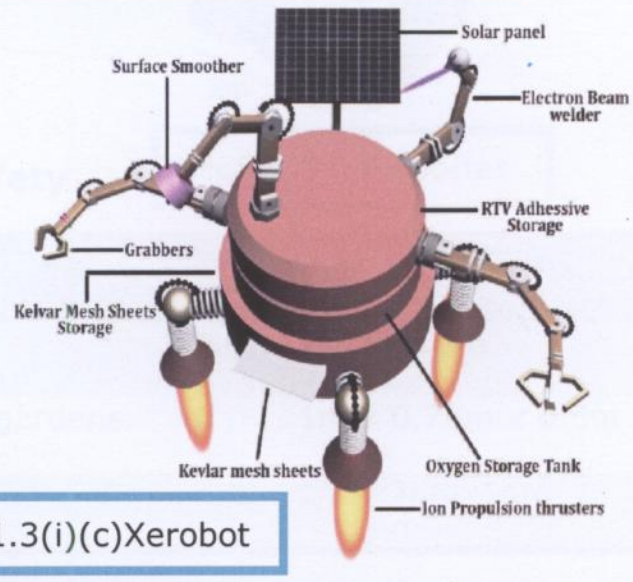


Fig5.1.3(i)(c)Xerobot

(ii) Internal construction

Construction of buildings: construction of houses will be done by a fully automated system called **contour crafting**. It is a layered fabrication technology, which speeds up the construction

process and reduces the construction time.

Advantages: It uses two trowels, which act as two solid planar surfaces, gives better surface quality

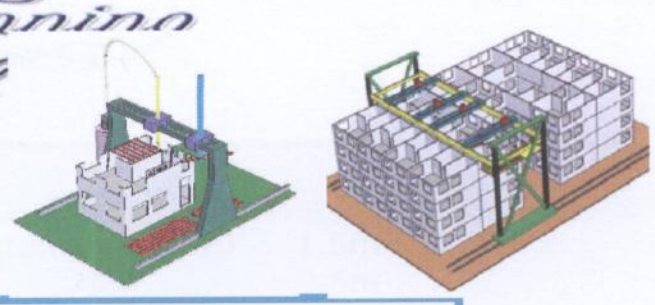


Fig5.1.3 (ii) Contour Crafting

and higher fabrication speed.

(iii) Industrial construction:

(a)Flexibot: It is a form of a robotic arm, joined in the middle with grippers at both ends. It travels across a grid or chain of sockets. Flexibot plugs one end into a socket and reaches to the next. It can navigate and travel at will. Flexibots have three **arm movements** (**up-down**, **in-out**, **side-to-side**) and three **wrist movements** on the end of the robot's arm: **yaw** (side to side), **pitch** (up and down), and **rotational** (clockwise and counter clockwise)

(b)Industro:

÷ 2Robotic arms, joined in the middle with grippers at both ends.
÷ 2Blade Cutters
÷ Inbuilt- Infrared sensor, Camera, Cutting, Welding, Drilling tools

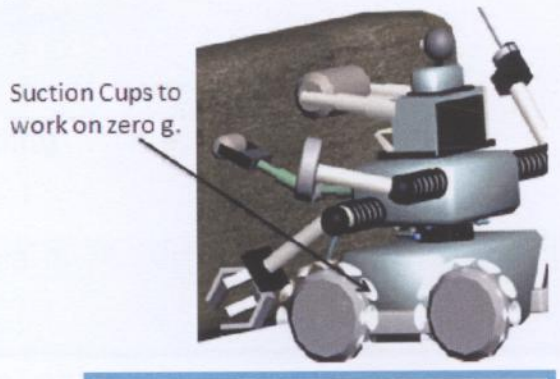


Fig5.1.3 (iii)(b)Industro

Functions: Material handling, Assembly, Arc welding, Resistance welding, Machine tool Load and Unload functions, Painting, Spraying etc

5.1.4 Interior Finishing:

Interiobot

÷ Does painting, welding and other related tasks
÷ Compact size, light weight, perfect for confined indoor spaces
÷ Fits electrical components
÷ Flooring along with its tiles and textures
÷ Wiring of the main circuit around the house
÷ Senses, locates potential architectural failures and prevents damage
÷ Installs security system, sanitary conditions, water supply, drainage system in the houses

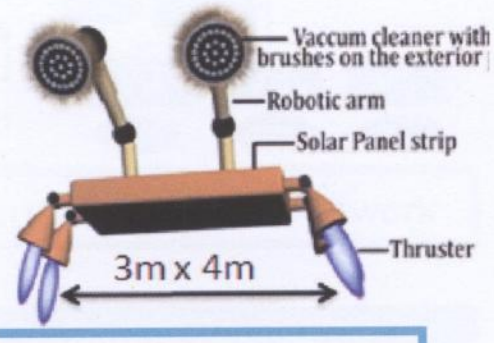
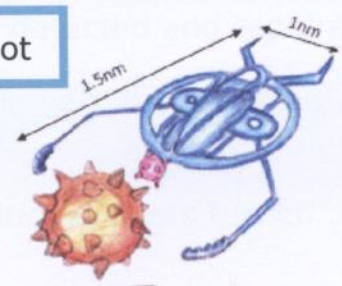


Fig5.1.3(iv) Interiobot

5.1.5 Automation in assembly: Nanobots

÷ Making an air-tight seal
÷ Placing solar panels, laying electrical circuits
÷ Repairing small cracks and fissures in pipes, walls etc.
÷ Embedded in the seals, enter a dormant stage, re-activated during repairs.

Fig5.1.3 Nanobot



5.1.6 Automation in transportation and delivery of materials:

Transporter

÷ Large storage capacity
÷ Programmable for the prescribed path
÷ Infrared sensor, camera for detecting objects

Fig5.1.5Transporter

5.2.1 Automation for maintenance, repair and Safety

Automation for maintenance, repair and Safety				
Category	**Name**	**Description**	**No.**	**Dimension**
Maintenance	Gardener	Maintaining public lawns and gardens.	6	1m x 0.75m x 0.5m
	Nanobots	Maintaining outer walls of the	n.a.	1nmx2nmx1nm

		settlement.		
	Repair-bot	Maintaining transportation systems and corridors.	10	1.5m x 0.75m x 0.5m
	Severobot	Clearing blockages in distribution pipes.	15	0.08m x 0.03m x 0.03m
Repair	Repair-bot	Repairing fissures in the outer structure.	10	0.1m x 0.5m x 0.2m
	Roller360	Repairing roads, buildings, offices and the settlement.	2	1.5m x 2m x 2m
Safety	Bio-passwords	Managing authorized access including series of security checkups.	n.a.	n.a.
	Sheriff	Maintaining law, emergency medical services.	20	1m x .5m x 2m

5.2.2 Back-Up Plans: Each of servers have got backup data disc in which all the data is being synchronized every minute. So in case of any failure in one server the data is retained. And as each server is also connected to each other, other servers can handle the work of broken out server till its back in job. As shown in figure P1, P2, P3, P4 & P5 represent the servers and P5', P2' & P3' represent the backups. Routers are provided from P5 to P2 and P3 in case there is some fault in P1.

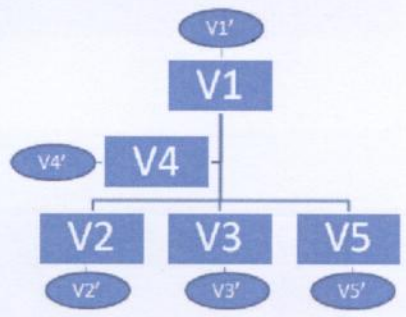


Chart5.2.2 Backup Network

÷ Interconnectivity using star and bus topology

5.2.3 Automation for maintenance, repair and Safety

Emergency	First Response	Second Response
Water routing	Infected Routes Blocked	Water route shifted to parallel lines
Pneumatic pipe bursts	Control shifted to parallel line	Line detected and repaired
Solar flares	Lead shields coated with reinforced polyethylene bricks raised	Settlement moved to safer place.
Atmospheric Contamination	People moved to chambers	Additional filters turned on
Unauthorized Access	Location traced and system logged off	Robot dispatched to site
Networking router failure	Redundant lines blocked, failure cause detected	Robots dispatched for repair

5.2.4(a) Location of servers The main server P5 is located at industrial segment of cylinder. Supercomputer P1 is placed at the centre of main torus, while P4 is set up at the centre of low g torus for the research. High capacity computers P2 & P3 are placed at the business centres of main torus.

Table 5.2.4(a) Locations of servers	
V1	Industrial module
V2 & V3	Residential & Agricultural Torus
V4 & V5	In docking areas

(b)Location of Robots: The nanobots are embedded in the seals, enter a dormant stage and are re- activated during repairs. Robots undertaking the safety functions are kept under the residential area in a corridor dedicated to robots, so that in case of any emergency these robots can be quickly dispatched to the site without wasting any time.

5.2.5 Protection from solar flare: All robots are provided with protection from solar flare activity. A **coating of lead shields coated with polyethylene material** is used to protect the electromagnetic system of robot.

Fig 5.2.4(b) Location of Robots

5.2.6 Authorized access

Technique	Description
Iris Scan	Image of retina is used as a password for access
PID Band	Wirelessly identifies the user by assigning him/her a unique ID
Vein, Vascular pattern	A low cost B&W CCD camera is used to capture image of veins which is used as a password.
Bio-Passwords	• Keystroke biometrics • Knowledge-based authentication
Smart Cards	• Used for storage, processing, triggering or authentication • Biometric data will be stored on a smart card.

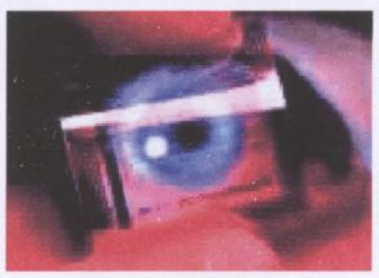


Fig 5.2.6 Iris Scan

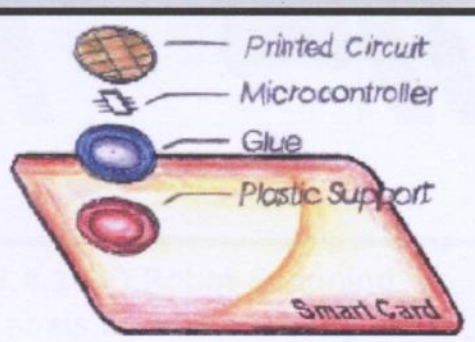
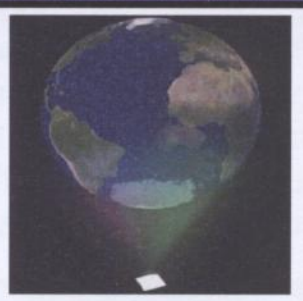
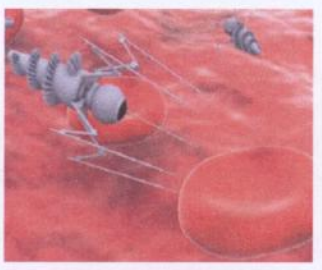


Fig 5.2.6 Smart Cards

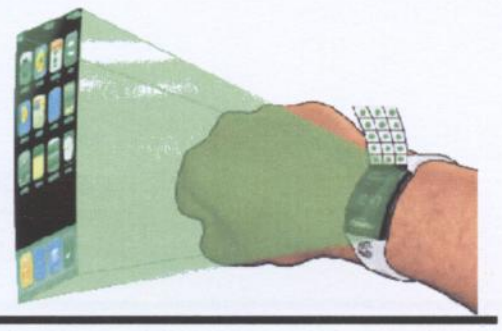

Fig 5.2.6 Vein Vascular Pattern

5.3.1Automation Systems To Enhance Livability	
Automation in Education: **Personalized Learning Uplink (PLU)**	• It analyzes student's strengths and weaknesses • Every student is connected with the Personalized Learning Up-link
Automations in Healthcare	• Nanobots used for medicinal purposes • Injected into the blood stream • Programmed to attack infection, cancerous cells, repair organs/tissue, remove wrinkles, and clear arteries. • Have knowledge of every disease known, new diseases discovered are updated.





PID Band	• Virtual Screen used to display the latest news • Monitors pulse rate to detect medical condition • Map Networking to detect exact position of user • Flight Status System to update user on deviations in Flight Schedule



5.3.2 BANDWIDTH ALLOCATION:

÷ The speed of the main server is 4.8GHz.
÷ Band gaps are left for expansion if required.

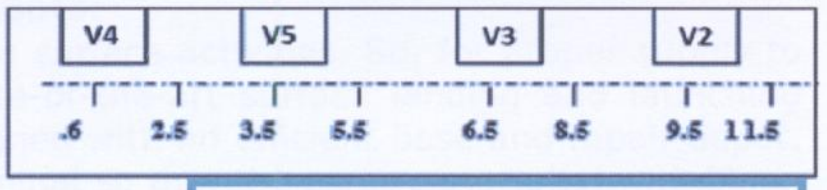
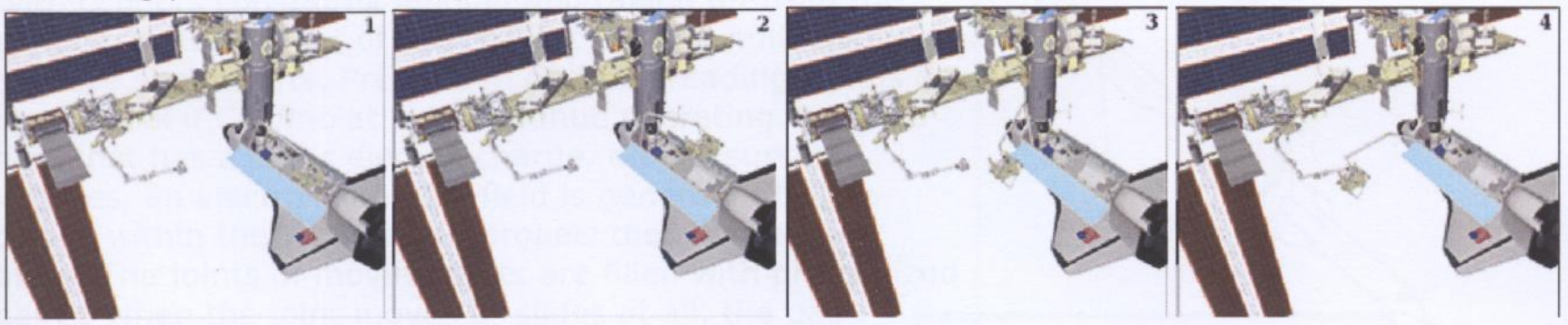
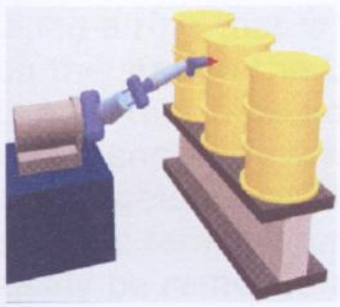


Fig 5.3.2 Bandwidth Allocation

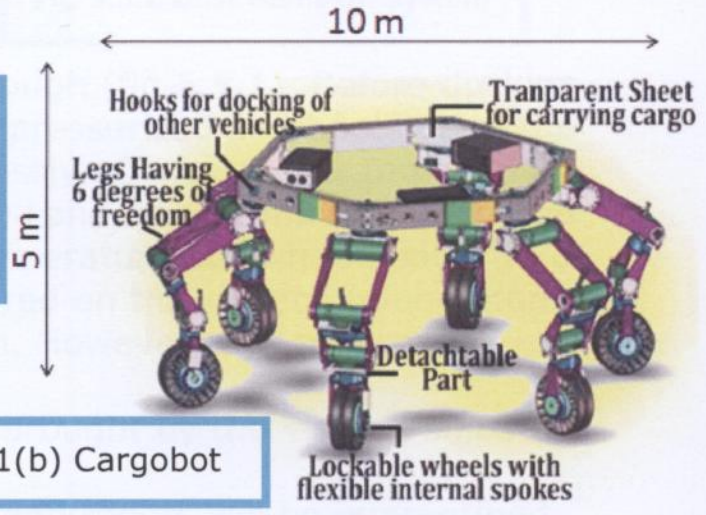
5.4.1 Cargo loading and unloading:

Columbiat will offer fully automated loading and unloading system on the docking port. As soon as the cargo ship arrives at the space port, the robots will scan the labels on the cargo and accordingly transfer the cargo to the warehouses.





5.4.1 (a) Robot Scanning Labels on spaceship by RIFD (Radio Frequency Identification)



5.4.1(b) Cargobot

5.4.2 Inventory Management System:

Inventory management system of docking ports of Columbiat connect inventory control, purchasing, and sales order processing with demand landing and help reduce costs , improve cash flow , labour work. It will be fully automated and efficient with the use of robots, computers and processors. All this will be managed by the following systems:

SYSTEM	FACILITIES	FEATURES
Passenger services system	Passenger reservations, inventory control, fares, ticketing, check-in, baggage control and spaceship control.	Parameterisation, modularity, scalability and extensibility
Cargo management system	Cargo reservations, capacity control, ratings, load planning, cargo revenue accounting, cargo terminal operations and freight-forwarding requirements.	It is modular, which makes for ease of adaptation to existing systems and functionality, ease of introduction of new functionality, and ease of maintenance.
i-label system	Tracks and monitors the location and quantity of all loose, stowed, and installed equipment items on docking ports. secured to all loose equipment and items requiring ground handling	The label machine readable code consists of a bar code strip which appears at the centre of the label with a human readable portion.

Linx	Ensures effective and logical workflows with proven functionality developed in co-operation with industry-specific business scenarios and user requirements	Proactive software
Record keeping system	Maintains the Columbiat space inventory. Provides policy direction, and approves changes to the Columbiat space inventory.	The computerized space inventory management system as well as the hard copy history of all space assignments

5.5.1 Maintenance and overhauling of robots:

Columbiat is the primary support for all Moon surface activities. So, for proper supply to all the moon colonies Columbiat has a state-of-the-art surface landing and launching fleet. To service this fleet, Columbiat is designed with an efficient base and repair depot. This main base is located near the cargo terminal so that the cargo associated with Moon surface development can quickly be transported between the cargo warehouses and the Landers cargo bay. For routine maintenance of the Landers and launchers, a group of repair robots is responsible for keeping the spaceships in pristine condition.

5.5.2 Dust Prevention:

With Landers constantly landing and taking off from the surface of Moon, a lot of dust collects on the hulls and joints of these spacecrafts. Prevention of the spreading of this dust is essential if Columbiat is to continue operating. To keep dust that has a static electric charge, off the surface vehicles, an electro-magnetic field is generated from a device within the vehicle that propels the charged dust away. The joints of moving parts are filled with pressurized gas so when the joint moves or slides at all, the gas quickly escapes and blows the dust off. The standard system for removing dust brought by Spacecrafts is using a ring that is large enough for all Landers to fit through (fig 5.5.1). Before docking on the station the Lander moves through the ring where pressurized air shoots upon the Lander that blows off the dust and the dust floats harmlessly off into space. In dust emergencies, or when the duster ring is in-operative, the Landers and robots are coated with a gelatinous film coating that is smooth at room temperature but when heated to a suitable temperature sticks dust to itself. The dust captured on the surface (gloop) can easily be removed and utilized for testing or construction. However, this process is seldom used due to its large amount of waste product.

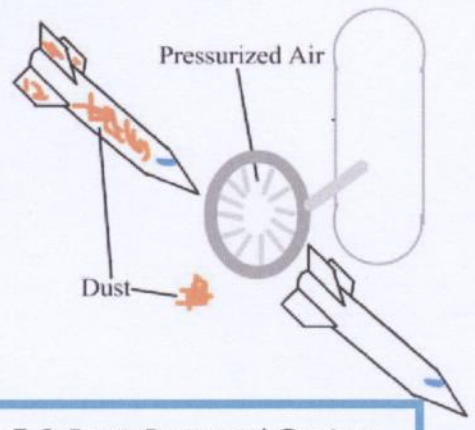


Fig 5.5.2 Dust Removal System

5.5.3 Robot Repair: Maintenance & overhaul of robots brought by the visiting ships will be carried out in Industrial area in centre axel.

First detection of the foreign contamination will be done and robots will be quarantined accordingly. The dust on robot surface will be blown away by electro-magnets. Then the robots will undergo following checks:

÷ **Comprehensive Inspection** – It includes inspection of the entire robot system, with special attention paid to the condition of the manipulator and control cabinet.

÷ **Replacement** – It replaces any faulty equipment found.

÷ **Testing** - Each system is fully tested for repeatability and reliability.

÷ **Painting** - Robots are fully cleaned, re-lubricated, and repainted, before refurbishing is complete.

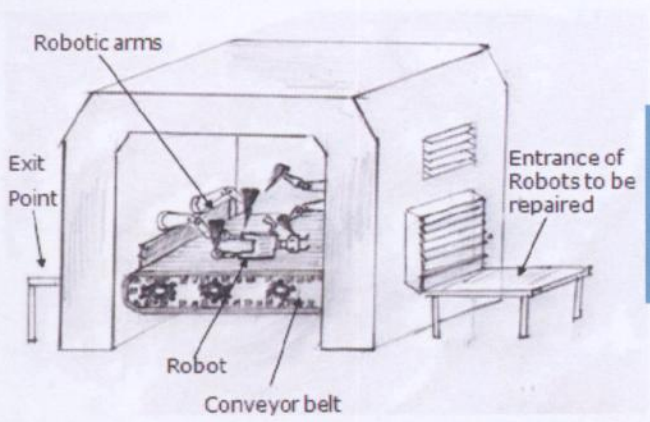
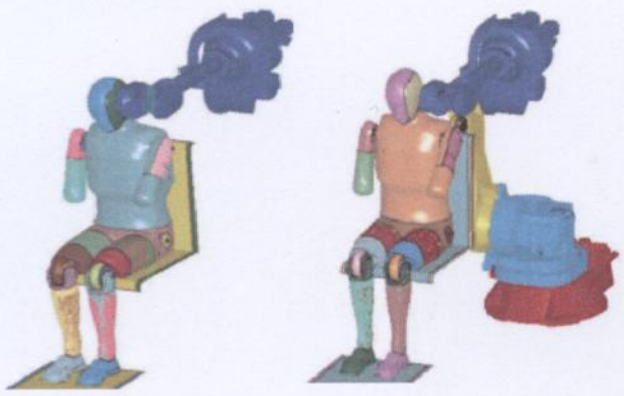
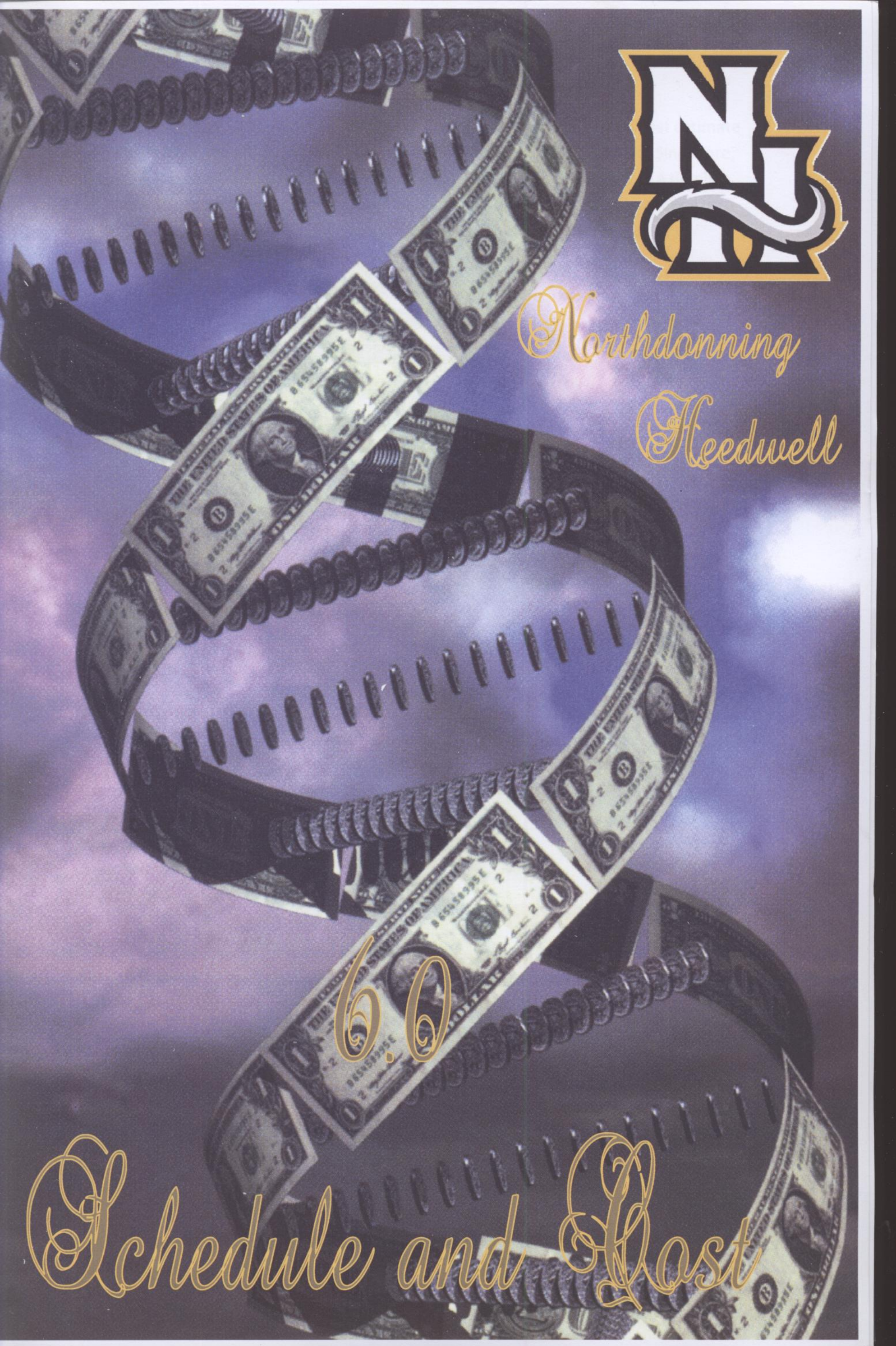


Fig 5.5.3 Robot Repair



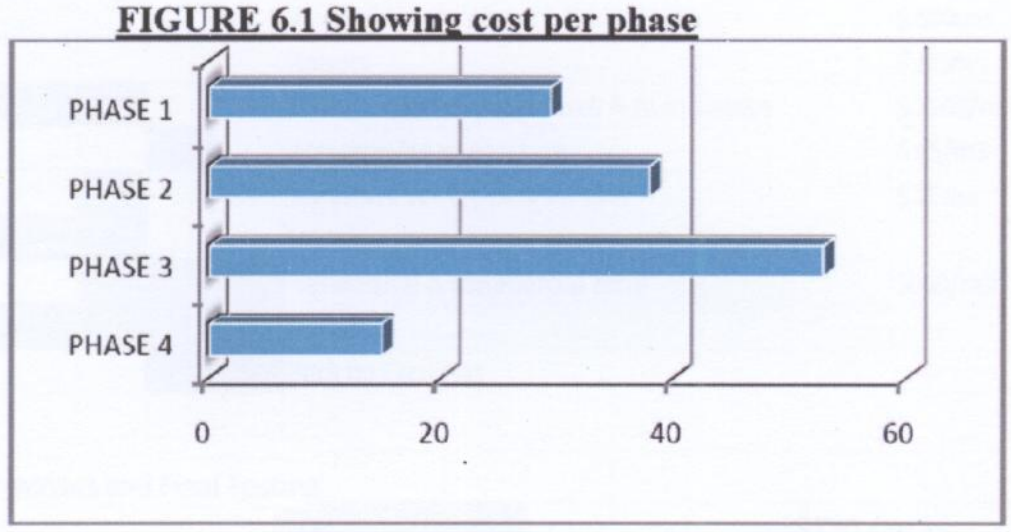


Northdonning Heedwell

6.0 Schedule and Cost

6.0 COST AND SCHEDULE: For any settlement to be feasible a timeframe and cost estimate are imperative. We at Northdonning Heedwell have designed a city just like Singapore, in space. A highly profitable business centre and which will be completed in a timely manner. The lucrative business ventures will generate extensive revenue that will turn Columbiat into a profit centre for Foundation Society.

FIGURE 6.1 Showing cost per phase



0-720 days	721-958			TOTAL COSTS
Phase - 1 Initial settings and Pre Construction	COST/UNIT	UNITS	($ bn)	
Pilot plant testings & Psycological training to persons	$ 2.5mn	40	0.1	
Construction ships	$ 1.5 bn	16	24	
Construction of the space-port	$4,200	-	1.65	
Construction of the central tube.	$2,500	-	2	
Construction of upper centeral platform	$2,762	-	1.6	
Artificial Lightning	-	-	0.04	
Backup Facilities			0.035	
Phase 2: Construction of central axle,Platform and industrial module				
Construction of central axle	2550/m^2	-	4	
Construction of industrial module	2000/m2	-	4.2	
Construction of lower platform	2762/m2	-	1.8	
Artificial Lightining	-	-	0.05	
Nanofet Electric Propulsion System	$ 1.0 bn	16	16	
Pneumatic lines:- (a) Large	$ 95/km	-	0.8	
(b)small	$ 65/km	-	1	
Robots	$1.5 mn	800	1.2	
Research facility setup	2200/m3	-	1.3	
Storage	2500/m3	-	1.2	
Industry	2000/m3	-	3.24	
Photon collector	$ 15/m2	-	0.005	
Linkage spokes	$ 140mn	12	1.68	
Artificial Lightining	-	-	0.3	
Back-up Facilities	-	-	0.75	
			37.525	

1678 - 3274 days	3274 - 3834 days			
	Phase 3- Construction of main torus and low g torus			
	Assembly of low g torus.	$ 1800/m2	-	3
	Atmosphere generation	$ 65/m3	4	6.2
	Thrusters for topping up spin	$ 20mn	-	0.08
	Artificial lightening	-	1	0.2
	Aeroponic system setup	$ 1.0bn	1	1
	waste water treatment & pipelines	$ 500mn	300	0.5
	Robots	$ 1.5mn	-	0.45
	Construction of outer torus & twin towers	$ 2500/m2	-	11.5
	Atmosphere generation	$ 65/m3	4	20.4
	Thrusters for topping up spin	$ 25mn	-	0.1
	Variable transparancy glass		-	
	Residential & commercial zone	5000/m2	-	6.1
	Robots	-	-	2
	Back up Facilities	-	-	1.4
				52.93

Phase 4 - Construction of mirrors and Final Testing.			
Concave Reflectors	$750 / m2	-	1.32
Satellite Installation	$ 400 / m2	-	9.38
Robots	$ 10 mn	50	0.7
Human Transportation	-	-	3.6
Back up Facilities	-	-	0.06
			15.06
	Total cost		$ 135.3 bn
	Labour Cost		$ 10 bn
	Insurance Cost		$ 10 bn
	Grand total		$ 155.3 bn

Employees	Phase-1	Phase-2	Phase-3	Phase-4
Pilots	50	100	100	120
Operators	50	200	300	400
Scientists	15	20	20	150
Managers/Supervisors	25	100	100	150
Engineers/Maintenance Workers	75	200	250	550
Docking Managers	10	40	40	100

Award of proposal	7 May 2044
Preconstruction and initial setting	8 May 2044 – 27 April 2045
Construction of central cylinder & spokes	28 April 2045 – 10 Dec 2048
Core construction of a Columbiat	11 Dec 2048 – 24 April 2053
Installation of systems and human transport	25 April 2053 – 2 Sept 2054
Final checking of systems	3 Sept 2054 – 7 Nov 2054

Columbiat will be handed over to the foundation society in its full vigor and glory on 7 November, 2054 after approximately ten and half years of operation at Northdonning Heedwell

COMPLIANCE MATRIX (*-BUSINESS RELATED POINTS)			
Sr. No.	**Requirements**	**How accomplished**	**Page No.**
1.0	**Executive Summary**		**1**
2.0	Structural Design ÷Safe and pleasant living conditions for 22,000 full time residents and 1500-2500 transient population ÷Natural views of earth	÷Structure consisting of two torii interconnected with central axle with six hollow spokes, central cylinder consisting of industrial module and docking ports at terminals ÷Recreational and educational zones, planetariums and observatories	
2.1	**External Configuration**		
2.1.1	Basic Structure ÷Overall exterior view of Columbiat, showing rotating and non-rotating sections, pressurized and non-pressurized sections, as well as dimensions and functions of each component	÷Figure 2.1.1 illustrating orthographic top , front views and overall view of Columbiat ÷Table 2.1.1 showing dimensions and usage of major structural components	**2, 3**
2.1.2	Construction materials ÷Materials required for construction of major structural hull components	÷Table 2.1.2 showing major materials required for construction of structural components and their uses and fig 2.1.2 (a) & (b) showing the layers of outer wall and windows respectively	**3, 4**
2.1.3	Radiation & Debris Protection	÷Section 2.1.3.1 and fig. 2.1.5.1 illustrates debris protection by the usage of titanium tiles joint by shape memory alloy ÷Section 2.1.3.2 illustrating the radiation detection systems and methods for protection from them	**5**
2.2	**Internal Arrangement**		**6,7**

2.2.1, 2.2.2, 2.2.3, 2.2.4	Overall map or layout of interior land areas, showing the usage of those areas	÷Fig 2.2.1 showing outer torus and its layout with classification of different areas	**6**
		÷Fig 2.2.2 showing area allocation of twin towers	**6**
		÷Fig 2.2.3 & Table 2.2.3 illustrating the inner torus with various activities undertaken and percentage share of each	**6, 7**
		÷Fig 2.2.4 portraying different segments of central axle	**7**
2.2.5	Orientation of down surfaces with respect to the settlement	÷Fig 2.2.5 showing the orientation of down surfaces	**7**
2.3	**Construction Sequence**		**8**
	Drawings showing several intermediate steps of settlement assembly	÷Construction sequence showing step by step construction of the whole settlement in 4 phases along with the diagram of each phase	**8**
2.4	**Docking Ports**		**9**
	Facilities for the docking ports that can: ÷Dock and unload/ load 6 cargo ships	÷Figure 2.4.1 showing the facility for the cargo port	**9**
	÷One passenger ship with long term docking for one ship requiring emergency repair	÷passenger port and illustration given in section 2.4.2	**9**
	÷* Cargo handling facilities provided on the docking port	÷Fig 2.4.3 showing the facilities for the docking port	**9**
2.5	**Facility for the visitors**		**10**
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