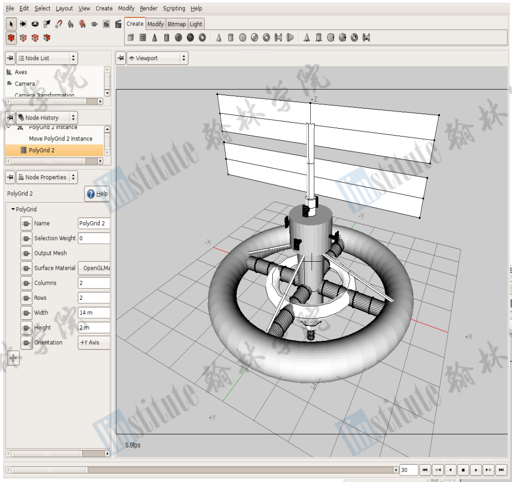
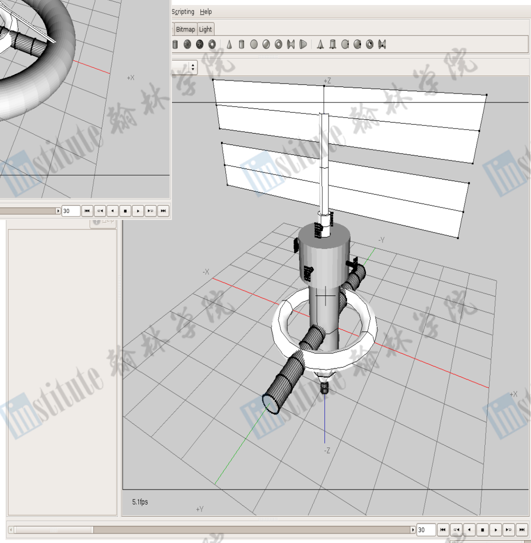
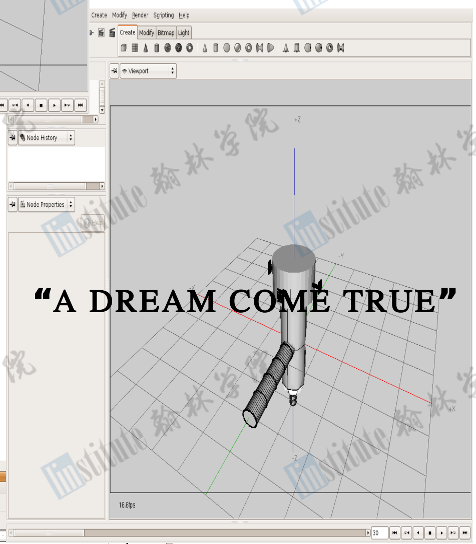


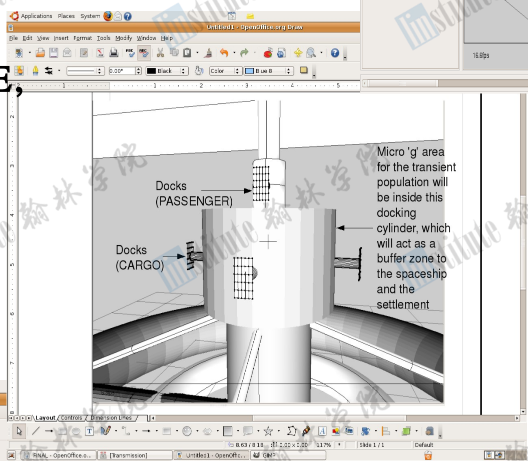




COLUMBIAT

"A DREAM COME TRUE"

AITCHISON COLLEGE,
LAHORE,
PAKISTAN.
54000
+92111363063



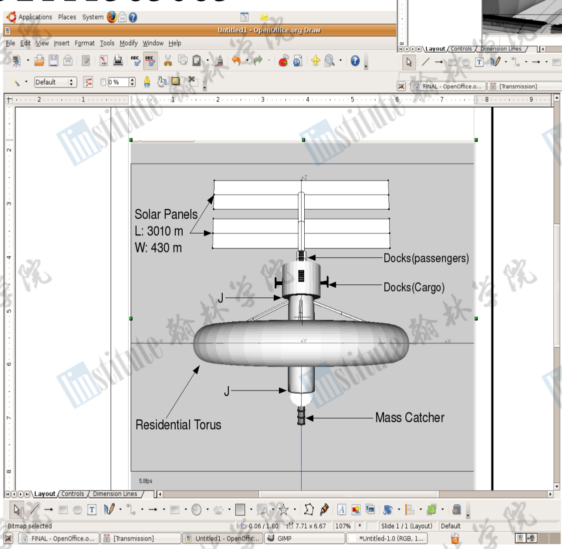


TABLE OF CONTENT

Executive Summary

Columbiat would basically comprise of two Tori, the larger having a cross-sectional diameter of 430m and a rotational radius of 1500m. This main Torus would be spun to achieve 1g, and would be the primary habitat for inhabitants, while the inner one would be used for agriculture. Another region, near the rotational axis, consisting of micro-g would be used for industry.

Columbiat would be constructed using a large influx of materials from the moon, earth and the first 2 settlements. Solar energy would provide power, while water and waste would be strictly conserved. A rapid Maglev transport system would facilitate intra-settlement travel. Hydrazine and aluminum powered thrusters would provide station-keeping at L2, as well as maintaining Torus rotation. Atmosphere would be kept congruent to the earth, while a freon temperature control system, and electro chromatic windows(creating day night cycles) would further aid the simulation.

An electro-magnetic shield, using plasma, would be used to protect the settlement from incoming ionizing radiation(gamma and cosmic rays.

This settlement will not only provide safe and secure living but will also provide a suitable and earthly environment to live in. This settlement will prove to one of the best homes in future and we at Northdonning Heedwell will make sure that if we are given a chance we'll prove our worth by completing this project with full efficiency and will do our best to provide with the optimum environment.

People here will live a modern life, by using stuff like PDA's and Super computers. This fast life although will be complicated on earth but we'll make sure that It's the most easiest one.

Aitchison Division

Northdonning Heedwell

STRUCTURE & DESIGN

2.1

For Columbiat we at Northdonning Heedwell have decided to make a settlement of 2 tori, The primary torus will be mainly used for living and commerce purposes and it will be called the Residential Torus. The Secondary Torus will be used for Agriculture and it will be called Agricultural torus. Micro-g industry will be placed it the central cylinder and the spokes. In the spokes along with the micro-g industry some farming will also be practiced in order to meet the demand of the people living on Columbiat. The docking cylinder will have a buffer zone for the transient population where they will l stay before they move to areas with more g or vice versa. 2 solar panels will be attached to provide an approximate of 3 GW which will be enough to power the whole of the settlement.

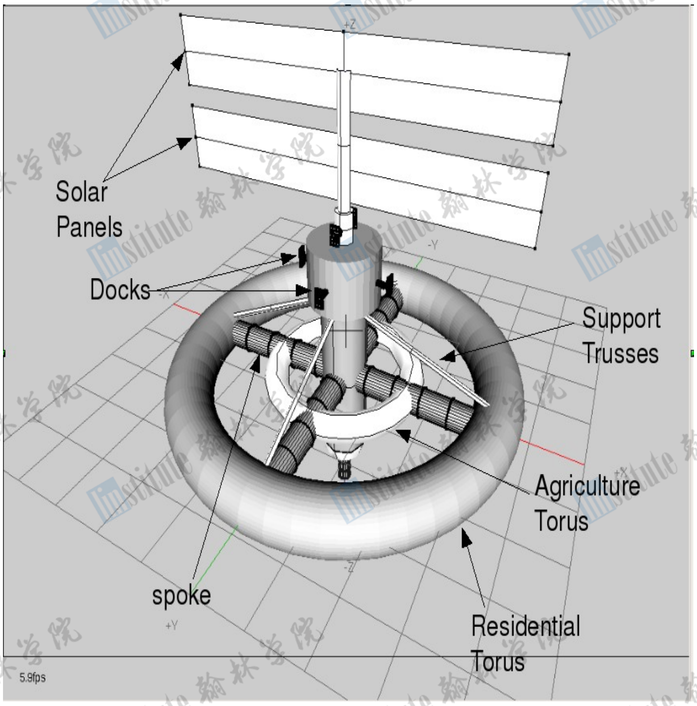
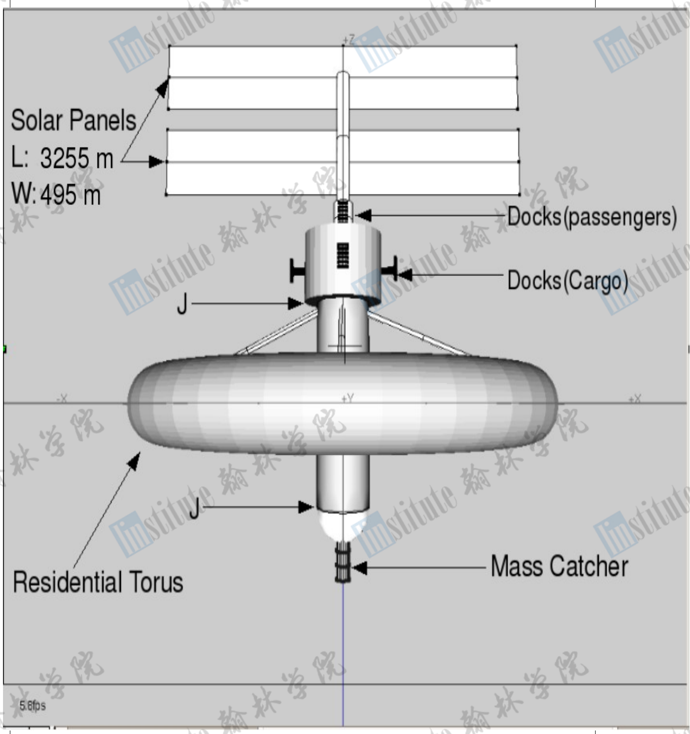


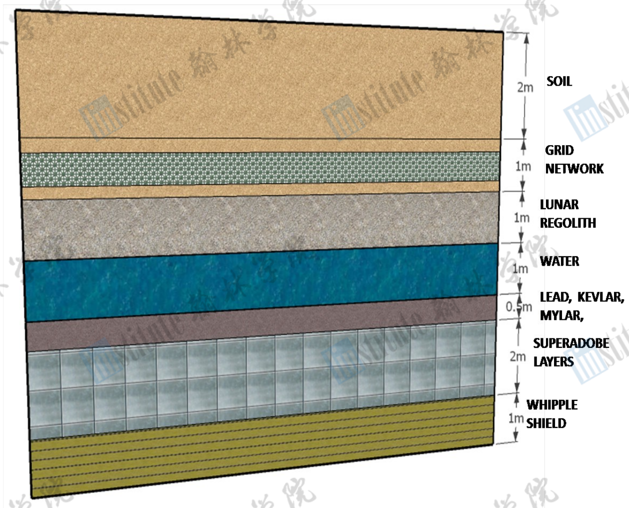
Table 2.1.1:Major Volumes and Surface Area

Major Hull Components	Volume (m^3)	DSA (m^2)	ACC (m/s^2)
Residential Torus	1313920568	4277881 (35 % of TSA)	9.81 +- .05
Secondary Torus	30020855	----	4.88 -3.62
Central Cylinder (Industry)	636172512	----	0-1.6
Docks (Docking and Transit)	140500466	----	0-3.0



Solar panels (to generate electricity)	-----	3222450	----
Spokes (To connect Residential Agricultural and the Central Cylinder)	190456188	---	1.6 -8.3

KEY:	
L : Length W: Width R: Radius J: Junction between rotating and non rotating parts	D.S.A: Down Surface Area T.S.A: Total Surface Area Acc: Acceleration Page 2



Soil layer of the settlement

Table 2.1.2 Rotation Characteristics (residential area)

Angular velocity	4.9 rad/min
Line of sight	77 m
Gravity	9.8 m/s^2
RPM	.78

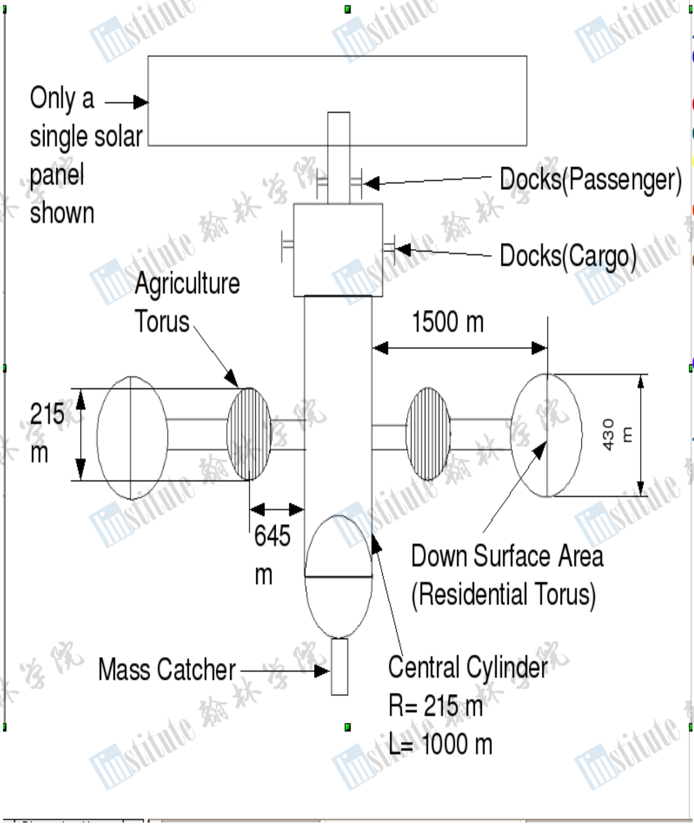
Rotation rate psychologically and physiologically comfortable.

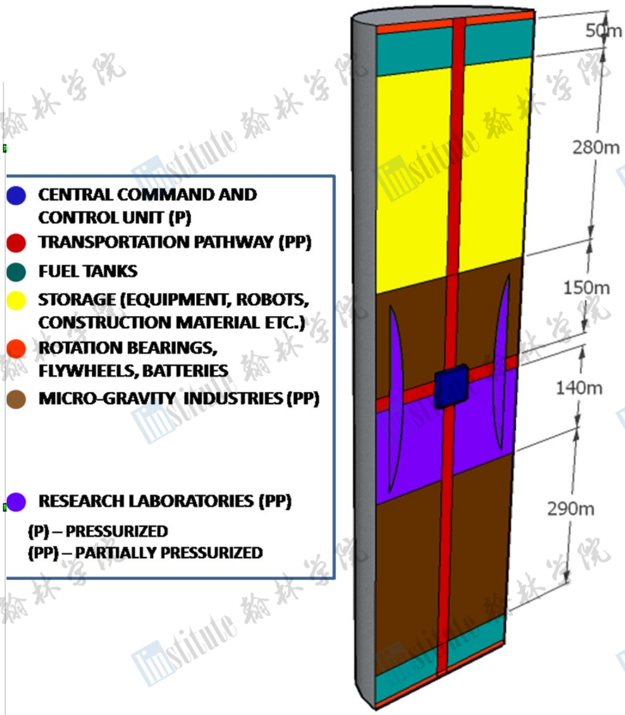
Low length of gradual curvature minimizes psychological discomfort due to low line of sight.

Soil layer containing Whipple, water and super Adobe will help us protect from any sort of radiations which pass through the shielding.

2m soil layer will help to make people feel like home as they can practice small farming of vegetables in their own garden.

2.2



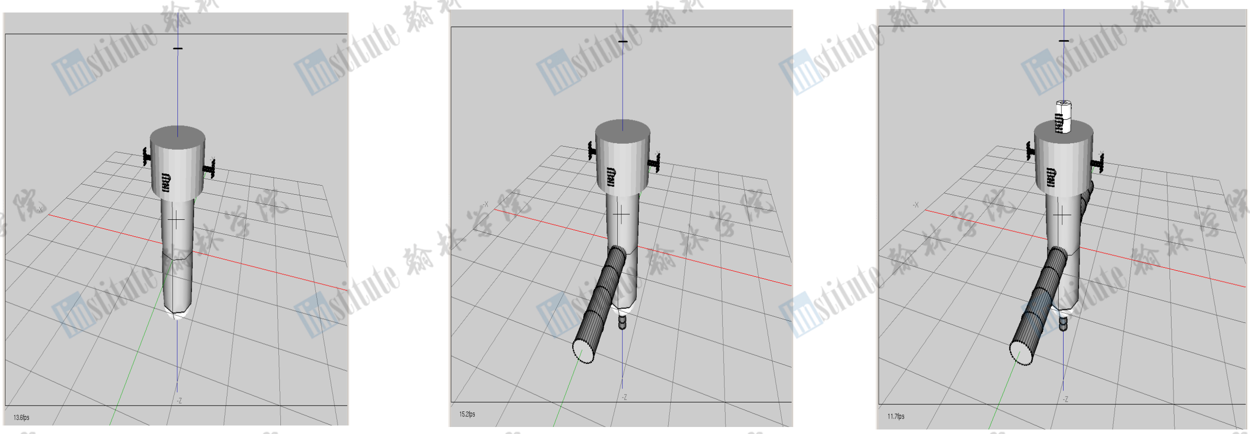


page 3

The total D.S.A of the Residential Torus= 4,053,180 m^2. This means that average area per person is 176.23 m^2 with a population of 23000.

The cross section of the settlement shows how the volumes will be utilized, it shows major parts like Primary, agriculture torus and the central cylinder. The agriculture torus is divided into many parts using hydroponics. In the main torus the Down surface area is a flat surface which not only increases the line of sight but also the value of g almost remains the same.

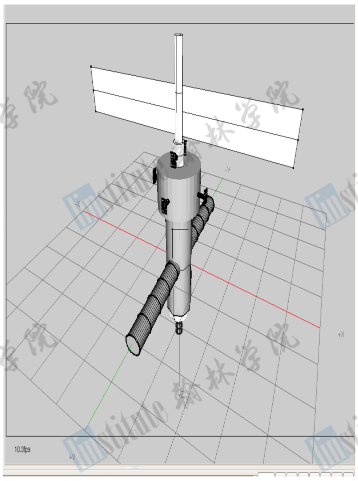
2.3: Construction Sequencing

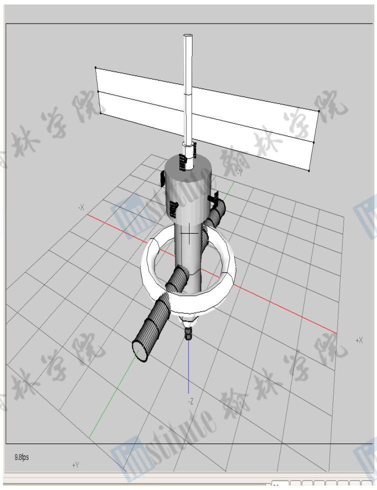


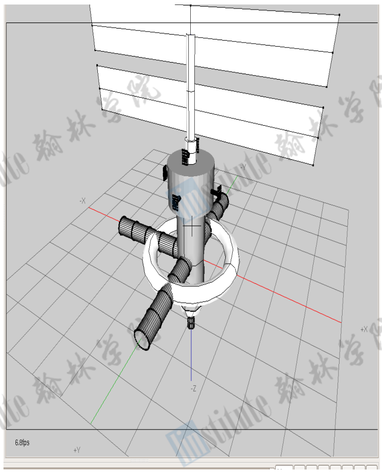
Initially The central Cylinder is sent to the L2 point (Phase 1)

The 1st spoke and the mass catcher are built (Phase 2)

The spoke opposite to the 1st one is made (Phase 3)



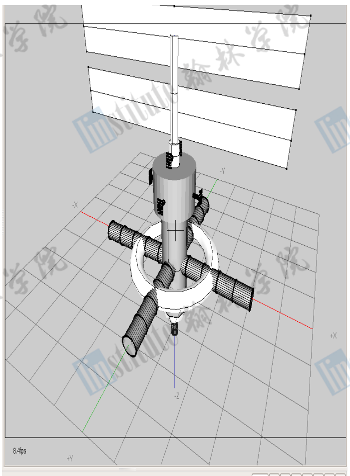


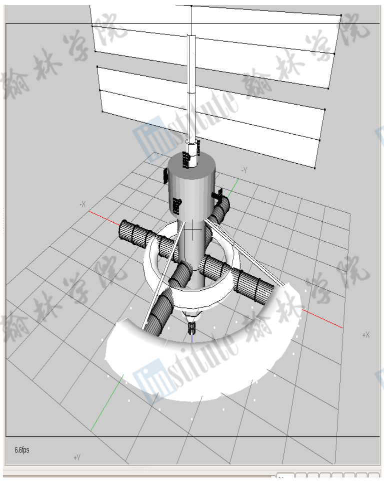


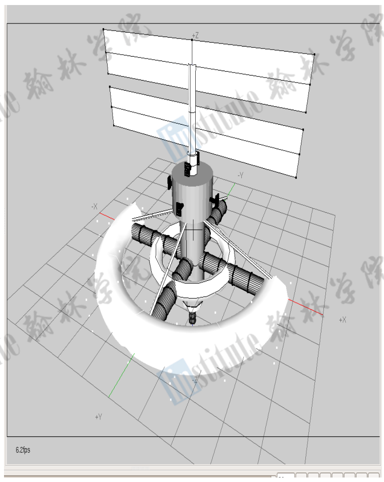
Solar Panels and passenger docks are built (phase 4)

Agriculture torus is built. (Phase 5)

3rd spoke is constructed along with some internal construction (Phase 6)



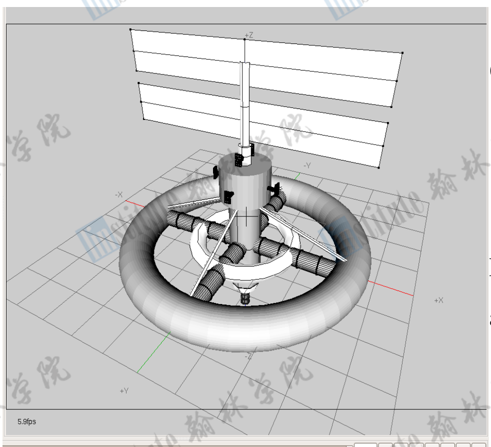




last spoke is constructed, construction of the

first quarter completed. Agriculture torus finishes primary torus starts (Phase 7)

Half of the torus is completed (Phase 8)



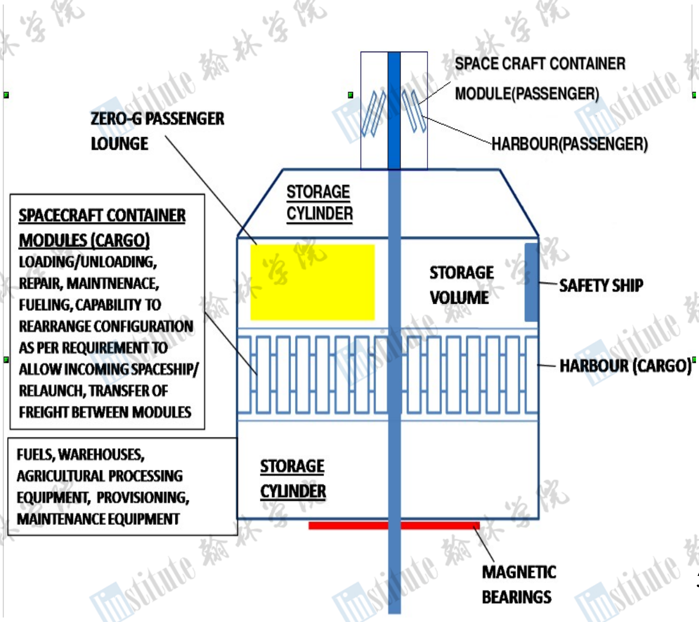
(Phase 9)

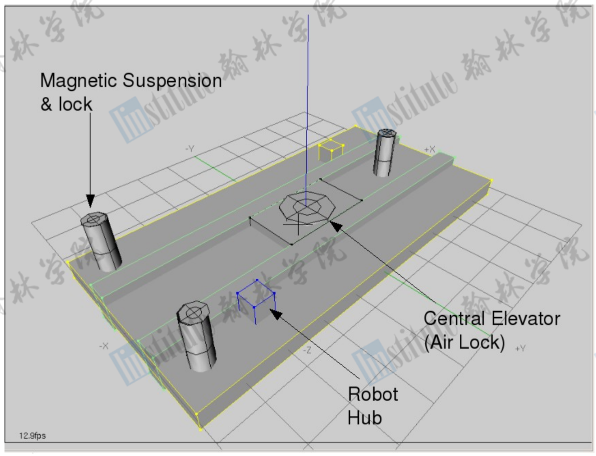
Final touches to the settlement are made and its ready for the spin and after that for its people

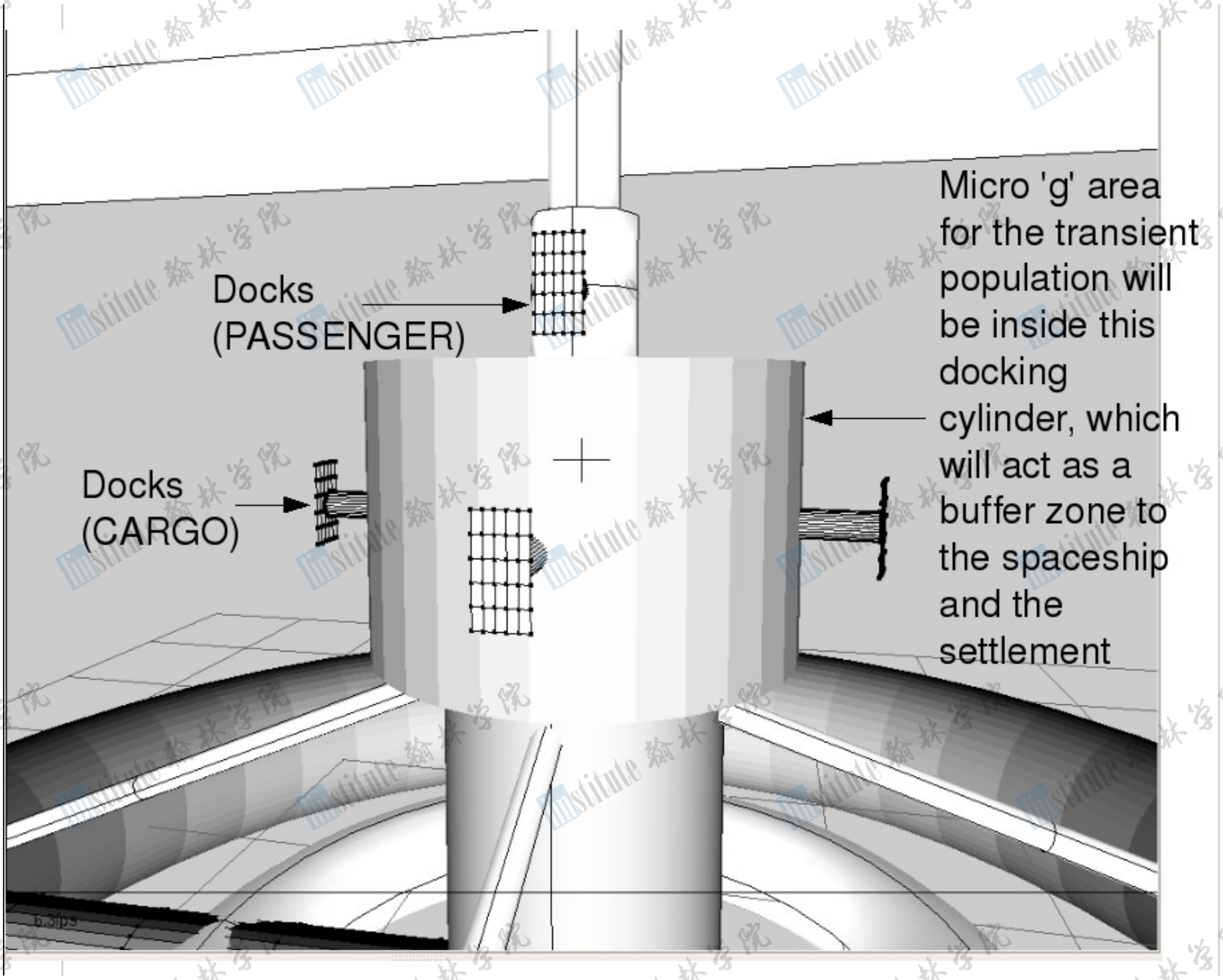
(Phase 10)

2.4 Docks

To ensure safe landing of space crafts, special ports are designed for safe landing and take off. For this purpose hydraulics with magnetic oil will be used and the landing base will be equipped with magnetic plates to assist landing and lock the ship once it has landed with its magnetic pull. Conveyor system is used to adjust the air locks with the arriving ship's air lock and after the airlocks are secured . Then doors are opened and transaction of the passengers take place. Two robots will be used to inspect that the ship's landing and look for any external damages, when they are in inspection mode, theses robots can also be used with some add-ons to repair minor damages to the ship.






Micro 'g' area for the transient population will be inside this docking cylinder, which will act as a buffer zone to the spaceship and the settlement
Docks (PASSENGER)
Docks (CARGO)

OPERATIONS & INFRASTRUCTURE

3. Materials and Equipment

Name	Purpose	Source	Method of transportation
Titanium	Titanium alloys(Aluminum Titanate) would be used basically in the construction of the Columbiat frame and body, as well as for producing tools and robots.	Moon: High Titanium concentrations have been explored in the near side mare regions* Alloys would be produced on Lunar settlement.	Electromagnetic mass driver Lunar launch vehicles

Aluminum	Aluminum alloys would be used in the construction of the Columbiat body, as well as a potential rocket fuel(Atomized aluminum powder makes a good fuel when burnt with oxygen**)	High concentrations of anorthite ore(75 to 80%) present on the Lunar surface** Alloys would be produced on Lunar settlement.	Electromagnetic mass driver Lunar launch vehicles
Iron	Steel-Titanium alloys would be used in the construction of the Columbiat frame. Iron would be used in "Superadobes"	Meteorite impact surfaces(craters etc) on the Moon. Near Earth Asteroids e.g. 4660 Nereus*** Can also be imported from Bellevistat	Electromagnetic mass drivers on the surface of source asteroid.
Moon dust(silicate)	Can be compounded with compost, gravel and cement to produce concrete for construction within settlement Will be used for passive Shielding. Also used for producing solar panels required for power, as well as glass	Moon	Electromagnetic mass driver Launch vehicles and space tugs for the more delicate produced Solar panels.
Nickel	Manufacturing of various tools and utensils	Metallic Asteroids	Electromagnetic mass driver
Kevlar	Producing Superadobes to transport goods using the electromagnetic mass driver Reinforcement in construction	Will be produced on Lunar space settlement or Bellevistat	Kevlar Superadobes would be used to transport other goods. Upon arrival the Superadobes would be dismantled and the Kevlar would be put to further use.
Clay	Ceramics and cement	Siliceous Asteroid mining	Electromagnetic mass driver
Copper	Wiring and piping	Metallic Asteroid mining	Electromagnetic mass driver
Plastics	Various utensils	Produced on Lunar Space settlement as well as Bellevistat and can be brought from earth	Electromagnetic mass driver

Most materials would be processed to their useful form(e.g. Metals to alloy sheets) before being sent to construction site, where they would be caught and stored for use. Processing would take place mostly on the Lunar settlement, when raw materials are extracted from there.

During the initial stages materials extracted from undeveloped asteroids would be sent first to Bellevistat, where they would be processed and then sent to the Columbiat site.

Later when processing facilities are completed on Columbiat, raw materials would be directly sent there.

Electromagnetic Mass driver and catching system

On the Lunar surface, a mass driver using alternating electromagnets(powered by solar energy), would accelerate"Superadobes" to a velocity a little greater than the escape velocity of the moon. These Superadobes would be constructed out of iron and reinforced by Kevlar The Superadobes would move towards L2. Upon reaching L2, due to a gravity well effect, they would start orbiting Columbiat.

A mass "catcher" positioned at the bottom of the Columbiat, would attract these Superadobes using strong magnetic fields. Apart from the catcher, space tugs would also be sent to catch strayed super-adobes around L2.

3.2 Basic Infrastructure

Atmosphere Control — Astronauts need to breathe air that is similar in composition to Earth's (78% nitrogen, 21% oxygen, and 1% other gases). Oxygen and nitrogen are supplied to the Columbiat during shuttle flights. Eventually, it will produce oxygen by the catalytic (Gallium Phosphide catalyst) conversion of Carbon dioxide to Carbon monoxide and Oxygen. Also, most of the raw materials imported from the moon contain Oxygen (like Titanium Dioxide). While we breathe nitrogen and oxygen, we exhale carbon dioxide. It would be dangerous to allow this to build up in Columbiat's atmosphere. However, we are using CO_2 to produce O_2 and CO which is an important industrial reducing agent. Also, CO_2 is being used as a fire extinguisher in case a fire breaks out on the Columbiat with valves situated near the the place where the detectors detect an excess of CO_2. Excess Carbon dioxide is filtered from the atmosphere and released to space.

Temperature Control — Columbiat is well insulated from the extreme cold of space. The on board equipment generates enough heat to warm it. In fact, the heat produced by equipment will cause overheating. Excess heat is vented off into space. However, in case of an emergency or an eclipse, measures will be taken to ensure that temperature is maintained. These include a finely spread network of tubes carrying freon gas which acts like a refrigerator. Cooled by convection currents, the freon will move through the torus and ensure a uniform, cool (298.15 K) temperature. On the other hand, if the torus gets too cool, radiators installed underneath the base will start immediately. Solar powered, and drawing heat from high resistance wires and power storing batteries they complete the requirements of a temperature control system with its sensors (Thermocouple thermometers) .

Water — Water has to be provided to Columbiat originally by shuttle flights. This is a costly provision and so water is carefully conserved — ! Recycling and purifying systems will recapture water from daily washing, moisture in the air from breathing, moisture from the heating and cooling systems on board the station, and water from urine. This recycling will reduce, but not eliminate, the need for water to be provided from Earth. These systems are are more than sufficient to ensure that water does not need to be brought in frequently(they will recover around 95-8% of the water used). However, for replenishing water supplies, another alternative is using ice from the moon or asteroids. In the former, the ice can be packed into larger Superadobes and sent to Columbiat using the electromagnetic mass driver. In case of the latter, shuttle craft can be used, at a much cheaper rate than launching water supplies from earth. Storage tanks placed in each community would receive water from the docks through a network of pipes, from where the balance 5-2% demand would be filled

RO(reverse Osmosis) plants would be located within each home to convert urine, water used for dish-washing and hygiene etc back to clean, potable water. Apart from that, water vapors released into the air through breathing would be collected through devices using silica gel, and then sent to RO plants for re-use. Nevertheless, we would still loose around 1-10% water, lost through excrete solids, operational inefficiencies etc.

Pumping: Columbiat employs a pump module to provide fluid pumping, fluid pressure and temperature regulation, and fluid management in its active thermal control system. The pump module utilizes a multifunction pilot pump for fluid pumping, a servo actuated vapor regulator for fluid pressure and temperature regulation, and an accumulator to aid with fluid management. Pump module component designs are tailored to the specific requirements of the thermal control system. Prior to use on Columbiat, the pump module will undergo a comprehensive test program that includes engineering development tests and flight qualification tests.

Electrical power generation:An significant advantage in space is the vast availability and efficiency of solar power. According to a NASA study from 1978, each square meter in space, around the earth's orbit receives 1390W of sunlight (approximately twice the maximum 747W/m^2 on earth, with light normal to the surface).(At L2, 1.5M km from the earth's orbit, this value only falls to 1362W/m^2)*. With factors like day/night cycles, angles of incidence of light less than 90 degrees, as well as cloud and atmospheric cover, each m^2 in space receives around 7.5 times more solar radiation than on the earth's surface, as well as a larger distribution of wavelengths.

Thus solar energy is an obvious unlimited option in space. Alternative choices like Nuclear fission are not only expensive in terms of fuel management and safety, but also have a limited lifespan of 30 years. Whereas harnessing nuclear fusion constantly is not only difficult and potentially dangerous, but also tremendously expensive and requires prerequisites like high temperatures, extremely strong magnetic and electric fields, as well as rare fuels like deuterium and tritium.
The crystalline silicon solar cell will be used for the Columbiat project, for it's high conversion efficiency of 42.8%, as well as the high availability of silicon, especially on the surface of the moon, which possesses a higher %age of Silica than the Earth's crust**.
Solar Power would be produced using a large solar array, with dimensions of around 3255 by 495m
Electrical Power output:
total area covered by solar cells=(3255*495)*2=3,222,450 m^2

Power per m^2 at L2=1362W/m^2
efficiency of Solar cells in 2044(approx): 80%
Thus total power produced=1362*(80/100)*(3254.84*494.98)*2= 3.51**GW**
Power distribution and allocation:One of the main consumers of power is the Columbiat shielding system, which would use plasma electromagnets to deflect radiation. The total amount of power it would consume would be roughly a little more than1GW.***

Aside from that, around 1 GW has been allotted to the easy operations of the Columbiat settlement. This includes power consumed by the life support system, automation, the Central computer, the Maglev system, the temperature control, the mass catcher etc.

The balance power is for consumption by the inhabitants and industry at Columbiat. Roughly around 40% would be allocated to industry, with 50% for domestic use and the remaining 10% will be stored for use during ant power outage That means that per person usage of electricity= 25KW.

* simple calculation, light intensity is inversely proportional to the square of distance

**"Origin of the Moon" by Roberto Bugiolacchi.

***http://www.islandone.org/Settlements/MagShield.html#ten

Solid waste management:Waste management is divided into two distinguishable sectors:

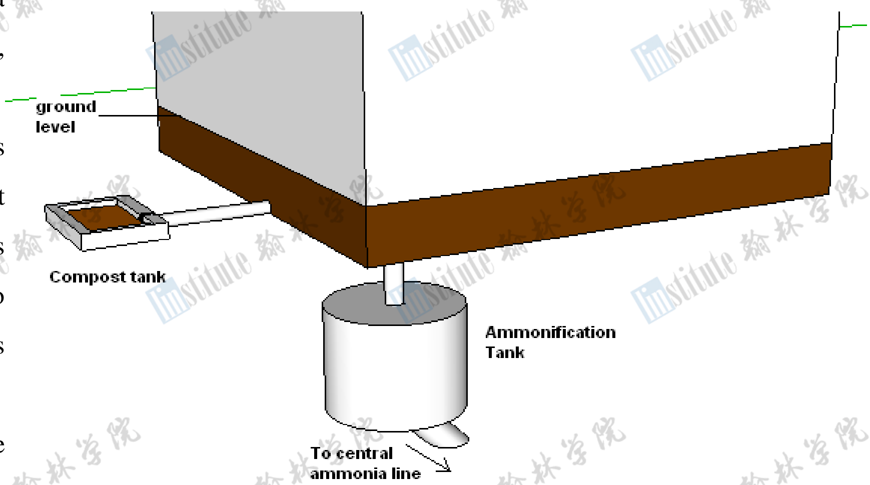
- Organic waste

All efforts are to make Columbiat as identical to earth as possible, ie creating an artificial biosphere, to get life going. Naturally, within the nitrogen cycle, organic nitrogen, from excretes is converted to ammonia by bacteria, using enzymes like, GS(Gln Synthetase) (Cytosolic & Plastid), GOGAT: Glu 2-oxoglutarate aminotransferase, as well as GDH: Glu Dehydrogenase.

These enzymes, especially GS have been synthesized* in numerous labs. Using further sequencing technology, the action of these synthetic enzymes has also been amplified.

Thus the enzymes can be used en mass to convert human and livestock excrete into ammonia. The rate of reaction can be maintained at optimal levels, while a large concentration of enzymes can be used.

Therefore, 30-50% organic waste would be collected in storage tanks, after which it would be passed through numerous grates , scrubbed with high concentrations of the above enzymes. Water would be passed through the system at low pressures, to carry the ammonia which would be stored in another tank, below the ammonization chamber.



Once the level of aqueous ammonia reaches a certain value, it would be pumped to various industries for use, most crucially, to be reduced to **Hydrazine**, which would be used as rocket fuel.

The remainder organic waste would be processed into compost heaps (using standard aerobic decomposition tanks), which would be used in horticulture, agriculture or construction, or would be sold for use on the lunar settlement.

*Novel Expression Pattern of Cytosolic Gln Synthetase in Nitrogen-Fixing Root Nodules of the Actinorhizal Host, *Datisca glomerata*

Alison M. Berry,* Terence M. Murphy, Patricia A. Okubara, Karin R. Jacobsen, Susan M. Swensen, and Katharina Pawlowski

- Inorganic waste

Although non-biodegradable substances would be severely restricted, "litter" would be collected in separate bins(metallic and non-metal). Non-metal "litter" like paper, wrappers, plastics etc, would be sent for crushing, and hence converted into boards, reinforced by chemicals like resin etc, which would be used to make furniture.

Used and broken metals, would be smelt, using micro solar furnaces, placed in the industrial section of Columbiat, to be re-used into utensils, tools or frames, for construction.

Bins would be automatically emptied, periodically by robots.

Internal Transportation System

Maglev trans-rapid

Due to the recent success of Maglev technology, we would incorporate an underground Rapid-transit Maglev system to provide rapid access between various parts of Columbiat. The track would be located in a tunnel, 10m below "ground" level, keeping g within the train to a safe 9.88 m/s^2, when stationery.

The system would consist of 2 trains(one traveling clockwise, the other anticlockwise),with 6 stations A,B,C,D,E,F,(different for both trains!) placed equidistant, nearly 1.5km from each other. The train would halt at each station for a variable time, depending on the number of passengers on that station, after which it will accelerate approximately uniformly by .7m/s^2 to a top speed of 32.4m/s, then decelerating by .7m/s^2 back to rest, upon reaching the next station. The time for each inter-station journey = 46s (Illustration1)

The halt time at each station would be proportional to the number of passengers waiting. Each passenger would slide his credit card, and enter his destination into a terminal, only after which he would be admitted into the waiting area. Thus the halt time per-station would be proportional to the number of passengers in the waiting area, as well as the number of passengers departing from that station.

A note for concern in deciding the maximum velocity is the effect of horizontal g-forces. The passengers would experience a maximum of 1.6g, and a minimum of 0.5g during each trip. However human tolerance to horizontal g-force is around 17g*, thus there's no health risk involved.

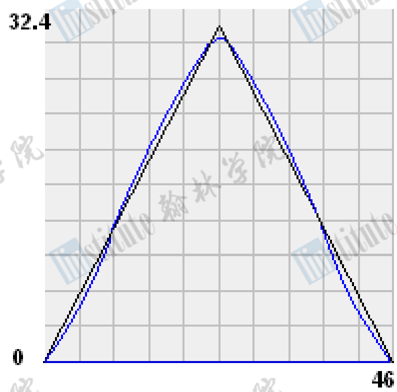


Illustration 1: Velocity(vertical axis)-time(horizontal axis) graph of the train, during an inter-station journey. Blue line marks

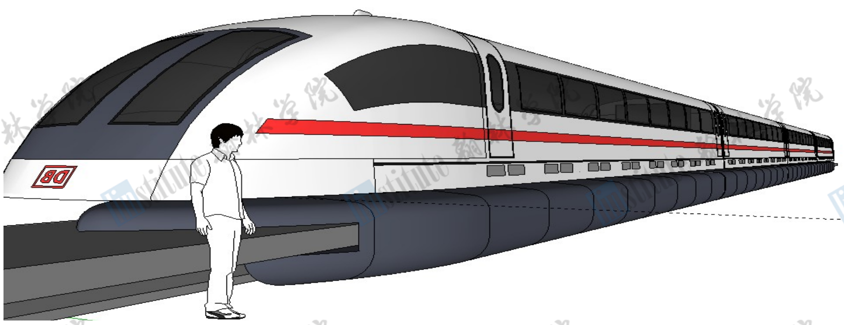
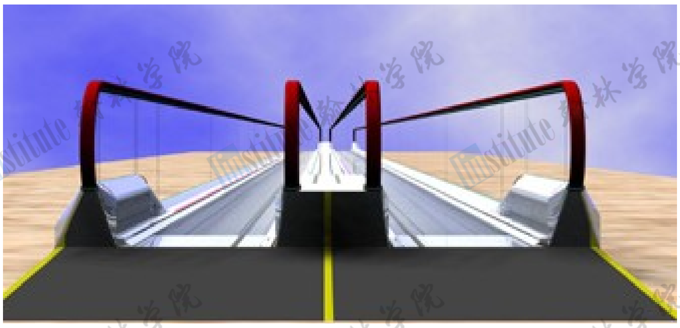


Illustration 2: The length of each Maglev train would be 69m from end to end, while 2.39m high from roof to floor, and 2.8m wide.

Each train would have a seating area of 60m*2.8m. That means if that there's a row of 4 seats after every 1m. Thus we can have a maximum of 240 seats per train.

*NASA Technical note D-337, Centrifuge Study of Pilot Tolerance to Acceleration and the Effects of Acceleration on Pilot Performance, by Brent Y. Creer, Captain Harald A. Smedal, USN (MC), and Rodney C



<u>Walkways</u>

For shorter distances, Columbiat would also feature a series of walkways at "ground" level. The branches would travel at a speed of 3.5 m/s, while the central one would move faster, at 7 m/s.

Food Production

The agricultural torus has been divided into 10 equal sectors for management of crops and further divided into numbered segments for organization. Each sector is self-supported with concentric centers for ease in transport of aggregate. Every sector is separated by Tree Plantation Strips.

The agricultural area in the main Torus would also consist of sectors(of congruent size), most prominently a Livestock Sector with processing units L1, L2, L3 for the respective produce from the Livestock Segments-1, 2 and 3, and a Livestock Supporting factor with processing units S1 and S2.

Processing and Storing

Processing and Storing is vital for long-lasting of food as without it the concept of Surplus or Reserve is destroyed. The various processes in the Reserve Segments are

- **Screening**
  All produce must be scrutinized to remove the potential decaying items and prevent the decay spread in other items. Highly important for fruits, especially mangoes.
- **Freezing**
  Food is frozen to low temperatures (0.0º – 5.0º) to inhibit microbial growth and to retain its flavor and freshness.
- **Drying**
  Moisture and water is evaporated via controlled heating to prevent decay and rotting, especially fruits
- **Pasteurization**
  Sudden and extreme changes in temperatures are produced to kill microbes which are unable to adjust to their environmental change. This is vital for milk and dairy products.
- **Refrigeration**
  Food items must be kept at a cool temperature (not freezing) to maintain the water and nutrient content.

Storing Means

- All the food items following screening would be sorted in equal and measured masses
- Measured amounts would be packed in synthetic, non-porous plastic
- Plastic covered commodities would be canned (zinc-coated tin) or stored in large cylinders (made of aluminum) depending on feasibility of size and repeated translocations.

- Packed commodities would be kept in the storage houses where the physical conditions would be automated to adjust to the need of the longevity of the commodity.
- Produce, packaging, demand and other statistics would be automated and monitored to observe order and profitable trends.
- income

Basic Analogy of the Aeroponic System

The analogy of the basic unit in the system is as follows:

- Water is filtered through Reverse Osmosis (RO) Units
- Nutrients are added in the filtered water from a nutrient reservoir. The nutrient reservoir contains macro- and micro-units for optimal plant health
- Water and nutrient solution is passed through the hydro- or water-controller unit to regulate its volume and flow and adjust the quantity of the spray pulse. The Hydro-controller also regulates the nutrients concentration for the hydro-jet and regulates the nutrient feed.
- The solution is sprayed in the root region using hydro-atomizing spray with each spray pulse lasting between 3-6 seconds
- Remaining solution can be reprocessed by RO units to recover nutrients with water for re-use or else drained away
- The enclosed environment of the Agriculture-Torus Sector (see below) will be adjusted for each specific crop harvested (Lighting and Heating adjustments as per the geographical specifications)

Agriculture aboard Columbiat is primarily based on Aeroponics due to the large advantages possible of the following:

- Decreased usage of
  - Water by 98%
  - Fertilizer by 60%
  - Pesticides by 100%
- Clean, sterile environment
- Flexibility in various agricultural processes
- Growing season is extended all year round
- Lack of need of soil as a growing medium
- Vegetative propagation and cloning is physically and economically feasible

The main objectives of agriculture are:

- To provide the residents with consistent food supply
- To have reserves of food in case of shortage or emergency
- To have a surplus to be exported to generate income

Internal and External Communications System:Columbiat would consist of an efficient wireless networking system, which would connect the inhabitants to each other, allow purchase of goods online, as well as reach out to the Earth or lunar settlement.

Due to the influx of PDAs that have dominated the PC industry, each user on Columbiat would possess one. A number of routers within the main and secondary Tori, as well as the industrial area would provide a wireless network, which would be linked to a central Router, placed near the industrial area, and powered by the central super computer.

The central Router would transmit high power microwave signals to other satellites in orbit, the Lunar settlement as well as Earth.

A powerful Microwave transmitter would be located on one of the ends of the central axis.

Day/Night cycle provisions: In order to simulate an earthly environment, Columbiat would feature day/night cycles, using electrochromatic glass, placed on the sides of the main Torus.

3.3 Space vehicles and infrastructure

Name and Type	Purpose and payload capacity	Present Status
2nd generation Percheron, Earth to HEO,LEO space-ports	Cargo carrier, 15^2ft*60ft	Currently used and under production. $800/lb
2nd generation Palomino, Earth to HEO,LEO space ports	Passenger craft, 110	Currently used and under production. $500,000/person
Upgraded Palomino, intra-Earth orbit and lunar surface	Passenger+cargo, 110 passengers OR 15ft*15ft*60ft cargo payload	Currently used and under production at Bellevistat, $10,000/person/day or $50/lb/day
Stallion, automated Shuttle	Mobile automated mining base, for use on extra-terrestrial bodies	Not under foundation Society contract.
Colt, transport aid vehicle	Features "electro-magnetic gun" that can shoot Superadobes to desired location. Lands at mining site, collects payload, takes off and "shoots" payload before returning and repeating.	Not under foundation Society contract.

Satellites

Columbiat communication systems require hi-power microwave or radio frequency satellites around L1 and moon orbit, so as to transfer data, to and from the earth with ease.

Lunar infrastructure

Although mass driver technology has been present since the first settlement, for a project with the magnitude of Columbiat, it would have to mobilized and expanded. Also, the Columbiat project relies heavily on the Moon's resources, thus requires mining and processing infrastructure on **Alaskol**.

3.4 Propulsion systems

Columbiat would require propulsion systems for mainly two purposes:

- Station keeping
- Maintaining the spin of the tori

Station keeping doesn't require a high impulse immediately. Propulsion systems like Electric propulsion using ions or plasma, can also be used in addition to the more conventional explosive fuels, as these build up momentum gradually. Similarly in case of maintaining the tori spin, thrust needs to be controllable and gradual, as large changes in angular velocities of the tori would have adverse g-force effects on the inhabitant population.

However keeping factors like resources to mind, Columbiat would use two types of propellants(both explosive):

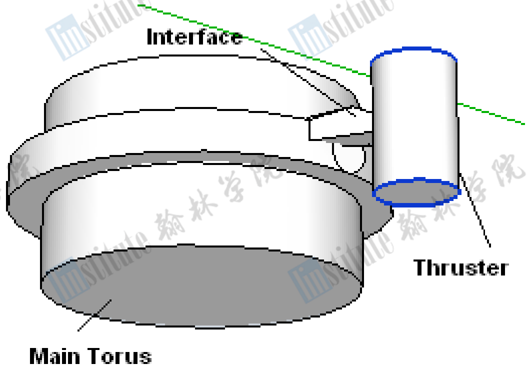
- Hydrazine or Methyl Hydrazine, produced from processing organic waste(see solid waste management for details). Hydrazine, when oxidized with Florine or nitric oxide, produces a powerful impulse. However has a high freezing point and is too unstable for use as a coolant, so instead Mono methyl Hydrazine is used, which is more stable.*

- Aluminum, extracted from lunar surface. Aluminum oxidized by ammonium perchlorate, produces a lesser specific impulse(though higher density impulse) impulse than Hydrazine fuels.

The Hydrazine fuel would be produced in plants located in each of the 16 communities. It would be stored in 6 underground tanks, connected to the Thruster fuselage(which would be located within the interface).

Thrusters would be placed on the sides of the main Torus, to provide and maintain rotation. There would be a total of 6 thrusters, equidistant and 60 degrees from each other by the center. These would use Hydrazine as propellant.

Additional thrusters for station keeping would be placed on the stationery part of Columbiat. These would use Aluminum and ammonium perchlorate – The aluminum sheets, packed it Superadobes would be caught and sent to processing facilities within the industrial micro-G cylinder, from where it would be transported via automated tanks, to the non-stationery part of the Torus.



*http://www.braeunig.us/space/propel.htm

3.5 Provisioning and Maintenance Services: Columbiat, being a commercial hub, would need to provide essential maintenance and provisioning services for visiting craft.

For essential utilities, like water, the craft's storage tanks would be connected to a pipe, linking the craft to the main storage tank. The needed amount would be filled, with a tariff proportional to the volume consumed.

Storage tanks for various rocket fuels would be located within the docks, so as to replenish visiting craft. In case of Hydrazine, a pipeline would connect the tanks in the main Torus with the tanks in the docks.

Packed food would be kept in a warehouse within the docks. An automated crane and conveyor belt system would pick the necessary amount and transport it to the craft's store

For waster disposal, Pipes would be connected to the craft's waste tanks. Liquid waste would be converted to water using reverse osmosis plants within the docks. Solid organic waste would be stored and sent in batches to a treatment plant within the docks, where it would be converted to ammonia or compost.

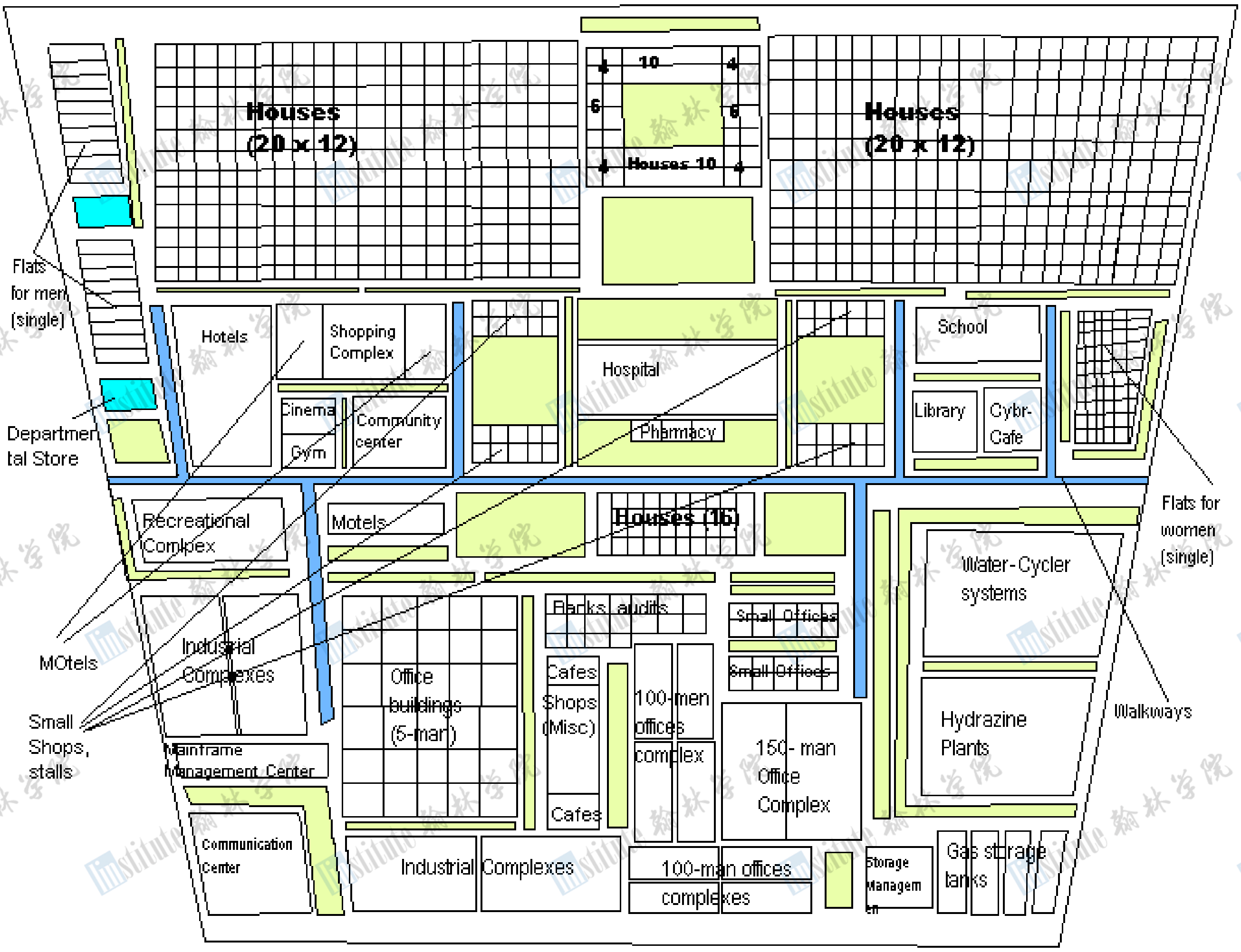
Health and livestock veterinary services would be provided by specialists, working at a medical center within the docks.

For repairs and craft maintenance, the craft would be transported via crane to a hangar, where automated repair robots or professionals would get the job done.

Common items like, tooth brushes, soaps, combs etc, would also be provided. A warehouse containing miscellaneous items would be located within the docks(stocked by markets in the main Torus). As per order, a set of items would be prepared and transported, once again using automated cranes(small size) and conveyor belts.

HUMAN FACTORS

4.1 Community design and consumables



This is one of the community design and such 12 communities will be built on the Down Surface Area of the Torus. This design contains almost all the basic necessities of life like banks, Hospitals, cafes, departmental stores and industrial complexes as well as motels and hotels for the tourist. Its dimensions are as follows.

List of Consumables

Source	Farming (Aeroponics)		Livestock (Cultivation)
Type of Edible	Vegetables and Produce	Dry Produce	Animal Sources
Items	▪Potato ▪Carrots ▪Tomatoes ▪Apples ▪Oranges ▪Broccoli ▪Onion	▪Wheat ▪Rice ▪Soybean ▪Corn	▪Milk ▪Eggs ▪Meat: ▪Beef ▪Chicken

Almost all of the crops and vegetables would be grown in the Agricultural Torus. They will then be transported to Outer Torus using inter-toroidal transport mechanism and from then on to respective departments and manufacturing companies using road bulk transport vehicles. Final manufactured consumables would be available
at the local stores, markets and shopping complex for the general public.

Nutritional Content and Daily Requirement

Item	Daily Need per person (g)	Proteins per 100g	Fats per 100g	Carbohydrates per 100g	Calories per 100g (kcal)	Proteins per need (g)	Fats per need (g)	Carbohydrates per need (g)	Calories per need (kcal)	Need for total population per day (kg)
Fruits and Vegetables										
Broccoli	270	2.8	0.4	4.3	30.0	7.6	1.0	11.6	81.0	6750.0
Carrots	80	1.0	0.2	9.0	40.0	0.8	0.2	7.2	32.0	2000.0
Onion	85	1.1	0.1	9.3	40.0	0.9	0.1	7.9	34.0	2125.0
Potato	120	2.0	0.1	19.0	80.0	2.4	0.1	22.8	96.0	3000.0
Apple	200	0.3	0.2	13.8	50.0	0.5	0.3	27.6	100.0	5000.0
Tomato	220	1.0	0.2	4.0	20.0	2.2	0.4	8.8	44.0	5500.0
Orange	180	0.7	0.2	11.5	50.0	1.3	0.4	20.8	90.0	4500.0
Dry Produce										
Wheat	375	23.2	9.7	51.8	360.0	86.8	36.5	194.3	1350.0	9375.0
Rice	150	7.1	0.7	79.0	370.0	10.7	1.0	118.5	555.0	3750.0
Corn	70	3.2	1.2	19.0	90.0	2.2	0.8	13.3	63.0	1750.0
Soybean	60	36.5	19.9	30.2	450.0	21.9	12.0	18.1	270.0	1500.0
Animal Source										
Milk	770	3.2	3.3	5.2	60.0	24.6	25.0	40.0	462.0	19250.0
Egg	230	12.6	10.6	1.1	150.0	29.0	24.4	2.6	345.0	5750.0
Chicken	200	19.0	15.0	0.0	220.0	38.0	30.0	0.0	440.0	5000.0
Beef	200	15.8	32.0	0.0	355.0	31.5	64.0	0.0	710.0	5000.0
TOTAL	3210	129.4	93.7	257.3	2365.0	260.5	196.2	493.5	4672.0	80250.0

Human needs and effluents mass balance (per person per day)

Needs			***Effluents***	
Oxygen	=	0.84 kg	Carbon Dioxide	1.00 kg
Food Solids	=	0.62 kg	Respiration & Perspiration Water	= 2.28 kg
Water in Food	=	1.15 kg	Food Preparation, Latent Water	=0.036 kg
Food Prep Water	=	0.76 kg	Urine	=1..50 kg
Drink	=	1.62 kg	Urine Flush Water	= 0.50 kg
Metabolized Water	=	0.35 kg	Feces Water	=0.091 kg
Hand/Face Wash Water	=	4.09 kg	Sweat Solids	=0.018 kg
Shower Water	=	2.73 kg	Urine Solids	= 0.059 kg
Urinal Flush	=	0.49 kg	Feces Solids	=0.032 kg
Clothes Wash Water	=	12.50 kg	Hygiene Water	=12.58 kg
Dish Wash Water	=	5.54 kg	Clothes Wash Water Liquid	=11.90 kg
Total	**=**	**30.60 kg**	Clothes Wash Water Latent	=0.60 kg
			Total	**=30.60 kg**

These values are based on average metabolic rate of 136.7 W/Person

Paper Replenishment and Source

▪ SOURCE

Tree Species	Mass of average tree (kg)	Yield of Pulp (kg)	Mass per meter square of paper	Area of Paper (m^2)
Pine	603.0	301.5	0.07	4307.1
Spruce	600-800	290-420	0.07	4143-6000

▪ RECYCLING

- Average per capita use annually is 50 kg and the average recyclable amount is 35%
- Paper can be recycled for use at the maximum of three times, after that the fiber strength and length decreases significantly
- Recycled paper is marked by embossing 'R' on the top-left corner with a characteristic criss-cross texture over the surface.

Cloth Replenishment and Source

▪ SOURCE

Material	Yield	Source	Typical Uses
Natural Fibers			
Cotton	Average 0.63g per plant	Aeroponics	Hosiery, sheets, etc.
Wool	Variable (100-80 crimps)	Livestock Farming	Blankets, rugs, carpeting, felt, wool insulation and upholstery
Synthetic Fibers			
Nylon	Manually adjusted	Industrial Polymerization	Common fabrics, veils, carpets, musical strings, and rope.
Polyester	Manually adjusted		Apparel and home furnishings: bed sheets, beds, curtains and draperies. Tire reinforcements, ropes, fabrics for conveyor belts, safety belts and coated fabrics

▪ RECYCLING

Natural fiber recycling

- Grading of incoming material according to type and color, it reduces dying and coloring quota of energy and input supplied
- Textiles are shredded into fibers and blended with selected fibers, mixture is carded to clean and mix fibers
- Can be spun, compressed for mattress

In flocking industry, are shredded to make filling material for car insulation, roofing felts, loudspeaker cones, panel linings and furniture padding.

Synthetic Recycling

- Removing of buttons and zippers
- Cutting of garments into small pieces

- Fabric is granulated and made to pellets, Pellets are broken down and polymerized and changed to chips
- Chips are melted and spun into new fabric fiber
- The recyclable amount from studies is 15.3% of the total production

Percentage Use of Land

Type	Percentage	Type	Percentage
Housing	33%	Green Belts	6%
Parks	2%	Offices	15%
Shops	1%	Industrial Complex	10%
Hotels, lodging, etc	3%	Roads	5%
Education	1%	Communication and Computers	1%
Recreation	5%	Water management	10%
Hospitals	3%	Other	5%

4.2 Residential Design

The houses would be re divided into three categories:

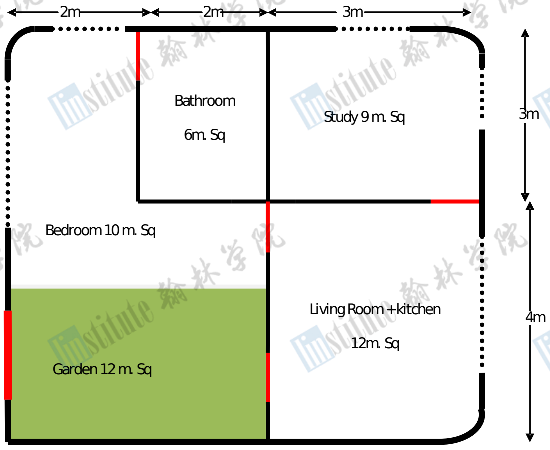
1. Houses for Couples
2. Houses For Families
3. Houses For Single Men/Women

Number of people	Number of houses	Description	Note
1	2750	Flats	Single Men
1	2750	Flats 110/building	Single Women
2	3850	Houses	Couples living together
2-4	3850	Houses	Families living together

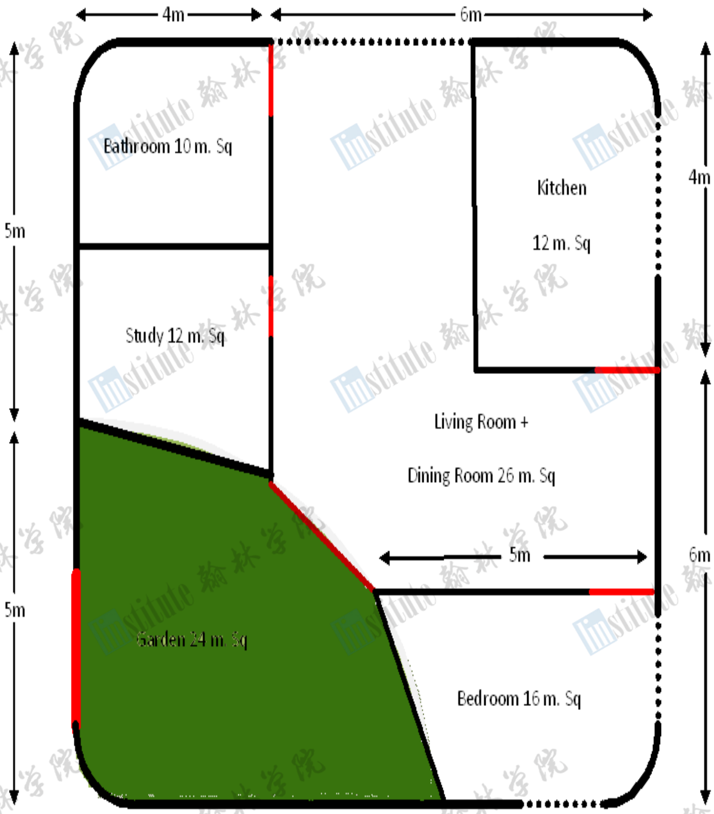
To keep the building expenses as low as possible 55 buildings containing 100 flats would be made instead of making separate houses for single adults. In this way it will be economical and a lot of space would be saved. The required internal living space for a person is 37m.sq and the external area is 12m.sq which makes the total floor area required for a person living in space 49m.sq. (1)

Design for 1 person Flat:

Floor Area: 49m. Sq

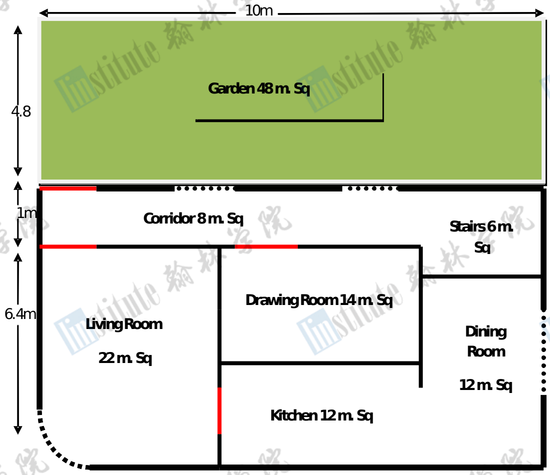


Floor Area= 49 (2) = approx 100 m.



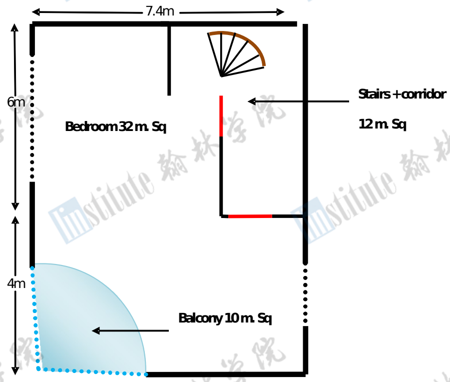
First Floor

Floor Area = 122 m. sq



Second Floor

Floor Area = 74 m. sq



The designs provided above would be the templates for future designs. To provide space for personal likenesses and lifestyle diversity, tenants would be able to modify these structures according to their own likeness, but complete changes to the designs would not be entertained.

These houses are designed while keeping the perspective of openness and spaciousness. Due to the relatively small sizes of the houses as compared to large scale homes present on earth , the major objective is to not only to save space but also provide a psychologically open and airy look to the houses. Keeping this into consideration the corners of the houses are curved to provide a softer look. Also, large windows are kept inside the houses for cross ventilation and airy environment. To provide a regular change to the internal environment of the houses, the windows are especially designed as a screen which can either provide outside view or show images of the choice of the tenants.

The houses will contain the following features

- Centrally cooled and heated.
- Made of Synthetic Material having good insulation.
- Sound proof to provide a serene environment.
- Furniture which can be folded back as a part of the wall.
- OLED,s to provide images of the choice of the tenant.

Sources for Furniture:

For preliminary requirements the furniture for Columbiat would be obtained by shipments from Earth, but when Columbiat would be properly established, then it will become self-sufficient in its needs and will produce its own furniture by using wood grown in the agricultural torus. Waste would also be recycled to make furniture. The non-organic waste would be processed into boards used for furniture

Amount of furniture for residential and office areas.

Residential

Type of Furniture	Flat Design for single			House Design for 2 Persons			House Design For 2-4 Persons			
	Required Amount	Number of Houses	Total Amount	Required Amount	Number of Houses	Total Amount	Required Amount	Number of Houses	Total Amount	Grand Total
Bed	1	5500	5500	-	-	-	2	3850	7700	13200
Bed (K.S)	-	-	-	1	3850	3850	1	3850	3850	7700
Chairs	2	5500	11000	4	3850	15400	6	3850	23100	49500
Tables	2	5500	11000	3	3850	11550	4	3850	15400	37950
Sofa Type1	2	5500	11000	4	3850	15400	6	3850	23100	49500
Sofas type 2	-	-	-	-	-	-	1	3850	3850	3850
Desk	1	5500	5500	1	3850	3850	2	3850	7700	17050
Stool	1	5500	5500	2	3850	7700	4	3850	15400	28600
Dining Tables	-	-	-	1	3850	3850	1	3850	3850	7700
Garden Chairs	-	-	-	2	3850	7700	4	3850	15400	23100
Garden Table	-	-	-	1	3850	3850	1	3850	3850	7700

Sofa type1: 1-Seater Sofa type 2 : 3-Seater

office:

Type of Furniture	4 Companies (type 1 office)	8 Companies (type 2 office)	15 (type 3 office)	30 companies (type 4 office)	3 Banks	Foundation Society	Total
Chairs	4*300 = **1200**	8*200 = **1600**	15*60 = **900**	30*10 = **300**	3*50 = **150**	**600**	**4750**
Desks	4*150 =**600**	8*100=**800**	15*30 = **450**	30*5 = **150**	3*25 = **75**	**300**	**2375**
Stool (for offices having kitchen)	4*10 = **40**	8*5 = **40**	15*5 = **75**	-	-	**20**	**175**
Conference Table	4*1 = **4**	8*1 = **8**	15*1 = **15**	-	-	**2**	**29**
Conference Chairs	4*50 = **200**	8*30 = **240**	15*10 = **150**	-	-	**100**	**690**
Side Tables	4*150 = **600**	8*100 = **800**	15*30 = **450**	30*5 = **150**	3*25 = **75**	**300**	**2375**

type1 office: 150 person, type2 office: 100 person, type3 office: 30 person,

type 4 office: 5 person, bank: 25 person, Foundation Society= 300 people

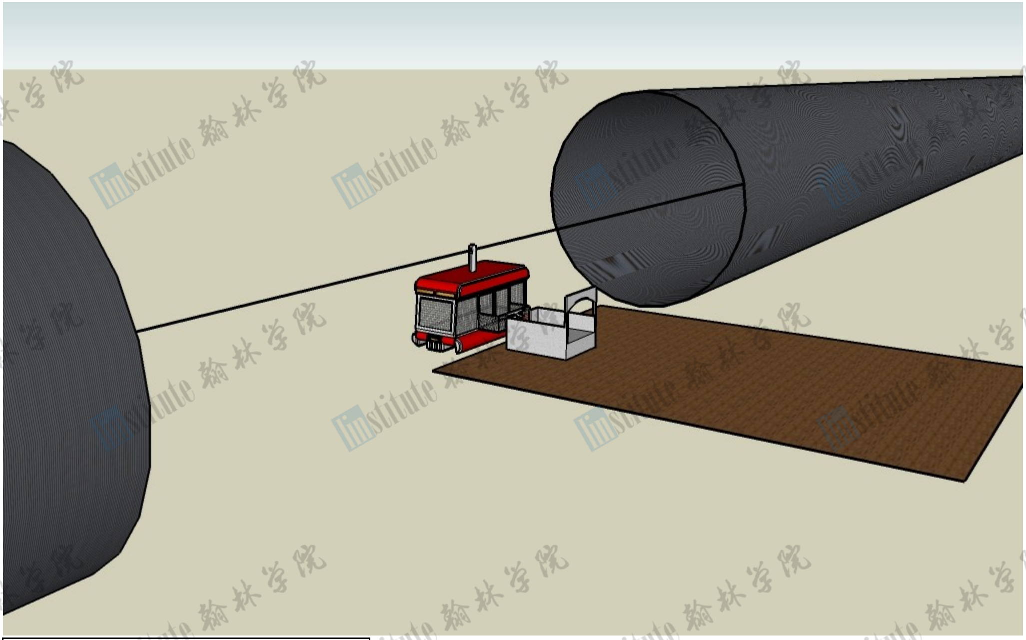
	Computing Centers				
Type of Furniture	15 Person Office	10 Person Office	5 person Office	1 Person Office	Total
Chairs	30	20	10	2	62
Desks	15	10	5	1	31
Side Tables	15	10	5	1	31

4.3 Safe Access

A number of devices will be used to provide safe access:

Cable Cars

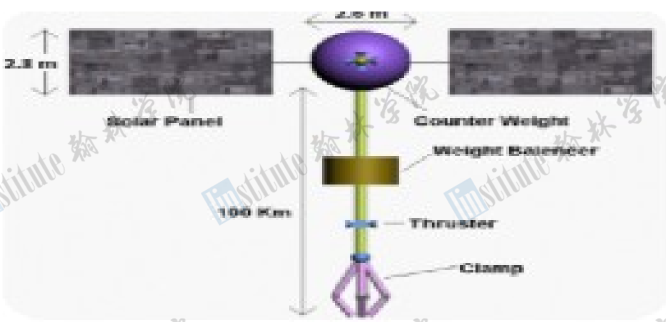
Cable Cars will be used to travel in the hull between the main cylinder and the torus. People will receive special training for traveling in the cable car as will move through low gravity areas. Special seats and seat belt will be designed for safely traveling through the low gravity areas.



4.3.1. Cable Cars

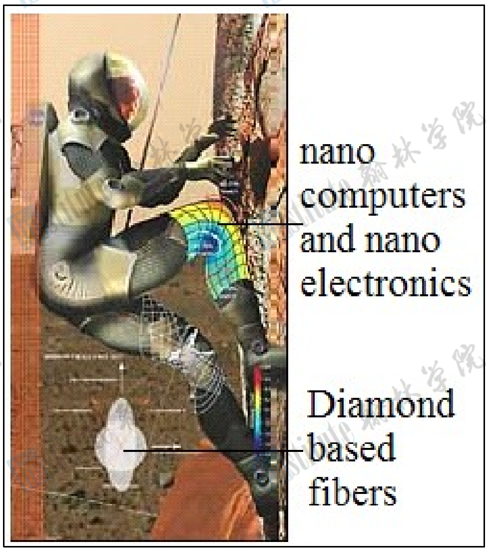
Tethers

The space-suits will have a tether attached in order to enable them to do internal operations and also allow them to move about safely in the low-g areas



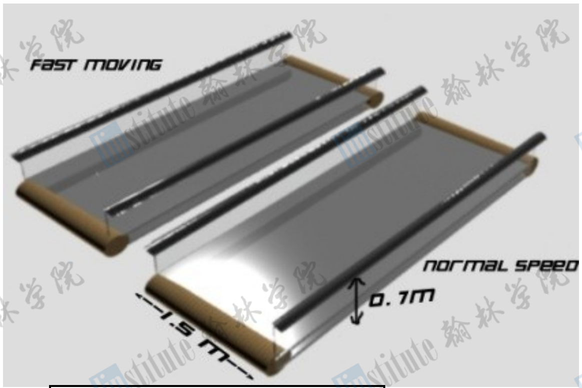
Padded Walls

The walls of the low-g areas will be padded so that the researchers and the residents do not get hurt when they fall from a great height and hit the hard surface

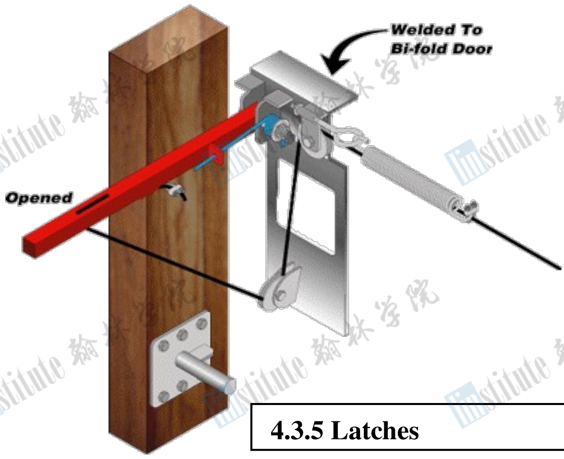


Handrails

A handrail is attached to the padded walls so that the people can hold them and walk safely in the 0-g areas.



4.3.4 Hand Rails

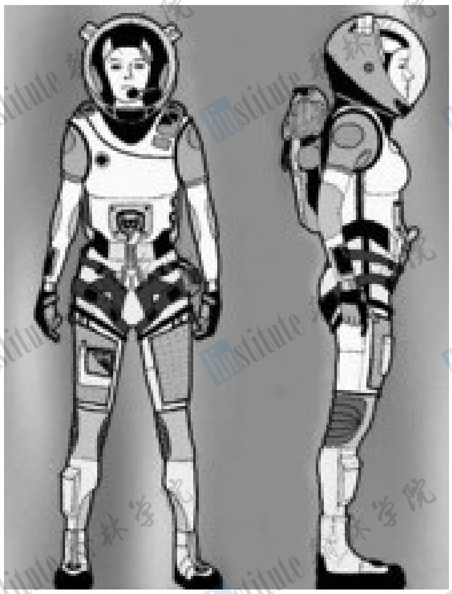


4.3.5 Latches

4.4 Space Suits and Air Locks

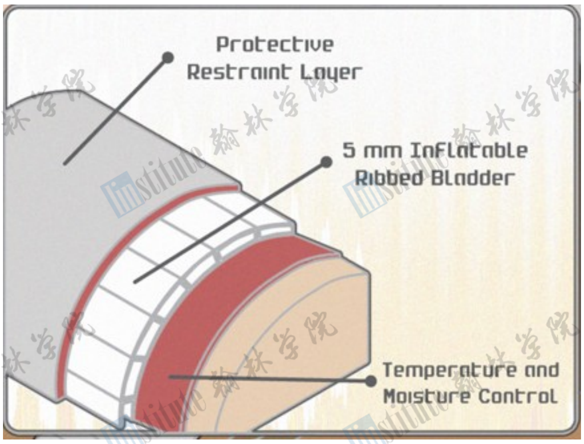
Space Suits know as the Bio-Suits will be used. These use mechanical counter-pressure instead of using gas pressurization. The suit it skin tight but stretches with the body, the person wearing the suit has freedom of movement. It is more flexible, light and adaptable then traditional suit. As it is light weight it is also ideal for working in environments which experience the force of gravity. The suits could also help astronauts stay fit. Studies have shown that astronauts lose up to 40 percent of their muscle strength in space, but the biosuits could be designed to offer varying resistance levels, allowing the astronauts to exercise against the suits during long flights.

Furthermore it has all other features of a regular space suit like the PLSS (Primary Life Support System), DCM (Display Control Model), CCA (Communication Carrier Assembly), etc.



4.4.1 Bio-Suit

The Bio-Suit basically consists of three layers, as shown in diagram 4.4.2. It protects the astronauts from space dust and other hazardous materials and also for moisture control (by letting out excess water vapor). Unlike conventional space suits it is also safer as any minor punctures can be easily fixed while working outside in space as it does not use gas pressurization.



4.4.2 Layers of Materials

The space suits will be stored near the air lock and docking area for easy access. Blasts of air will be used to remove space dust and other material off them. Before entering the air lock the astronauts will be required to enter an area where the pressure will be reduced to 0.7 atm and they will breathe in pure oxygen for 30 min. This is to prevent bends due to depressurization and formation of nitrogen bubbles in the blood stream. Then after putting on the MAG (Maximum Absorbtion Garment), they may enter the airlock.

Donning a Space Suit

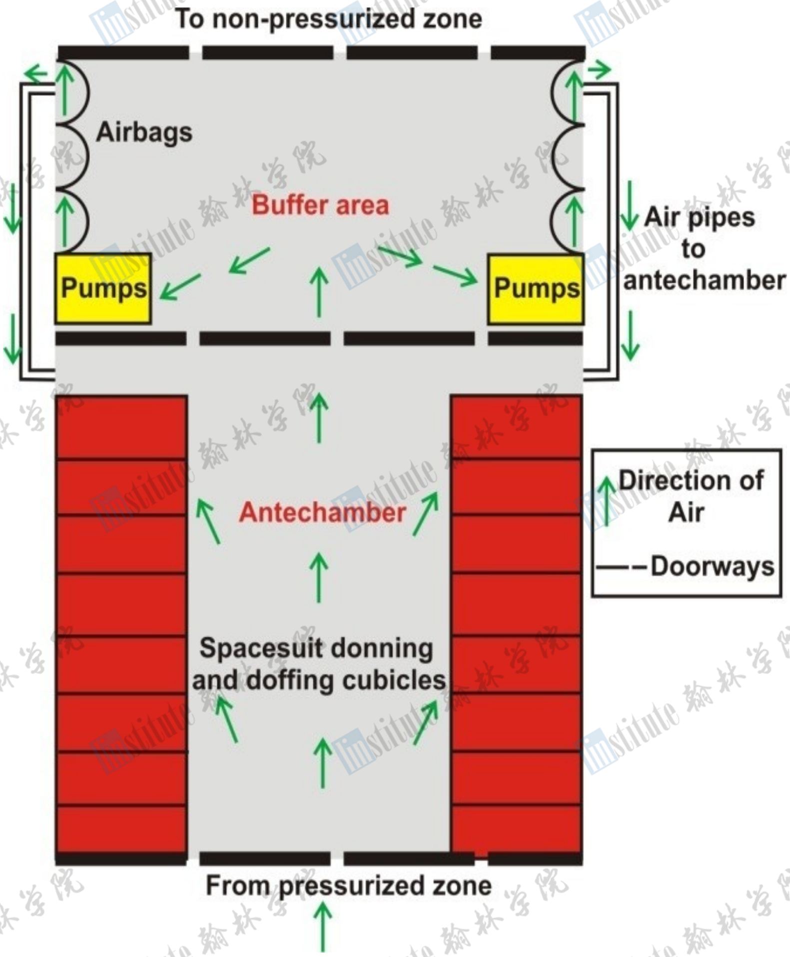
To prepare for a spacewalk, crewmembers must do the following:

- Enter the airlock
- Put on the LCVG
- Attach the EEH to the HUT
- Attach the DCM to the HUT (PLSS is pre-attached to the HUT)
- Attach the arms to the HUT
- Rub the helmet with anti-fog compound
- Place a wrist mirror and checklist on the sleeves
- Insert a food bar and water-filled IDB inside the HUT
- Check the lights and TV cameras on the EVA
- Place the EVA over the helmet
- Connect the CCA to the EEH
- Step into the LTA and pull it above their waist
- Plug the SCU into the DCM and into the shuttle
- Squirm into the upper torso portion of the suit
- Attach the cooling tubes of the LVCG to the PLSS
- Attach the EEH electrical connections to the PLSS
- Lock the LTA to the HUT
- Put on the CCA
- Put on comfort gloves
- Lock on the helmet and EVA
- Lock on the outer gloves
- Check the EMU for leaks by increasing the pressure to 0.20 atm above the airlock pressure

No leaks mean the airlock is depressurized. Once these steps are completed:

- The EMU automatically depressurizes to its operating pressure.
- The suits are tethered to the airlock.
- The outer airlock door is opened.

- The SCU is disconnected from the EMU.
- The astronauts step out of the airlock into the shuttle's cargo bay.



Air lock mechanism

4.5 Visitors

Response To Unanticipated Problems And Issues

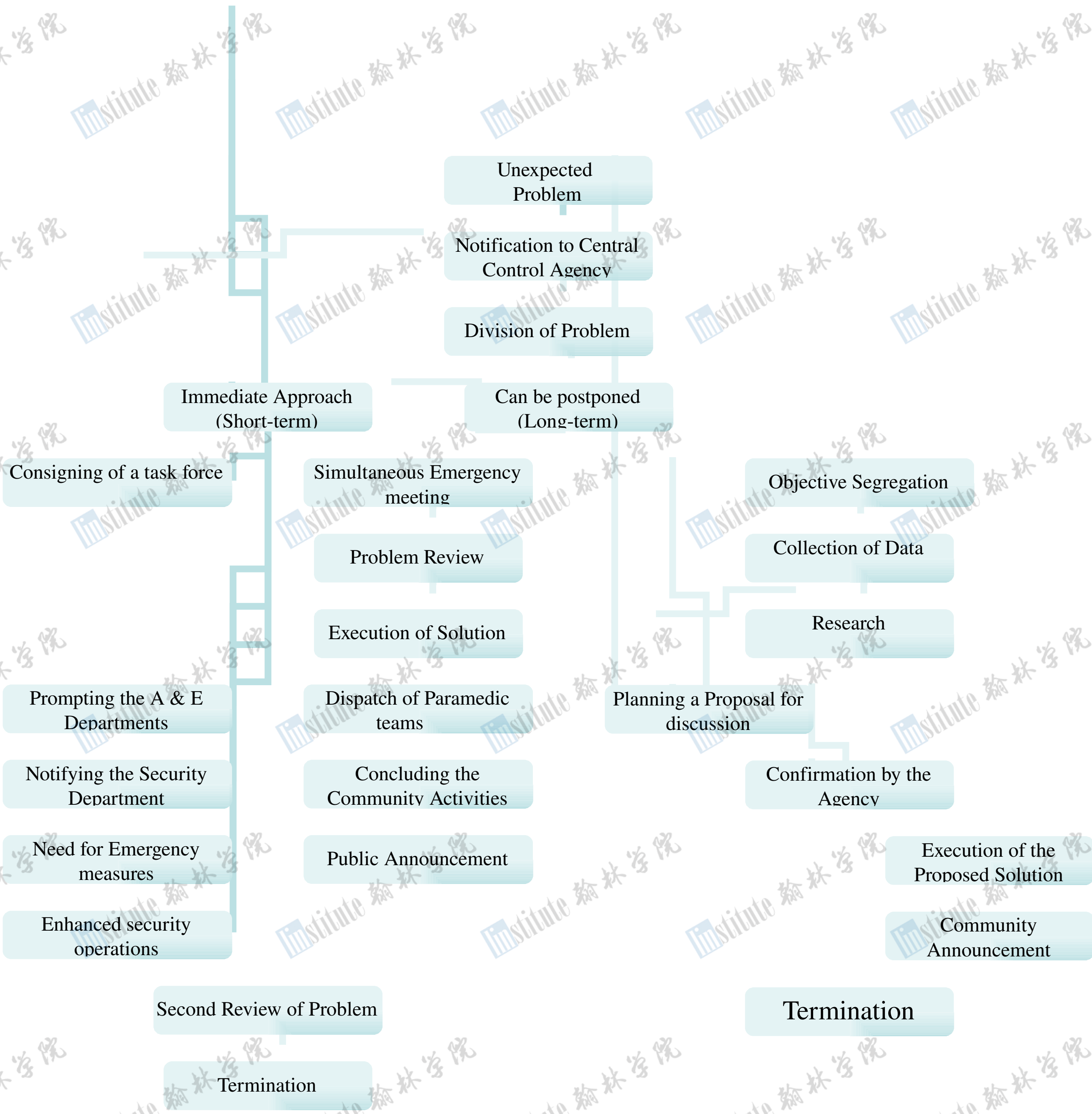
Two categories of problems are expected aboard Columbiat:

- Those originating from the activities on the settlement.
- Those emanating from the ships docking on the settlement i.e. carried on from earth

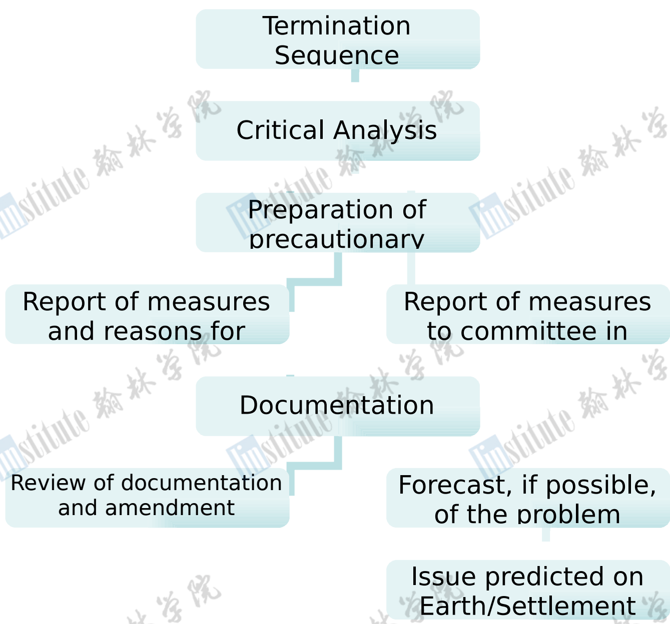
The prospect in all cases is to learn from all past experiences and to ensure that none of the problems repeat in the future.

For this regard, all problems are analyzed continuously.

Problems which require immediate approach e.g. casualties from a ship docking incorrectly, are those which require instant physical and technical action.



Problems which are prone towards long term base are generally problems related to activities aboard the Settlement itself. The Sequence of termination is to ensure that the problem is not repeated and this works by learning the counteractive measures to it and using them to look for characteristic forecast signs of the problem to predict it before the arrival.



Health Risks and Consequences

Risk	Result
Spread of diseases with and without (Need for Quarantine)	• Immediate isolation • Prompt treatment • Destroying of all secretions and excreta from the infected person • All personnel handling the infected person should wear masks and be immediately vaccinated if possible. • Possible diseases easily spread: Pneumonia, Influenza (Common cold), Avian Influenza (Bird Flu), Whooping cough, TB (but very close contact)
Accidents resulting in physical injuries on board	• Temporary first-aid provided on board • Ambulance and paramedics kept ready • Immediate relocation to the nearest hospital • Prompt treatment • Medical examination to observe the need for quarantine
Difficulty in adjusting gravitational differences (from flight to settlement)	• Relocated to habilitation department (affiliation of the hospital) • Kept under observation • Distracted by recreational facilities and gradually introduced in the community to provide near ‘home-based comfort’

Anticipated Security Issues and Problems

Category	*Issue*	*Results*
Electronic	Spread of data-corrupting software or computer viruses	• Complete disconnection from all terminals of the central mainframe • Scanning the data-transferring device on an isolated system with an anti-virus software • Re-scanning the device for safety
	Cyber-crime	• Guarding all terminals with employee-recognition mechanisms and authorization. • Having a team of software specialists monitoring vigilantly and constantly all systems • Upgrading and updating the system • Reporting all criminals and crimes to the central policing authority in Settlement as well as on earth
	System hacking, data theft, loss and manipulation	

Financial	Insufficient financial credit to support oneself	• Providing loans on interest • Loans taken are electronically recorded and duplicate records are relayed back on earth
	Financial theft by stealing	• Reporting all details to the central policing authorities • Extracting a low-interest support loan till recovery
	Financial theft electronically – hacking	• This refers to hacking and theft through e-banking • Reporting theft to central authority and banking committee • Showing of material records to prove identity and theft • Rooting out the criminal, reporting and restoring the credits
Identity	Fake identity proven	• Instant deport back to earth on the next flight under the following legal action
	Loss of identity-proving documents	• Contacting the Data Administration on earth • Providing provisionary documents till stay on Settlement
	Expiring of permit to stay on-board settlement	• Prompting a warning and request to apply for extension • Reporting to central authority • Refusal would be followed by deporting
Other	Vandalism	• Legal action by the Central Security Committee
	Unethical and illegal actions	
	Malfunctioning or explosion within hydrazine plants	• Analysis and report of the incident, Alerting all hospitals with emergency departments to be ready for casualty • Dispatch of Fire-Fighters and Special Force to help move the injured and extinguish flames, Immediate evacuation of nearby offices, etc. • All walkways and means of transport clarified to relocate the casualties and injured

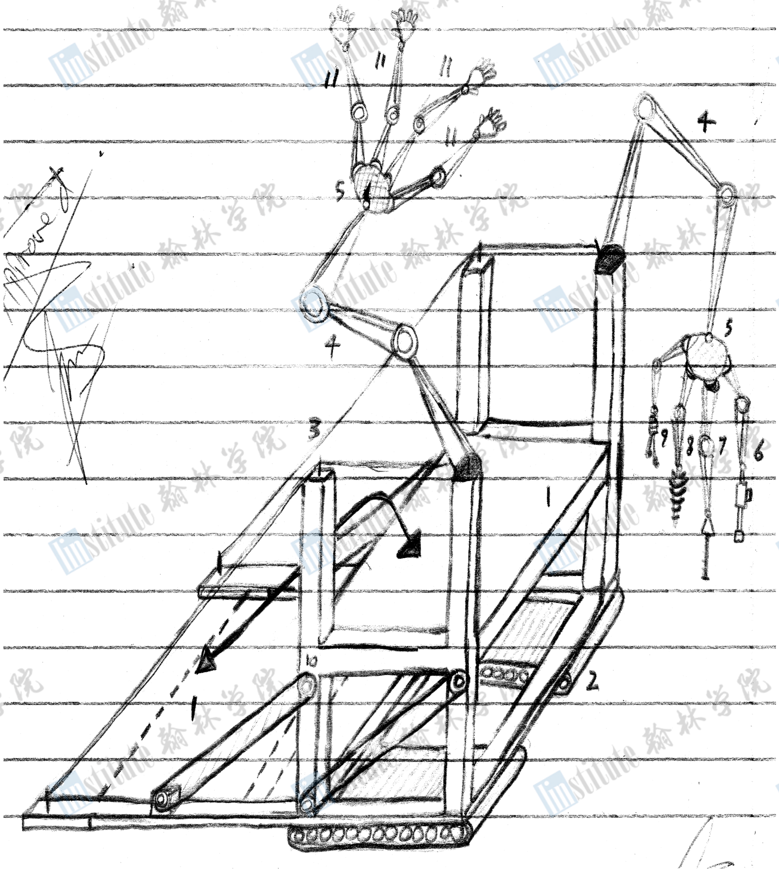
AUTOMATION

5.1Assembloid

The assembloid would be used to construct the settlement. It would be controlled from the control room, using microwave communication. Its microprocessor would have a set of operations involved that it would periodically follow. In case of malfunction it could be controlled by the person sitting in the control room.

The assembloid would move using a rocket thruster that can move 360 degrees. Two large hydraulic claws would be used to hold a settlement part in position while the hydraulic arms, plasma welders attached to hydraulic arms and nuts and bolts guns construct the settlement. A 360 degree camera would be mounted below the assembloid to offer a complete view.

Interio



The Interio would be used to construct the interior part of the settlement. It would include a temporary platform that can be raised and lowered to the ground. A microprocessor Inside the interio would store all the blue prints and building procedures. In case of malfunction the interio can be operated by using a PDA.

Two giant hydraulic arms would be used to construct the buildings. The hydraulic arms would have the following facilities: hydraulic hands to facilitate construction, plasma welders mounted on hydraulic arms and nuts and bolts guns.
An automated truck would be used to supply the building parts. Its movement would be controlled using a PDA and
Bluetooth technology.

5.2Central Computer

All robots and computer systems would be centrally controlled by the central computer. Access to the central computer would be restricted to the concerned authorities who can access the relevant systems from there PDAs after iris and Verichip identification. All information would be held at the central database, which would be updated daily. Access to the database through a PDA would require iris and verichip identification.
Two data centers would house the two central computers. One central computer would be located in the central command center, while the other one would be located on the moon.

The data center on the moon would serve as back up in case of failures, and would be updated constantly using a real time communication link with the settlement. Data would be transmitted to the moon via microwaves. The data center on the moon would we equipped with solar panels to produce electricity.

Access to the data center would be blocked to the general public. Data centers would be accessed by a maximum of 5 people using iris and verichip identification. The entrance room would be located outside the computer room for greater security.

Specifications

50 micrometer multi mode fiber would be used for backbone cabling because of its capability of supporting higher network speeds over longer distances while being more cost effective to implement then single mode fiber.

The highest capacity media available (10GB Ethernet) would be used for horizontal cabling to reduce the need for re cabling in the future. Backbone fiber optic cabling would be limited to 300m while horizontal copper cabling would be limited to 100m.

The power and communication wires would be separated with a physical barrier to increase efficiency.

4 feet of space would be provided between rows and cabinet, which would be aligned on raised floors (60cm) to allow easy lifting of tiles, ventilation and circulation of air and to provide space for power cabling. 19 inch racks would be used.

A temperature of 20-25 C would be maintained by using automated air conditioning and heating.

Humidity range of 40 to 55 % would be maintained, with max due point of 17 C, using air conditioning.

Supercomputer specifications

The properties of the most powerful supercomputer currently available (IBM road runner) are as follows:

Software: open source Linux
Power: 2.35MW
Space: 296 racks, 6000 sq feet

According to Moore's law memory and processing capacity doubles every 2 years for the same cost therefore we can expect the following capacity by 2044.

Memory	103.6TB * 2^17 = 13,579,059 TB (543TB/resident)
Processing speed	1.7 Petaflops * 2^17 = 222,822.4 Peta flops
Inter settlement transfer speed:	5 Ghz/sec

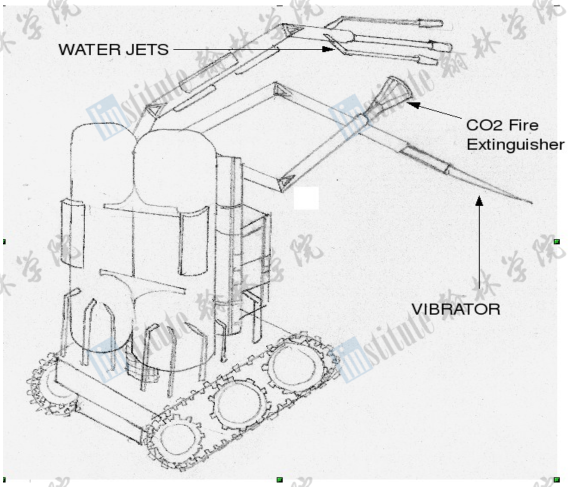
Fire Control

Fire detectors would be installed throughout the settlement. The fire detectors would consist of heat sensors connected to a microprocessor which in case of high readings would start a fine sprinkler and a gaseous (CO2) fire suppression system to reduce the fire.

Atmosphere controls would reduce the amount of oxygen in the air reducing the severity of the fire. Firewalls made of concrete or aluminum-titanium alloy blocks would restrict the fire to a portion of the settlement.

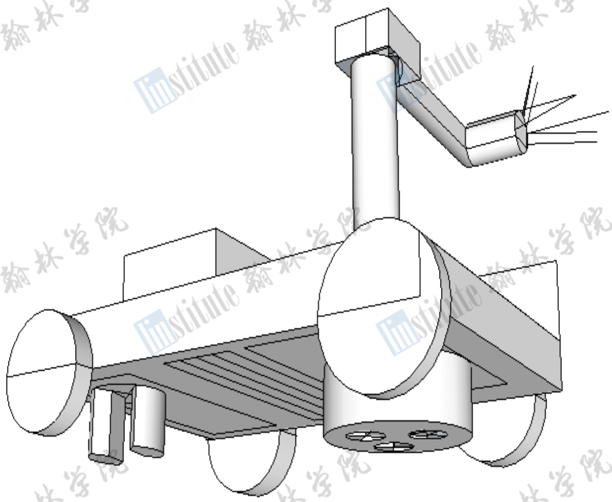
Fire Droid

A Fire Droid would be placed in every neighborhood. It would be made of a refractory material (chromite), and it would have caterpillar tracks. It would have three hydraulic arms: vibrator (to break walls) , water sprinkler and a CO2 fire extinguisher. It would also have two, a water and a CO2, tanks.



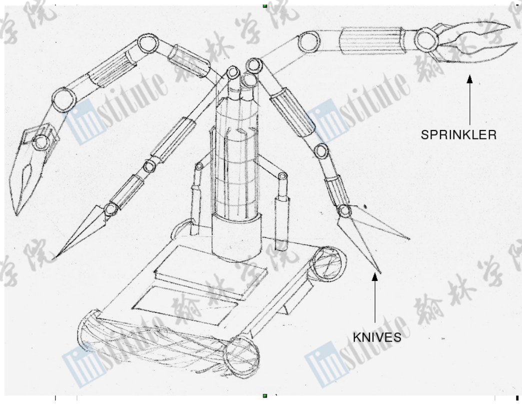
Cleanobot

The Cleanobot would be used to clean roads and sidewalks. Its base would consist of movable brushes, a movable vacuum and a cleaning agent spray.



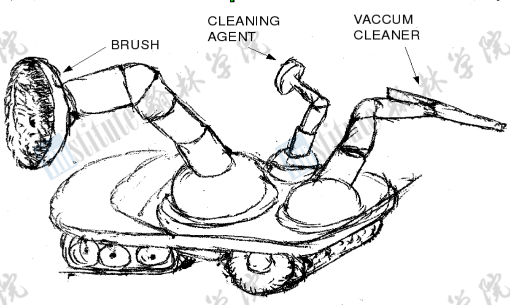
Its path would be stored on a microprocessor and it would repeat its task every day. It would also perform the job of a garbage truck. A conveyor belt would bring dustbins from inside the house outside. The Cleanobot would collect the dustbin by using a magnetic hydraulic arm and then empty it. The trash would be compressed and transferred to a special recycle unit using the goods infrastructure. In the recycle unit metal would be separated by using magnets. Bio degradable trash would be converted into nutrients for agriculture through the process of composting that uses involves aerobic bacteria.

Lawn Mower / Automated Gardner



The automated lawn mower would consist of rotary blades to cut grass, two hydraulic arms with knives and two hydraulic arms with water sprinklers for precision oriented sprinkling. It would also have a tank to store water. It would have a microprocessor with preset paths and jobs. Flower patterns would be set using the PDA.

Home Cleaner



The home cleaner consist of movable brushes, a movable vacuum and a cleaning agent spray to clean the floor. It would also have three hydraulic arms with brushes; a vacuum cleaner and a cleaning agent spray to clean the furniture. It would have a microprocessor with fixed scenarios and it would repeat its task every day.

<u>Repairobot</u>

The Repairobot would be used to repair the outer torus in case of damage. It would be controlled from the control room, using microwave communication. Its microprocessor would have a set of preset scenarios and a set of instructions to deal with a scenario.

The Repairobot would use its hydraulic legs with magnetic ends for grip, and its hydraulic hands for repair work. It would also consist of an electric drill, a plasma welder and a nuts and bolts gun.

In case the microprocessor cannot deal with a problem then a PDA from inside the settlement would be used to control the Repairobot. The cameras on the Repairobot would give a 360 degree view.

Supply parts would be provided by a transporter that would use hydraulic legs with electromagnetic ends to move.

5.3Security/Privacy

Iris recognition, a form of biometric recognition, would be used to access personal accounts, homes and restricted locations. Iris recognition uses camera technology to create images of the detail rich intricate structures of the iris. These images are converted into digital templates which provide mathematical representations of the iris that yield unambiguous positive identification of an individual. These mathematical representations are converted into binary data which would be stored as identification in the central computer.

Advantages:

- Stability and longevity.
- It is an internal organ that is well protected by the cornea.
- Unique for every individual, DNA is not unique for about 0.2% of the population.
- An iris scan is similar to taking a photograph and can be performed from 10cms to a few meters away. No need to touch equipment.
- Has an unprecedented false match rate(better then 10^ -11)

Methods to counter fakes:

- Testing for retinal retro reflection(red eye)
- Testing reflections from the eyes four optical surfaces to verify there presence, position, and shape.

VERICHIPS (Radio Frequency Identification)

A verichip is the same size as a rice grain, and has a unique 16 digit identification. It is inserted in the tuscle area of the right arm muscle in a quick and painless process similar to giving a shot. It emits a radio frequency to communicate with the central computer through the wireless network. It would be used to track the movement of people and visitors for security purposes. It would be used to monitor the heart rates, blood pressures and walking patterns of citizens: which would be sent to the central computer. The central computer would compare the reading to preset levels, and incase of abnormal readings, the relevant data would be sent to the concerned doctor on his PDA through the wireless network. The verichip is FDA approved, and it can also protect children from kidnappings.

PDA

A PDA would be provided to every resident and it would be used:

- As a universal remote for controlling appliances, it would communicate with appliances using Bluetooth technology.
- To surf the internet and odder goods online.
- To control the temperature.

No data would be stored on the PDA; all the data would be stored on the central computer along with all the applications and computer services. Digital TV can be viewed online by using the wireless internet network

Specifications

Screen size: 3.5 inches	3.5 inches
Resolution: 420 * 320 pixels	420*320 pixels
Dimensions(inches)	4.5(h) * 2.5(w) * 0.5(d)
Processing Speed:	412 MHz * 2^17 = 54,001,664 MHz
Memory:	128 * 2^17 = 16,777,216 MB DRAM
Storage	1 GB * 2^17 = 1,048,576 GB
Operating system	Linux Power
Battery	3.7V 1400mAh

<u>Hand held projection</u>

A small projector would be built into the PDA with the following specifications:

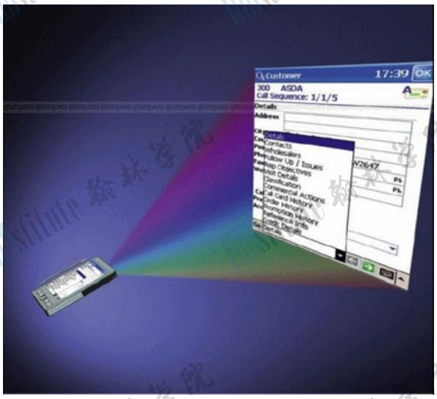


Image size: 6″-50″ diagonal

VGA(1280 * 786)

Light source LED

Connected to PDA′s Battery

<u>Projection Keyboard</u>

A laser keyboard would be built into the PDA that senses finger movement using motion sensors and translates them into keystrokes. The detected coordinates determine the actions.

Automated Fridge/Cooker

An automated fridge with a microprocessor would keep a check on the temperatures in different compartments to provide optimum temperatures, and would identify different foods by using an optical scanner on a movable hydraulic claw and edible bar codes. Data concerning the foods in stock would be kept in a database with the levels of different product already set. If a product is below the desired level then the fridge automatically sends command to the central computer, using the wireless network, for additional stock.

Food recipes would be stored on the microprocessor and would be updated everyday through the internet. Food would be moved towards the cooking compartment by using a hydraulic arm and a conveyor belt. The cooking compartment would consist of a microwave, cooking stove, an oven and an automated chopper. Food would be cooked by using a hydraulic arm with knives and spoons and a hydraulic hand which mimics human movement. Food can be decided by using a PDA and prepared food would is transfered into the fridge. Cooking utensils would be kept on top of the cooker and would me moved by using the claw.

Temperature Control

A temperature sensor (thermistor) would constantly feed readings to a microprocessor. The readings would be compared to a preset range in the microprocessor. If the temperature is higher then the range then air conditioning would be used to lower the temperature. If the temperature is lower then the range then an electric heater would be used.

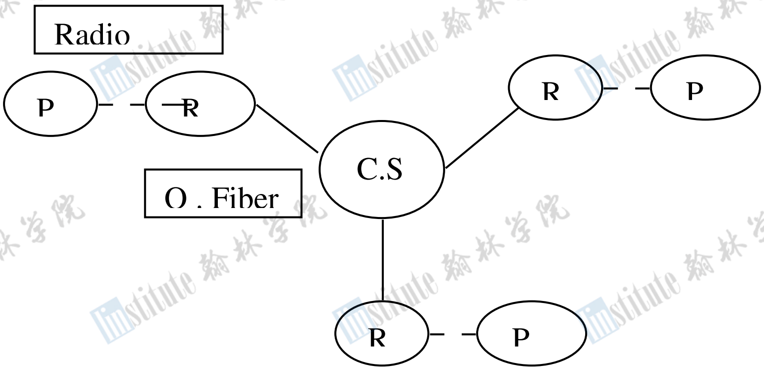
Network

The whole settlement would have a wireless local area network. Every PDA would have a wireless network interface card in order to communicate with the network. Access points (routers) would be used to transmit and receive radio frequencies.

3GPP Long Term Evolution technology would be used for the network. The technology has the following specifications:

326.4 Mbps download rates for every 20Hz spectrum
86.4 Mbps upload rates for every 20Hz spectrum
20 Mhz bandwidth
Optimal cell size of 5 Km, our settlement would therefore require two cells but an additional cell will be installed to provide a good signal strength.
IEEE 822.6

Star Topology



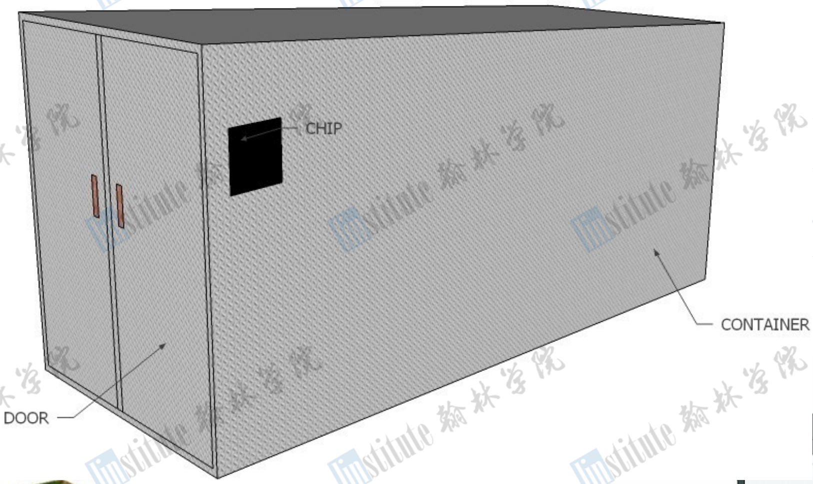
C.S: Central Server, R: Router, P: PDA, O. Fiber: Optical Fiber

Advantages

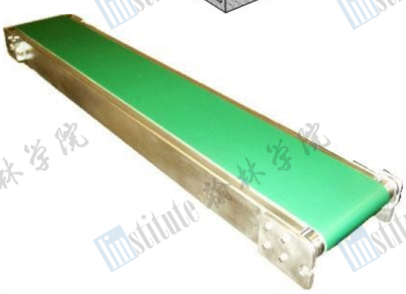
- Simplicity: Easy to understand, establish and navigate.
- Benefits from centralization: Greater security.
- Isolation of devices: prevents any non central failure from affecting the network

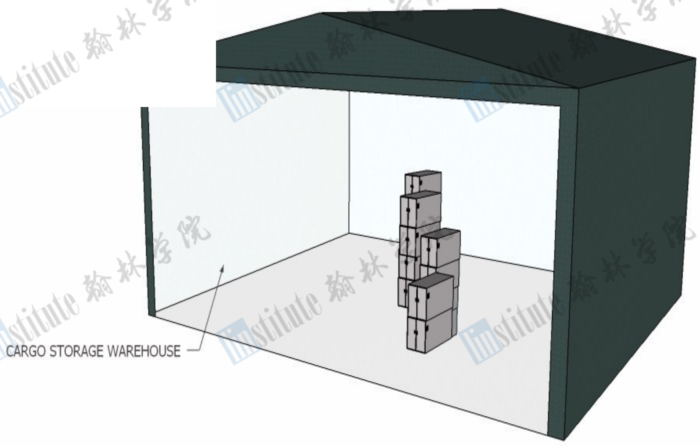
5.4 Automation for Cargo

Once the cargo arrives in the space ships a robot will place the containers on the conveyor belt. Cargo will arrive in special containers built form a light weight and strong alloy. The cargo will be brought in from space ships. A robotic arm will pick up the containers using an electromagnet and place the container on the conveyor belt. Each of these containers will be water proof and airtight; and will be built to contain a specific type of good. The containers will also be fitted with a chip that will be scanned by a machine. The size of the container will be 10m * 2.5m * 3.5m (L*W*H).



Once the machine has scanned the container, it will send the information about the goods inside it to the CGIMS (Columbiat Goods Inventory Management System) server. And the containers will be sent to the warehouses accordingly.





An extensive system of conveyor belts will be in the settlement.

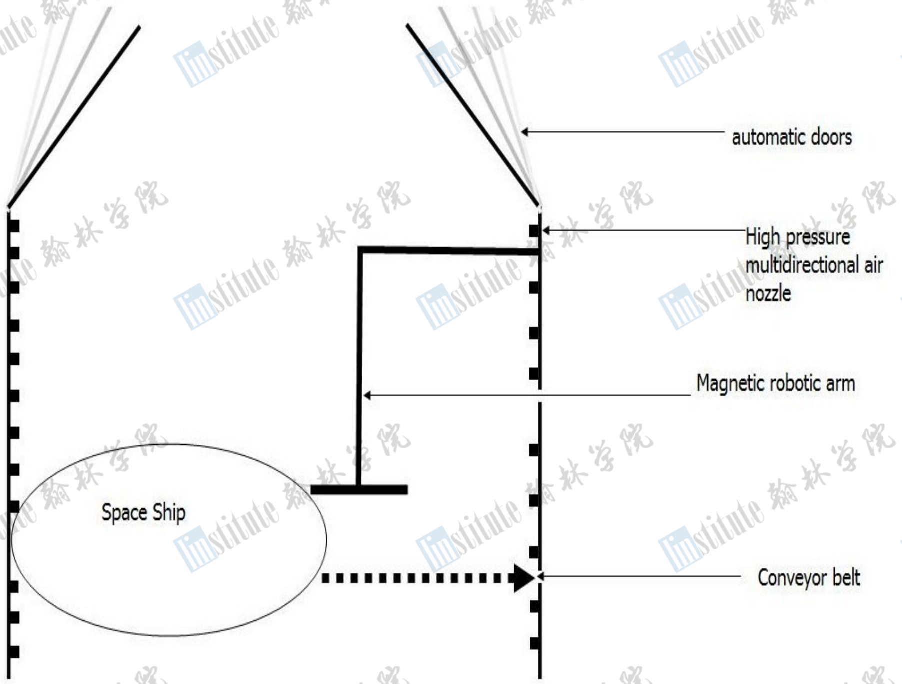
The conveyor belts will be used for (cargo handling) transportation of cargo from the cargo unloading area to the special warehouses. The conveyor belts will be specially designed to carry the containers. These goods will be stored in the containers and in the warehouses.

5.5

For the maintenance of robots there will be a place called the Columbiat Robots Repair Facility. Full time engineers will work here to repair all sorts of robots. The facility will contain all sorts of technology and machinery such as welding tools, robot programming computers e.t.c.(types of computers are mentioned in 5.2)

In order to prevent solar dust contamination throughout the settlement, anything that enters the settlement will be first sprayed with high pressure of air in an air tight room to remove all dust particles. The air will be vacuumed and cleaned, and then reused as breathable air. The solar dust will be disposed off.

Everything will enter the settlement through the upper dock which will have retractable doors. Once the (Cargo vehicle) spaceship enters through the dock, the retractable doors will close creating an airtight environment. Then the high pressure air will be sprayed. The nozzles used will be able to spray in multiple directions and will be placed on the walls of the docking station. This is shown in the picture:



Cross-sectional view of docking station

SCHEDULE & COSTING

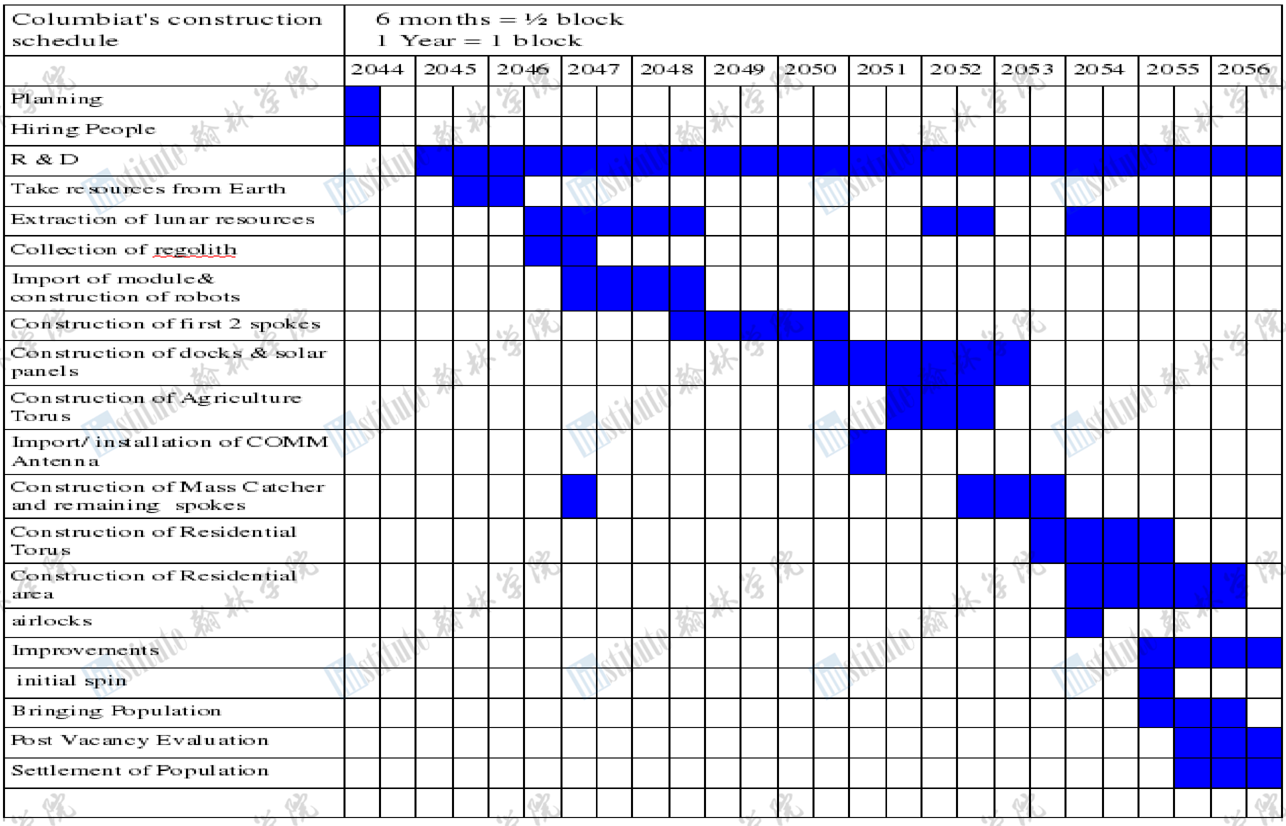


Table 6.1.2 Major Tasks Involved	Completion Date	Major Tasks Involved	Completion Date
Research and Development	31-DEC-56	Construction of Residential torus	21-may-55
Extraction of lunar resources	07-Aug-55	Construction of residential areas	8-mar-56
Construction of constructional robots	15-Sep-48	Initial spin of settlement	07-Sep-55
Construction of docks	3-Sep-52	Bring original population-7500	15-Jul-56
Construction of 0 g areas	10-Jan-51	Settlement of population	28-dec-56
Construction of solar array	5-jun-52		

Department	Salary per person per year	Total salary
R & D	$200,000	$360 mn
Engineers	$180,000	$ 576 mn
Construction	$152,000	$317 mn
technician	$125,000	$262.5 mn
	total	$1515.5 mn

Major Task	Cost	Net
Research & Development	$2000 mn	14925 mn
Extraction of lunar resources	$3000 mn	
Construction of robots	$ 1500 mn	
Construction of space infrastructure	$ 8000 mn	
Construction of COMM. Antenna	$ 25 mn	
Construction of COMM. Satellite	$ 400 mn	
Construction of Docks	$ 925 mn	$ 30918 mn
Construction of zero g	$4500 mn	
Construction of solar array	$ 250 mn	
Construction of Residential torus	$15025 mn	
Construction of spokes	$ 1193.92 mn	
Construction of Agriculture Torus	$9024 mn	
Initial spin	$ 10 mn	$ 12010 mn
Bringing Initial Population	$ 5000 mn	
Binging rest of population	$7000 mn	
Settling Population	$15000 mn	$72200 mn
Salaries	$ 3200 mn	
Logistics	$ 18000 mn	
Equipment	$36000 mn	
Net Costs Billed	$ 131 bn	

Net cost billed: $ 131 bn

7.5% service charges(Northdonning Heedwell): $ 9.825 bn

Total: $140.825 bn