ARESAM

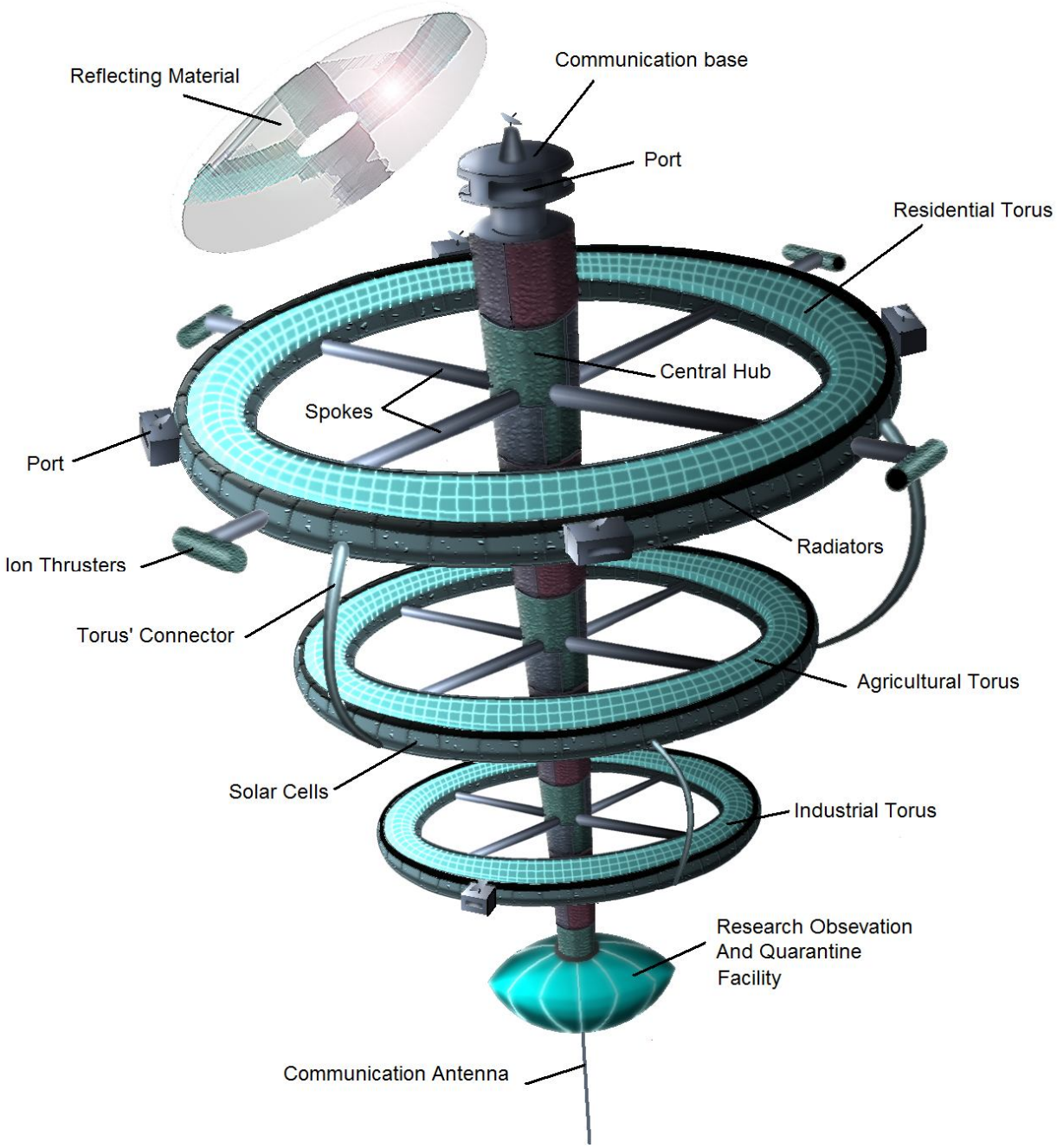
LAHORE GRAMMER SCHOOL
JOHAR TOWN

1.0 Executive summary

Lahore Grammar School for Boys Johar town is pleased to present the proposal for Aresam, the first ever human mega project around Mars, as per requirements of the foundation Society laid down in the request for proposal (RFP). As the first human settlement near another planet Aresam is expected to become the commercial, technological, residential and industrial hub for future Mars and deep space missions. Aresam's creation will be the culmination of past human dreams about Mars and a new beginning for dreams beyond Mars.
Some salient features of Aresam are given below:

1. Aresam will provide comfortable living conditions to 20000 residents in the residential torus, and will have the capacity to easily accommodate increase in its population annually
2. Aresam will have 4 major hull components other than the residential and business torus, including the agricultural and industrial tori, the central axle (cylindrical) and a special observation and cutting edge research lab area.
3. Aresam's design offers complete expansion capabilities for future need in both the residential and industrial tori as well as the port complex.
4. Aresam will be the hub of Mars related tourist activities and will provide special mars and outer space observation area, zero g recreation and sports and future tourist visits to Mars. These unique features will attract tourists from the Earth as well as other Space settlements.
5. Aresam's dedicated transit/ cargo and passenger ports will ensure rapid, safe and comfortable transit and transport facilities.
6. Aresam will also offer cutting edge communication network to facilitate continuous Earth – Mars communication even at times of solar conjunction.
7. The quarantined research labs and clean rooms will provide the scientists and engineers a clean, dedicated area to research on Martian resources and manufacture electronic and biological systems and to research about possibility of life on Mars and beyond.
8. All the life support facilities and intra settlement transport systems will be fully automated to ensure standardized and safe living and work conditions.
9. Aresam will offer all the ultra modern facilities for new businesses related to mars and other space related business outlets.
10. Aresam consist of various reboots, specially designed for personal assistant and for emergency handling.
11. Aresam consist houses which are significant in their design, as they uses the maximum space available for efficiently providing amenities to its residents
12. Specially designed connectors will join the tori directly together . this will be particularly helpful in preventing physical and mental stress experienced by travelling from residential(0.9g)l to other tori(0.5-0.2 g) through the central axle(micro-g).
13. The primary construction machine "constructex" is a versatile multitasking machine which can operate in automated or crew control modes to rapidly attain assembly line construction sequence.
14. Aresam will stay in constant connectivity with the earth due to lissajous orbit satellites around Mars- Sun L1, L2 points. And Aresam' giant data servers will constantly down load earth server data to create instances of instant internet access for the residents.
15. Details of each of the above mentioned facilities and the cost and schedule plan can be found in the following chapters.

2.1



Component	Feature	Value
Central Axle	Radius	70m
	Height	2000m
Residential Torus Spokes	Length	1482.6m
Agricultural Torus Spokes	Length	623.3m
Industrial Torus Spokes	Length	142.5m
Space Port	Radius	25m
	Height	70m

Features	Residential Torus	Agricultural Torus	Industrial Torus
Angular Velocity	0.073 rad/sec	0.073 rad/sec	0.073 rad/sec
Interior Volume	551,032,350.7m3	405,403,870.4m3	381,238,933.6m3
RPM	0.7	0.7	0.7
Artificial Gravity	0.98 gE	0.5 gE	0.2 gE
Large Radius	1786.6m	912.8m	365.1m
Small Radius	125	150	230
Number of Compartments	4	4	4

All volumes are pressurized except spokes and connectors

Residential Torus: It is the largest hull component serving as the hub of residential and commercial activities. To provide comfortable yet natural living conditions similar to the Earth, artificial gravity of magnitude 9.6 m/s2 will be applied which is a little less than that of Earth to increase the comfort level of the residents. Residential torus will be further divided into four compartments. gE =9.81 m/s2

Agricultural Torus: This torus is the food production, storage and processing facility for the entire settlement. It is also divided into four sections for the same reason as the residential torus. This part of the settlement is provided with an artificial gravity of 0.5 gE because in low gravity conditions, plants can be genetically engineered with weaker trunks and stems leaving more energy available for the edible parts of the plant. Agricultural area is divided into four different chambers isolating environmentally different plant species and enabling optimized specific environment controlling for each type.

Industrial Torus: Low g industrial torus is the hub of small and medium industrial productions of mars' bases and future mars missions. For instance, the undeployed prefabricated bases for mars exploration would be made in this torus. This torus also processes materials coming from Phobos and Deimos processing them into semi assembled components(which will be sent to the zero g industrial area for heavy manufacturing), and/or fully assembled products(Mars mapping satellites to other planets, rovers , communication robots for earth to mars or settlement to mars ventures and maintenance robots for the settlement itself.

MATERIAL	Usage	Properties	Source
Titanium – Aluminum – zirconium Alloy	For the construction of basic structural framework of Aresam.	Very High welded and non welded tensile strength and toughness.	Alexandriat/Belle vistat/Columbiat
RTV adhesives	For binding all hull component layers together	Very good sealant and strong corrosion resistant adhesive	Phobos/Deimos/ Asteroids
Regolith	Prevents environmental leaks and protects against impact from uncharged high velocity particles not deflected by the magnetic shield	Radiation protection and impact resistance	Phobos/Deimos/ Asteroids
Silica Aerogel	insulation material -Prevention against thermal shock -Embedded between the solar panel layer and the mains structural framework.	Low thermal conductivity Physical shock prevention	Phobos/Deimos/ Mars/Asteroids
Chlorinated Polyvinyl Chloride piping	-provides channels for liquids and gases to be transported throughout Aresam	Corrosion resistance and long life piping	Phobos/Deimos/ Mars/Alexandriat /Columbiat
High Strength aluminum alloy	For construction of interior structures	Light weight but strong construction material for interior frameworks development	Alexandriat/Belle vistat/Columbiat

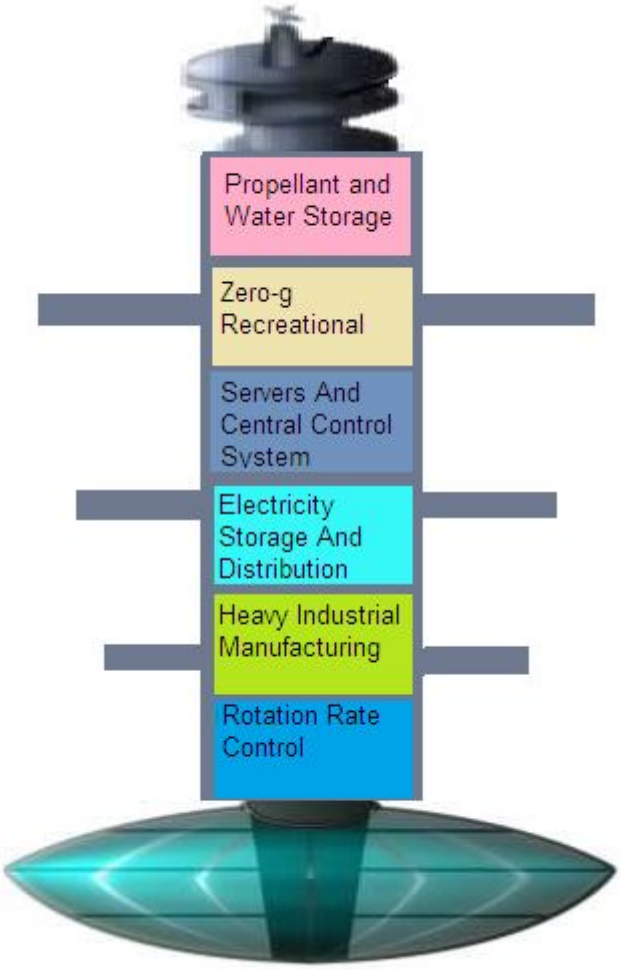
Carbon Nanotubes	-To reinforce spokes, for superconducting wires, electronic circuit components	High tensile strength suitable for spokes under great tension. Superconductivity and unique electronic structure	Phobos/Deimos/ Bellevistat/Earth
boPET	Shield against radiation and debris; micrometeoroid collisions.	Radiation protection and impact resistance.	Alaskol and Bellevistat
Polyethylene (VLDPE)	Protection against debris	Impact modifier when blended with other polymers.	Phobos/Deimos
Lead Glass	Making Windows	Strong and prevents X-rays from passing through	Soil from Phobos/Deimos and Earth

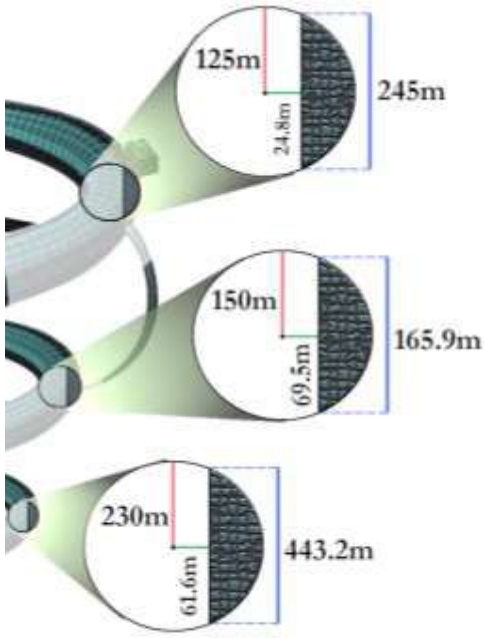
Protection from Radiation and Debris Penetration: Protection against radiation and debris will be provided by plasma shields, polyethylene, boPEt and silica aerogel. Plasma is any gas that has had some of its atoms or molecules ionized, it forms a shield against radiation and its high viscosity gives it the ability to withstand high pressures. The plasma shields require electricity for ionization which is provided by the solar panels. Copolymers of polyethylene significantly increase its strength and make it more resistant to impacts. boPet has high tensile strength so is effective in preventing damage from collisions and it also deflects radiation. Silica Aerogel also helps in shock absorption. In the areas below down surfaces where sunlight is not required to pass regolith will also be used for protection against radiation and debris instead of polyethylene and boPET.

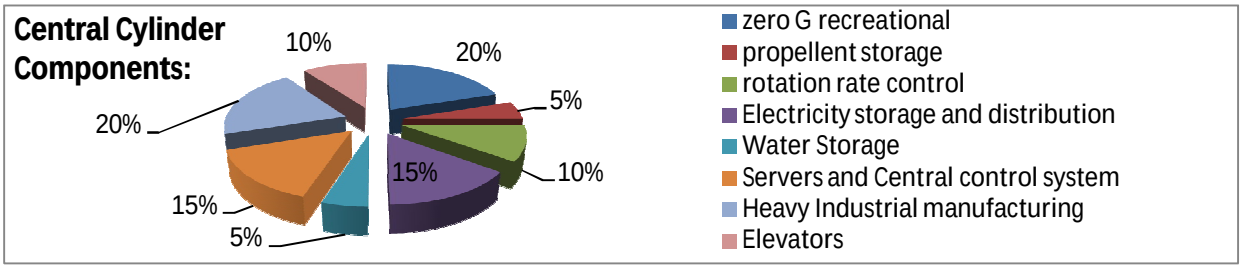
Isolation in Case of an Emergency: One of the reasons to make a separate torus for industry is to minimize the chance of damage to residential areas and loss of life. Besides that, residential torus is divided into four equal sections. At the joint of every two section will be an annular structure where there will be no infrastructure except road, tram tracks, transporting pipes and cables etc. In case of accident in any section, the infrastructure passing through these rings will folded up and two heavy gates, one on each side of the ring in each section, will close and isolate the sections. These specially designed air tight gates will be made up of Zetix[1] fiber and several layers of metals to increase their sturdiness and make them blast proof. Each section in torus will have sufficient food & water, and electricity to sustain life for at least a year if rescue or repair missions take too long. If major accident such as meteoroid hits Aresam and settlement is sure to be destroyed, people (trained beforehand by emergency drills) will be immediately transported to safe sections of torus before the sections are isolated. The isolated sections can be detached from each other and rocket boosters with the sections will be used to take them to a rescue point.

2.2

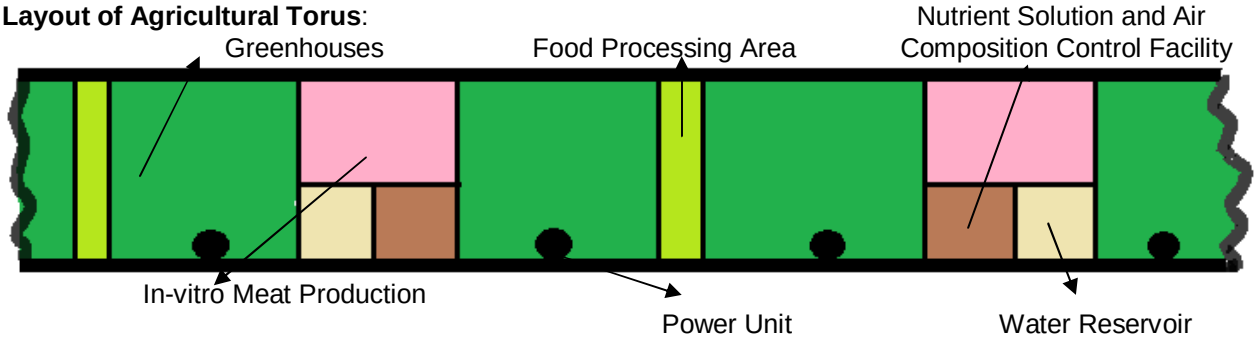
Part of Settlement	Surface Area/m2
Residential and Commercial	2, 750,000
Agricultural	1,525,000
Micro g Industrial	1,016,666.7
Zero g Industrial	508,333.3



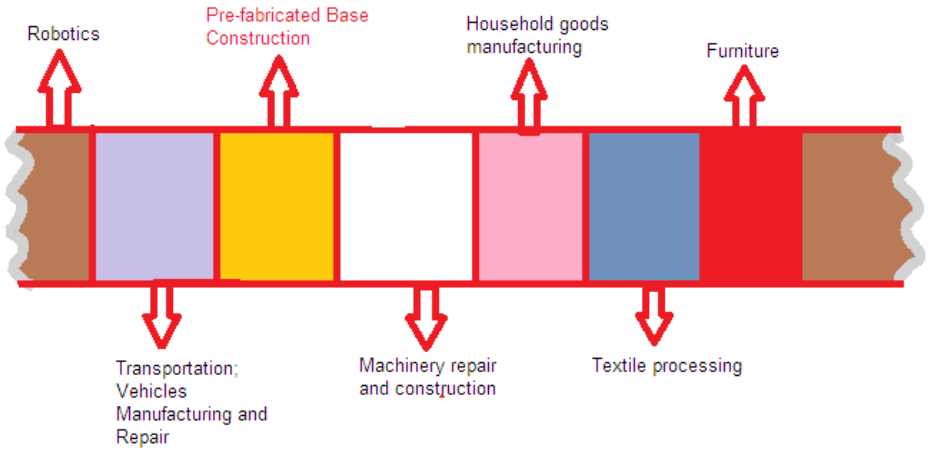




Layout of Agricultural Torus:



Layout of Industrial Torus



For layout and percentage allocation of residential torus refer to section 4.1 community design

2.3 Settlement Construction Sequence

Stage 1
The construction of the settlement begins with the arrival of construction ships that start building the upper platform, the main port area and the central cylinder of the settlement. As the central cylinder is built with all its elevator mechanisms, materials from the construction ships are transferred to the main storage area.

Stage 2
The construction ships start building of the four spokes for each of the three tori. Starting from the upper most spokes, the construction ships build the spokes in batches of four. Each of the spokes constructed have four elevators incorporated in it. One of these transportation elevators functions as mediums for cargo transfer to and from the residential torus while three of them are allocated for human transportation. This ratio is increased to 3 to 1 for both agricultural and industrial tori where human intervention is less.

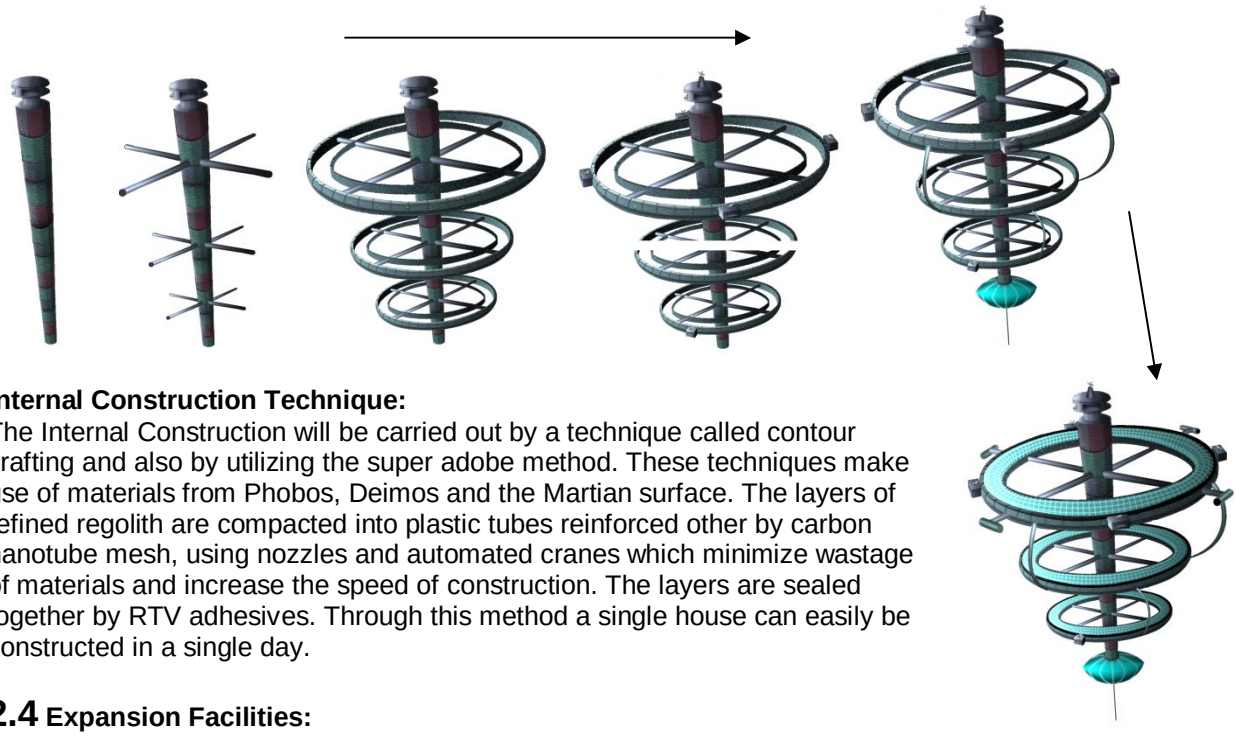
Stage 3
After the spokes are constructed, the inner most layer of each of the tori is constructed simultaneously. Then the outer most layers are constructed which consist of solar panel materials and radiators.

Stage 4
Four ports are constructed on the residential torus; one on the industrial torus and satellite communication systems is installed on the main port, also the rugby shaped component is constructed. Its full mechanism is described in section 7.The ion thrusters for rotation are also installed. The thrusters provide force to spin the settlement, to provide artificial gravity.

Stage 5
After the main skeleton of the settlement has been constructed, there are two direct connections constructed between the residential and agricultural tori and one connection is built between the agricultural and low g industrial torus. These direct connections are anchored elevators on both connected tori and enable rapid and easy transportation in the case of the central cylinder elevators being busy. The windows made of lead glass are also installed along with all the radiation protection mechanisms.

Stage 6
After the connections have been made, the ion thrusters are used to start the rotation of the settlement. The thrusters are located on the largest torus i.e. the residential torus and act as a force couple in order

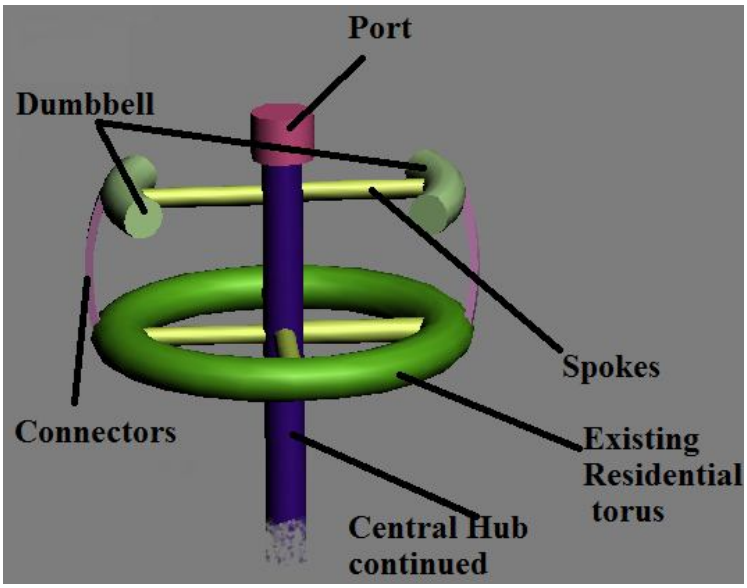
to produce a moment for rotation and as a result gravitation. As artificial gravity is initiated, the inner parts of the tori are completed one by one.



Internal Construction Technique:
The Internal Construction will be carried out by a technique called contour crafting and also by utilizing the super adobe method. These techniques make use of materials from Phobos, Deimos and the Martian surface. The layers of refined regolith are compacted into plastic tubes reinforced other by carbon nanotube mesh, using nozzles and automated cranes which minimize wastage of materials and increase the speed of construction. The layers are sealed together by RTV adhesives. Through this method a single house can easily be constructed in a single day.

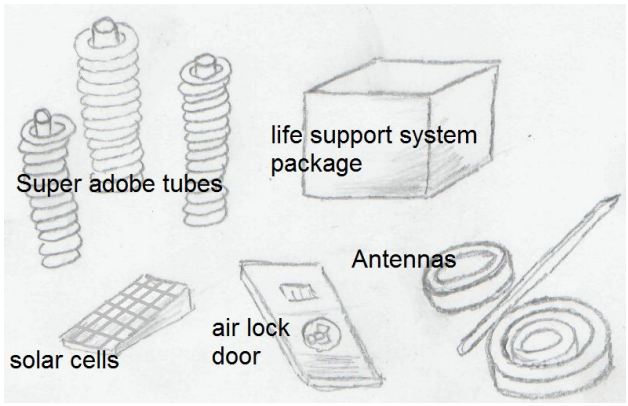
2.4 Expansion Facilities:

Aresam will offer extensive expansion facilities to handle the expected increment in passenger, Cargo and Resident facilities. The expansion will be started with the construction of a dumb-bell shaped component above the pre-existing residential torus. The central hub will also be extended and port will be installed at the new end, whereas existing ports will be slightly modified. This dumb-bell will be connected to the main residential torus through connecters and will be extended if needed and has the ability to be transformed into a complete torus identical to the primary residential torus. The expanded section will have its own docking ports which will also enable alterations to accommodate future space travel vehicles. The new component will be at a distance from the pre-existing residential torus so that it does not block the view of space and any sunlight from reaching the primary torus. This mechanism has multiple inherent benefits:

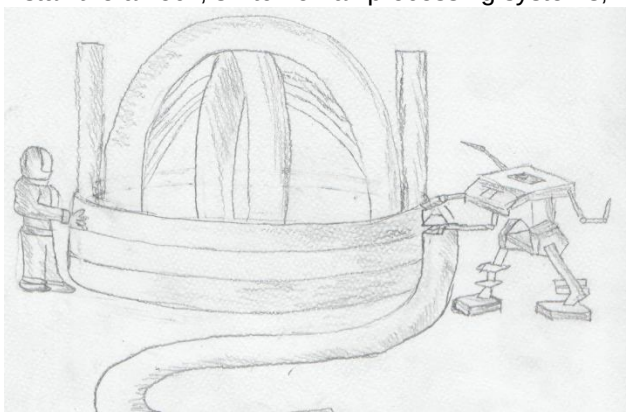


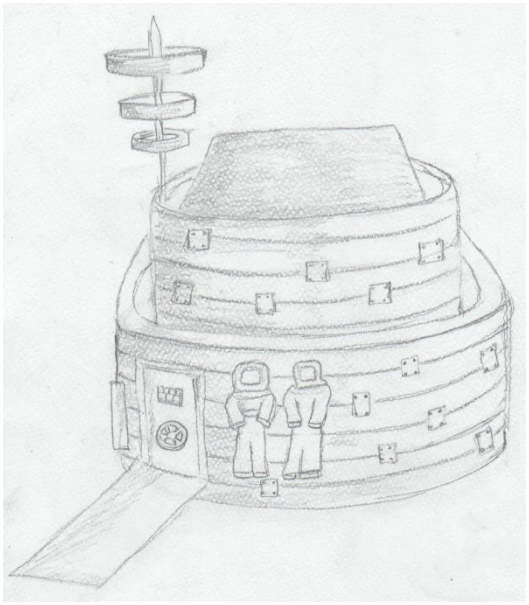
1: ease of expansion and lack of interference with existing infrastructure.
2: secure interface(s) with existing components
3: Cost effective

2.5 Prefabricated Base



The oval shaped prefabricated base would be made up of superadobe tubes that will be made my compacting soil of Phobos/Deimos in carbon nanotube reinforced plastic tubes. Dirt will provide strength under compression and carbon nanotube will be strong under tension.This base will be assembled by four space suited persons and two robots. Superadobe tubes will be stacked upon each other and joined by bolts and RTV adhesives for instant adhesion. The space suited persons, with the help of robots assemble the base, install the airlock, switch on all processing systems,





erect and position the solar panels according to the computer calculations of latitude and longitude where the base has landed. At the end, a ladder is bolted to the main base area and the solar panels are connected to the power generating systems inside the base. Then, the space suited astronauts enter the base to configure and check all systems manually and switch them on for operation. The base would require 350m (6 inch thick) of superadobe tubes which will acquire a volume of 53 metre cube.

3.1.1 Orbital Location

Aresam will be in a geostationary orbit from the Mars' equator. Reasons: It will ease in the operation of mass drivers; and deployment of shuttles between Mars and settlement by decreasing the time of travel, reducing technicalities of launching to variable stations on surface of Mars. Aresam's distance to Mars will be such that it will be placed between Phobos and Diemos, hence ensuring easy and quick access to both the moons. Cost of station keep and orbital decay will be very low.

Formula used: $R^3=GM/w^2$ where G is gravitational constant,M is mass of Mars and w is angular velocity of Mars rotation.

Quantity	Description	Value
R	Distance of settlement from centre of Mars	22049km
H	Altitude above Martian surface	17053km
V	Orbital Speed	1.56km/s
Orbital inclination	Angle between Mars equator and settlements orbit	0^o

3.1.2 Material and Equipment

Materials for construction see 2.1

Materials For Operations	Source	Use
Oxygen	Electrolysis of water from Mars/Phobos/Deimos	For respiration
Water	Mars/Phobos/Deimos	Drinking,industrial uses etc.
Nitrogen	Earth	Atmospheric diluent
Hydrogen	Electrolysis of water from Mars/Phobos/Deimos	Synthesis of polymers, fuel for rockets
Organic compounds	Phobos/Deimos/C-Asteroids	Carbon source, nutrients for plants

Name of Equipment	Source	Use
Ion engine rockets	Bellevistat/Columbiat	**To Transport Engineers and Scientists to construction site**
Heavy Lift Launch Vehicle	Bellevistat	**To transport heavy equipment and material from existing settlement or from mining base at Phobos and Deimos to Aresam**
Primary Construction Machinery	Bellevistat/Columbiat	**For construction of major hull components**
Robots	Earth/Columbiat/Bellevistat	**Construction, mining and surface exploration during initial phases**
Deployable Mining Base Modules	Bellevistat/Alexandriat /Columbiat	**To construct mining bases at Phobos, Deimos and Mars**
Mass Driver	Bellevistat	**To transport materials from Phobos, Deimos and mars to Aresam**
Mass Catcher	Bellevistat	**To catch materials launched from Mass Driver**
Central Hub Framework	Bellevistat/Columbiat	**To provide a base to initiate construction**
Super Computers and computer components	Earth/Bellevistat/Columbiat	**High technology computers built by engineers on earth and bellevistat to carry out operations of settlements. ref 5.2**
Docking Port	Bellevistat	**To allow spaceships and cargoships to land on Aresam during construction**
DSN antennas and wimax routers	Columbiat/Bellevistat	**To allow for communication in initial construction phases**

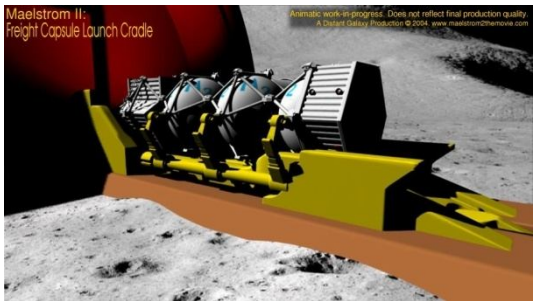
Solar cells	Phobos/Deimos/Bellevista t/Alaskol	**For electricity generation**
Spacesuits	Bellevistat/Earth	**For extra-vehicular activities**
Suitlocks	Bellevistat/Alexandriat	**For exiting pressurized volumes**
Electrical wires	Phobos/Deimos/Moon	**For electricity distribution**
Fibre optics	**Phobos/Deimos**	**For internal communication**

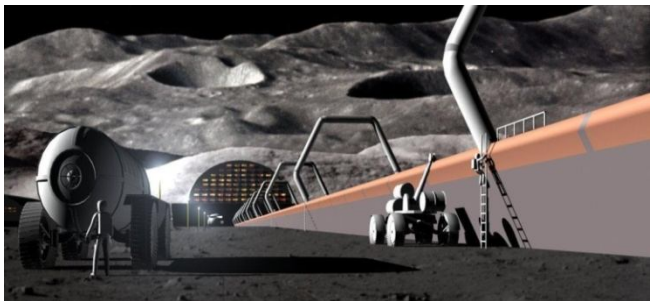
3.1.3 Transport:

Heavy Lift Launch Vehicles (HLLVs): HLLVs will be used to transport heavy payloads from earth to existing space settlements e.g. Columbiat, Alaskol. They have advantage of high thrust which enables them to escape earth's gravity and atmosphere. But due to large reactant mass requirement, these reusable vehicles will transport cargo and passenger modules only to existing settlements where these payloads will be loaded into ion engine powered rockets. Space X Falcon 9 Heavy, a reusable HLLV will be used for this purpose space.skyrocket.de/doc_lau/falcon-9.htm

Ion Thruster Rockets: Ion engines uses ion thruster (a form of electric propulsion) propulsion that creates thrust by accelerating ions. They are very mass-efficient and suitable for providing low thrust for travelling over large distances. They will be used to transport cargo and passengers from existing settlements where cost of manufacturing is lower than earth, no air resistance and negligible gravity, to Aresam and Mars orbit.

Mass Driverand Catcher: Mass Drivers will be used to transport construction material over short distances from Phobos and Diemos to Aresam. In ground-based Mass Drivers, small payloads are accelerated in a special bucket containing super conducting coil magnets. Buckets containing tens of kilograms of compacted lunar material will be magnetically levitated and accelerated up to 30 g by a linear, synchronous electric motor to achieve escape velocity. These buckets will be collected by mobile Mass Catchers near Aresam. These Catchers can then be taken into Aresam and buckets can be unloaded.





(http://www.distant-galaxy.com/maelstrom2/MaelstromIISynopsis30Aug2K7.html)

3.2 Atmosphere

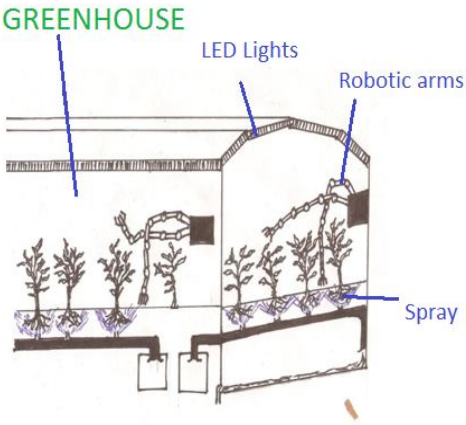
Gases	Percentage			Pressure(kPa)			Quantity(moles)		
	Residen.	Agricult.	Industr.	Residen.	Agricult.	Industr.	Residen.	Agricult.	Industr.
Nitrogen	66.7	66.7	66.7	50	50	50	1.1E10	8.2E9	7.7E9
Oxygen	30.3	26.7	30.3	22.7	20	22.7	5.1E9	3.3E9	3.5E9
Carbon Dioxide	0.4	4	0.4	0.3	3	0.3	6.7E7	4.9E8	4.6E7
Water Vapour	1.3	1.3	1.3	1	1	1	2.2E8	1.6E8	1.5E8
Other	1.3	1.3	1.3	1	1	1	2.2E8	1.6E8	1.5E8
Total	100	100	100	75	75	75	1.66E10	1.23E10	1.15E10

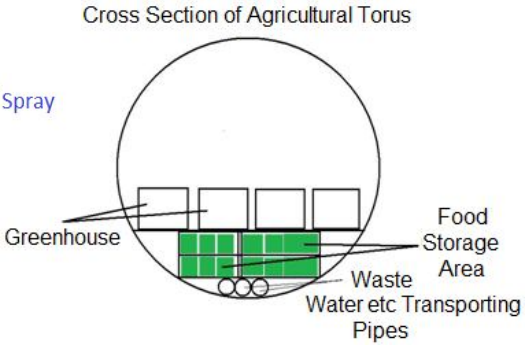
- Air pressure is kept low to decrease structural mass and cost; but it is sufficiently high to allow transmission of sound at large distances and to prevent danger of fire by diluting air with nitrogen.
- Agricultural torus has higher CO_2 percentage to allow faster rates of photosynthesis.
- All the industrial, operational and power generation, distribution facilities and radiation absorbed from space will generate large amounts of heat in Aresam , excess heat will be radiated in space using variable conductance heat pipes and radiators.
- Dehumidifiers will condense water vapors by cooling and then restore temperature to normal by heating. Humidity level will be 50% and temperature will be 25^{o}C.
- In Air Purification Chamber, CO_2 and other acidic gases will be removed by ion exchange resin scrubbers. Activated charcoal filters will remove foul smells, and particle filters will remove particulates and aerosols. UV radiation will be used to eradicate microbes and bacteria in air.Carbon dioxide will be reclaimed from scrubbers for agricultural.
- Oxygen will be produced from electrolysis of water from Mars. Later it will be produced by photosynthesis in agricultural torus.
- Wind will be produced by pressure differences in different areas by ventilators.
- Weather parks will be made in the settlement (to prevent structural degradation of whole settlement) where people can enjoy varied weather patterns e.g. rain and snowfall through cloud seeding.

FOOD PRODUCTION

Growing	In the agricultural torus, aeroponics will be used to grow crops in greenhouses. Each greenhouse will have mechanism to optimize the growth of a certain crop e.g. LEDs and shutters to controls light, temperature and humidity regulator suitable to each crop. Meat (fish,chicken,beef) will be grown by providing a suitable culture to muscle cells and allowing them to grow into in-vitro meat.
Harvesting	Automated arms and robots as shown in the diagram will carry out harvesting, initial processing of harvested plants e.g. washing, choping off extraneous parts, and collection.
Storing and Packaging	Food will be dried and packed by vacuum packing method. Semi-processed food seed will be stored in specialized compartments under projected floors of agricultural and residential tori at low temperatures.
Delivery and selling	Conveyor belts will be used to bring food from basement storage areas to ground. Elevators in the connectors will transport food from agricultural torus to residential torus.Food will be sold at retail outlets and restaurants.Residents can also place orders themselves or by automated system for purchase of food from warehouses, which will then be transported by robots.

Energy	**3000 cal**
Carbohydrate	**470g**
Fat	**300g**
Protein	**60g**
Fiber	**25g**
Sodium	**2.4g**
Potassium	**4.7g**
Minerals	**6g**
Vitamins	**100mg**





Total	**870g**

Daily Food production for 20500 people = 18000tons. Annual food production = 6500 tons

Storage:

The Food Storage Facility will store 6500 tons of food to last for one year in a volume of 11000m^3 (at 600kg/m^3). Storage of food to balance demand and supply will be done in agricultural torus whereas most of the food storage for emergency purposes will be done in residential torus in case if any residential section has to be isolated from the settlement.High energy drinks and tablets will also be stored as a precaution for extreme unforeseen problems. A seed bank will be made which will store seeds at a very low temperature to be used if currently used seeds are genetically contaminated or infected.Imported or manufactured commodities needed for daily life e.g. nitrogen, robots, furniture etc will be stored in central hub as it is near industries and ports.

3.2.3 Electricity Generation

Primary Source: Multi-junction photovoltaic cells will be used for their high efficiency (upto 40%) as they absorb nearly entire solar spectrum by using different band gap materials . Solar cells will be mounted on all the external surfaces of Aresam. Transparent solar cells will be mounted on the lead glass portions to prevent hindrance to light transmission. Transparent panels will also be used on most of the residential as well as commercial buildings to ensure maximum energy output while preventing aesthetic displeasure. After the establishment of Aresam for some years solar power satellites will be made at Aresam and sent in mars orbit which will harness light energy and transfer it back to Aresam as radio waves.

Use	Amount required(MW)
Residential (2kW/person)	41
Commercial	60
Industrial	190
Agricultural	138
Other(e.g. plasma shielding, elevators etc)	140
Total	569

Solar power available on Mars(1366/d^2)	**590W**
Productivity of Solar cells(40% efficient)	235W
Area covered with solar cells required	2.4E6m^2

Secondary Sources:

Bicycle dynamo power	**Bicycle used for internal transportation by residents will produce electricity by dynamo and store it in batteries and these batteries will be discharged at public bicycles stands to supplement power requirement.**
Plasma chambers	The plasma gasification chambers used in solid waste management also produces a great amount of energy which can be used for the operation of any desirable electric appliance.

Power distribution: DC supply from solar panels converted to AC by inverters. Multi-wall carbon nanotube superconducting wires will be used for transmission at room temperature. Main Grid System will step up the voltage before transmitting to the torii, in each torus the voltage will be stepped down by Grid stations for safe use. The main storage regions will be located in the central hub using sodium sulfur (NaS) batteries; NaS batteries are cheaper than other batteries,90% efficient and already being used in space. Besides that, each home or office however will have its separate small dc power storage unit in the basement.

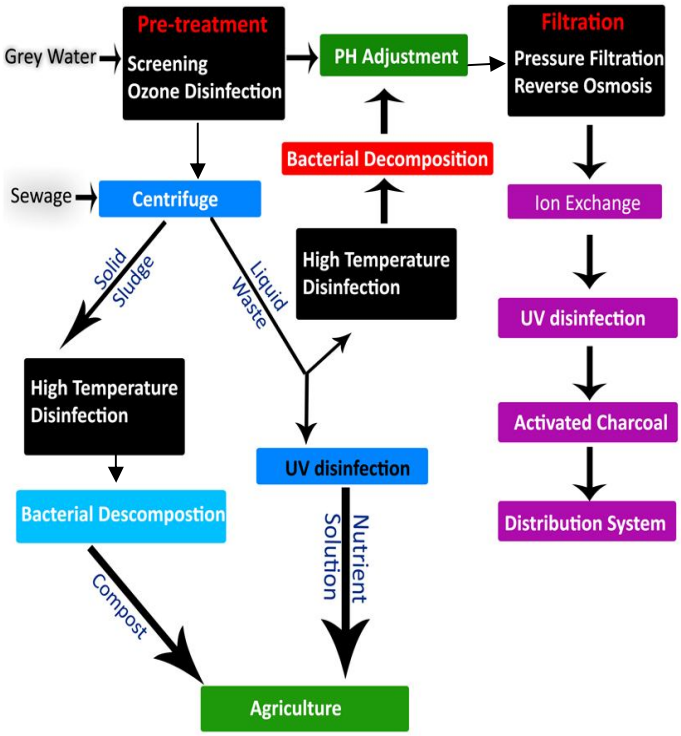
Water Management

Acquisition and Delivery:

Water will be extracted from polar ice caps of Mars and Martian regolith by evaporating water and condensing it. Water will be transported to construction site by large tanks propelled by ion thrusters.

Use	Amount (liters/day)
Residential (20 liters per person)	410000
Industrial	400000
Agricultural	300000
Loss (2%)	25000
Other	100000
Total	1235000
Annual requirement (365*25000+1235000)	9125000

There will be 4 large reservoirs () of water in residential torus (100000litres each). Each community will have its own sub-reservoir which will receive water from main reservoir. From these sub-reservoirs (10000litres each), water will be distributed to individual units for use. Agricultural torus will have two large reservoirs (200000 liters each) of water adjacent with each Nutrient Solution processing facility. Water to be used in Industrial Torus and Central axle will be stored in reservoirs in central axle. Water will be transported in tori through pipelines beneath projected floors.



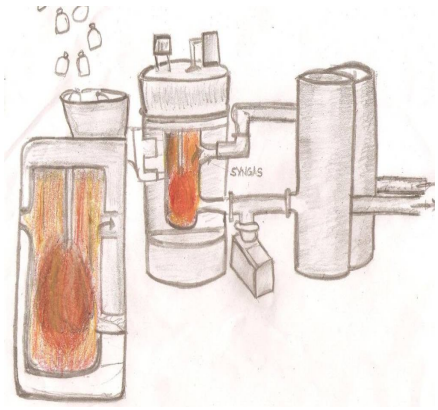
3.2.5 WASTE MANAGEMENT:

Small specialized portals installed In houses and large dumping buckets in industries will be connected to a system of underground pipes where suctions force will be present at different times due to suckers installed at different intervals. These pipes will take the waste to the recycling facility in industrial zone of central hub.

Waste Water:

Sewage will be treated as shown in the figure in order to obtain nitrogenous compost and feedstock for fertilizers. Industrial waste water will be recycled using wet oxidation technique as it is a complete process in itself doesn't require further treatment of water.

Solid Waste:



Metallic waste will be removed using magnetic separators and aluminum magnets. Glass would be removed using optical sorting. Thermoplastic polymers would be the first preference in polymers' use as they will be easily recycled. Rest of the waste, household or industrial, will be recycled by plasma gasification chamber. This is a self sustaining process and can provide surplus electrical energy to settlement.

Internal Communications:

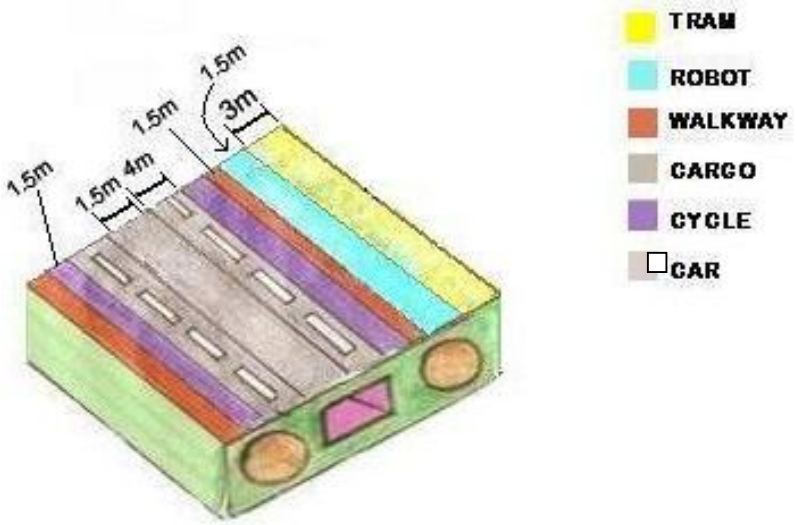
Technology	Purpose	Equipment
Wimax	High speed wireless transmission of data	Wimax base stations,handsets,usb dongles, routers,MIDs (installed in all robots and vehicles)
Fibre optics	Transmission of data where transmission is difficult due to obstacles, e.g. wall between two tori	Fibre optic cables

External Communications:

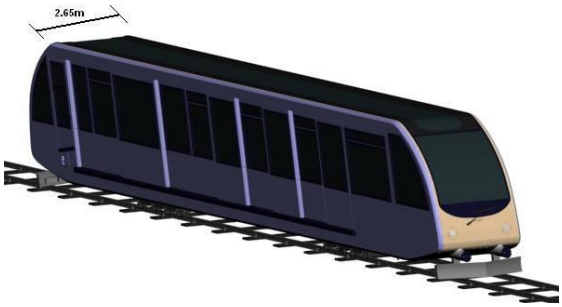
Technology	Purpose	Equipment
Earth orbit – mars orbit laser link	High bandwidth, data Transmission During line of sight periods.	Laser generator, optical telescopes and amplifiers
Radio wave [Ka(32 GHz) – X (8 GHz)] bands Deep space networks.	Communication between Aresam, Earth and different settlements.	DSN antenna

Earth Mars Communication: To ensure constant communication link between Earth and Aresam, two primary systems will be used:
1 - Earth-Mars Laser Link: This high bandwidth data transmission system will primarily be utilized when Aresam is in direct line of sight of Earth.
2 - Ka-X band: Although this link will be in continuous connection with Aresam, it will gain primary importance at times when the sun or other celestial bodies (Moon, Diemos, asteroids etc) disturb the laser link. This link will be established through Relay Satellites at Earth-Sun L4 and L5 points to satellites in lissajous orbits around Mars-Sun L1 and L2 points, which relay the signals to Aresam. This system has the inherent advantage of covering ~ 99% of mars at any time … due to distance between mars and Aresam the connection of these satellites with Aresam will be continuous.

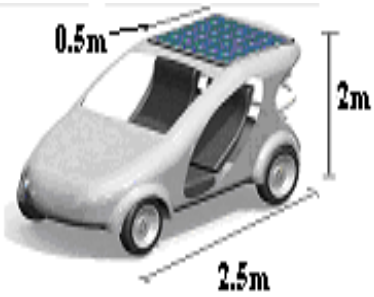
INTERNAL TRANSPORT:
The diagram below shows the routes to be followed by different vehicles:



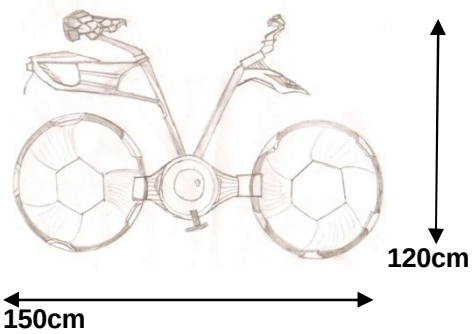
1. Trams (20m in length)will be used for transportation of a large number of people within the residential torus.

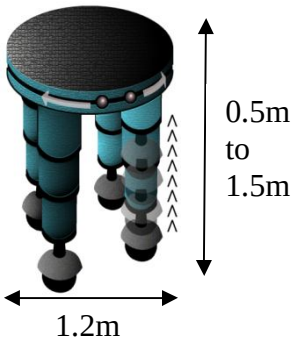


2. Electrically powered cars used by permanent residents.



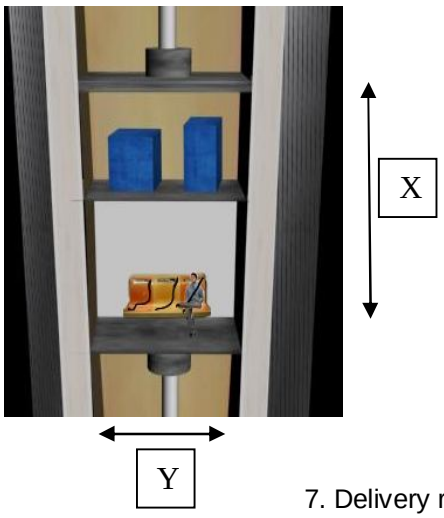
3. bicycles, which have a mechanical to electrical energy converter, used to move short distances.





5. Cargo robots used to transport cargo.

6. Elevators used in spokes and central hub for inter-torii transportation. These have seat belts attached to the seats and the walls have a layer of vinyl (to reduce the effect impact if collision occurs).it is also used to transport cargo.



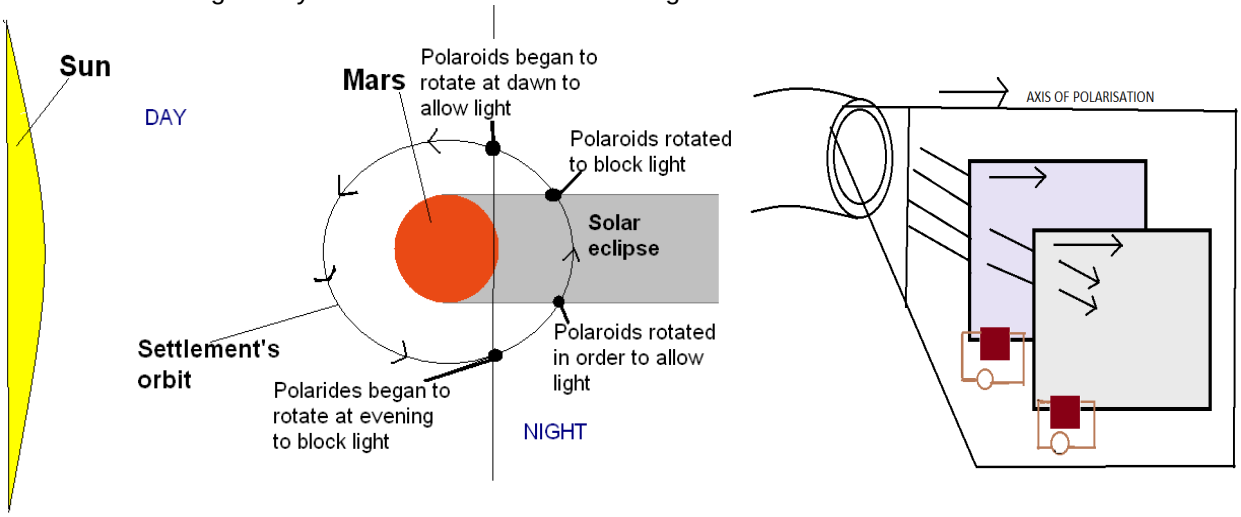
x: 15m, y: 5m

7. Delivery robots will also be used. They will have a box in them to hold items.
50 x 120 cm

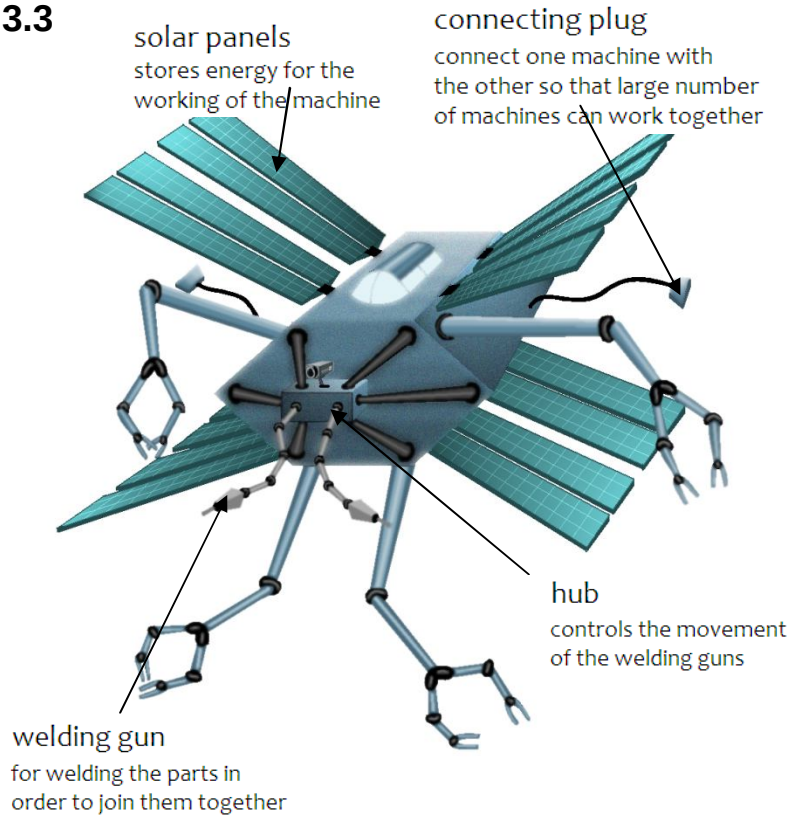
Day and Night Cycle Provision

Natural day and night cycle cannot be provided because of large variations in time of eclipse behind Mars, and partial shadow on settlement due to rotation of settlement. Two layers of Polaroid sheets will

be attached to the windows to control the amount of light. One layer will be fixed and sheets in other will be rotated by motors.Light will not pass through Polaroid sheets when transmission orientations of both sheets are at right anlges. The day/night cycle is designed to allow resident to have a view of outer space and sky at night during eclipse.To account for variation in light reaching inside the settlement due to rotation, high intensity gas discharge lamps, Metal-Halide lamps giving 100lumen/watt will be used to simulate artificial light. Day will consist of 13 hours and night will consist of 11 hours 40 min.



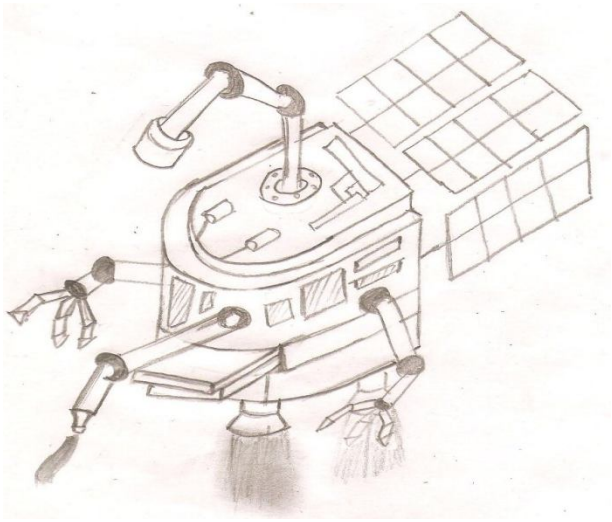
3.3



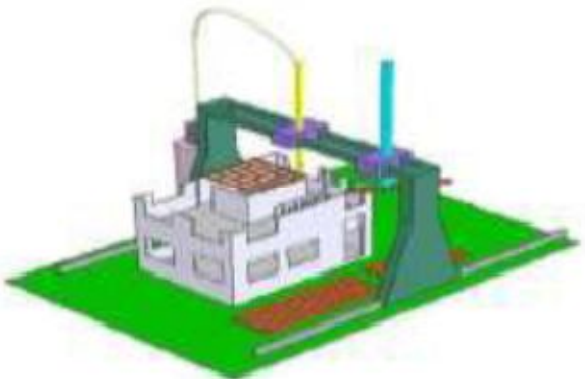
Constructex will serve as the primary construction and coordination machine between Omni eye, earth and other robots.
Its four robotic arms will hold and arrange large structural blocks in a precise location prior to welding together
After the blocks are arranged the two welding arms will arc weld the blocks together
The supervision bay will carry sophisticated intelligent cameras and processing computers, ensuring coordinated and accurate actions.
Connecting plugs on both sides will allow the machines to connect with similar machines and attain an assembly line configuration
Constructex will be driven by plasma rockets Its belly will act as material storage area It can accommodate human controllers if needed.

KEVOT

- Kevlar will be loaded in raw shape
- 1 mm thick sheets will be produced.
- The nozzle will spread glue
- Robotic arms will hold it high and fix it on the torus frame.
- Pressor will press it to ensure the proper placement of kevlar.



Contour Crafter

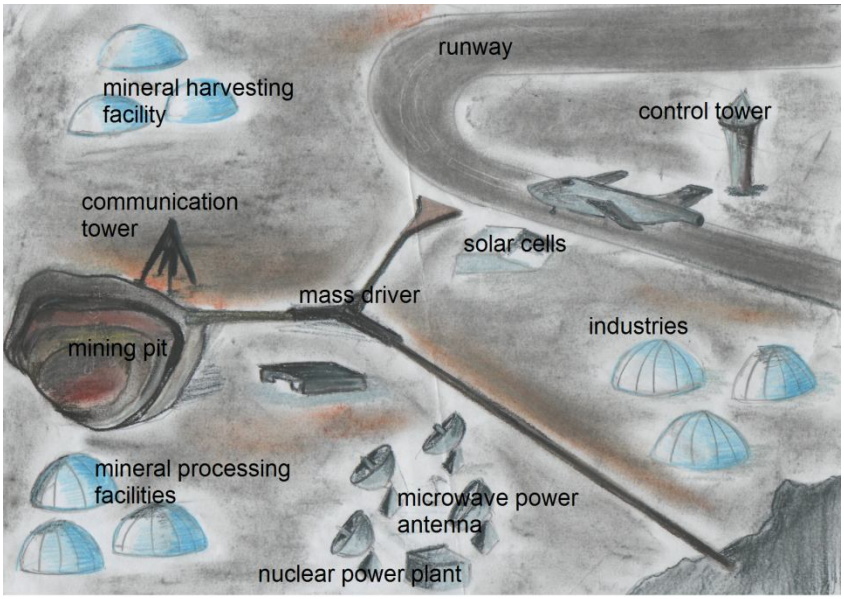


This automated system will use prefabricated materials to rapidly and cost effectively produce housing and building construction

3.4

Phobos and Deimos Mining Base :

Operations:



First of all, modules from Bellevistat or Earth will be sent to construct mining base on Phobos and/or Deimos to tap the minerals available for construction and use in Aresam after construction. These modules, scientists, engineers, basic construction material for base, construction machineries and mining equipments (robots, drill, excavators etc) will be transported by reusable HLLVs and ion thruster rockets. Mining robots (called Mega Miner) will be classified into two categories: Deep miners and shallow miners. Deep miners will be required to drill deep beneath regolith or mine in underground tunnel/adit tunnels. These will be equipped with lager and harder drills, excavating claws, scoopers, explosives and a cargo space to transport minerals. Deep miners in tunnels will have Radio isotopic Thermal Generators with backup batteries as opposed to deep miners on surface which will have solar panels with backup batteries. Shallow miners will have smaller drill, but giant claws

and scoopers to collect regolith and other minerals found on surface (strip mining), and cargo space. There will also be exploring robots that will have spectroscopy tools and ultrasound equipment for surveying seams underground, testing equipment for analysis of soil. They will communicate and interact with Mega miners and indicate them the positions of minerals layers. All robots will be navigated from mining base through GPS system. Miners will be anchored with grapples in the milli-g gravity of Phobos and Deimos. Large canopies will also be used as ores will be flying off. Base will have a landing/takeoff runway for HLLVs. Processed minerals will be launched from a Mass Driver in the base to Mass Catchers in the construction site or Aresam after construction. HLLVs will also be used for transportation of large payloads. Before construction of Aresam, mining base will receive supplies from Columbiat/Alexandriat/Bellevistat. After construction, it will be supported by operations on Aresam. Power will be supplied to base by solar panels and which will be complemented with nuclear energy during unavailability of sunlight.

Examples of refining processes in Mining Base:

- Different minerals in regolith will be separated by electrostatic separation (beneficiation) and concentrated from powder form into large lumps by sintering.
- Olivine found on Phobos/Deimos will be processed by fluoride extraction to obtain nickel, iron and silicon(from silicate).This process will use potassium fluoride catalyst brought from earth.
- Glass and glass fiber will be made from silicon by mixing with boric oxide in plasma wound furnaces.
- Carbon dioxide will be obtained from regolith by thermal dehydration. Sabatier reaction will be used to convert CO_2 to methane. Alkenes can be formed from methane by dehydration and hence polymers can be made by addition reaction.
- Carbon nanotubes will be made by highly efficient laser ablation method.
- Solar cells will be made using plasma reduction and deposition.
- Hydrogen and Oxygen gas will be produced by electrolysis of water. These gases can be used as propellants for HLLVs as well as for Aresam atmosphere (oxygen) and industry(hydrogen).
- Regolith will be packed in carbon nanotube reinforced mesh encased tubings by robots and automated machines.
- Organic compounds will be separated by fractional distillation.

3.5 Operations and Infrastructure of Prefabricated Base

Req. ment	Management Description and Sources	Quantity
Air	Nitrogen as diluents will be brought from Aresam as well as some oxygen for initial use. Then oxygen will be produce by devices called Elektron[1], which are currently being used in ISS. The Elektron will electrolyze water from Mars and condensate from dehumidifiers. The oxygen is vented into the cabin and the hydrogen is vented into space. An atmosphere monitoring system collects air and checks its composition. Lithium Hydroxide cartridges will remove carbon dioxide by scrubbing. All other gasses such as nitrogen will be recycled as they are. Humidity level will be controlled by dehumidifiers; air will be sterilized by UV light. There will be backup tanks for oxygen. Astronauts will use air tanks fitted in their spacesuit when they depart from base. Atmospheric pressure will be kept low but concentration of oxygen will be increased, this is primarily to reduce the risk of atmosphere loss when exiting the base and less structural mass(hence less strength) will be needed.	Oxygen=1.3kg*4(person)*30(day) =156kg Nitrogen=50% composition =156kg Loss=1 kg of air/day Total mass of air required =312+30=342kg
Food	Food will be provided in rations quite similar to those used by army e.g. C Ration. These ration will contain dehydrated food will be made ready to eat by adding even dirty water or urine[2]. Endosmosis of water through nano-membranes will allow 99.9%	Total mass of food =1.2kg*4(person)*30(days) =144kg

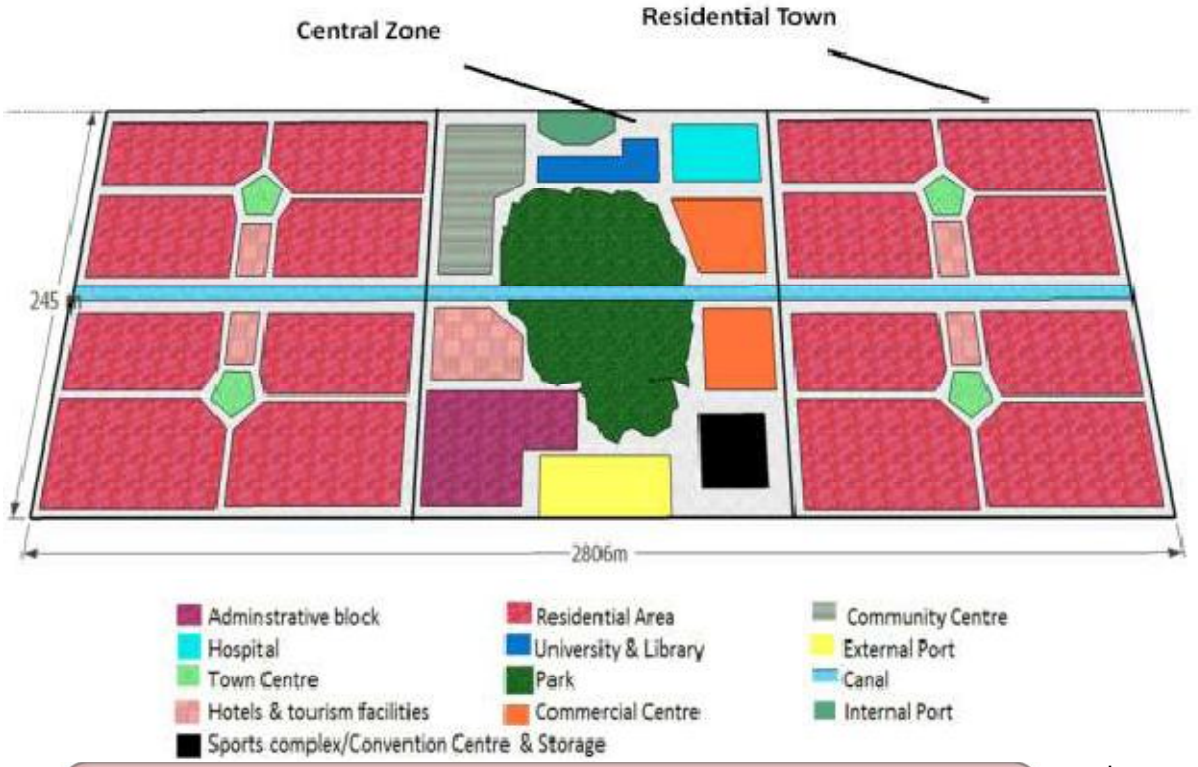
	pure water to reach dried food. This will decrease the mass of food needed to be transported and will keep food fresh for very long period of time. There will be a menu of rations with a multifarious range of food to prevent monotony and mal-nutrition.	One ration will provide 3600 calories
Power	Solar panel mounted on the top of base, will provide electricity for the base. There will be backup batteries and radioisotope thermoelectric generator to provide electricity during night.	Total energy consumption =1.1kW*30(days)*24(hours) =792kWh $5m^2$ of solar cells required Voltage supply= 28V DC
Water	Some of the water for initial use will be brought in tanks from Aresam whereas most of it will be obtained by heating permafrost soil of Mars in by heating in microwave ovens[3].Dehumidifiers will also recycle the water lost in air. Recycled water will be disinfected with UV lights and charcoal filters to adsorb organic chemicals that poison reverse osmosis membranes. Carbon nanotube membranes will be used in reverse osmosis for completion of water filtration.	Consumption per day =8litres*4(person)=32 litres Loss=2litre per day Total water required=32+60=92litres
Waste	Urine will be recyclyed. Wastes that won't be recycled e.g. blackwater, CO_2 scrubbers and other inorganic waste such as papers, plastics etc, will be compacted in galvanized steel can. This can will be totally leak proof and air tight to prevent.This can will later be taken back to Aresam for recycling as it is very necessary for Aresam to be self-sufficient in matter such nitrogen.	1.76 kg/person/day Carbon Dioxide 3.98 kg/person/day biological waste Total waste=690 kg
Heat radiation	Variable conductance heat pipes and radiators will be used to expel extra heat form base. Dehumidifiers will also act as temperature regulators	
Airlocks and Suitlocks	Airlock will be used for passage of automated equipment. For energy saving, suitlocks will be used by astronauts.	One airlock, four suitlocks

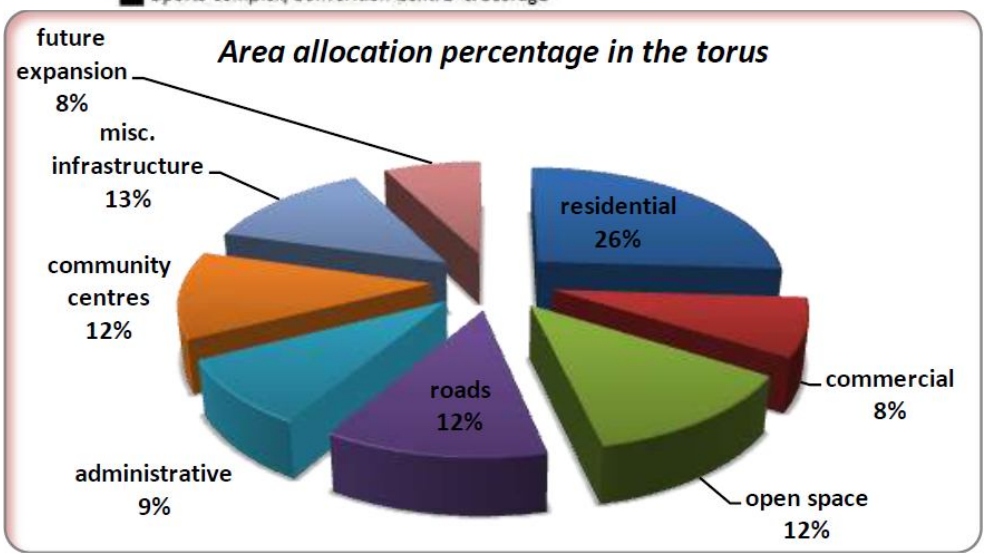
1-http://en.wikipedia.org/wiki/Elektron_(ISS)
2-http://news.bbc.co.uk/2/hi/americas/3915659.stm
3-http://www.moontoday.net/news/viewpr.html?pid=29440

4.1.1 Community Design

Aresam seeks to provide a blend of space age facilities and the homeliness of the earth. We have designed earth like communities with spacious residential designs while also incorporating unique facilities such as the views of mars and zero g entertainment. All this ensure that inhabitants can enjoy the excitement of living in a space settlement without feeling any sense of sadness of living far away from earth.

Place	Area ($m^{2)}$
Residential torus	2,750,000
Area of one sector	687,500





The diagram of one sector is shown above. Each sector contains 4 'residential towns' and 1 central zone reserved for commercial and administrative functions. The central zone has huge community centres containing recreational facilities for the public such as gymnasium, spa, arts gallery, theatre, and religious centres. A university with a digital library is also situated near the community centre. Land is also allocated for hospitals, sports complex and convention centre. Moreover, around the canal hotels for transient population are built accompanied by tourism attractions such as museums, galleries, and space memorabilia. Two ports – one connected to external torus for outer space travel and one inside for tram transportation – along with

two commercial centres containing offices, and super markets are also placed in the central zone. Every residential town will have localized and medium-scaled facilities. A pentagon shaped complex located at the heart of every residential town acts as the town centre. It contains a clinic, gym, bar, local market, religious centre (used as a convention centre), emergency response system (police and fire dept.), a theatre, a school and some play grounds. Residential complexes with varying designs surround the town centre. Moreover, a hotel and tourism facilities are also placed in each town.

4.1.2 Unique Features

Though Aresam will offer the standardized community facilities such as comfortable homes, natural sunlight(using mirrors), an organized community design, excellent health and education facilities, there are some features unique to Aresam. **Green Environment**: Instead of block style urban growth in the community, the residents will enjoy greenery induced environment everywhere. Aresam has a dual purpose central canal around the torus. The canal provides a refreshing view and water gauges placed underneath the canal floor also supply water to the vegetation planted alongside the canal and in the towns. Moreover, extensive green roofing is also done in most of the house types.In addition to the central park, small parks, playgrounds, and wide open sidewalks (12% open space and 12% area for roads) also provide ample plant cover.

Tourism Facilities: The major role of Aresam is to act as a port and a base for people travelling to/ from Mars to Earth and other settlements. In order to provide services to transient population, hotels are built in each residential town and central zones. For easy accessibility these are located near to ports as much as possible. Moreover, hotels provide luxurious housing according to the different needs of the customers, and all of them are built near the canal and community centres containing supermarkets, galleries, bars, museums and other recreational facilities. One more special feature is the stunning view of Mars from the residential settlement. All these facilities ensure that travellers enjoy their brief stay and make. Aresam a top tourist attraction.

4.1.3 List and Distribution of Consumables

List of consumables:

Name	Quantity(for whole settlement/year)
Food(vegetarian)	5500tons
Meat	1000 tons
Water	410000 litres
Beverages	31000 litres
Clothing	1230000 m
Toiletries	1000000kg
Electrical appliances	1200000 units
Stationary	500000kg
Office equipment	250000kg
Medicine	50000kg
Data volume	2000 terabytes
Furniture	750000 items

Distribution Method:

The goods will first be transported from the manufacturing sector and agricultural torus to supermarkets and warehouses in residential torus. Residents who wish to buy manually would visit these supermarkets or the vending machines which will be installed in various places throughout the residential torus. They can also be ordered from home using robots as delivery tools for convenience.
Consumables such as food items that are regularly consumed can also be replaced by an automated system. Residents, after consuming the item would simply enter the name of the food item in a computer and the quantity consumed. The computer system will automatically place order for that item when its stored quantity falls below a threshold. The ordered items will reach the consumer by delivery robots from warehouses within few hours of order. Residents can also place order for delivery of an item manually and have it delivered immediately. The residents will then be charged for their deliveries monthly.

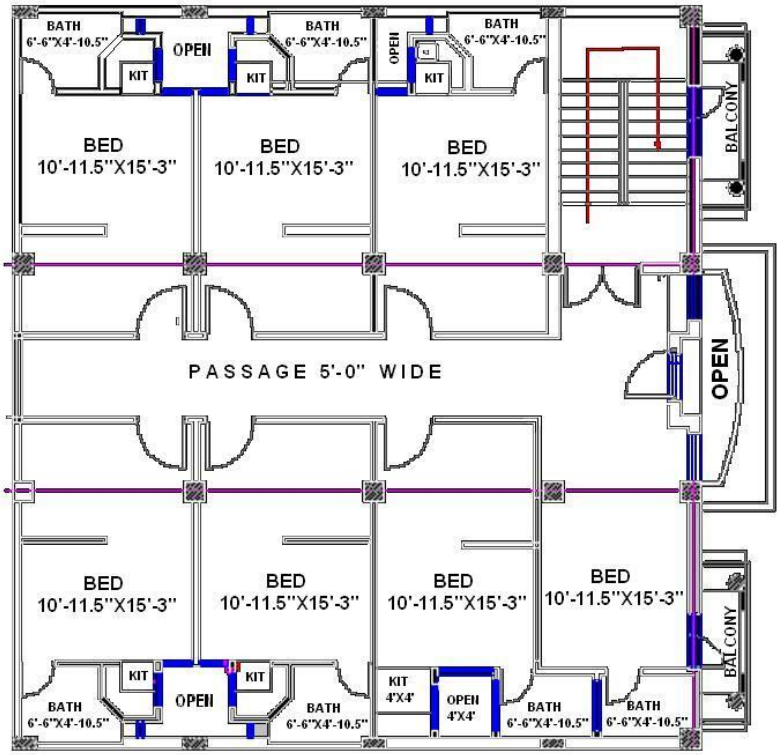
4.2 Residential Design

TYPE OF HOUSE	CAPACITY PERSON/ HOUSE	LEVELS	Area (square feet)	No. of houses	Total people
APPARTMENT BUILDING	18	4	2000	545	9810
COUPLE HOUSES	2	2	1032	3000	6000
FAMILY HOUSES	3-4	2	1500	200	600
DUPLEX HOMES	2-4	2	1700	3600	3600

Total Houses	**4945**
Total Area	6,444,400
People accommodated	20010

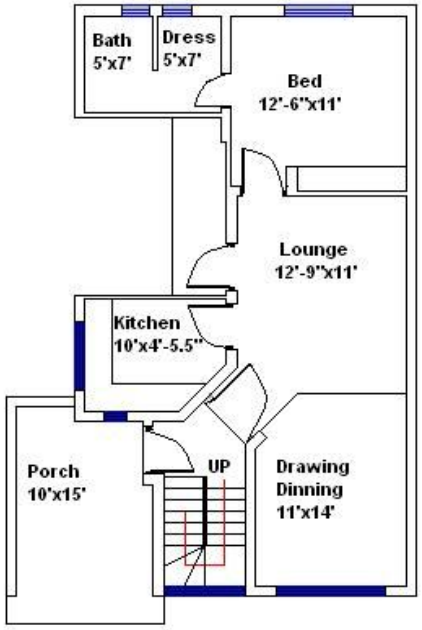
HOUSE DESIGNS:

1 APPARTMENTS: As about 58% of the aresam's population consists of single adults, so apartments have been build keeping in mind all of their needs. These apartments will consist of a sitting area near the entrance, a bedroom, a bath and a kitchen. A balcony is also made to give view of outer space.



DIMENSIONS[feet]: BED 10-11.5"x 15-3", BATH 6-6" x4-10.5", kitchen 4x4, passage 5 feet wide.
These Apartments will be part of an apartment building. This will consist of 3 floors, each floor comprises of 6 apartments, so a total of 18 apartments will be part of the building. All the apartments have a basement that can be used as parking

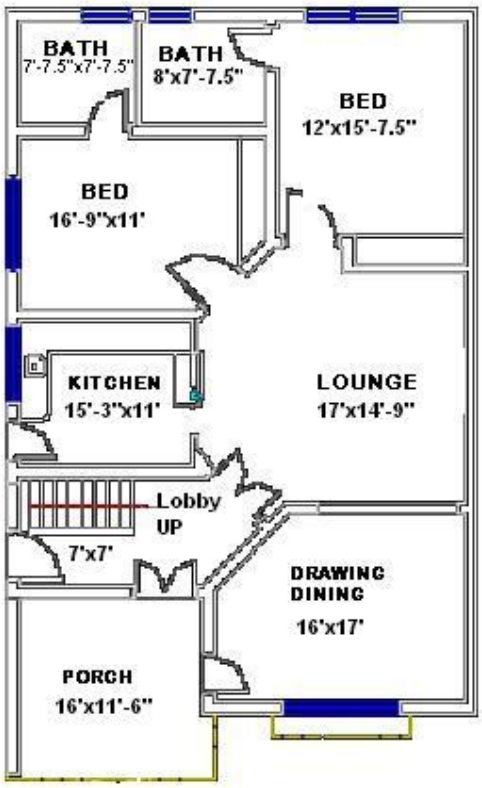
or as a storage area. The basement also contains the Emergency control room, which is connected to the town's central command system As many single people residing in the same building, this will give them more chance to interact with each other.



2. COUPLE HOUSES: These houses are designed keeping in mind the needs of the newly married adults. The house is single story, with an extra room on the first floor. If the couple has a child this can be used as the child's room. The roof is well designed so that the couple can enjoy the view of space. On the ground floor a patio has also been made to allow the light to enter and to give view of space.

DIMENSIONS [feet]: porch 10'x15', drawing dinning 11'x14', kitchen 10'x4'-5.5", lounge 12'-9"x11',bedroom 12'-6"x11', dress 5'x7', bath 5'x7'

3. FAMILY HOUSES: The family houses are designed so that the 2% children population can live easily with their parents. Keeping in mind the needs of family, this design has two bedrooms in the ground floor. The upper floor has 1 bedroom (attach bath), a study room and a sitting area which has glass roof to allow the beautiful view of space.



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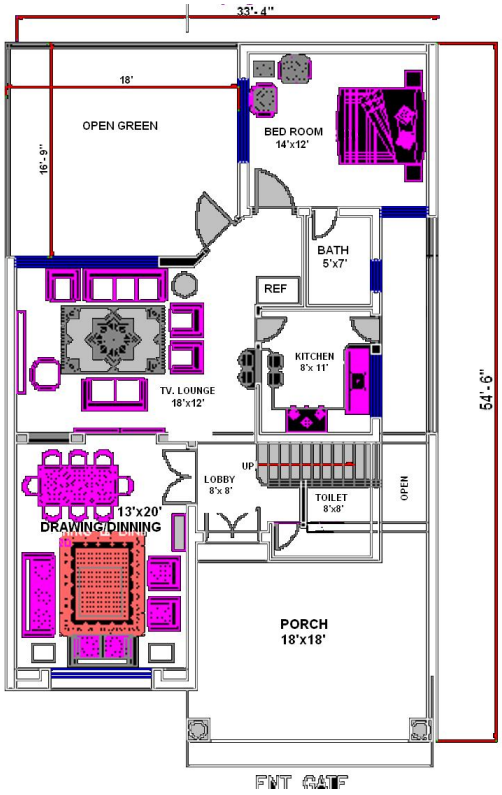
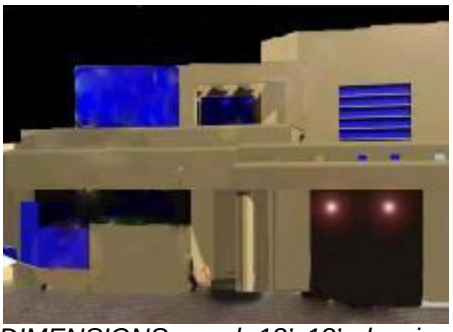
DIMENSIONS: porch 16x11-6", drawing-dinning 16'x17', lobby 7'x7',lounge 17'x14'-9",kitchen 15'-3"x11', bed(on left) 16'-9"x11' attach bath 7'-7.5"x7'-7.5",bed(on right) 12'x15'-7.2" attach bath 8'x7'-7.5"

4. DUPLEX HOMES: These houses are double storied, containing 1 bedroom in the ground floor and 1 bedroom on the upper floor. The ground floor will have an open area, which will have a glass roof to allow light to enter and to enable a perfect view of space above. On the upper floor a room is made totally of glass, this will allow max amount of natural light and a view of space





DIMENSIONS: porch 18'x18', drawing dinning 13'x20', lobby 8'x8', toilet 6'x6', kitchen 8'x11', lounge 18'x12',open 18'x16'-9", bed room 14'x12'

FURNITURE:

Furniture will be made of plastics rather than wood. To make plastics the raw materials as Carbon and hydrogen will be taken from phobos and/or diemos. Furniture can also be made of steal or iron, as we can take iron from Mars, Phobos and Diemos.

To join items RTV adhesives be used instead of screws or nails. These raw materials required can be brought from phobos and diemos.
More technical machinery needed can be brought from earth or bellevistat.

4.2.2 House Amenities

All these homes have some common features briefly mentioned below:

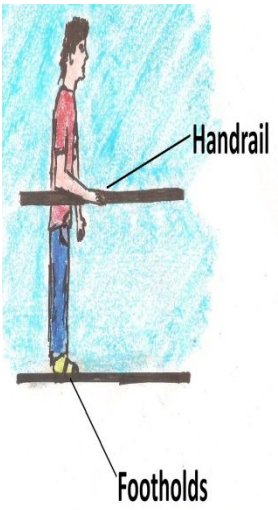
Green Roofing: Intensive (low profile) green roofing would be used in couple house, family houses and duplex homes. Whereas extensive (high profile) green roofing would be used in apartment buildings. Solar powered active irrigation systems, with a high quality waterproof membrane, would be used too. Green Roofing would serve various purpose various advantages superb energy efficiency, increase in the building's aesthetic appearance, and re oxygenation of air.

Spacious living: All our homes are similar in shape to those found on earth to ensure that inhabitants can easily adapt to the surroundings. All houses are designed to have minimum heat loss, automated temperature and humidity control, and maximum utilization of space. The rooms have high-definition audio and video systems, household robots, large windows, and spacious rooms. To increase security and privacy, all rooms are sound proofed, and apartments have digital key, biometric and password entrance.

Uniqueness: Aresam recognizes that like on earth, individuals have the right to choose homes of their own liking. So a person can build his own home design if he does not wish to live in one of the 4 standard residential designs. However, the plan, house area and building procedure must be approved from the municipal council beforehand. Moreover, the interior is entirely up to the choice of the resident. This ensures that the community life does not become stagnant, but it grows and expands according to personal choices.

4.3
MOVING IN LOW g AREAS:

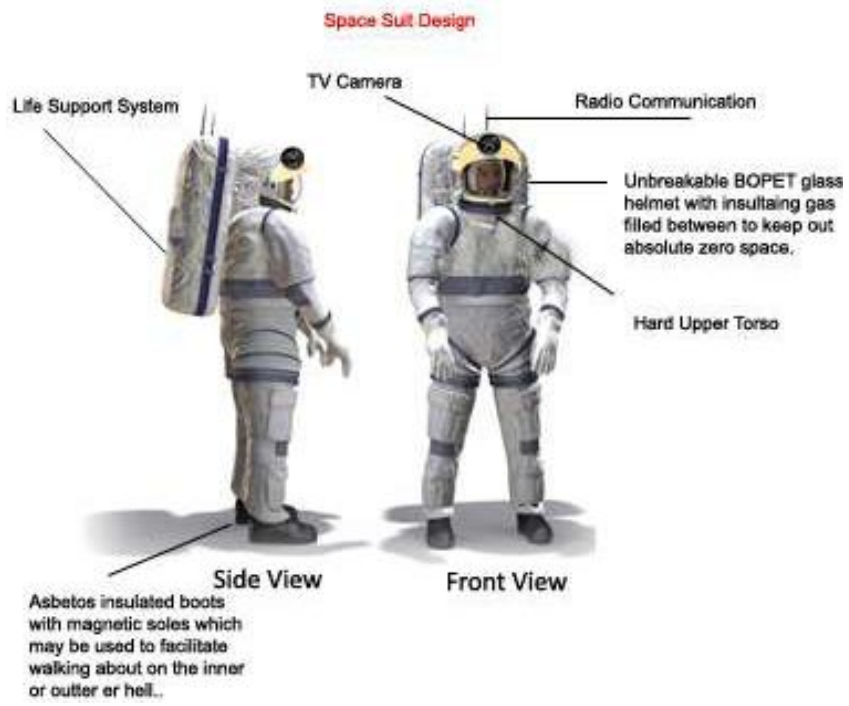
Type of support	Advantages
Moving platform	Allows easy access to remote parts of the agricultural area.
Control panel	Allows the user of the platform to steer his way through the terrain.
Handrails and magnetic boots	The magnetic boots hold the feet of the user in position so that he/she does not fly off. Handrails provide added supports to the upper part of the body, so that it does not feel weightless.
Magnetic Skateboards	These will be used as alternative to magnetic boots.

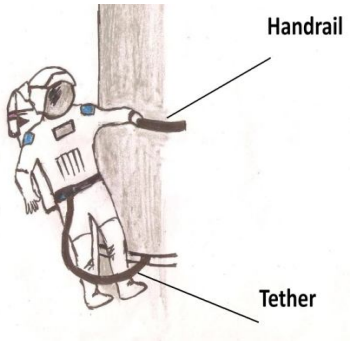


Elevators will take people through the spokes from any torus to the central hub and within central hub. Special cages and shoulder support will be present in elevators to prevent passengers from the roof of elevator as gravity will decrease greatly as we move toward central hub from torus through spokes or during deceleration of elevator.

SPACE SUITS:
Space Suit Design:

These will be mechanical counter pressure suits which will use heavy elastic body stocking to compress the body. The head is encompassed in a pressurized helmet, but the rest of the body is pressurized only by the elastic effect of the suit. This eliminates the constant volume problem, and reduces the possibility of a space suit depressurization. The space suit fabric will would be light andtherefore it will allow finer and less laborious movement. It will be coated with TMG (Ortho-fabric) layer so that it will also shield the wearer from bombardment by micrometeoroids and insulate the wearer from the te mperature extremes of space. There will be a bag at the back which will contain life support system. The space suit will maintain a pressure of 0.56 bars. The back of the helmet would be incorporated by a radio whereas the area of the helmet near the mouth of the wearer would have a microphone. This would ensure proper communication between the people living there. A video camera would also be placed on the top front of the helmet so that the space centre could be aware of the happenings of the people. Boots would have a magnetic soul which would facilitate walking about the inner or outer hull.



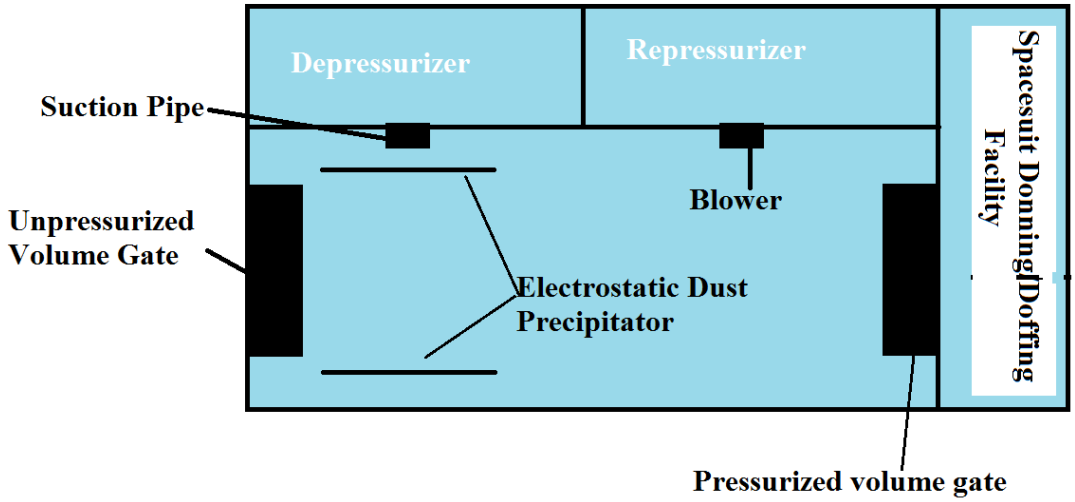


Size of spacesuit is kept as small as possible while considering the operational needs, so that it is easy for people to handle and don/doff the suit. Donning and doffing facility will be provided next to airlocks. Spacesuits will be hanged by their backside with a door with a large opening in it. People can walk from behind the door and put their head, legs and arms in the space suit, which is similar to the suitlock system. This system has an advantage of extremely less time consumption and ultra-simplicity. After wearing the suit, it will be detached from the door and life support system will be attached to the back of the suit, people will wear gloves, helmets and boots finally. Trained staff will help these people in donning/doffing procedures. Prebreathing pure oxygen time: 30 min. Donning time:20 minutes. Doffing time:5 minutes. Stowage will be done by robotic arms. These arms will detach different parts of the suit e.g. lower torso assembly, upper torso

MOVEMENT IN ZERO G:

Type of Support	Purpose
Tethers	To hold the astronaut connected to the space station. Strong and durable, hence reduces the possibility of the astronaut detaching from the space station and fly away into space
Handrails	If the astronaut does not have something to hold on to, he can execute translational as well as rotational motion; hence handrails prevent uncontrolled motion.

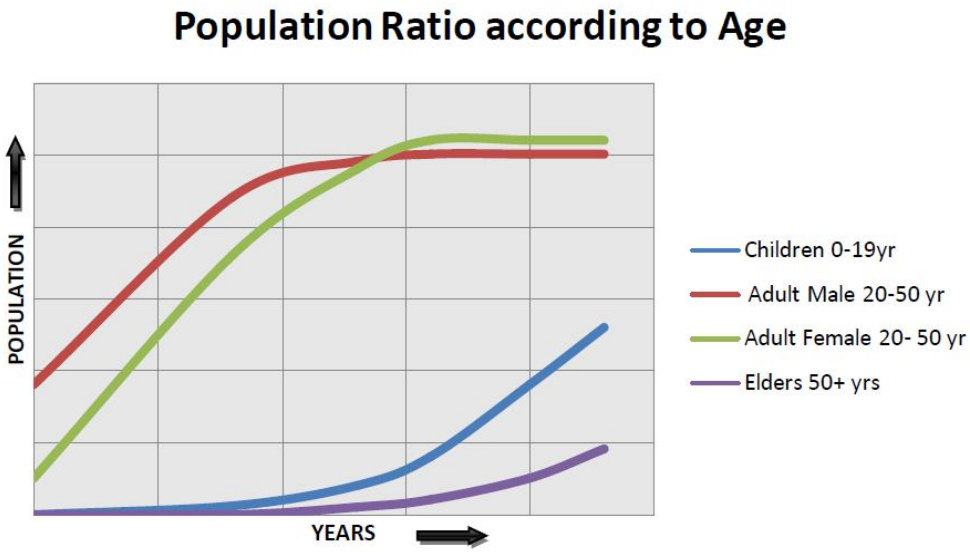
4.3.4 Airlock Design: Airlocks will be situated next to the entrances of ports in central hub and residential torus. Airlocks will have to gates, one leading to pressurized volume and other opening to unpressurized volume. Depressurizers and repressurizers will change the pressure in the airlock from the pressure of the place where the person is coming from to the pressure of the place that person is going to. This is to reduce the loss of atmosphere of pressurized volume. Walls of the airlock will be made up of titanium alloy and boPET to able them to withstand pressure changes. Electronic dust precipitator will remove debris from the spacesuit of astronauts entering settlement.



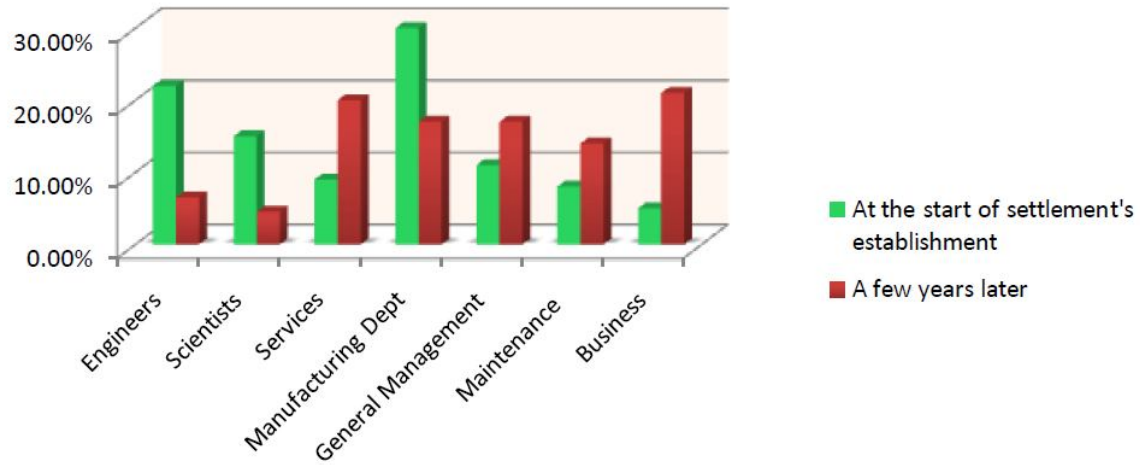
4.4 Demographics

4.4.1 DEMOGRAPHIC CHANGES:

1. During the construction period the male to female ratio will be 2:1 and almost no dependant age groups (children, old people) will be present. Till the time Aresam gets functional the male to female ratio will become 1:1 and dependant age groups begin to grow due to settlement of families.



2. During the construction phase the percentage of engineers, scientist will be high. This decreases with time as they will move to bases in mars or to other construction sites. This gives way to people, from other settlements(including earth) to choose aresam as their residence, concerned to business or service sectors e.t.c.



3. The transit population also increases with time, the number of people using Aresam as a base for transportation to/from Mars increases.

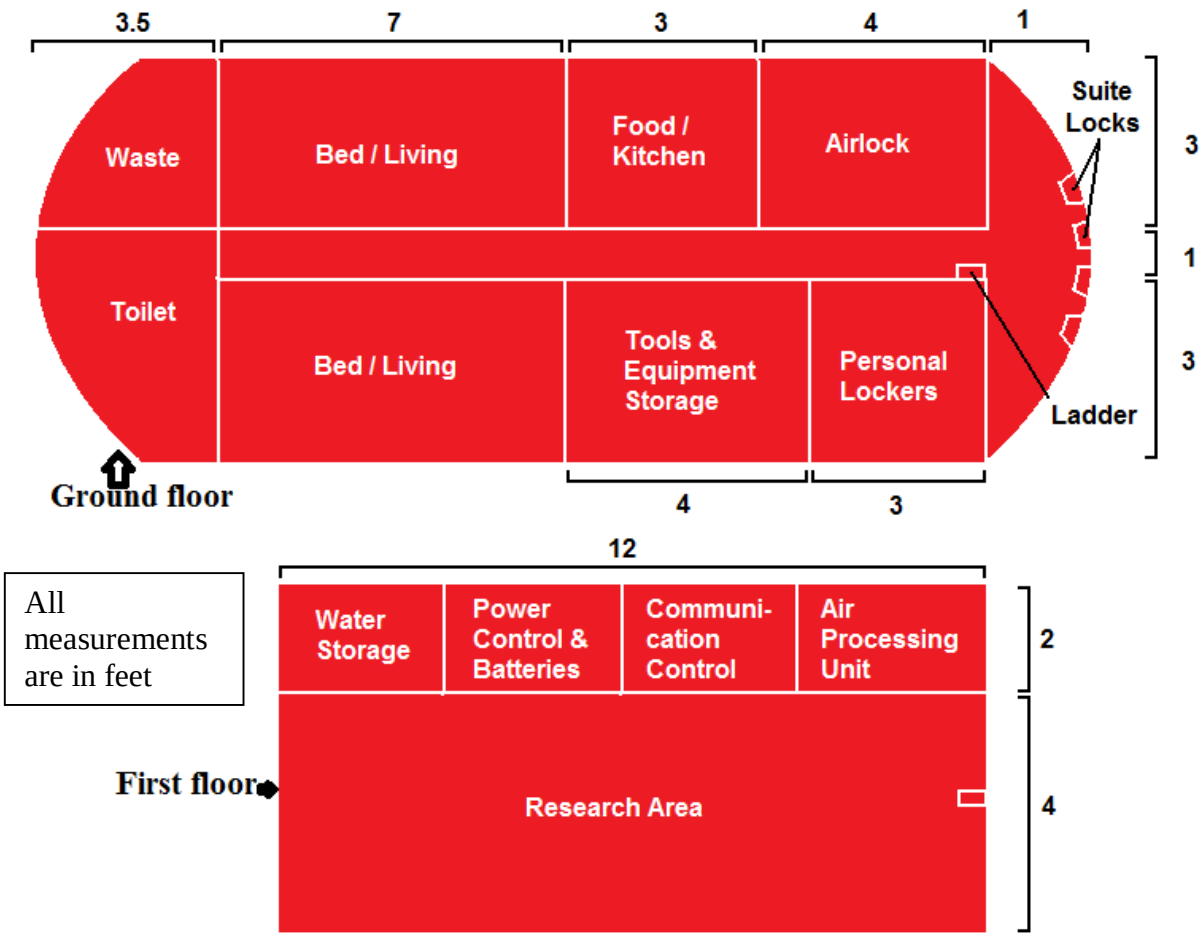
4.4.2 WAY TO COPE WITH CHANGES:

1. 8% of residential area has been left for construction when need arises. This space will be used as parks before the construction occurs, when the population of the torus begins to increase in addition to building houses, this area can be used to build hotels to accommodate the increasing transit population, schools, sport complexes for teenagers and old age homes for old people, shopping malls/markets to provide the increasing population with its needs e.t.c
2. Further construction is possible on the roofs of family, couple and duplex homes to accommodate the increasing population.
3. In the couple houses an extra room is made on the upper floor (roof). If family grows this can used as the child's room.

4.5 Prefabricated Base Interior Plan

The base is divided into two floors. Ground floor consists of a bedroom/living room where inflatable bed will be used. Two beds will be placed in each side of the main aisle, one upon other. When not in use, these beds will be deflated and packed up; bedroom will be converted into living room which will be used for for eating food, any leisure activities such as reading or watching DVDs, and discussion board. A small exercise machine will also be installed for astronauts' health maintenance to countermeasure lower gravity effects. Upper floor consists of research area having equipments like diffraction and spectroscopy tools, communication equipment, batteries for backup and power control. Air processing unit is placed just above airlock facilitate in depressurizing and repressurizing. Water purifying and storage facility is situated just above toilet and waste cell for purification of water.

There will be four suitlocks on the exterior wall of base to facilitate the passing of astronauts. One airlock will be installed in order to move soil samples for inspection or other equipment (robots) in to the base.


3.5
7
3
4
1
Waste
Bed / Living
Food / Kitchen
Airlock
Suite Locks
3
1
Toilet
Bed / Living
Tools & Equipment Storage
Personal Lockers
Ladder
3
Ground floor
4
3
12
All measurements are in feet
Water Storage
Power Control & Batteries
Communi-cation Control
Air Processing Unit
2
First floor
Research Area
4

5.0 Automation

5.1USE OF AUTOMATION FOR CONSTRUCTION

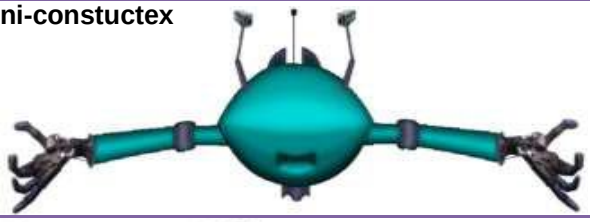
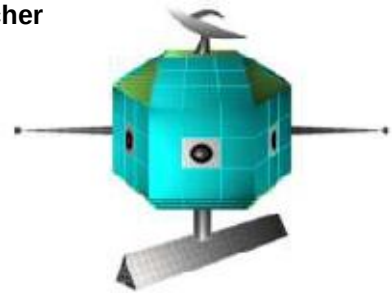
Exterior Assembly of the entire station will be in accordance with a premade computer model. The various stages of the construction are going to be fabricated in chronological steps by a control panel mainframe which will be in direct control of human engineers and architects who will be able to troubleshoot and monitor the construction in real time through use of intelligent cameras on each mechanism. Constuctex will be encoded as the prime signature robot which will be able to transmit commands to secondary mechanisms to aid it in the entire process. The human engineers will be notified of these processions and if needed, a proposition can be given to supersede constuctex's commands. The watcher will also be providing complete video feed depicting the entire construction's progress.

The control panel:

Computer types	Specifications	Function
Super computer mainframe	• multi-core chips mixed with simultaneous multithreading • Vector Processing capability • RAM approx. 500TB • RAID system Hard drive up to 1 Zetta bytes • LAN 100TB/s	Carry all the algorithms that would depict the entire construction sequence and assembly. The main server to which all the core booths are connected.
Core Booths	• Multi core processors • 100GB RAM • RAID HDD 50TB • LAN 1TB/s	Individual booths will be assigned to engineers where each can monitor various phases of the construction processes. These booths will be in direct connection with the Supercomputer mainframe and connected in star topology with other booths for local communion.

Interior Finishing will be covered by the mini constructex. The house and utility construction will be mainly the assembly of provided materials and this will also be monitored by the control panel. These materials will be provided by cargo robots that will be in its direct control. Furnishing of the houses will commence as soon as a segment is completed.

NAME	Purpose and Features
Cargonal 	To transport and carry construction material.Its arms will catch and hold the construction materials .It will have ion exchange thrusters to transport materials at the assembly site. Mass catchers can also be installed on it to catch payloads sent by mass driver. The intelligent camera will allow it to synchronies with constructex

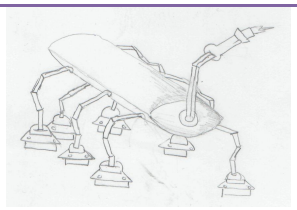
Mini-constuctex		The main interior finishing robot with versatile handling capabilities. Its dual intelligent camera sight allows it to have 3-D focus. Its Smart hands allow it to perform delicate interior finishings. It will also serve as a secondary robot that maybe used to aid constuctex and repair it in case if something goes wrong.
Watcher		To coordinate different construction machines with each other and the control centres. 6 intelligent cameras will provide omnidirectional (360°), 3-D view of construction site. The deep space communication dish will allow uninterrupted communication with control panel (Earth or other settlement) Phased array/ general purpose antenna(s) to coordinate with construction robots
RFID Tags		Easily identifiable and permanent tags to ensure large scale management.It will be attached on every construction material so that its location can be easily determined

5.2 Automation Systems for maintenance, repair and safety

Maintenance, Repair and Safety Systems:

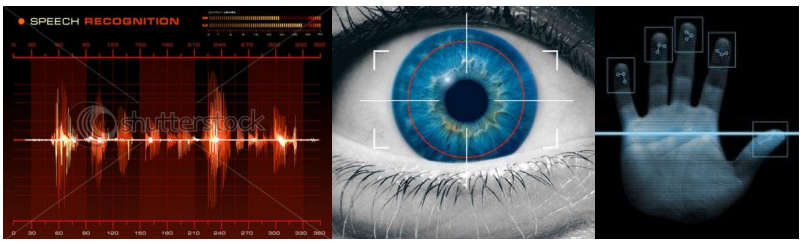
Robot personnel maintenance system	This system will be organized by the torus control room. Its basic aim would be to monitor the robots, their locations and conditions. The individual robots will be marked by a health bar showing literally, the condition of the specific robot. A database will be in charge of this ordeal and will notify engineers if there is a break down or the health bar falls below 60%.
Torus shell maintenance system	This system would keep track of damages suffered during a meteor shower et cetera and arrange for specific contingency plans and emergency repairs. If there is exterior damage, the mainframe computer will dispatch repair robots to the problem area. This would be pointed out by intelligent pressure sensors embedded in the torus exterior. These sensors will send individual pulses at small intervals to the mainframe. If the pulse becomes strong, it would signify some damage. Thus the concerned parties will be notified and a Watcher can be sent out before any specific action is undertaken.
Gravitation Maintenance System	This is the main system for keeping check on the angular velocity of the torus. The thrusters will be kept in constant check and other mechanisms associated with the rotation and centrifugal forces or artificial gravity generation. If the rotation slows down, the system will automatically send command for the thrusters to start working. The exact power of the thrust will be closely and precisely monitored to keep the gravity constant.
Environment analysis and maintenance system	This is a special system that would employ the use of air quality sensors such as humidity and composition sensors. The system will check on the environmental conditions and keep the atmosphere as close to that mentioned in section 3.2. Oxygen levels will be closely monitored and incase of an anomaly, some protocols can be evoked that would ensure the public's safety.

Safety System	The safety system works by making sure that all the systems are in working order and in case of emergency, would identify the cause and send an alarm to the safety team and personnel. This system will regulate the airlock and port security procedures. It will also ensure that only authorized personnel are allowed in and out of classified rooms and structures by using various biometric scans that will be in connection to a database having all the necessary information on an individual along with the security levels. It would hold contingency plans that are preprogrammed protocols that would be put into play when something goes wrong. It would be interlaced in the control room's mainframe and can be initiated automatically or manually from a lever/button.
Transport System	The system will allow for automatic transportation in the torus for domestic use. It will make sure that none of the transportation passage is being blocked or in damaged state. It will also monitor incoming and outgoing space traffic and ensure a steady flow.

Name	Purpose and Features
Medico 	This robot is designed for medical purpose. It contains an health diagnosis system in its microprocessor. Contains first aid kit will be able to relay data and video to the settlement hospital
Repirio 	This robot will be used for repair of external walls of tori. It has tools to detect and seal any leakages in the structure due to micrometeroid collision. It will also clean any dust settled on the windows.It will have suction creating feet to hold with the walls of tori as centrifugal force will tend to throw the robot in outward direction.
Fire Buster 	This fire extinguishing robot will be highly mobile and able to creep around tight corners or into maintenance shafts

Security Measures and Authorization Procedures:

Certain biometric scans in direct control of the safety system, will be allocated on different security levels and prevent unauthorized access or a security breach. Multiple scanners can be used for highly classified areas. These scanners can also be used for the residential buildings so that the owners are guaranteed security.



Retinal Scan:A scanner will process an individual's retinal

signature. If the entry is valid, access will be granted.
Hand Print Scan:This will find the match of a person's hand print from a premade database.
Voice Recognition:The oral output of an individual, such as speaking his/her name, would allow the system to comply it with a pre-existing match.

5.3 Enhanced livability:

A number of devices and robots will be used to enhance the living standard at the Aresam. Aresam will offer ultramodern computing services to its residents, there will be body mounted or Wall mounted, gesture sensing holographic computers with complete independence from traditional point and click devices or key interfaces. The total bandwidth available will be 1 Tbps, half of which will be reserved for the settlement's internal systems and control management.

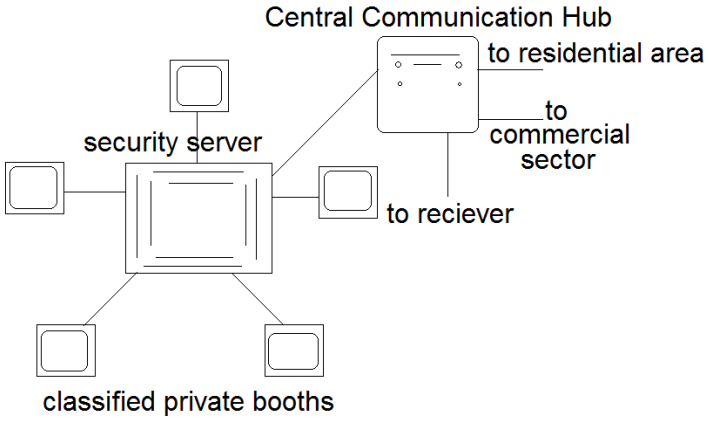
Personal Assistance Robot

This robot will do the daily household activities. Including cooking, cleaning and babysitting. It has intelligent cameras and human language comprehending software. Can understand verbal commands? Its two arms can attach to different modules to perform different jobs. Its 3 feet act as suction pods to do vacuum cleaning.

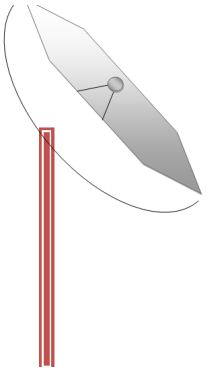
Security Measures for privacy of data:

The safety system department can issue dog tags or specialized key cards with pin codes and unique passwords to individuals for accessing their computer systems so that their privacy is ensured. Anti-Spyware and anti malware software will be provided to rid off unwanted access.
Encryption software along with specially allocated keys can be introduced. This encryption will cipher the data and can only be translated through a user's special key/password.
Biometrics can also be employed in achieving fool proof security.

Bandwidth Requirements

Network Type	Bandwidth
SONET (synchronous optical networking) 	Use of fiber optics and standard OC192 with bit rate 9.8 Gb /s
Wimax	IEEE 802.16 standard employing 70 Mb/s

Communications (Networking)
The various segments of the torus will each be provided with its communication hub in the central comm. Room. These comm. rooms will be fully automated but a small staff of 5 will be positioned at the private booths where the security server will be providing them live feed of the security processions on the particular segment. The network being used will be the SONET. This network will stretch over the entire segment both in the residential and commercial cells. The central communication hub will be connected to the receiver which will be broadcasting and providing for internet facilities and communications with other segments.



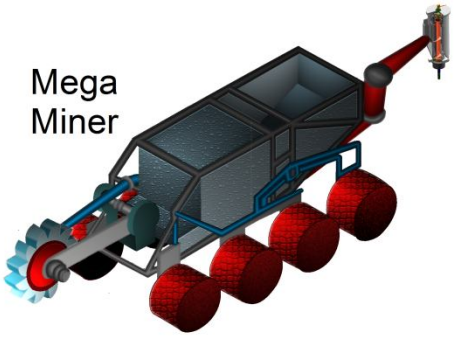
5.4 Posting Information

Time delays experienced by residents at Aresam will be between the following range:

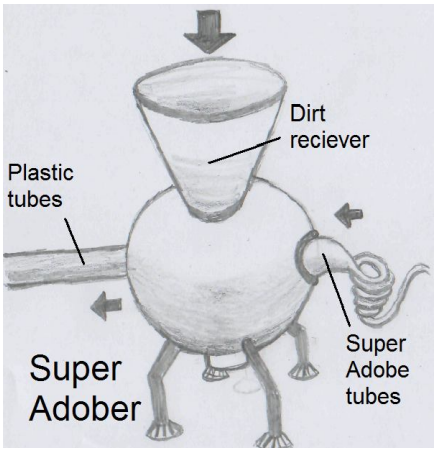
Time delay	Reasons	Remedy (retrieval)	Message
4 minutes	The shortest distance between the earth and our settlement is approximately 56 million km, so if radio waves will be sent from earth to Aresam then it will take approximately 4 minutes.	Aresam will have its own mega server with its supercomputers. The server will automatically download most visited sites from earth to give the residents some instances of instantaneous access to internet	
22 minutes	When Aresam, mars, sun and earth will come in one line then the distance between earth and Aresam is approximately 401 million km, so it takes 22 minutes to radio waves to reach our settlement.	**Same as above**	

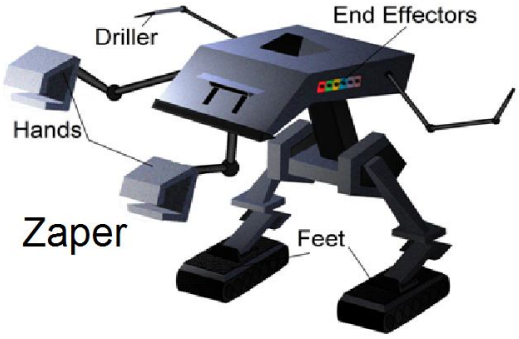
The onboard internet command system will send data in packets to earth based internet. These packets will be sent to the satellites from amplifiers and ensure that the data reaches earth unaltered. This packet will be specially encoded to keep it safe from hackers and unauthorized parties and only the designated receiving booth will receive the key for the unlocking the packet.

5.5



Mega Miner: Its surface mining rotary arm can collect surface materials efficiently and place them into cargo bay. The rear digging arm can dig deep under the surface to excavate subterranean ores. Its cargo bay allows it to transport materials in bulk to the mass drivers.





Beneficiation Robot: This robot helps in refining ores by separating and concentrating different minerals in the Phobos/Deimos soil by electrostatic separation.

Super Adober:It will compact regolith of Phobos/Deimos in long plastic tubes to be used in construction.

Zaper: This robot will help in deployment of of prefabricated base on mars.It can perform multiple tasks by changing end effectors of one its hands. It can be pre-programmed to perform all required deployment tasks.

6.1 Schedule

Phase 0	Date	0-1425 days
Objects to be completed		
Refinery	July 1st 2055	
Assembler	August 7th 2057	
Transportation	January 1st 2059	

Phase 1		1425 - 3746 days
Objects to be completed	Februray 1st 2059	
Central Rod	June 1st 2062	
Connecting Bolts	June 5th 2062	
Zero G Sphere	June 10th 2062	
Galaxy Navigation System	August 18th 2064	
Ion Engines	September 1st 2065	
Elevators	December 2nd 2066	

Phase 2		3746 - 5025 days
Objectives to be completed		
Zero G Industrial Torus	1st March 2067	
Ore Refineries	18th August 2068	
Industrial Automation	4th August 2069	
Fuel Pipelines	1 Jaunary 2071	
Power Generators	2 Feburary 2073	
Docking ports	1st march 2074	

Phase 3		5026 - 6147 days
Objects to be completed		
Atmosphere Regulator	12th November 2074	
Powersupply	15th January 2075	
Residential Circle	13th March 2075	
Artificial Lightening	2nd June 2075	
Domestic Robots	1st December 2075	

Phase 4		6147 - 7921 days
Objects to be completed		
Low G Residential Circle	5 February 2076	
Docks functional	11th March 2076	
Food Processing Industry	7th November 2076	
Recycling Industry	1st January 2077	
Observatory	11th March 2077	
Solar Power Satellite	19th September 2080	
Transportation (Domestic)	1st January 2081	

6.2 Cost

Labour Expense	Formula (No. Employed * Salary * Years Employed)	Value ($)
Engineering Technicians	5000 * $53000 * 27 years	7,155,000,000
Financial Officers	100 * $105410 * 15 years	158,115,000
Engineer	1000 * $87610 * 30 years	2,628,300,000
Construction Workers	10000 * $34130 * 27 years	9,215,100,000

Material Expense	Formula (Quantity * Rate)	Value ($)
Titanium	20*815*82*640 ($12.35 / kg)	257,066,270,60
Kelver Net	132034 dm^3 * 58.32 / m^2	311,445,63
Aluminium – zirconium Alloy	7000 tons	78,647,23
RTV adhesives	4700 pieces	221,56
Regolith	4200 blocks	21,369,98
Silica Aerogel	1000 tons	12,54
Chlorinated Polyvinyl Chloride piping	7000 sheets (100*35 m^2)	1,548,986,21
High Strength aluminium alloy	17000 tons	23,132,121,54

Support Facilities	Value ($)
Expansion Facility	520,000,000
Launch Facility	800,000,000
Ore Mining Facility	26,344,676,180
Operation Core	2,000,000,000
Automation	74,600,000,000
Adaption Center	2,000,000,000

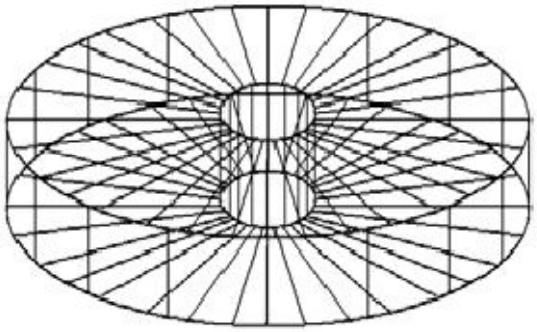
Research and development	Value($)
Transportation	45,000,000,000
Station systems	4,500,000,000
Station structure	100,000,000,000
Construction processes	2,000,000,000

Transportation	Formula = Quantity * Rate	Value ($)
Heavy Life Vehcile	100*236665	23,666,53
MPRE Modulator ropus	125*1770123	22126546
Electro Shocks	50*8306643	41533216
Aesteroids Blocker	300*8543848	256315454
Ion Engines	500*510691	25534554

7.0 Business Development

7.1 Transportation Node and Port

7.1.1 Docking ,Warehousing, Cargo handling:

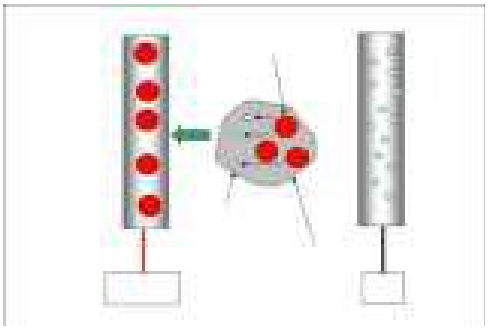


The transit port on the upper side of the central axle is dedicated for the transit cargo and passenger handling to and from mars, 10% of the total volume of central axle is dedicated for fuel and food storage. The space ships carrying the passengers will dock at the port and will automatically refuel and packed food will be provided for onboard passengers. The port is also planned to have a cargo storage facility for transfer of cargo to and from the space ships. Large scale mars surface deployment, however, will also be carried from the ports on the industrial torus.

7.1.2 Repair and servicing:

Located at transit port , industrial Torus. Small repairs will be automatically done at the transit port by the highly precise Repirio robot. (section 5.2)

7.1.3 Dust Protection:



Located at all port interfaces. To protect accumulation of dust inside aresam the ports will have a pressure, electrostatic dust precipitator system. Although most of the water of the settlement will be recycled small quantities cannot be completely purified (<0.5%). This water will be stored in special tanks and will be electrically broken down into ions which will be sprayed onto the docking site of spacecrafts prior to docking at high pressure. The pressure will cause dust to be removed from the surface which will be trapped.

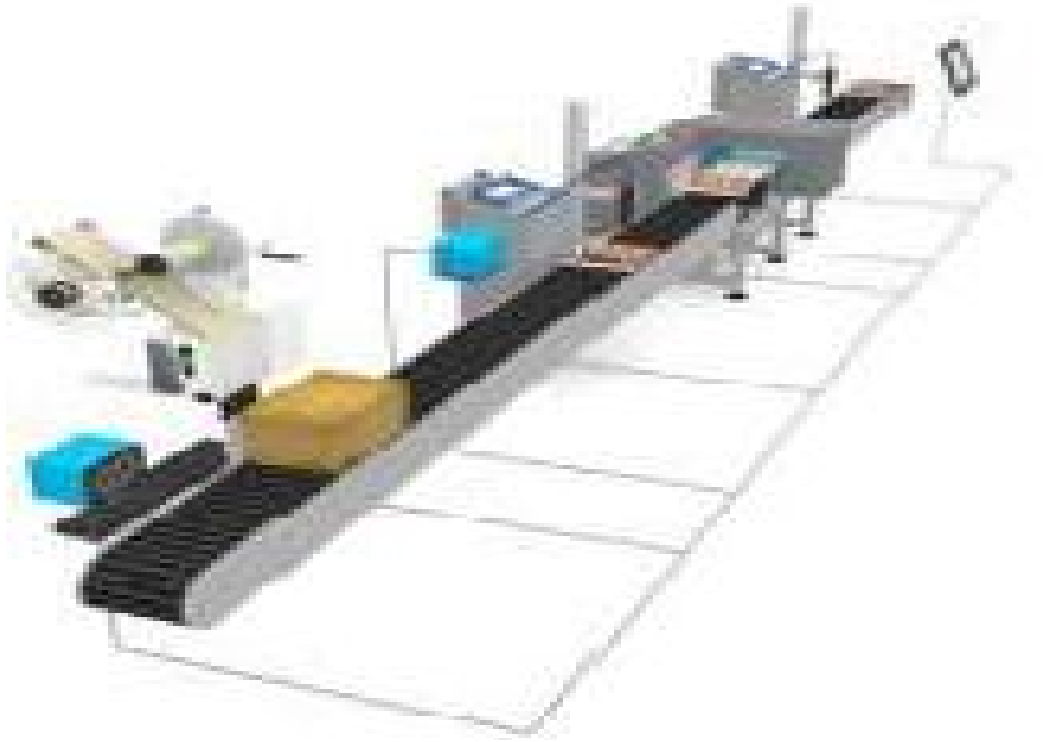
7.1.4 Medical/Quarantine

Located at Specialized Research, Quarantine and observation facility. A separate section in the facility (lower most part of the settlement) is dedicated for advanced treatment for space sickness.

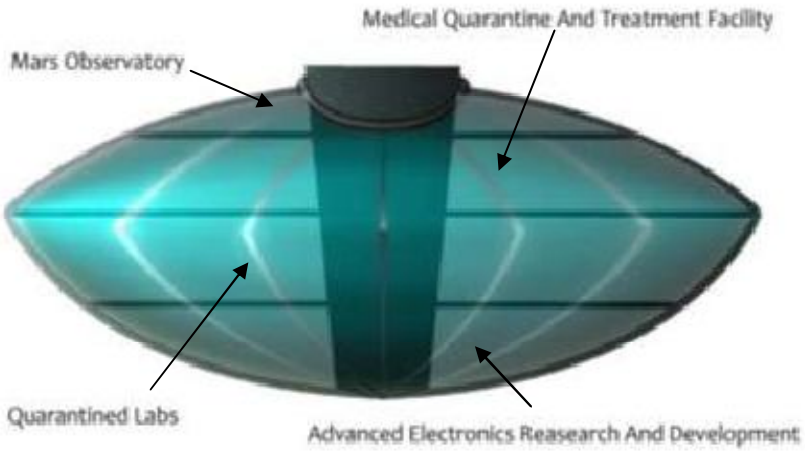
7.2 Manufacturing for mars infrastructure.

The manufacturing for mars / Phobos and/or Diemos infrastructure will be carried out in the zero g industrial area and in the low-g industrial torus. Raw materials will initially be obtained from other settlements gradually shifting completely to the raw materials from the Phobos and Diemos mining basses. Complicated and heavy parts will be manufactured in the Zero-g (non- rotating) area for ease of operations. Final assembly, however, will be completed at the low – g industrial torus (rotating) In an

assembly line configuration. Vehicles and robots will be directly transported to the ports on the outside of the torus trough connecting tunnel interface(s).



7.3 Research and development



Aresam will have a Specialized Research, Quarantine and observation facility on its lower most side. This area provides specialized area for advanced electronics and new material research labs and clean rooms for advanced sciences. This special area will provide specialized facilities for Martian material research and development of new and advanced products from them. This area will be clean and particles greater than 0.5 micro meter will not be allowed. Materials and technologies found commercially significant will be manufactured in the industrial tours. The lower most portion of the facility is reserved for research on possibility of life on Mars and other space bodies. This area will also be completely secure and quarantined to prevent any potentially harmful organism to spread through Aresam. This area will be separable from the main body in case of emergency or quarantine failure to protect the rest of the settlement.

8.0 Appendices

A-Detailed assessment:

A comprehensive study for the location of the heavy manufacturing facilities is given below, with refrence to the advantages and/or disadvantages for choice of a particular hull region for location of the heavy manufacturing facilities.
1: The Residential and agricultural tori:
Advantages

- Comfortable conditions for the engineers and technical staff (0.5-0.98 g)
- Ease of access for the workers due to short distances from their residential buildings.

Disadvantages

- Very high power consumption in moving heavy materials due to high gravitational force.
- Noise pollution for the residents of the residential torus
- Possible harmful emissions may harm the community
- Visually obstructive
- Interference in human activities
- Will pose significant stress on the structure
- Difficult and/or unpleasant to transport the finished machines from the manufacturing site to the port through the residential community
- Any possible accident ill pose serious threat to the human population's survival

2-Rthe industrial torus/ micro G industrial area:
Advantages:

- Very low power consumption due to low or micro gravity
- To noise or visual obstruction or interference due to separation from the residential torus
- Separate from the torus no visually and or other construction
- Easy to transport heavy machinery

Disadvantages:

- Access to and from the industrial area will take longer
- The conditions are not good for human habituation

Nearly all the industrial activities will be conducted in the low g industrial torus or the micro g industrial area in the central hub. The lower g torus will primarily function as a site for the production of semi finished products which are not very heavy independently, parts like trusters and circuitry and control sstems will be manufactured here . The low g will facilitate the engineers and technicians and provide better environment than the micro g area .
Major assembly of the components and the exterior of the machines will be done in the micro g industrial area. The completed machines/ modules can then be transported to the main port

complex through elevators in the central cylinder. Alternatively , the machines /surface modules can also be sent to the existing ports on the exterior of the industrial torus.

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Compliance Matrix

Section	Requirement	Page number
2.1	On exterior drawings identify attributes and uses of large enclosed volumes	2
	Show dimensions of major hull components and design features	2,3
	Show construction material of major hull components	3,4
	Specify volumes where artificial gravity will be supplied	3
	Rationale for selected rotation rate and artificial gravity magnitudes	3
	Specify means of protecting from radiation and debris penetration	4
	Design must show capability to isolate any two……in case of emergency	4
2.1 Minimum requirement	Overall exterior view of settlement with major visible features……function inside each volume	2,3
2.2	Specify percentage allocation of interior down surfaces	5,6,20
	Dimensions of interior down surfaces	4,5
	Drawings labeled to show residential …..and other uses	5,6
	Show orientation of down surfaces……..vertical clearance in each area	5
2.2 Minimum requirement	Overall map or layout…..showing usage of those areas	5,6,20
2.3	Describe the process…..by showing construction sequence	6,7
	Specify when artificial gravity will be supplied	6,7
	Describe a construction technique….. phobos and/or deimos	7
2.3 Minimum requirement	Drawings showing…… for artificial gravity	6,7
2.4	Show design features….and later operations disruption	7
2.4 Minimum Requirement	Drawings or maps…..vehicles	7
2.5	Create a design for pre……	8
2.5 Minimum Requirement	Drawings of deployed,undeployed,interim configurations	8
3.1	Recommend and orbital location….inclination.	9
	Reasons for its selection	9
	Sources of material for construction and operations	9,3,4
	Equipment for construction and material	9,10
	Means of transport	10
3.1 Minimum requirements	Table identifying… materials	9,10
3.2	Atmosphere….. quantity	10,11
	Food production…..selling	11,12
	Electricity power generation….. allocation for specific uses	12
	Water management	12,13
	Household and….. and/or disposal	13
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	Internal transportations system …. With dimensions	14,15
	Day night cycle….. for providing it	15,16
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3.3	Show conceptual designs……. completed settlement structures	16,17
3.4	Describe materials harvesting operations	17,18
	Refining and processing of resources of phobos and deimos resources	18

3.5	Describe air,food…… paragraph 2.5	18,19
4.1	Maps or illustrations ….locations of amenities	20,21,24,25
	Identify percentage of land are…… roads and paths	20
	List major types of consumables….. quantities	21,22
	Specify means of distributing consumables	22
4.2	External drawing and interior floor plans of at leasr four home designs	22,23,24
	Number required for each design	22
	Identify sources and/or manufacture of furniture items and appliances	24
4.3	Design of systems,devices….. will emphasize safety	25,26
	Show spacesuit designs…..donning/doffing procedures	26
	Show airlock designs… ……unpressurized volumes	27
4.4	Show examples of flexible……. to anticipated changes	28
	Chart or…. Demographic trends for aresam	27,28
4.5	Show interior configuration ……. Drawings of base structure and amenities	28,29
5.1	Describe use of automation for construction	30,31
	Consider automation for transportation,delivery of materials	30,15
	Automation for assembly of settlement and interior finishing	30,31
5.2	Specify automation systems……backup systems and contingency plans	31,32
	Robots required for emergency external repairs…..solar flare activity	32
	Describe means for authorized personal……..and only for authorized purposes	33
	Identify particular systems and robots to meet each automation need.	31,32
5.3	Describe automation …….requirements for manual labour	33
	Describe devices for personal……. And robot resources	33
	Diagrams of networks and bandwidth requirements to enable connectivity	34
5.4	Describe access processes to…… retrieving and posting information	34,35
	Tables/images showing internet user experience	35
	Include user messages……methods to create appearances of instant access	35
5.5	Provide robotic assistants for deployment of pre-fab base	35
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6.1	Durations and completion dates…….chart or drawing	36,37
	Show schedule dates when foundation society……established in the community	36,37
6.2	Specify cost billed per year…….. costs to design and build the settlement	38
	Charts or table listing eperate……. Billed to the foundation society	38
7	Transportation Node and Port	39
	Manufacturing centre for elements of Mars and Phobosldeimos infrastructure	39
	Research centre for development of commercial products from Mars resources	40