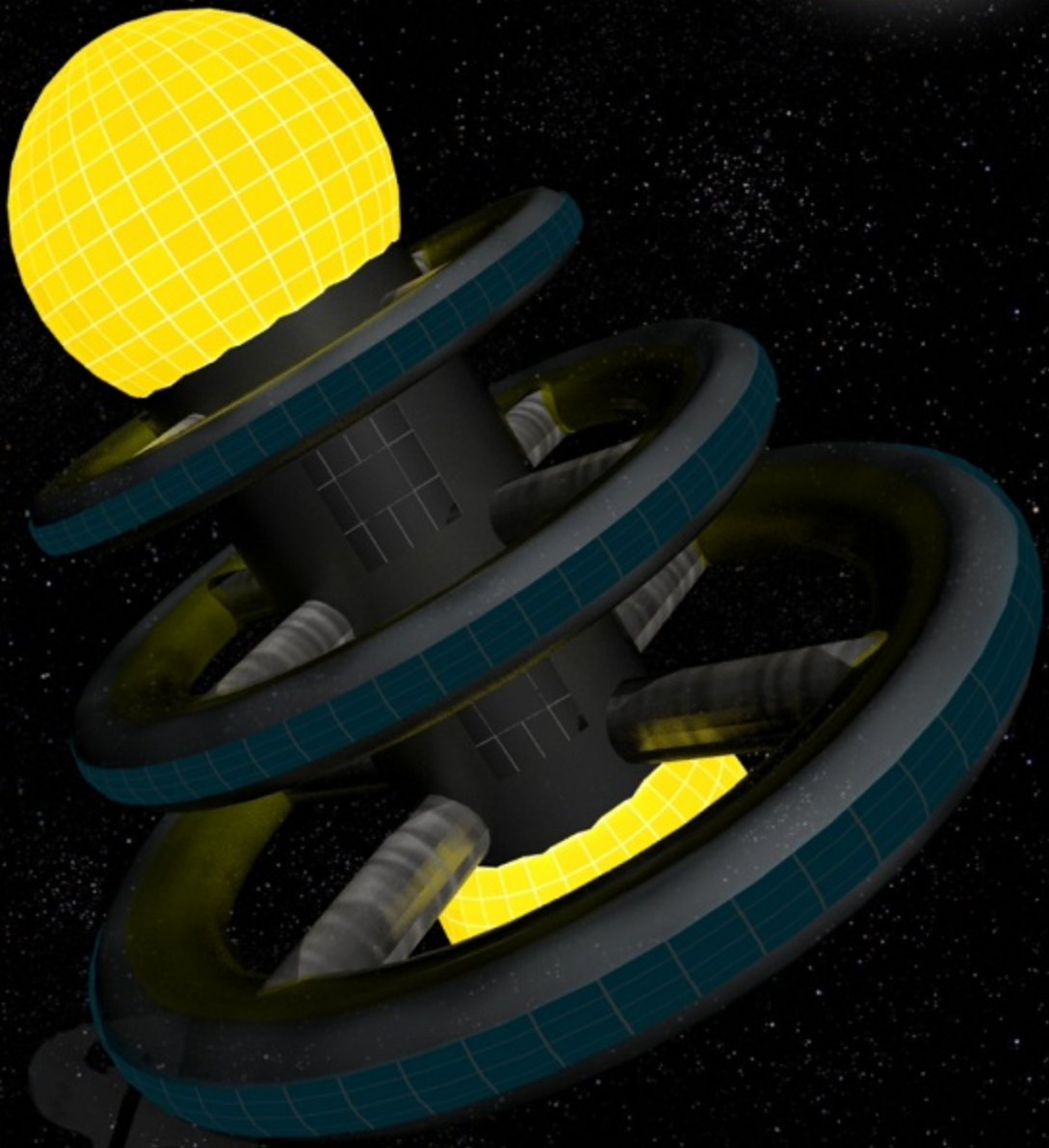
ARESAM



LGS
Lahore Grammar School For Boys
49 CIVIC CENTRE,
MA JOHAR TOWN,
LAHORE, PAKISTAN.

17th Annual International Space Design Competition
Proposing Team Data 2010

Name of responsible Teacher: KHALIL AKHTAR
School for other group name: LAHORE GRAMMAR SCHOOL FOR BOYS
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Names, [Grade levels], and {ages} of 12 students currently expecting to attend the Finalist Competition:
(We request that participants must be at least 14 years old, and not older than 19)

MUHAMMAD JUNAID	[A1](17)	MUHAMMAD ASAD MASOOD	[A1](17)
SYED MUTAHIR HUSSAIN KAZMI	[A2](17)	MUHAMMAD SHOAIB SHAFIQUE	[A2](18)
SYED JA'FAR ABBAS BUKHARI	[A2](18)	WAQAS AHMED	[A2](18)
AHMED HAQ	[A2](18)	SAEED BOOR BOOR	[A2](18)
HANAAN AMHED	[A2](18)	WAHAAJ UD DIN KHALID	[A2](18)
ISMAIL ABDUL WAHID	[A1](17)	SYED MUHAMMAD ALI	[A2](18)

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

KHALIL AKHTAR MUHAMMAD FAROOQ SALAHUDDIN

I understand that if our team qualifies for International Space Settlement Design Finalist Competition July 30 – August 3, we will be expected to finance our own travel to / from Nassau Bay, Texas, USA.

Responsible Teacher / Advisor Signature

03-03-2010
Date

1.0 Executive Summary

Responding to the Foundation Societies Request for Proposal, the research team at Lahore Grammar School for Boys is pleased to present its proposal for "Aresam" the 1st space colony which will open doors towards the "Red Planet". Constructed in Mars' orbit, the settlement caters to all human needs and takes into account the variety of factors affecting human life in space. With the ability to expand itself whenever needed, along with its practical and largely automated infrastructure; Aresam will be the ideal location for all scientists interested in research and development, also serving as the launch pad for prefabricated bases intended for assembly on Mars' surface. The structure will host 20,500 residents at the start of operations, however, keeping in mind extensive expansion, space for 30,000 full time residents is provided. The exceptional & most noteworthy features of Aresam are detailed:

The Executive Summary has been broken down to better highlight all Important Aspects:

Date of Contract	2nd January 2055
Date of Completion	**16th January 2080**
Total Cost	**$5.15 X 10^{12}**
Payback Time	**25 Years**

Features	Pseudo-Torii
Rpm	**0.55**
Total Population	**20500 (Increases)**
Total Volume	**2.9 X 10^{11} m^3**

2.0 Structure & Design:

1. **Constructed, bearing in mind that there will be coronal mass ejections during 2056 corresponding to the Solar Maximum which takes place in 11 year cycles, with the last one being observed in 2001.**
2. **Settlement structure aims at maximizing living surface area, while minimizing volume. Structure has been designed using Pseudo-Torii to overcome the drawbacks of conventional Torus design, while making efficient use of its qualities.**
3. **A variety of structurally ideal materials have been used which provide the settlement with a range of structural attributes, resulting in a very safe and practical structural design, making it resistant to nearly all sorts of impact.**
4. **Efficient construction sequences, resulting in greater safety, lower costs and better time management.**
5. **Designed to ensure excellent expansive capabilities.**
6. **Designed with a priority on safety, all volumes can be sealed off and separated efficiently in cases of emergency, without letting the structure lose its integrity.**
7. **Docking ports have been constructed bearing in mind possibilities of future expansions which will result in better spaceships, using different docking methods.**
8. **A special capsule for the prefabricated base has been designed which helps ease transport and assembly.**
9. **The designs for a prefabricated base have been made with careful attention, resulting in a simple and practical design, which is exceptionally easy to assemble and transport, resulting in less exposure of our astronauts to the unshielded harsh environment of the Martian surface.**
10. **All aspects of the settlement have been properly integrated to ensure reliable and proficient working.**

3.0 Operations & Infrastructure:

1. **Constructed in Mars orbit with a circular orbit, with a radius of 30,000Km. Its position ensures constant sunlight and eliminates "gravitational turbulence".**
2. **An extremely efficient method of power production has been detailed, which minimizes cost and maximizes safety, operating as a regenerative heat exchanger to provide electricity, using turbines.**
3. **Operations have been carefully divided and integrated with automation for efficient and fast procedures.**
4. **Robots and construction equipment has been designed bearing in mind the coronal mass ejection which is bound to take place as mentioned above.**
5. **The settlement has been surrounded with an electromagnetic field similar to the Earth, which helps in deflecting solar winds.**

6. A more efficient process for obtaining materials for harvesting other than regular mining has been detailed. Drawbacks of mining nearly eliminated by using this method. Greatly reducing transportation and material costs.
7. Extremely low cost water source used i.e. Main Belt Comets. Provides large amounts with very low cost.
8. Great importance has been laid on agriculture and food requirements of residents. Aeroponics and Hydroponics have been used with nutritional details regarding human needs and usage.
9. Uses an extremely efficient transport system which caters to human orientation and sudden gravitational changes.
10. A network architecture linking various settlement components has been provided.
11. Operations for the deployed prefabricated base have been detailed.

4.0 Human Factors:

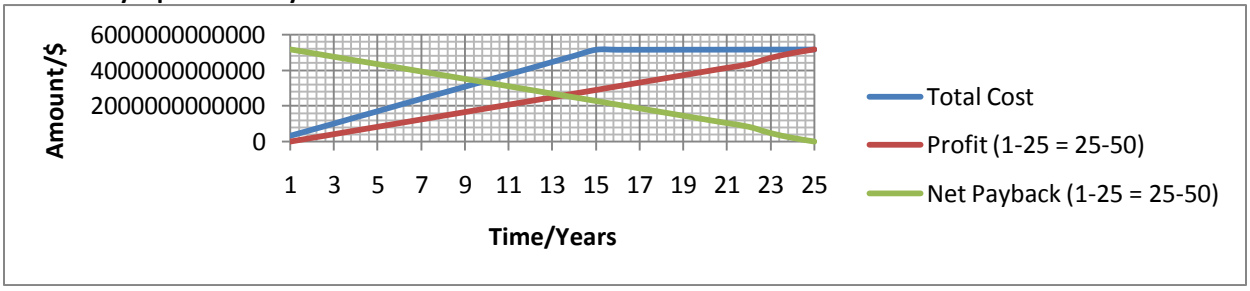
1. Residents have been provided with a variety of houses and amenities; great emphasis has been laid on education.
2. Residents have been provided with a robotic pet which provides emotional attachment and helps the residents benefit from all positive psychological factors associated with keeping pets.
3. The health and psychological acclimatization of inhabitant's has been of paramount importance. In terms of food, special care has been taken to provide a wide array of food items to provide balanced diets. Moreover, the varieties of cultivated crops will always reflect the changing dietary patterns of our citizens.
4. Quality education will be made accessible, as the main university complex which houses kindergarten, primary, secondary and graduate education will be in proximity to most residential areas. Efficient transport by tram will be available for the benefit of those who wish to travel to different areas of the Pseudo-Torus.
5. Demographic shifts in the population of Aresam have also been meticulously predicted, using both qualitative and quantitative measures, to ensure the best standards of accommodation and research possible.
6. Solutions have been provided to cater to all predicted demographic shifts.

5.0 Automation Design & Services:

1. The settlement has been highly automated bearing in mind its use as a research facility as well as a residential colony.
2. A variety of robots have been designed for all sorts of construction and maintenance requirements, great emphasis has been placed upon security and residential requirements of communication.
3. Solutions have been proposed for problems which can cause disruption of communication between Mars and Earth, and the other settlements.
4. All anticipated automation requirements for the operation of the settlement have been identified and listed.
5. Details of all bandwidth requirements needed for computer connectivity have been explained.
6. Solutions for the problem of a delay in communication between Mars and Earth have been proposed, which outline possible methods of minimizing this in certain cases, while acknowledging its impossibility in certain other applications. The Settlement has a three tier communication redundancy.
7. Diagrams showing methods and devices for internal and external communication have been provided.
8. Great detail has been provided over security measures implemented in the settlement.
9. Automation for the prefabricated base has been shown, with details of use of automation for construction and assembly of the base.

6.0 Cost & Schedule:

1. Cost has been spread over a range of time and the total cost has been provided
2. The schedule for completing the settlement has been spread into 3 phases, with a starting phase of 15 years, followed by 2 phases of 5 years.

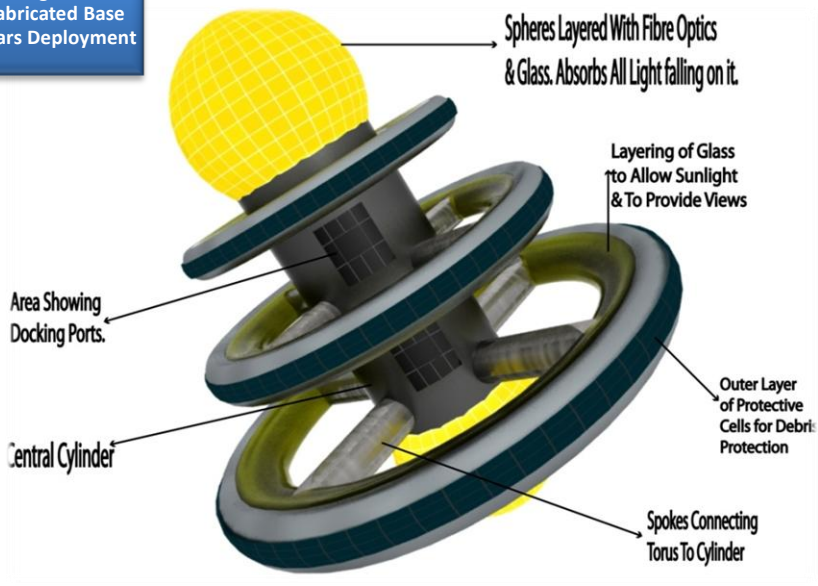


2.0 Structure & Design

Aresam shall be the home of more than 20500 people who will come to Mars orbit in search of creating a new home on Mars. This settlement which shall be the gateway to the Red Planet must have a Structural Design which is efficient in helping its residents achieve their aim, and can provide them with a safe, comfortable living and working environment. With this hope the Structure & Design for Aresam is presented as follows.

Structure & Design is summarized in the Following Chart:

- Labelled Diagrams Showing Major Settlement Components & Areas
- Chart Showing Materials Used in Construction
- Calculations of Settlement Dimensions
- Construction Sequences
- Description of Each Settlement Component
- Features For Future Expansion
- Design of Prefabricated Base for Mars Deployment



2.1.0 Diagram shows the basic structure of the settlement. The Structure consists of a **Central Cylinder** which is surrounded by **3 Pseudo-Torii**. The rate of rotation is constant; therefore change in radius has been used to alter the gravity in each Pseudo-Torus. The **2 Spheres** will absorb all light falling on them, and will help in power production **(Ref 3.2.1).** **Docking Ports** are shown between the Pseudo-Torii. **4 Docking Ports** exist in total. Each **Pseudo-Torus** is connected by **4 Spokes**; these **Spokes** contain Passages for travel. The **Pseudo-Torii** have been **modified**. They **do not** have a circular cross-section. These **Pseudo-Torii** have a cross section resembling a **Circular arc joined to a rectangle and a trapezium.**

2.1.1: There are 12 separate Volumes, which can be sealed off and isolated. In case of a major catastrophe, an entire Pseudo-Torus can be separated from the settlement. Each of 4 Sectors can be Sealed and Isolated.

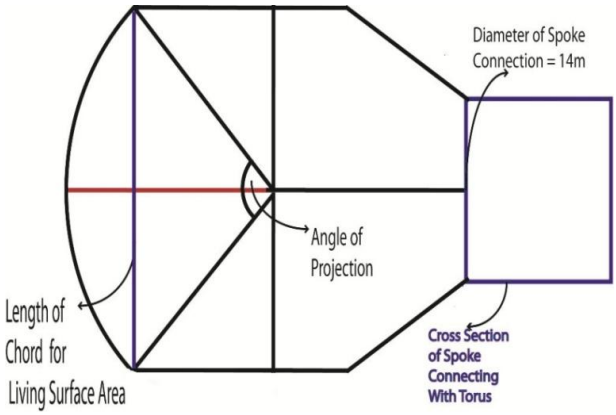


Image Shows Cross Section of Pseudo Torus:

Component	Rotation/rpm	Pressure/atm	Gravity/g
Central Cylinder	0.55	0	0
Docking Ports	0.55	0	0
Spheres	Non Rotating	0	0
Delivery Tubes	0.55	0	0
Spoke Tubes	0.55	1	Gradient
Elevators	0.55	1	0
Residential Pseudo-Torus	0.55	1	1
Residential Spoke	0.55	1	1-0
Industrial Pseudo-Torus	0.55	1	0.6
Industrial Spoke	0.55	1	0.6-0
Agricultural Pseudo-Torus	0.55	1	0.3
Agricultural Spoke	0.55	1	0.3-0

By using this shape, we reduce an immense amount of volume, which saves lots of materials and **reduces cost immensely. Also Maximizes living surface area.**

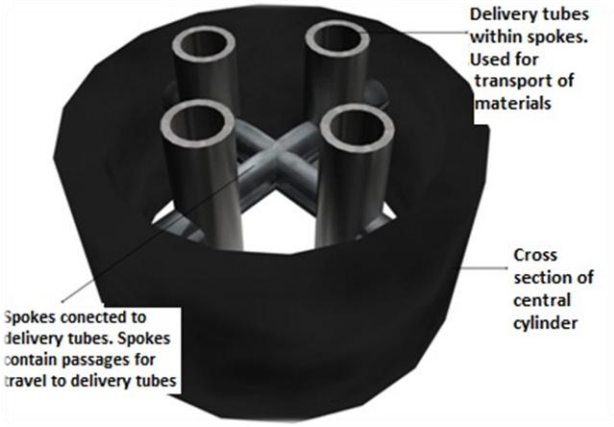


Image Shows Cross Section of Central Cylinder at the Point of Spoke Connection: The **Cylinder** has **4 Delivery Tubes** which will be used for transport of people and materials. **The Spokes** at each **Pseudo-Torus** will be used to enter these **Delivery Tubes.** There are **3 Elevators** within each **Delivery Tube.**

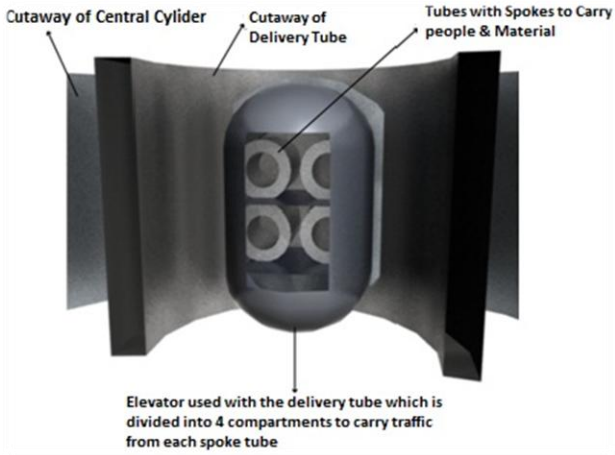
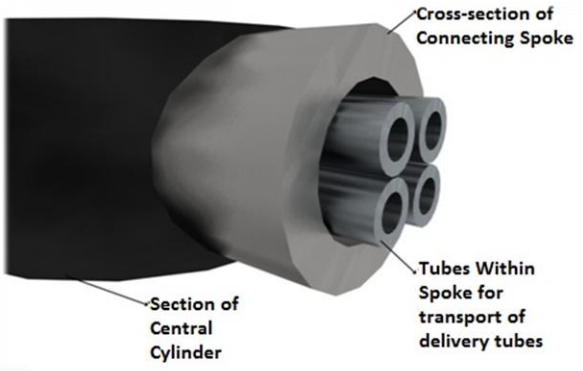
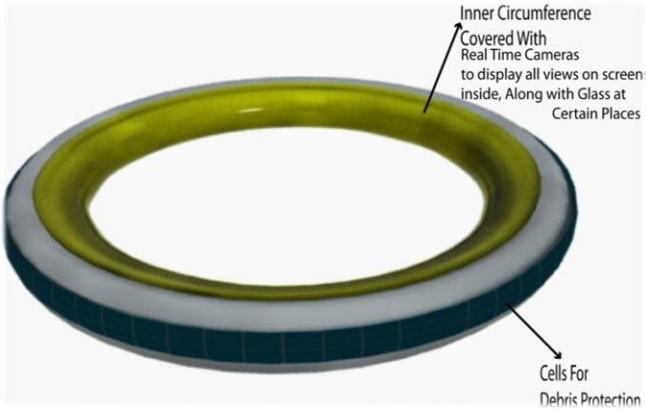


Image Shows Interior View of Delivery Tube:
Image shows the **Interior View of the Delivery Tube.** There are **3** such **Elevators** within the **Delivery Tubes.** These **Elevators** are divided in **4** compartments so that traffic from each **Spoke Tube** can be catered to. These **Elevators** operate side by side and **Rotate** along a Track within the **Delivery Tube** to come towards the **Spoke Entrance** when needed

Image Showing Spoke:
Image shows **Cross Section of Spoke**. These spokes have **4 Tubes** within them. The tubes are used **for transport from within the Pseudo-Torus to the Delivery Tube**. These Tubes have an **internal transport mechanism**. The people who enter these tubes climb onto a vehicle which is assigned to a track. **This track is designed in such a way that it slowly changes the orientation of the people so that they do not need to suddenly change orientation when they reach the Delivery Tube Elevator**





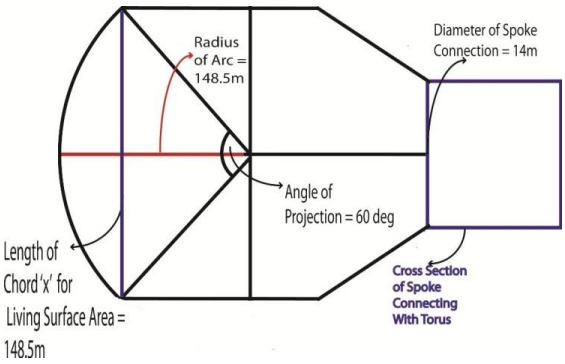


Image shows the Residential Pseudo-Torus and Its Cross Section. The Pseudo-Torus has a **layer of cells for debris protection** (Ref Appendix) which are layered to provide proper support from hits from debris. There is a coating of **glass at some points and real time imaging cameras on the surface** of the Pseudo-Torus which allows light to enter and the cameras display real time images on a screen on the inner side of the Pseudo-Torus ensuring constant views for people while increasing safety. The Cross section shows the dimensions of the Pseudo-Torus. The total Dimensions have been explained in greater detail in the **table of calculations**. The Pseudo-Torus has a gravity of 1g. This has been selected to provide comfort and a natural living environment to Residents.

Image shows the Industrial Pseudo-Torus Cross Section: The Pseudo-Torus has a **layer of cells for debris protection**, which are layered to provide proper support from hits from debris. The Cross section shows the dimensions of the Pseudo-Torus. The Pseudo-Torus has a gravity of 0.6 g. This has been selected to provide enough gravity for industrial processes while minimizing work done against gravity.

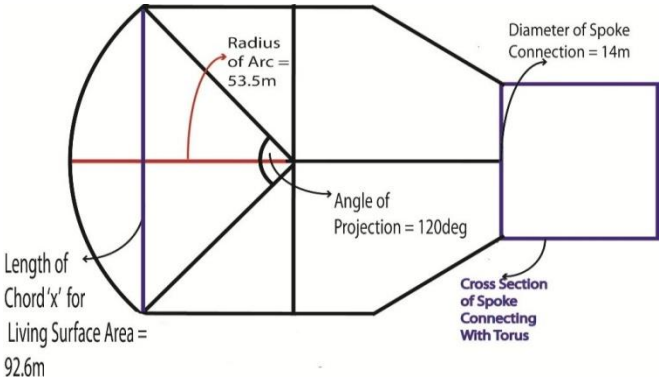
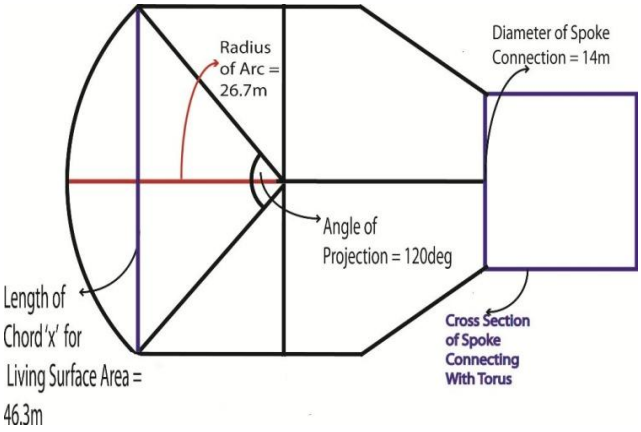


Image shows the Agricultural Pseudo-Torus and Its Cross Section. The Pseudo-Torus has a **layer of cells for debris protection**, which are layered to provide proper support from hits from debris. The Cross section shows the dimensions of the Pseudo-Torus. The Pseudo-Torus has a gravity of 0.3 g. This has been selected to ensure rapid plant growth with better productivity



Settlement Component	Rate of Rotation (rpm)	Radius of Cross Section/m	Length/ m	Surface Area of Cross Section/ m2
Residential Spokes	0.55	7	2750	154
Industrial Spokes	0.55	7	1700	154
Agricultural Spokes	0.55	7	820	154
Central Cylinder	0.55	40	2000	4500
Delivery Tubes X 4	0.55	5	2000	74

2.1.3 Calculations of Settlement Dimensions:

2.1.3 Calculations of Settlement Dimensions:

Settlement Component	Rate of Rotation (rpm)	Radius of Cross Section/m	Major Radius/ m	Minor Radius /m	Length of Chord/ m	Vertical Clearance/m	Gravity at Outer Edge/g	Total Volume/ m^3	Volume Under Floor/m^3
Residential Pseudo-Torus	0.55	90.4	3000	2819.2	65.6	177.1	1.02	2.35×10^{11}	5.1×10^{6}
Industrial Pseudo-Torus	0.55	53.5	1774.3	1667.3	92.6	38.65	0.6	4.87×10^{10}	1.96×10^{7}
Agricultural Pseudo-Torus	0.55	26.7	887.2	833.8	46.3	18.85	0.3	6.1×10^{9}	2.44×10^{6}

2.1.4 Table Shows Materials Used for Construction:

Composition	Purpose	Properties	Volume/m^3
Titanium Alloys Titanium + Aluminium or Vanadium	Skeletal framework of structure	High strength to weight ratio Corrosion resistant High temperature resistance	3.36×10^7
Aluminium Alloys Aluminium +Zinc (Aluminium7000)	Internal structure of settlement	High Strength Moderate toughness Tensile & Yield strengths comparable to steel. Great stretch before ultimate failure.	2.52×10^7
Shape Memory Alloys Nickel + Titanium	Structural Support	Can withstand impacts, and be brought back to original shapes easily. Can be built to any shape and size. High stress yield	1.68×10^7
Super Adobe Regolith	Provides protection against Cosmic radiations	PTFE (Poly-Tetra Fluoro Ethylene) and soil couple to give high resistance against UV radiation and Cosmic rays.	1.68×10^7
Silicone Adhesive RTV Polymer but chemical family is Organopolysiloxane	It will be used as an adhesive.	Good chemical Resistance U.V resistance Flexible No toxicity Wide operating temperature.	1.68×10^6
Silica Aerogel Silicon, Oxygen, Hydrogen.	Thermal Insulation and prevention against thermal shock	Very light weight. Nearly eliminates all methods of heat transfer.	1.68×10^7
Kevlar	Primary debris protection	Extremely high breaking stress Breaks down into strands upon impact which absorbs all or most of the momentum of the projectile.	3.36×10^6
RX-F1 Polyethylene Based Composite	Shielding from Solar Flares & Cosmic Rays.	Stronger and Lighter than Aluminium 50% better shielding against Solar Flares than Aluminium.	2.52×10^6

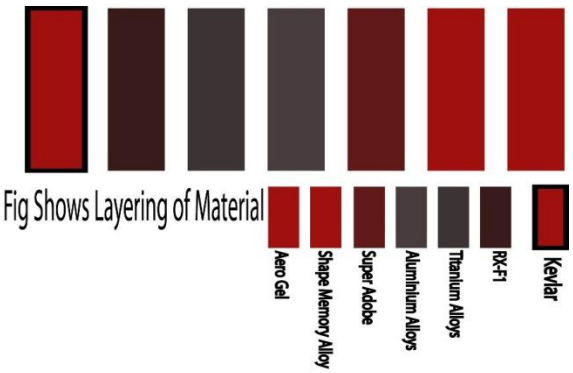
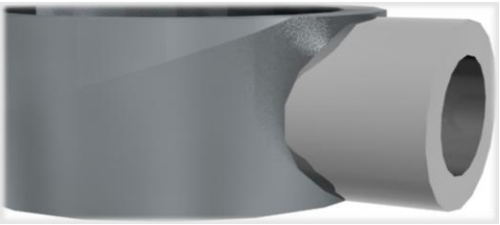
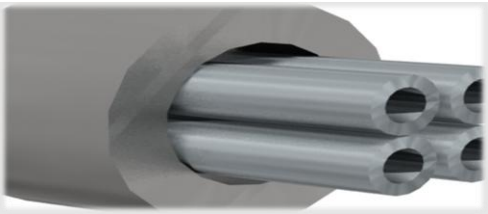
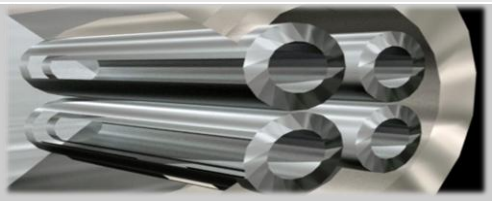
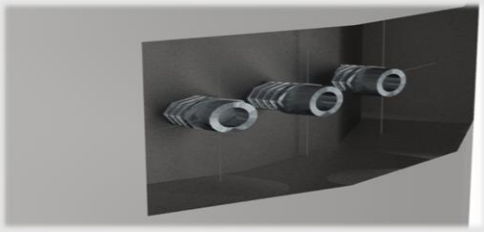
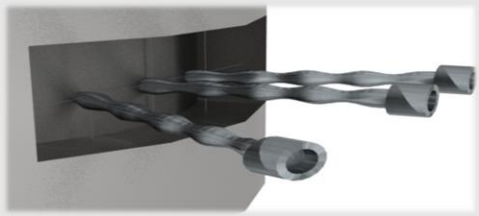
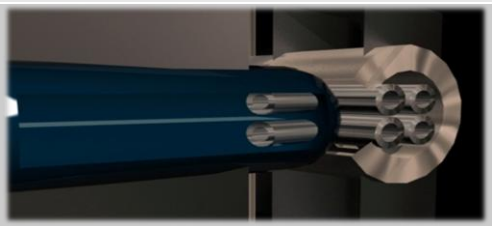


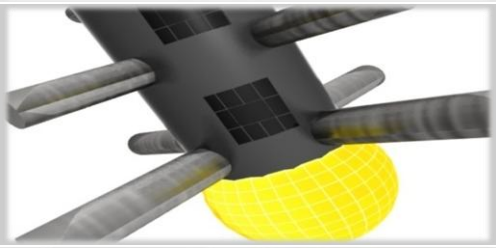
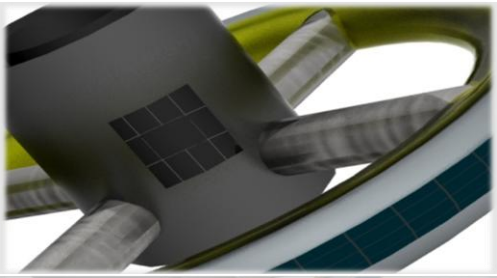
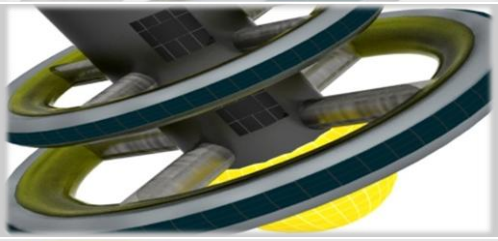
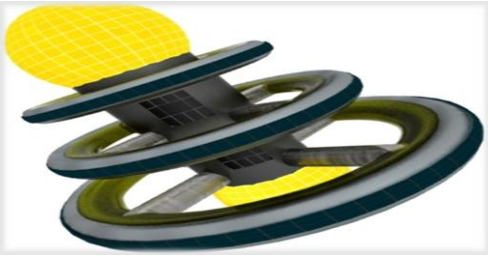
Figure Shows Layering of Material: (Appendix)

2.3 Construction Sequences: To see robots used to automate the construction process (Ref 5.1) the construction sequences will start with initial deployment on Deimos for mining and refining(**Ref 3.3 ,3.4**). **Thrust Initiation (Ref 2.3.1)**

Cost Reduction during Expansion

The expansive capability provided in Aresam is the most efficient and cost effective method. The expansive methods used ensure that we do not need to uproot a large number of people from their houses which reduces costs of movement, other than this as the new structure is built upon the old one we do not need to take a new start in the construction process which saves us time and as we are building upon our old structure we save lots of material as well which once more reduces cost

Phase 1	Construction Sequence
	The 1st phase of the construction sequence will start with material being collected from Phobos/Deimos. We will use this material and start with the Central Cylinder. The Cylinder will be partially completed after which the start of a spoke connection will be made.
	After constructing the initial parts of the spokes which will be attached to the cylinder, we will start completing the rest of the cylinder and we will construct the initial part of the spokes for each Pseudo-Torus as we construct the cylinder. We will join the spokes within the cylinder so that each spoke supports the other.
Phase 2	**Construction Sequence**
	We will construct the initial parts of the spoke tubes within all the spokes.
	These side entry points will be used by people and material which needs to move towards the Central Cylinder. All people and material coming from the docking ports will move into the spoke tubes from this point after which they will move through towards the Central Cylinder.
 	During the construction of the Central Cylinder the Docking Ports will be constructed. The Images show the point where ships will come in contact with the settlement and attach to it. The Tubes are expandable and will expand upon arrival of any ship. After connecting, the tube will become rigid and will allow for the movement of people and materials into the spoke tubes which will take it further towards the Delivery Tubes. (See Below) See Below for further details regarding Docking & Transportation.
	A capsule will be constructed which will connect the docking ports to the spoke tubes. The People and material will move into this capsule from the docking ports and will move into either one of the two tubes. The capsule has been divided into two stories for ease of access.

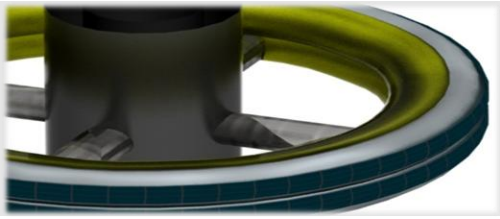
	**After the entry points for the docking stations have been created we will have the delivery tubes within the Cylinder constructed to help us with delivery of materials and people from the docking ports. This will facilitate transport and will speed up the construction process.**
	**2.3.1: After the Delivery Tubes, Docking Ports and Spokes have been built. We will Construct our lower Sphere which will be used to provide energy. As soon as our power production starts working, the engines which we have installed on the Cylinder will take energy from these systems and will initiate thrust. These systems will provide a force until we achieve our desired rpm. At this moment, Artificial gravity will start to act.**
	**After the construction of both Phase 1 & 2 we will have completed part of the Central Cylinder which will be associated with Docking. As soon as we achieve this we will move towards the construction of the Residential Pseudo-Torus. With the construction of the Residential Pseudo-Torus we will start moving engineers within the settlement. The Pseudo-Torus will be built 1 sector at a time, with 4 sectors in total. Each sector will have the ability to seal off in case of emergency (Ref 3)**
	**With the Construction of the Residential Pseudo-Torus complete. We will move towards the construction of the Industrial Pseudo-Torus. At this point we will have created an entire internal system of transportation.**
	**As Soon as Phase 3.1 is complete, we will start construction of the Agricultural Pseudo-Torus and also of our 2nd Sphere which will also facilitate in our power production. At this point we will be able to start bringing in residents to the settlement. At this phase we will have completed construction of all Pseudo-Torii, all Docking Ports, all Delivery Tubes, Spheres for power production and an internal system of transportation. Our settlement will be complete.**

2.1.5 Rotating & Non Rotating Parts:

Our Spheres are non rotating with respect to the settlement, this has been achieved by joining the spheres by an axle which is within the cylinder, the axle is attached to the sides of the cylinder through minimum friction ball bearing, this keeps the sphere stable and also non rotating with respect to the settlement and as the system is very simple, maintenance issues are minimal.

2.4 Ability for Future Expansion: The settlement has been designed to be able to expand according to need. The design of the Pseudo-Torii is such that everything is divided into sectors. These sectors are separate volumes and can be sealed off and separated according to need. Expansion of each Pseudo-Torus will be such that we will build upon each sector, forming a double Pseudo-Torus. This allows us to be able to build 3 more Pseudo-Torii forming a total of 6 Pseudo-Torii arranged in the form of 3 Double Pseudo-Torii.

We need to have accommodation for space vehicles which may be engineered in the near future on mars which may need to dock at the settlement, therefore space has been provided for expansion, and several docking areas have been left with empty slots, these slots will be constructed bearing in mind the requirements of the new space vehicles.

Construction Phase	Construction Sequence
	**As soon as we need to start expanding the settlement, we will start by building atop our Residential Pseudo-Torus. Each Pseudo-Torus is divided into 4 sectors. We will seal of 1 complete sector and start building another sector exactly on top of it. This will be done for all 4 sectors one after another. This method will ensure that while construction is taking place people do not need to be displaced.**
	**After the completion of one sector we will start building the following sectors. Construction will continue until we have a Double Pseudo-Torus.**

Docking & Transport: The docks will cater for all types of space craft including V-STOL and conventional landing and takeoff ones. The VTOL spacecrafts will not need a large space as they will take off and land vertically and don't even need a runway. Hence they will land at the ramp directly the neighboring aircraft will be protected from their wash by a series of walls which will emerge when an aircraft is landing or taking off and will go back in the ground when the aircraft is not in use. **(Appendix)**

Sector	Type of Maintenance	Provision Services	Procedure
Docking Areas	1. Engine Overhaul of visiting ships. 2. Fuelling of visiting ships. 3. Checking of electronic systems of visiting ships. 4. Checking of Fuel storage areas.	1. Replenishment of food for visiting ships. 2. Warehouses for storage. 3. Loading & Unloading systems. 4. Storage Facilities for Hydrazine, Nitrogen Trioxide, Helium-3 and Deuterium. 5. A small medical facility will be provided in the docking areas for detection of any contagious or harmful pathogens.	1. Robo Serve robot used for fuelling and food replenishment purposes as well as loading and unloading towards conveyor belts. 2. TECHNOTRON will be used to check electronic systems and communication systems of visiting ships. 3. U.V radiation used for the detection of cracks or damage to fuel storage areas. 4. There will be technicians and robots at docking stations that will maintain and check the engines of incoming ships. 5. There will be different Fuel storage containers at all docking stations, for storage of Hydrazine, Nitrogen Trioxide, Helium-3 and Deuterium. The largest of these fuel storage containers will be kept at the long term repair dock. 6. A small medical facility with scanners and Robo Protector Robots will scan all incoming cargo and passengers for any harmful pathogens. If detected they will be quarantined for further medical treatment & harmful cargo will be disposed.

2.5.0 Prefabricated Base: The Prefabricated Base will consist of a Dome, which is connected to two smaller Domes through two Tubes. This structure will be inflated upon arrival at mars. The dome will be made of small cells shaped like hexagons, in the pattern usually found on Buckminsterfullerene's these cells have empty spaces within them for thermoset plastic materials. The cells will be filled with these materials which will harden on application of pressure and leave the structure rigid. The structure will have a wire structure made of titanium foldable wires covered with Kevlar thread. This structure will have the cells embedded within it, and when we arrive at mars the

cells will be filled. The internal pressure of the base maintained by the gases will keep the structure rigid and help in setting the thermoset plastics. The cells in the tubes will be rectangular in shape and the same principals will apply to them.

2.5.1 Transport of Robots and Base:

An Updated version of the NASA's Pegasus launch vehicle will be used for launching of surface vehicles, robots and prefabricated bases. This launch system is used due to its relative small size and cheap operational costs.

The Payload will be placed in the center of the Pegasus and the vehicles will take off like a regular spacecraft. But once it is at a suitable distance from the settlement it will deploy its rockets to align with the trajectory, once this is done it will enter the atmosphere of Mars. And will make a soft landing by deploying its reverse thrusters and it will land like VTOL aircraft. This will ensure that equipment is brought where it is needed, not to some centralized airstrip, which in will reduce the operational cost of the Bases on Mars.

2.5.2Calculations of Inflated Prefabricated Base:

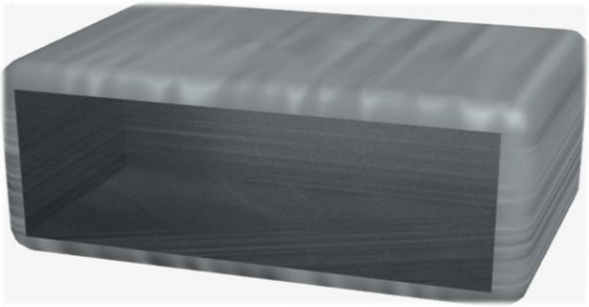
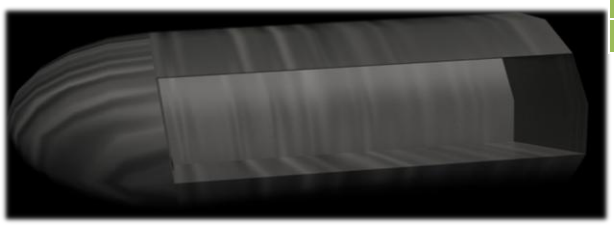
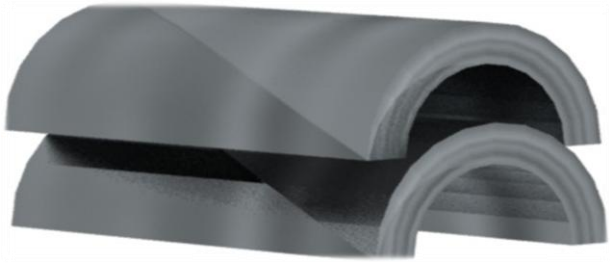


Image Shows Container with dimensions of 4 X 4 X 9 this will carry the Capsule

Total Volume of base	**1320000+4800+66000 =1390800lit =1390.8m^3**
Volume of connecting tubes	π x 2x1.5x5x2/2= 15π m^3
Volume of the spherical domes	1390.8-15π = 1343.7 m^3
radius of smaller dome	5.44m
the radius of the larger dome	6.85m
Minor Radius (Tubes)	1.5m
Major Radius (Tubes)	2.0m
Length (Tubes)	5.0m

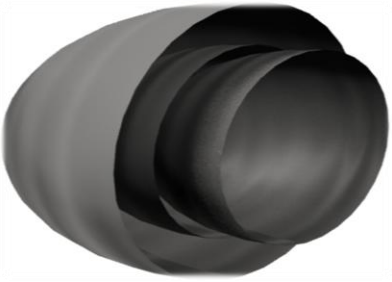


2.5.3 Image shows the capsule which will contain the prefabricated base before it is sent out to mars. The Hemisphere of the Capsule is to contain the non inflated Dome. The Rectangular portion of the Capsule will contain the non inflated tubes. This Capsule **WILL FIT into the 4 X 4 X 9 container.**



2.5.3: Image Shows Non Inflated Domes Fitted Within Each Other During Transport The Domes will be fitted within each other in the hemispherical part of the capsule. It will be easy for the two space suited astronauts to assemble these with the help of the construction robots. **(Ref Sec 5)**

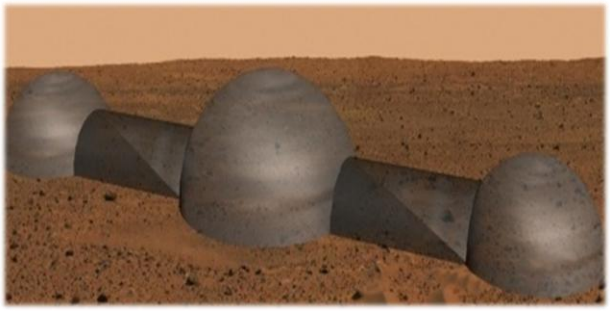
2.5.3: Image Shows Non Inflated Domes Fitted Within Each Other During Transport These Tubes will fit within each other during transport. As all parts of the prefabricated base are ready, apart from inflation, it will take very little time for our astronauts to complete the assembly



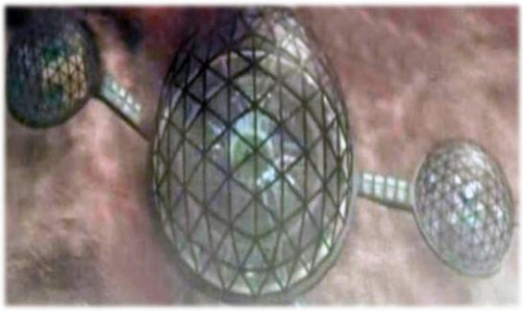
2.5.4 Images Shows Start of Deployment of the Prefabricated Base: (Below)

The Domes and the Tubes will be brought out of their Capsule, and will be placed on the Martian surface. After these are put together, we will join some of the cells of the Tubes and the Domes to give air tight packing and a joining medium for the Tubes and the Dome.

2.5.5 Images Show Interim Prefabricated Base:



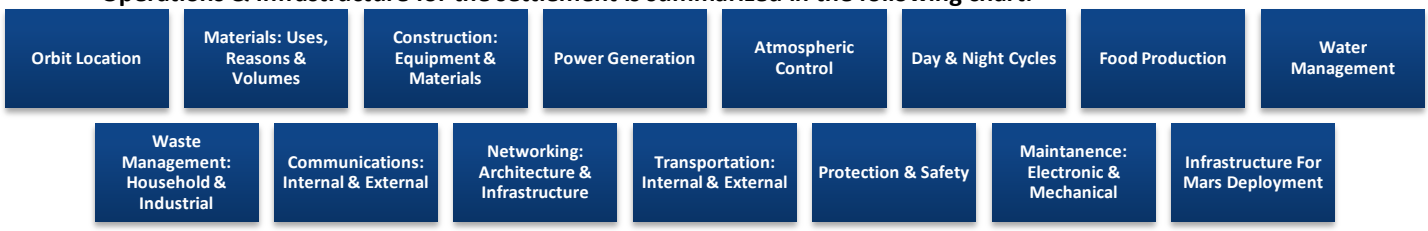
2.5.6 Image Shows Final Prefabricated Base



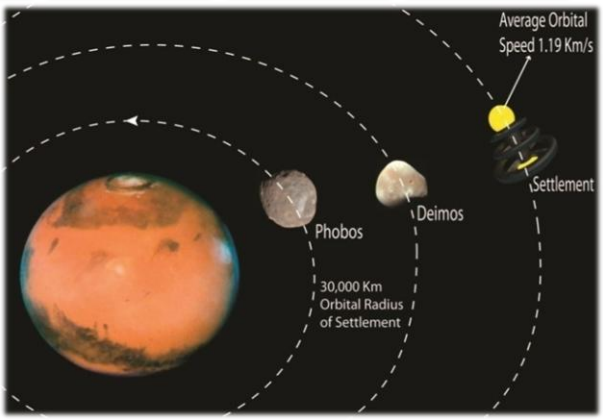
3.0 Operations & Infrastructure

If humans are to settle in space and in turn use their settlements as a base for further exploration, the operations and infrastructure related to their survival and purpose of exploration must be good enough to cater to each one of their needs. Aresam will be a residential settlement which shall provide the link between Mars and the human race. It will be a platform for all research and exploration on Mars and will be a base for all engineers and scientists developing an infrastructure on the Red Planet. As Aresam is a "gateway" to the Red Planet the operations and infrastructure have been carefully divided so that each aspect is detailed and provided with proper attention.

Operations & Infrastructure for the settlement is summarized in the following chart:



3.1 Settlement Location: Aresam will be constructed in the orbit of Mars. It will have a circular orbit which will be able to provide the settlement with constant exposure towards the sun. The radius of the orbit will be **30,000Km.** It has been made sure that the settlement does not become a direct part of the gravitational system of Mars and its moons. The settlement's radius of orbit ensure that the settlement remains in orbit around mars without experiencing any 'gravitational turbulence' which might be experienced due to energy changes within the gravitational system of Mars and its moons. Automated thrust systems will be used to control the settlements



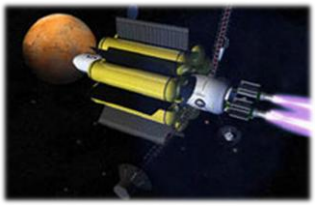
angular velocity and to ensure that its time period does not alter. The **Orbital Inclination** has been taken to be **0.93°** with respect to the Mars equator. The **Average Orbital speed is 1.19Km/s**. The **Orbital Period is 1.83 Days.** Using **Kepler's Laws we have calculated that the Settlement behaves exactly like Deimos. We have calculated that Mars will block our view of the sun once a day for a maximum of 1 hour 20 minutes. This will happen for 4 months. (Ref 3.2.1)**

3.1.1 Materials Used for Construction:

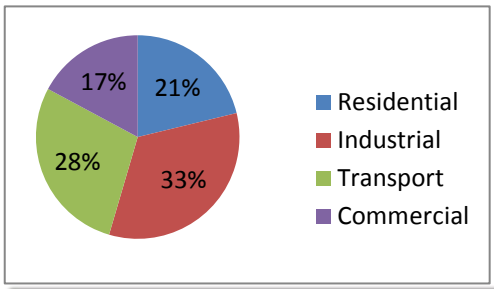
Composition	Purpose	Properties	Source	Storage	Transport	Volume/m^3
Titanium Alloys Titanium + Aluminium or Vanadium	Skeletal framework of structure	High strength to weight ratio Corrosion resistant High temperature resistance	M-Type asteroids from The Asteroid Belt	Stored in the Industrial Pseudo-Torus As a raw material Also stored for refining on Deimos	Low cost Transportation From Asteroids Close by in the Asteroid Belt. Transportation can Be done using VASIMR	3.36×10^7
Aluminium Alloys Aluminium +Zinc (Aluminium 7000 series)	Internal structure of settlement	High Strength Moderate toughness Tensile & Yield strengths comparable to steel. Great stretch before ultimate failure.	M-Type asteroids from The Asteroid Belt	Stored in the Industrial Pseudo-Torus As a raw material Also stored for refining on Deimos	Low cost Transportation From Asteroids Close by in the Asteroid Belt. Transportation can Be done using VASIMR	2.52×10^7
Shape Memory Alloys Nickel + Titanium	Structural Support	Can withstand impacts, and be brought back to original shapes easily. Can be built to any shape and size. High stress yield	M-Type asteroids from The Asteroid Belt	Stored in the Industrial Pseudo-Torus As a raw material Also stored for refining on Deimos	Low cost Transportation From Asteroids Transportation can Be done using VASIMR	1.68×10^7
Super Adobe Regolith	Provides protection against Cosmic radiations	PTFE (Poly-TetraFluoro Ethylene) and soil couple to give high resistance against UV radiation and Cosmic rays.	Soil of Deimos Soil of Mars	Available on Deimos's Surface.	Mass Drivers Will be used to Propel Material from Deimos's surface To the Settlement.	1.68×10^7
Silicone Adhesive RTV Polymer but chemical family is Organopolysiloxane	It will be used as an adhesive.	Good chemical Resistance U.V resistance Flexible No toxicity Wide operating temperature.	S-Type asteroids from The Asteroid Belt	Processed on Deimos's refining Base and sent to The Settlement Using Mass Drivers	Low cost Transportation From Asteroids Close by in the Asteroid Belt. Transportation can Be done using VASIMR	1.68×10^6
Silica Aerogel Silicon, Oxygen, Hydrogen.	Thermal insulation and prevention against thermal	Very light weight. Nearly eliminates all methods of heat transfer.	S-Type and C-Type asteroids from The Asteroid	Processed on Deimos's refining Base and sent to The Settlement Using Mass Drivers	Low cost Transportation From Asteroids Close by in the Asteroid Belt. Transportation can	1.68×10^7

	shock		Belt		Be done using VASIMR	
Kevlar (Strands of poly-paraphenylene terephthalamide)	Primary debris protection	Extremely high breaking stress Breaks down into strands upon impact which absorbs all or most of the momentum of the projectile.	Raw Materials Found on Deimos's Surface It is classified As a C-Type Asteroid	Processed on Deimos's refining Base and sent to The Settlement Using Mass Drivers	Mass Drivers Will be used to Propel Material from Deimos's surface To the Settlement	3.36×10^6
RX-F1 Polyethylene Based Composite	Shielding from Solar Flares & Cosmic Rays.	Stronger and Lighter than Aluminium 50% better shielding against Solar Flares than Aluminium.	S-Type and C-Type asteroids from The Asteroid Belt	Processed on Deimos's refining Base and sent to The Settlement Using Mass Drivers	Low cost Transportation From Asteroids Close by in the Asteroid Belt. Transportation can Be done using VASIMR	2.52×10^6

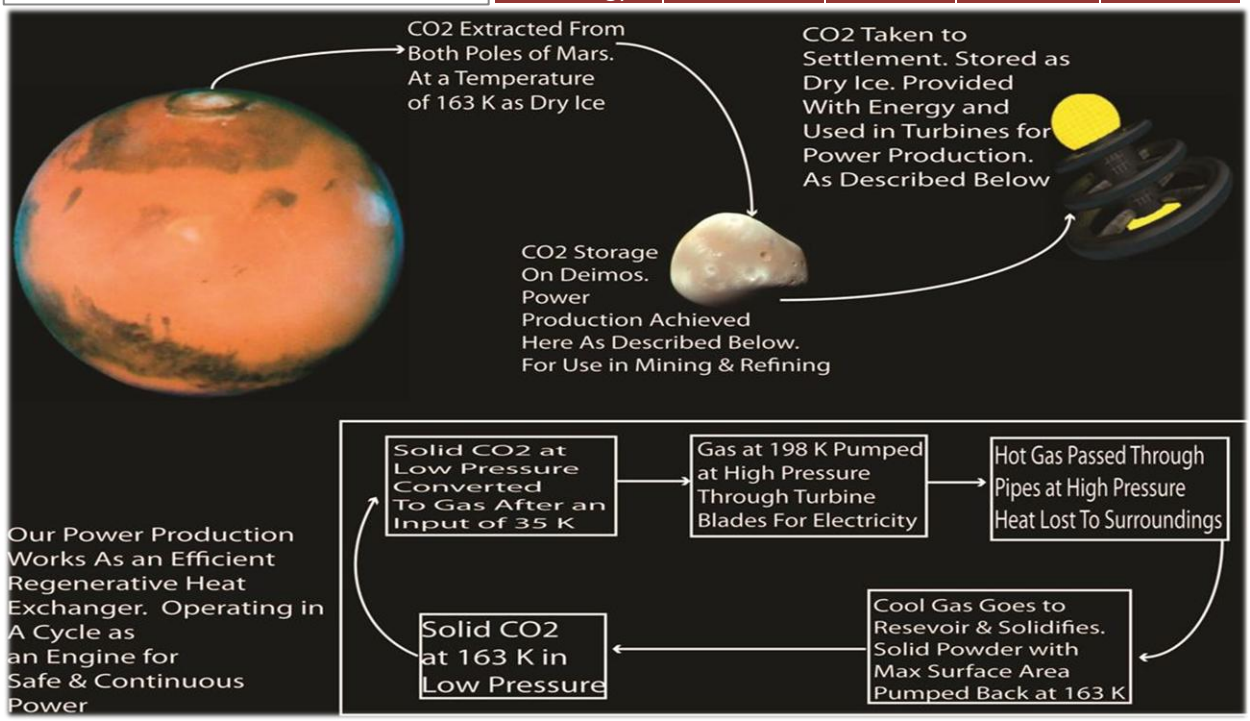
3.1.2: Transport Vehicles: Our transportation costs have been majorly reduced. Our position in orbit further away from Deimos puts us closer to the Asteroid belt which is a source of nearly all materials needed for construction and maintaining operations. Our position near the Asteroid belt means that our interplanetary costs are majorly reduced. All raw materials are available, and the **Main belt comets** are a source of water. All important materials being found so close by results in our using expensive means of transportation only during the initiation of operations on Deimos. After this is done, our raw materials will be found in our Asteroid belt and all transportation costs will be reduced dramatically. This also means we can **nearly eliminate** the very inefficient process of mining on Deimos. For details on how to improve mining (**Ref sec 3.4)**

Type	Purpose	Status	Description	
Heavy Lift Launch Vehicles (HLLV)	Transportation from Earth to Lower Earth orbit	Included	HLLV have huge fuel tanks, initial thrust and capacity and so they're capable of lifting more than 30,000 lb (14,000 kg) from Earth to Lower Earth Orbit. **ONLY NECESSARY FOR INITIAL OPERATIONS. MATERIALS NOT NEEDED CONSTANTLY FROM EARTH / FAR AWAY.**	
Variable Specific Impulse Magnetoplasma Rocket (VASIMR)	Transport of heavy material in bulk from Lower Earth orbit to Moon	Included	Electromagnetic thruster for spacecraft propulsion. Radio waves are used to ionize a propellant and magnetic fields are used to accelerate the resulting plasma to generate thrust. Velocity can range from 30 – 300 km/s	
Mass Driver	Transportation of materials from Deimos to Aresam	Included	A method of space launches which does not use rockets. This driver accelerates the container carrying cargo, by using the principles of electromagnetism. The container is accelerated until it reaches escape velocity after which it is released.	

3.2.1 Power Production:



Energy Per Person Per Capita (U.S.A.)	Consumption By30000 People/Year	Energy Needed /Year	Energy Needed/ Day	Energy Needed/ Hour
24.8 Barrels of Oil/ 16864 KWh of Energy	**5.0×10^{11} KWh**	**5.0×10^{11} KWh**	**1.4×10^{9} KWh**	**5.75×10^{7} KW**



- Our entire infrastructure and the systems depend upon our power production. The Sun generates **63 000 W/m^2 of light** out of which we will be able to get **589.17W/m^2.** This includes light reflected from and from the sun directly and from the other planets as well.
- Our power production systems will be divided into 2 sectors of the Industrial Pseudo-Torus and within the two spheres in our settlement. One sector will contain solar panels while the second will have super capacitors and rechargeable batteries. The two spheres will have our turbine systems which will use the light energy to produce power using the conventional method of the steam turbine as shown. This will ensure that incase we face problems in any way our backup systems remain intact and functioning.

We will use sunlight as our constant source of energy. Solar Cells will be used along with Super Capacitors and rechargeable nickel hydrogen batteries as backup systems. We plan to install batches of multi mode fibre optic cables on the surface of our settlement and any light falling on these cables will be directed towards mirrors within the settlement which will redirect these light beams; Fresnel lenses will be used to concentrate them. **The energy from the concentrated light beams can be used to make electricity from conventional methods such as making steam to drive turbines**.

- A steam turbine which receives **1000 litres of water/hour has a power rating of 6 x 10^5 W** and according to the energy consumption in USA we will need **5.75 x 10^7 W of energy per hour for our entire settlement**.
- Using **10 turbines of 6MW** each, we will consume **100,000 litres of water and generate 4.8 x 10^7 W of energy; 3 MW extra**. The extra energy can be sent to our battery systems for their charging.

However, water will consume a sufficient amount of energy to boil as the temperature is approximately 163 K therefore we **plan to use Dry Ice as the replacement for water**. **As Shown in the Diagram our Method of power production works as an efficient regenerative heat exchanger. This method eliminates the need for costly methods of alternative power production, it also provides us with the ability to carry out processes like those on Earth, as we have sufficient power generation at all times**

- Along with providing heat energy the Fresnel lenses will be used on our solar cells to make them more efficient as they will receive concentrated sunlight. This will be especially useful when we need a large amount of initial current in heavy industrial processes.
- Our super capacitors will be used parallel to our solar cells and nickel hydrogen batteries. They will be especially useful when we need to shift between power systems, allowing for shifts between systems without losing any power in the process.
- The fibre optic cables which we use will be divided into sections along the settlement. Light from these fibre optics along with being used for power generation will also be directed towards our agriculture area. This will ensure efficient agriculture as we will have constant photosynthesis which will ensure that the proper oxygen supply in the settlement, and we will have a large agricultural output ensuring that proper food supply in the settlement.

It must be noted that we will face 4 months of time when there shall be blockage of light for a maximum of 1 hour 20 minutes. We will switch to batteries for this time.

3.2.2 DAY/NIGHT CYCLE PROVISIONS: Aresam will provide a 15-hour period of day and 9-hour period of night time. The sunlight will come into the settlement by the use of mirrors within the settlement which will receive sunlight from the batches of fiber cable optics installed There will be mirrors with shutters which will be closed when light is not needed in a particular area or we will automate the mirrors so that they angle themselves differently and focus their light at other areas. For the Agrarian Pseudo-Torus

3.2.3 ATMOSPHERE AND WEATHER CONTROL: Atmosphere composition: 78% Nitrogen, 21% Oxygen, 0.03% Carbon dioxide and 1% Noble Gases. Pressure maintained would be the same as the atmospheric pressure i.e. 101325 Pa. In the agrarian sector though there would slightly higher levels of Carbon Dioxide replacing some of oxygen, this higher level of Carbon dioxide would be helpful in the photosynthesis of plants. An automated atmospheric monitoring facility will maintain the air composition by using gas pumps. Natural vegetation will also help to maintain the atmospheric composition.

Sector	Volume/m^3	Volume/N_2	Volume/O_2	Volume/CO_2
Residential Pseudo-Torus	2.35×10^{11}	1.83×10^{11}	4.93×10^{10}	**7.5×10^{7}**
Industrial Pseudo-Torus	4.87×10^{10}	3.8×10^{10}	1.02×10^{10}	**1.46×10^{7}**
Agrarian Pseudo-Torus	6.1×10^{9}	4.75×10^{9}	1.28×10^{10}	**1.83×10^{6}**
Connecting Spokes	3.25×10^{6}	2.53×10^{6}	6.82×10^{5}	**9.75×10^{2}**
Total	2.89×10^{11}	2.25×10^{11}	6.10×10^{10}	**8.67×10^{6}**

Oxygen would be produced by chlorate candles (or oxygen candles). They are a mixture of sodium chlorate and iron powder. When ignited, the mixture smolders at about 600 °C, producing sodium chloride, iron oxide, and a lot of Oxygen. They produce about 6.5 man-hours of oxygen per kilogram of the mixture and releases oxygen at a fixed rate. The candles can be brought in bulk and stored in the Central Cylinder. The mixture has an indefinite shelf life if stored properly; candles stored for 20 years have shown no drop in oxygen output. **Our Oxygen Can also be produced by this process: $nCO_2 + nH_2O = (CH_2O)n + nO_2$** The CO_2 is extracted from the poles of Mars and the water can be easily found in the **Main Belt Comets**. Our large available source of water and the close proximity of the

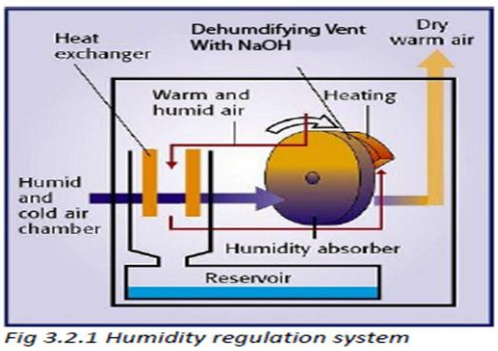


Fig 3.2.1 Humidity regulation system

source make this an ideal process.

Humidity Control: Humidity levels in air would be maintained the same as that present on Earth, of about 40% level. Vents would be used containing solid Sodium Hydroxide (NaOH). As air would be passed through these vents, all of the moisture present in it would be absorbed by the solid Sodium Hydroxide and only dry air would come out from the other side.

Heaters would be placed beside these vents to continuously provide heat to the NaOH, this would separate the absorbed water from the NaOH vents. The water would be collected separately and controlled amount of water can then sprayed into the air later to maintain constant humidity.

3.2.4 FOOD PRODUCTION: **Growing:** There are a variety of options available for choice of cultivation medium for the settlement. First, nutrient-rich spoil which supplies most of the minerals needed for healthy plant growth could be brought from the earth and used as a medium. Secondly lunar soil, (from the Earth's moon) which contains particularly high amounts of Oxygen (42 percent), Silicon, Iron and Magnesium could be brought in for cultivation in the agricultural Pseudo-Torus. Thirdly, aeroponics and hydroponics could be employed as cultivation techniques, in a way similar to that on earth, when fertile soil is not available or for roof gardens. It should be noted that practicality issues will be most pronounced in using soil from Deimos and Phobos, because the composition of the soil is not certain. Hence this possibility should be excluded for cultivation.

Soil/ Method of Growth	Advantages	Disadvantages
Earths Soil	Safe, earth-like produces from major crops.	Crop rotation has to be practiced, to replenish exhausted soils. Huge expenses involved in transporting soil to the settlement. Careful maintenance of soil pH (6.5-8) will be necessary.
Hydroponics/ Aeroponics	Removes the need to transport/ use soil Output similar to that of soil Regulation of nutrient content easier Yield output in shorter time Aeroponics allows excellent root aeration	An entirely aqueous base for cultivation stimulates motile bacteria to grow Certain plants will not survive for long with the roots immersed in aqueous solution

See Appendix for detail on Aeroponics & Hydroponics.

Type of Nutrient	Composition	Uses
Macronutrients	Nitrate Magnesium Potassium Calcium	• Production of plant proteins, such as enzymes and tissue components. • Synthesis of photosynthetic pigment which harness light for the process essential for seed germination • Operation of sodium-potassium pumps in plasma membranes enhancement of flavour • And colour in crops • Adds to strength of cell wall Facilitates cell division
Micronutrients	Cobalt Silicon Sodium	• nitrogen fixation in nodules of legumes • provides resistance by addition to cell walls • maintenance of osmotic potential Operation of sodium-potassium pumps

3.2.5 Food Storage & Delivery:

Food Production	Process	Advantages
Harvesting	We will use an agricultural robot called Agro Bot. These robots will be equipped with threshers, pluckers and crushers. Robots will be assigned to different crops and will be programmed to harvest and process each crop at its optimum	Using robots will make things very efficient and less time consuming. Each robot will be able to store its designated crop to a different

	time.	compartment which will make storage easier.
Storing	Compartments will be made in the storage facility for different crops. Each robot will deposit its harvested crop to its designated compartment. Storage area will be regularly disinfected and sterilized.	Healthy and fresh crops will be grown. Quick availability for residents. Very efficient and will give greater productivity with less wastage.
Packing	Harvested food will be packed using shrink wrap. Batches of each crop will be collected and packed separately with a colour coded system.	Shrink wrap will protect from disease during transportation. Good surface for stick on labels. Reduces weight of packing material. Less wear and tear of transportation systems.
Delivery	Elevators operating from gas pressure will be used for transport. These elevators will already be operating in bringing cargo to the commercial Pseudo-Torus. They will take food from the agro ring and will deliver it to the food storage area in the residential Pseudo-Torus. Robo Serve will deliver the food items to the supermarkets.	We will not be using a separate delivery system for cargo and food. Robots will be efficient in transporting and replenishing food items in living areas.
Selling	There will be a supermarket business. The food items delivered by Robo Serve to the supermarkets will be sold to residents. Transactions will be done through the consumer chip attached within each residents arm.	When transactions will be done by the consumer chip, there will be no mess of receipts and no currency will be needed.

Water consumption by a person for domestic purposes	**12 litres/day**
Water intake by 22,500 inhabitants	**360,000 litres/ day**
Other	**2,080,000 litres/day**
Total water consumption/day	**2,440,000 litres/day**

3.2.6 WATER MANAGEMENT: Water is one of the most important resources for the settlement; careful handling of it is required. A main reservoir and two sub reservoirs will be used. Reservoirs in the agro and industrial Pseudo-Torus will be bigger in size and though built on ground, will provide water to all levels. Near each sub reservoir will be a water purification plant. Two pipelines will be used, one for carrying fresh water and one for bringing back contaminated water to the purification plants. Pumping stations will be used for a regular flow of water and also to maintain a suitable water pressure. **Due to our position near the Asteroid belt, we will have access to the Main belt Comets, which will be our source of water. This ensures a vast supply of water which increases possibilities for industrial work which require large amounts of water.**

Water purification: A water treatment plant would be set up which will clean all the contaminated water. Flocculation would be used to join together large particles and filter them out, chlorination would be done and water would be passed over activated Charcoal to remove odors. Water waste from humans shall also be treated like this.

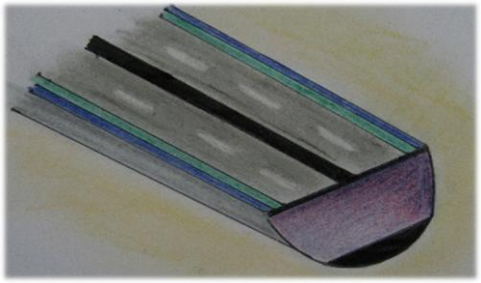
3.2.7 Household & Industrial Waste Management: Solid wastes from houses will be collected at a small dump present on the station. Waste materials would be brought here by robots that would act as garbage collectors once per week. On the dump, materials would be stored separately according to their different classifications which would help in recycling them.

A recycling plant would be present besides this dump and would convert normal wastes like paper to a reusable form. Industrial waste would be transported using underground capsules to the dump. These capsules would

propel at high speeds when heated and pressurized industrial waste gases would strike them bringing them to the dump in a short amount of time.
Once there, operations would be performed on waste materials in the following ways:

Type of Management	Processing	Benefits
Garbage Incineration	1000's of tons of waste materials will be combusted in one day at high temperatures to give out energy	The energy produced can be used to produce excess electricity
Biological reprocessing	Organic wastes can be recycled using biological digestion or composting.	The organic material is then converted to compost which can be used in agricultural and landscape uses

Materials which cannot be recycled or are of no use any more would be transferred from the station and dumped on asteroids that have been completely used up or are of no use to us.



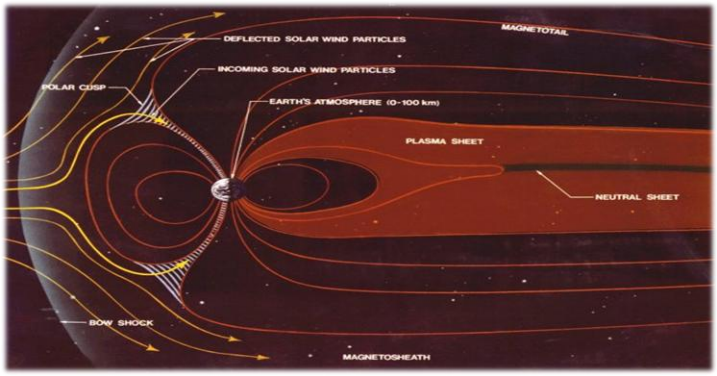
3.2.8 Internal & External Transport: For internal transport of residents, each resident will be provided with a special bike, which can fit into the wall of the resident's house. (Ref 4.2) This bike will be used by all normal residents for transport within the residential Pseudo-Torus. Lifts powered by gas pressure will be used for transport between different sectors of the settlement. Also, residents with disabilities will have special automated transport systems which will take them wherever they want to go. The Robo Serve robot will also help residents with disabilities by performing tasks which are difficult for them. A belt will be made in the settlement that will constantly move, residents with disabilities and those who do not wish to use their bikes, can travel on these belts, which will take them wherever they need to be. For external transport we will use re launch able spacecraft for the transportation of humans. For transport in the spoke tubes, we will have small train like compartments moving on a track, this track will curve within the tubes in such as a way that when the people reach the delivery tube, they do not feel a sudden gravity gradient and they do not need to change orientation suddenly.

3.2.9 Internal & External Communication: We plan to use radio waves for intra settlement communication along with this we will use WiMax within the settlement, data transference with WiMax will be up to 74Mbps. For communication to Earth we plan to use medium Earth orbit satellites using S-Band communication antennas. Communication between residents will also be possible through the bio matrix consumer chip implanted in each resident's arm. A special watch given to residents will create a holographic image which will allow residents to communicate in a virtual reality. The TECHNOTRON robot will be used to correct any faults in the communication systems. **Also Refer (5.4)**

External communication will be done using medium Earth Orbit satellites that are based on S-Band communication antennas. The use of S-Band communication antennas will also enable the use of WiMax.

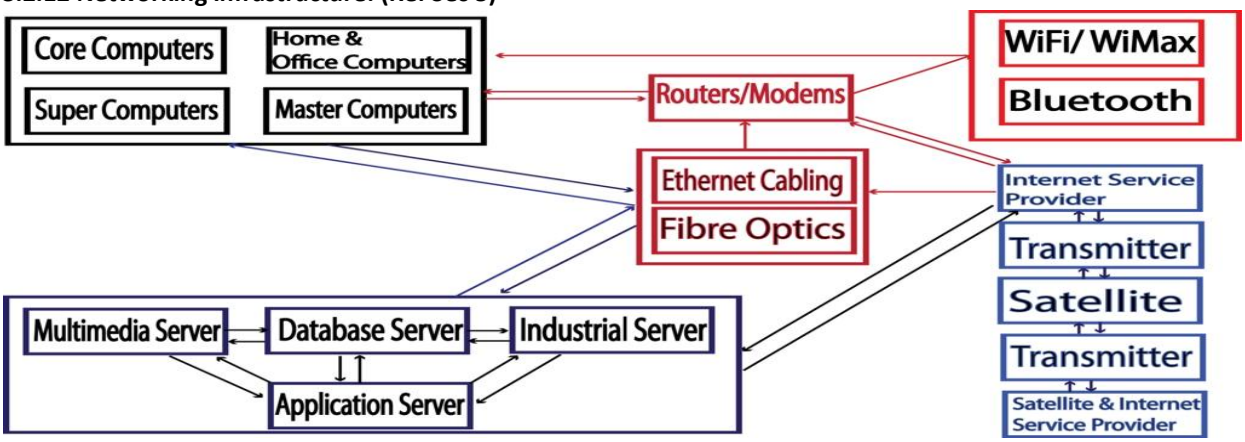
3.2.10 Protection & Safety of Residents: The safety of our residents is of the utmost importance. We will have rescue ships at various points in our settlement. These rescue ships will basically be kept towards the outer edges of the settlement and in case of an unforeseen emergency we will evacuate our residents using these ships. These ships will run on mini nuclear reactors, because we can always rely on such fuel to run and it will not consume a lot of space. For protection and safety within the settlement we will have a small block within the Administrative district in all 3 residential sectors. This block will contain teams for fire protection, crime protection and health emergencies. Each team will have humans and robots working in collaboration. A special set of transport vehicles will be used for health emergencies and for fire protection purposes. **(Appendix)**

3.2.11Settlement Protection & Safety: Various protective systems have been designed to keep Aresam safe from threats such as space debris and solar wind activity. The sun has a peak of solar activity in 11 year cycles, during these periods of intense solar activity there are coronal mass ejections and the solar wind, which is a stream of super charged particles, is flung out into space. These particles can cause the electric fields and electric systems to malfunction; therefore an electromagnetic shield will provide Aresam with an electromagnetic field **(Appendix)** such as the earth, in order to deflect the solar winds **(ref. fig.).** The last solar maximum was in 2001 and if extrapolated, we should expect a peak of activity around 2056 which is at the time when our settlement will be in construction.



Radar systems have been installed within the settlement, which use the Doppler Effect to map out and identify incoming objects. These radar systems can make a map within 300 degrees of their installation area, therefore we will have 4 such systems along each section of the Pseudo-Torii to ensure that all incoming objects are located and identified. Once the threat has been detected, the system will activate weapons which will depending on the size of the object, either destroy it or hit it so as to deflect it away from the settlement. The settlement has been constructed in such a way, that if any part of the settlement is damaged and poses a threat to the rest of the settlement, the part will be detached and thrust into space. Also, in case a part cannot be detached, it will be sealed off and unpressurized. All the Pseudo-Torii will have 4 areas which will have sealing doors for emergency purposes. As the Pseudo-Torii are each divided into 4 sectors we will have the capability of sealing off any sector according to need. Each sector will be provided with a rescue ship incase an emergency escape needs to be made.

3.2.12 Networking Infrastructure: (Ref Sec 5)



3.3 Equipments and Functioning: The **transporter train (ref 5.1)** consists of 6 large carrier chambers. The prime purpose of this is to carry harvested/refined materials to and fro from mining base, refineries and construction robots. Purpose of having numerous chambers is to separate and sort out materials. For this we can have each chamber made of different materials and of different shapes e.g. we can have central chambers which consist of oil tanks and cylinders to carry fuel and gases to either space ships or working robots or even machinery used in mining base and/or refinery. Once the settlement has been completed, this carrier train can be used for carrying food (grains) and materials for internal constructions.

The **Builder Ship** is the major construction ship. When refined and purified materials are brought to it, with the help of its accessories and tools, it shapes out the required construction object or the part to be used in settlement. The builder ship shall be used for large scale construction. It is used for breaking down the harvested material into smaller pieces (crushed) so that they can be processed and also after the material is refined and processed for carving and shaping. The large storage room under it stores materials temporarily for both stages i.e. for carving and breaking down. When the builder ship has done its work, the materials stored in the storage room

are again handed over to the carrier train which further transports them to the rest of the construction robots for later processes.

There are three types of worker robots working for the construction of settlement directly. The work of these three is inter-linked as they support and assist each other. Out of these three **Worker X (ref 5.1)** and **Worker Y (ref 5.1)** are the main construction robots. Worker X mainly shapes the small and complex components to be used in constructions which can be internal as well as external. Worker Y carries materials to worker X and Worker Z mainly due to the ease of movement within the settlement as it is supported by wheels. **Worker Z (ref 5.1)** is also named as the GUIDE WORKER as it orders the other workers where to cut, weld, drill or hammer. Worker X and Worker Y work on the basis of laser guidance. Using the camera, Worker Z first judges the given shape and the current shape of the object and then spots the point using laser where either of the workers needs to cut, drill, weld or hammer. Worker Z also carries the materials made by other robots and attaches them to any part on the Pseudo-Torus as it can move easily due to its ability of adhering to walls of Pseudo-Torus using its feet and can carry objects of various weights with the help of its hook.

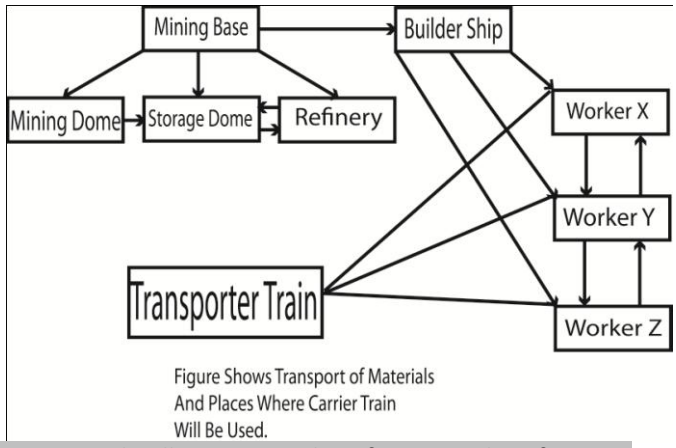
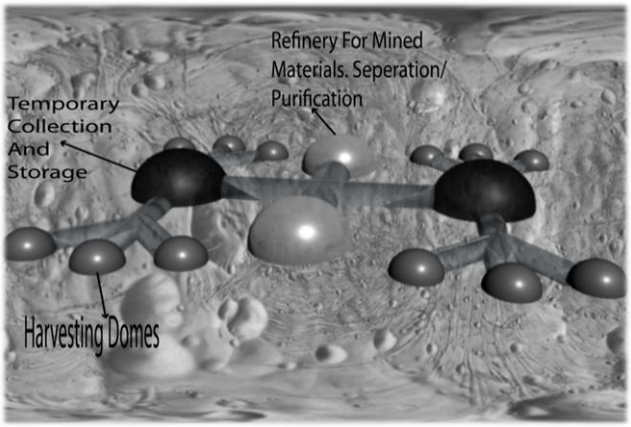


Figure Shows Transport of Materials And Places Where Carrier Train Will Be Used.

3.4 Harvesting Operations: Once we land on Phobos/Deimos, the first thing to do is to have mining bases and refineries established. Both of these shall be located adjacent to landing station. Establishment of all these shall form a small transit colony where primitive construction of parts for the settlement shall be done. **Mining on Deimos will be a very inefficient process and will consume a lot of energy. Therefore, we must use materials from the Asteroid belt. We will find Asteroids which consist of Metals, Silicates and Carbon compounds. As we are very close to this belt, we will not have any transportation costs and our mining cost will be reduced dramatically. All these asteroids must be brought to Deimos which will be the main place for all refining and construction. All raw materials will be available and as the escape velocity of Deimos is just 20Km/h we will not need to provide a lot of fuel to work against gravitational attractions. Therefore, it is suggested that WE SHOULD NOT WASTE ENERGY IN MINING. We should use THE ASTEROID BELT for raw materials which will be available in bulk at a very low cost.**



3.4.1 Mining Base: The following diagrams show the mining base which will be constructed on the moons of Mars. These bases will process and refine material, which will then be manipulated by robots and used for the construction of the settlement.

Harvesting domes drill out the minerals and using shovels and automated arms, transfer them to the tubes.

In the tubes, materials move on conveyer belts and are brought to the storage domes.

Storage domes are further divided into two sectors.

The material that comes to storage domes is then sent to refineries.

The refined material is then sent back to the storage dome which then further supplied to Builder Ship and rest of the construction robots by transporter train (as shown in the material flow diagram).

To divide work load, these storage domes and refineries are connected and this can also be expanded by having more connected refineries or storage domes.

3.5 Food, power, water, and waste systems for Prefabricated Base: (see Appendix A)

	per person (per day)/ liter	For 4 Persons (per day)/ liter	For a total of 30 days/liter
Volume of air inhaled	11000	44000	1320000
Oxygen consumption*	**550**	**2200**	**66000**
Carbon Dioxide Production**	**381.7**	**1526.8**	**45804**
Water	40	160	4800

Food and Waste:

	Per person per day/kg	For 4 persons per day/Kg	For 30 days/Kg
Food	2.5	10	300
Waste	2.1	8.4	252

Power:

	Per person per day/KW	For 4 persons per day/KW	For 30 days/KW
Power Consumption*	54.8	219.2	6576

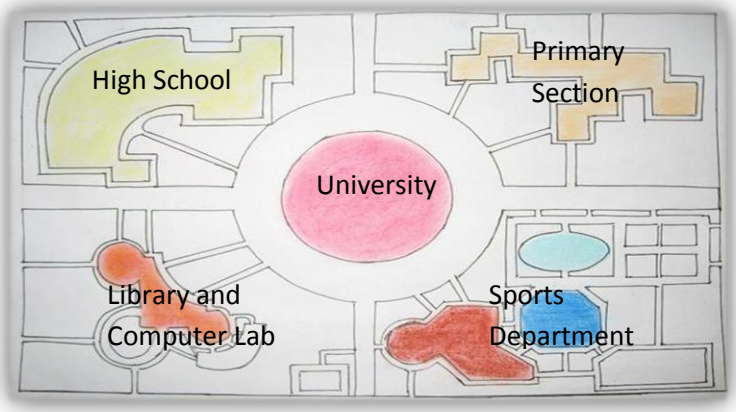
***Given that an average person consumes 20000KW of power per annum (in USA).

4.0 Human Factors

Aresam ultimately aims to be a centre of research and colonization of space. This is primarily why, in the construction and provision of the necessities of life for Aresam's inhabitants, special care has been taken to ensure maximum human comfort and safety. For this purpose, inhabitants will have access to a variety of residential, eating, educational and recreational options. All these measures are geared towards ensuring that our inhabitants enjoy standards of life comparable to, or even, in some cases, better than, those on earth.

4.0.1 Attributes of the residential sector are divided and shown in the **Appendix**.

4.0.2 **Sunlight for the residents:** The feasible option for illuming the residential and Recreation areas inside the Pseudo-Torus swill using natural sunlight. To reflect the solar rays in the desired location of the colony the Pseudo-Torus internal layer will be made of glass which allows sunlight to illuminate the settlement. The two sensors containing photoreceptor cells will permanently determine the position of the Sun towards the mirrors. By connecting them to the shutter system of the mirrors, they will always keep settlement maintain the day night cycle. To make sure that the amount of light reflected onto the surface of the Pseudo-Torus is at maximum, the glass layer is slightly curved so that their convex shape will allow the reflection of the light on a wider area.



4.0.3 **Coriolis Effect:** In an artificial gravity system coriolis forces occur due to the rotation of the settlement. However residents can adapt to them when provided optimum conditions. Larger the radius of habitat lesser the coriolis force. Extrapolating this graph shows 1g environment is obtained within the comfort zone.

4.1.0 Educational Sector:

This sector would contain a complete educational facility required for students starting from pre-school to university. The sector is divided into three parts, the university facility, the middle and high school section, the pre- and primary section. **(See Appendix)**

4.1.1 Transportation:

Refer to section 3. Bikes will be arranged for all residents, and trams will be used within the settlement, for longer distance.

Category	Crop	Proportion/ g	Nutritional Information
Fruits	Strawberry	152	Water: 138.24 g Calories: 49 Protein: 1.02 g Carbohydrates: 11.67 g Fiber: 3.0 g Sugars: 7.08 g Total Fat: 0.46 g Calcium: 24 mg Iron: 0.64 mg Magnesium: 20 mg Phosphorus: 36 mg Potassium: 233 mg Sodium: 2 mg Zinc: 0.21 mg
	Orange	131	Water: 113.64 g Calories: 62 Protein: 1.23 g Carbohydrates: 15.39 g Fiber: 3.1 g Sugars: 12.25 g Total Fat: 0.16 g Calcium: 52 mg Iron: 0.13 mg Magnesium: 13 mg Phosphorus: 18 mg Potassium: 237 mg Sodium: 0 mg Zinc: 0.09 mg
	Tomato	180	Water: 170.10 g Calories: 32 Protein: 1.58 g Carbohydrates: 7.06 g Fiber: 2.2 g Sugars: 4.73 g Total Fat: 0.36 g Calcium: 18 mg Iron: 0.49 mg Magnesium: 20 mg Phosphorus: 43 mg Potassium: 427 mg Sodium: 9 mg Zinc: 0.31 mg
Vegetables	Potato	213	Water: 172.44 g Calories: 153 Protein: 4.03 g Carbohydrates: 33.87 g Fiber: 3.6 g Sugars: 2.13 g Total Fat: 0.30 g Calcium: 21 mg Iron: 1.55 mg Magnesium: 47 mg Phosphorus: 130 mg Potassium: 969 mg Sodium: 13 mg Zinc: 0.70 mg
	Onion	38	Water: 33.65 g Calories: 16 Protein: 0.35 g Carbohydrates: 3.84 g Fiber: 0.5 g Sugars: 1.63 g Total Fat: 0.03 g Calcium: 8 mg Iron: 0.07 mg Magnesium: 4 mg Phosphorus: 10 mg Potassium: 55 mg Sodium: 1 mg Zinc: 0.06 mg
	Carrots	122	Water: 107.71 g Calories: 50 Protein: 1.13 g Carbohydrates: 11.69 g Fiber: 3.4 g Sugars: 5.54 g Total Fat: 0.29 g Calcium: 40 mg Iron: 0.37 mg Magnesium: 15 mg Phosphorus: 43 mg Potassium: 390 mg Sodium: 84 mg Zinc: 0.29 mg
	Rice		Carbohydrates 79 g - Sugars 0.12 g - Dietary fiber 1.3 g Fat 0.66 g Protein 7.12 g Water 11.62 g 2% Calcium 28 mg 3% Iron 0.80 mg 6% Magnesium 25 mg 7%
	Maize		Carbohydrates 19.02 g - Sugars 3.22 g - Dietary fiber 2.7 g Fat 1.18 g Protein 3.22 g - Water 75.96 g Iron 0.52 mg 4% Magnesium 37 mg 10% Potassium 270 mg 6%

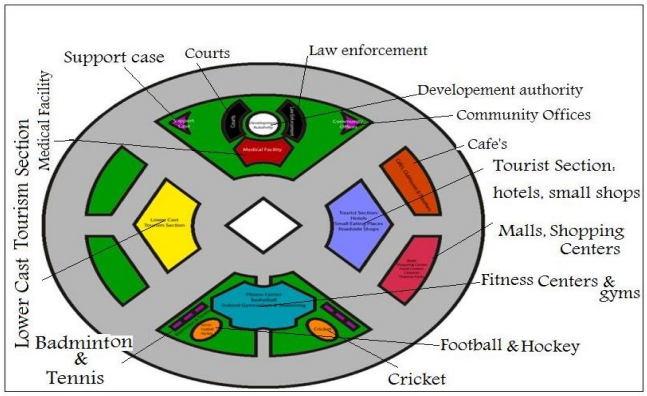
Different synthesized polyfibres are the main source for furniture; items will be brought from Columbiat. Sofas and cushions will be filled with poly-urethane foam also brought from Columbiat.

4.1.2 The furniture requirements for residences will be as follows:

	Office	High Class Residency	Student's accommodation	Middle Class Residency	Low Class Residency
Dining table	0	1	0	1	1
Chair	3	8	5	4	3
Sofa	1	5	1	3	2
Bed Set	0	3	4	3	2
Desk	1	0	0	0	0
Study Table	0	1	4	1	0

4.1.3 Community Sector:

The residential Pseudo-Torus contains two of the community sectors which would be accessible by both classes of residencies. The main idea of the community sector contains all kinds of recreation, entertainment, tourism, sports, medical, law and enforcement and development facilities. **(See Appendix)**



4.1.4 Agriculture:

There are a variety of options available for choice of cultivation medium for the settlement. First, nutrient-rich spoil which supplies most of the minerals needed for healthy plant growth could be brought from the earth and used as a medium. Secondly lunar soil, (from the Earth's moon) which contains particularly high amounts of Oxygen (42 percent), Silicon, Iron and Magnesium could be brought in for cultivation in the agricultural Pseudo-Torus. Thirdly, aeroponics and hydroponics could be employed as cultivation techniques, in a way similar to that on earth, when fertile soil is not available or for roof gardens.

Agricultural Pseudo-Torus: Crops

Due to the limitations of area, and for providing the inhabitants of the settlement with a variety of food and commercial crops for consumption, the following varieties will initially be cultivated. However, as per the changing requirements and demands of the citizens, the types of crops will regularly be modified.

(See Appendix for other Details)

4.1.5 Transporting facilities of Goods:

Goods will be transported to different areas using custom built space car and also using transporter train. Refer to Section 5 (Automation) for transportation methods.

4.1.6 Physiological and Psychological Problems: Due to the immensely complex nature of the human race, Aresam has been competently designed to keep in mind the limits of the human race. Psychological and Physical problems that might be encountered by the residents have been taken into account and thus the design has been made keeping these problems to a minimum.

Here is a list of a few psychological and physiological that can be faced by the inhabitants and also mentioned are their remedies:

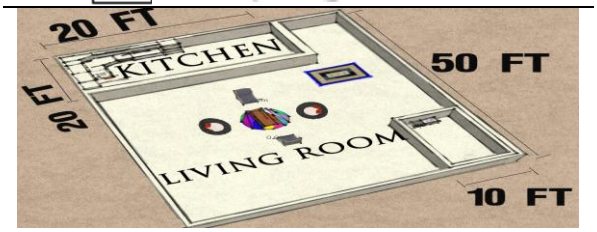
Psychological Problems and their Remedies		Physiological Problems and Remedies	
Problem	**Remedies**	**Problem**	**Remedies**
• **Homesickness** • **Isolation** • **Boredom** • **Depression** • **Aviophobia (Fear of Height)** • **Kenophobia (Fear of large empty space)** • **Solipsism Syndrome** • **Loss of Sense of State** • **Asphyxation (on entering low pressure area)** • **Insomnia** • **Stress** • **Confinement** • **Hallucination**	• Earth like environment • Meditation and Yoga • Maintained Day and Night Cycle • Proper Medication • Open Spaces • Systematic Desensitization (Constant exposing of phobic things) • Recreational Activities • Entertainment • Suitable Jobs • Cognitive Behavior Therapy • Proper Physiotherapist	• Reduction of Bone Mass Cardiovascular De-conditioning • Weightlessness • Osteoporosis (Weakness of Bones) • Asthenia Syndrome (Fatigue) • Growth of Kidney Stones • Neurophysiolo	• Artificial Gravity • Radiation Shielding • Regular Medical Checkups • Regular Exercise • Proper Medication • Space Suit for EVA • Safety methods in low (g) areas

• **Lipism Syndrome (Person feels everything is dream)**		gy	

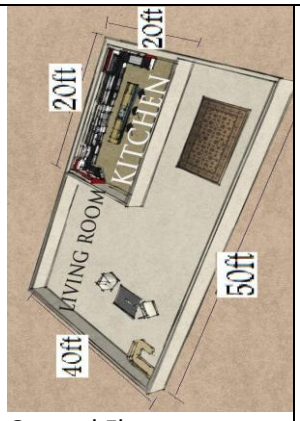
Every effort will be made to ensure the psychological and physiological welfare of inhabitants. Parks, orchards, entertainment centers with restaurants and sport complexes will fulfill the needs of aesthetic pleasure, and more importantly, provide options for socializing with our inhabitants. Psychological assistance will also be available to

High Class Residential Houses

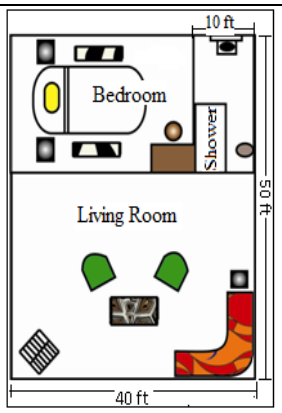
Plan A	
Total Area	1500 sq. feet
Capacity	4 ppl
Number of Floors	2
Number of rooms	4
Total bedrooms	2
Toilets	2



Plan B	
Total Area	2000 sq. feet
Capacity	4 ppl
Number of Floors	3
Number of rooms	6
Total bedrooms	3
Toilets	2



Ground Floor

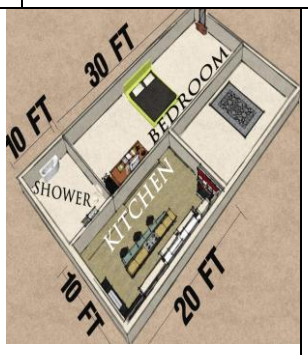


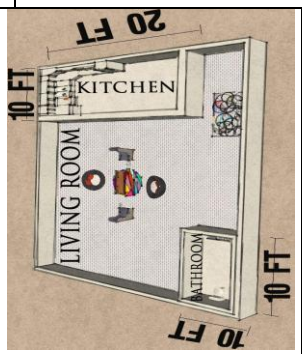
First Floor

Second Floor

Total Area	**800 sq. ft**
Capacity	1 person
Number of Floors	1
Number of Rooms	3
Total bedrooms	1
Toilets	1

Middle and Low class

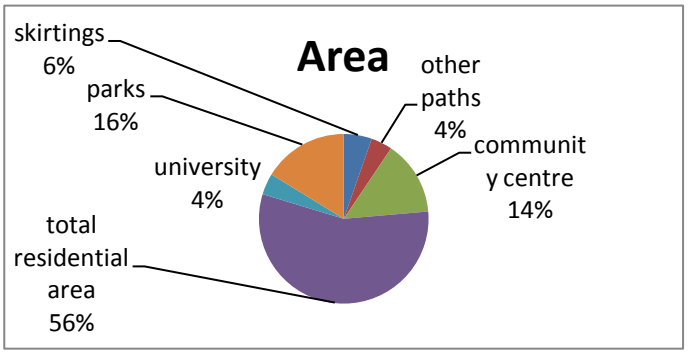




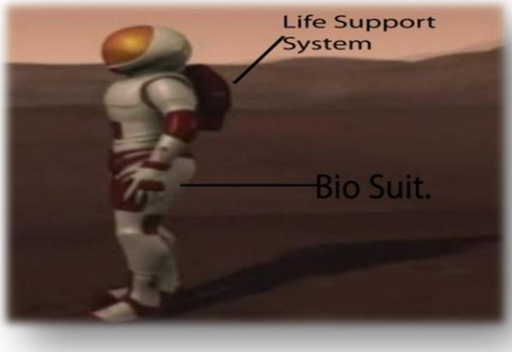
Exterior Designs

4.3 Security, systems, devices, vehicles, space suits and quarantine issues:

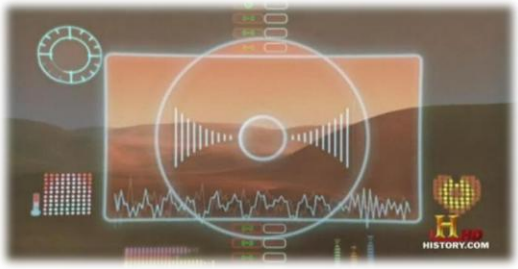
Extensive measures have been taken to avoid any security issues on Aresam, as the safety of our residents is of paramount importance. Also different types of systems, devices and vehicles will be used by humans outside artificial gravity volumes. Refer to sections 3 and 5 for security, devices and vehicles and screening methods.



Space suit design and donning doffing: This suit will make space exploration safer and easier and maybe a little more fashion forward thanks to specially reinforced fabrics. Traditional space suits are too heavy and ungainly to meet the challenges of future space travel, which will likely require more mobility and greater comfort. Traditional pressurized space suits, known as extravehicular mobility units, weigh about 300 pounds (135 kilograms) and are fastened together in three sections. The BioSuit, made mainly of nylon and spandex, is lightweight and allows greater flexibility.

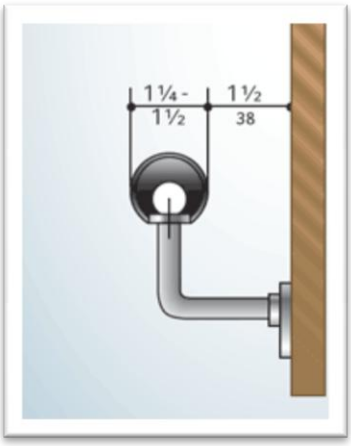


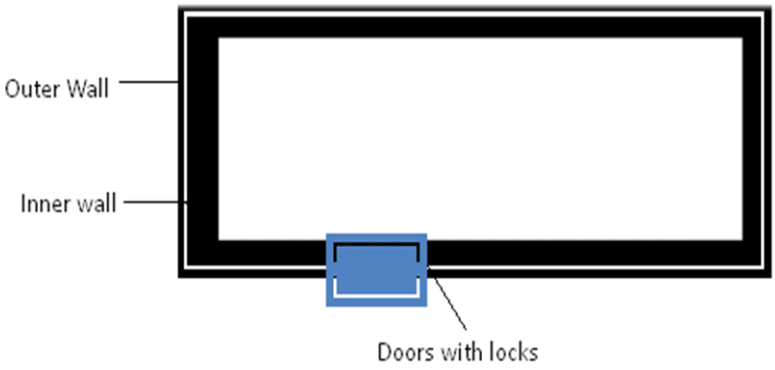
A conventional space suit forms a pressurized envelope around an astronaut to protect him from the vacuum of space. BioSuit is a revolutionary departure from the traditional model. Instead of using gas pressurization, which exerts a force on the astronaut's body to protect it from the vacuum of space, the suit relies on mechanical counter-pressure, which involves wrapping tight layers of material around the body. Another advantage to her BioSuit is safety: if a traditional spacesuit is punctured by a tiny meteorite or other object, the astronaut must return to the space station or home base immediately, before life-threatening decompression occurs. With the BioSuit, a small, isolated puncture can be wrapped much like a bandage, and the rest of the suit will be unaffected.



Quarantine, airlock designs and safe human access:

During the exploration of Mars some evidence of life may be found, if that happens then it will be sent to the research centre for further investigation. Initially we will not know if the substance contains some bacteria or other substance that maybe hazardous to human life so it will be kept in quarantine. The quarantine chamber will consist of a room with thick dual walls with a multiple doors each with its own airlock system. No one will be allowed to enter the area without proper biological and radioactive hazard suits. The quarantine chamber will be self sufficient in terms of disaster relief. It will have its own fire management system and will be build of exceptionally strong materials to ensure no damage to the structure if even the building in which it is housed is damaged. The walls will be lined with lead to ensure containment of the radioactive materials. Any waste from the quarantine e.g. the clothes of the researchers will immediately be sent to the incinerator for safe disposal and minimize chances of hazardous waste to be exposed to the public.





(See Appendix for Further Details)

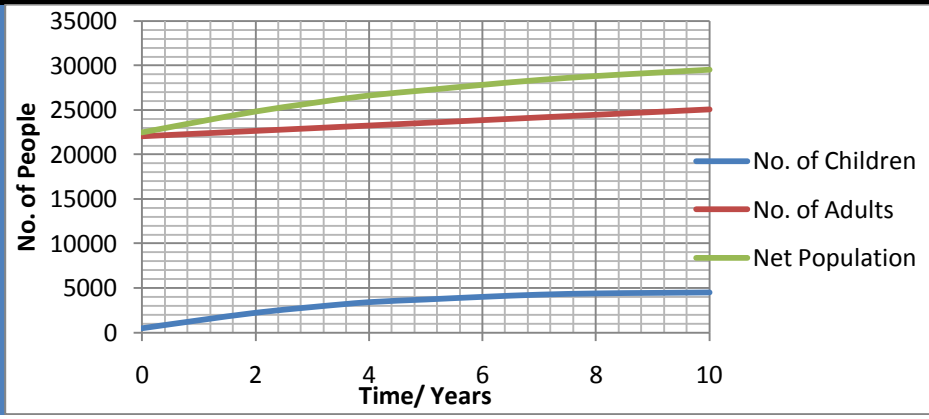
4.4 Demographic Shifts:

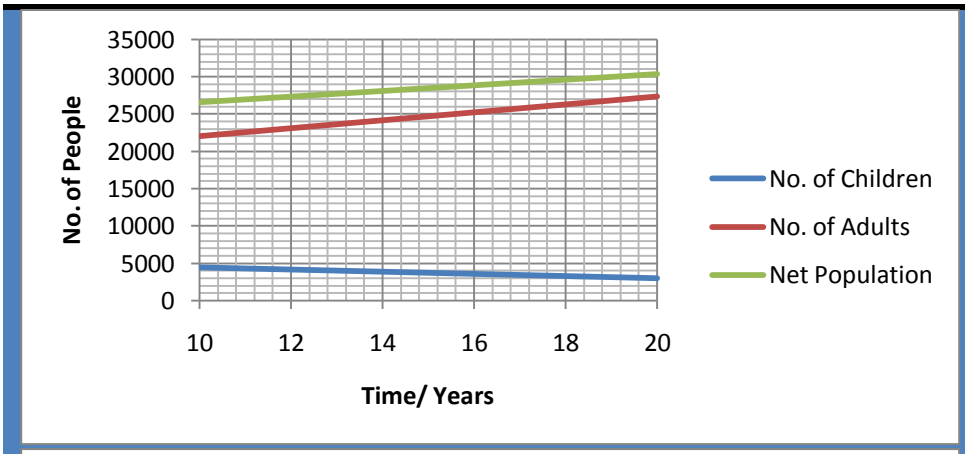
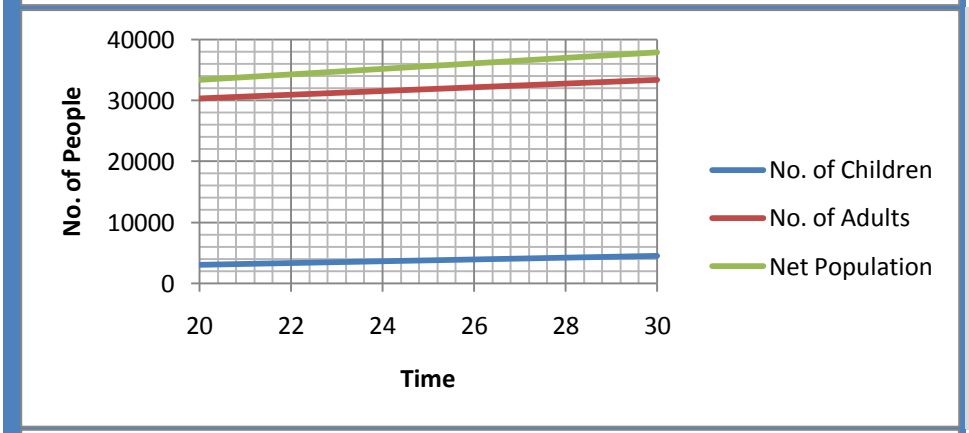
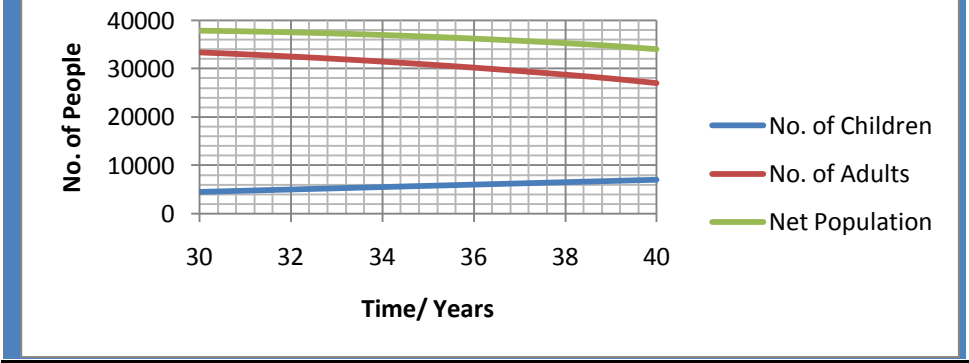
Number of sectors	**4**
Population in each sector(maximum)	30000÷4=7500
Number of extra houses/ flexibility (per sector)	7500÷3=2500

We expect the population of children to increase sharply at the start of the first decade. To cater to this increase, we have designed most houses for small families, rather than just couples. Moreover, the hospital will have a large children's ward;

Schools will slowly be expanded and the community centre will gradually develop to provide more activities and amenities to children.

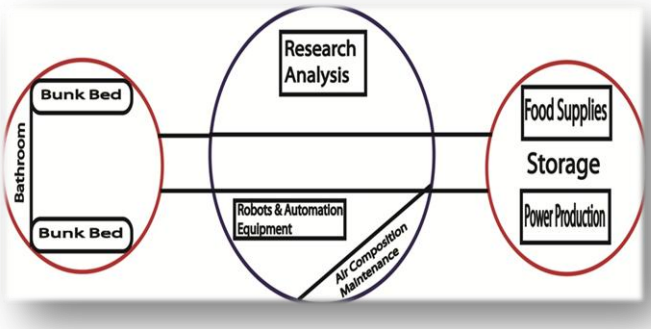
The residential Pseudo-Torus of Aresam provides housing to a total of 22,500 initial dwellers. Further on, extra space provided will be used up to expand the residential sector and also the community centre. The Pseudo-Torus is divided into four sectors each has a maximum capacity to hold 7500 residents. When expanding the Pseudo-Torus, the processes describe in section 2 shall be carried on. The sector which needs to be expanded shall be evacuated, moving dwellers to other sectors, such that one-third of the population of that sector shall settle in each of the remaining three sectors. Once the construction/expansion of that sector is complete, the residents can shift back to their houses from respective sectors. In cases of emergency, cardboard houses will be provided for temporary residency.

Demographic Graph	Explanation
	Approx mortality rate is 0.4% per year, less than half of that of a developed country; Number of children rise by 450 per year to 4500. Moreover, 500 new adult inhabitants are accommodated per year, resulting in a general trend of increase.

	Number of adults shows an appreciable rise, of around as a fraction of the first generation children grow into adults, and as new members continue to inhabit. Moreover, approx 200 adults begin to inhabit Mars per year, and the net increase in adult population is around 420. The population of children falls gently, due to increasing psychological acclimatization of adult population.
	Second decade trends prevail as both the adult and children population generally increase, resulting in a steady rise in total population.
	Demographics trends become non-linear and approach those of the first decade, as the proportion of initial inhabitants falls considerably, the mortality rate approaches 0.6% and the number of children increase. Total population approaches that at the end of the first decade.

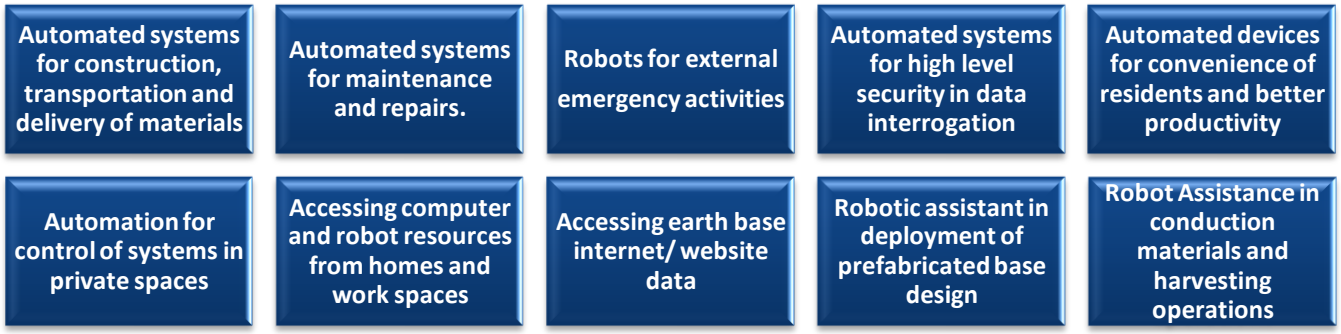
4.4: Table Shows Demographic Shifts **(See Appendix)**

4.5 Interior Configuration of base structure and prefabricated base:



Interior Layout of Prefabricated base

5.0 Automation Design & Services



To enhance the livability in the community, productivity, economical growth and security of the settlement the community will comprise of a number of automation systems varying from power generation to retina scanning door opening systems. Such systems will not only automate data recording and preparation but also reduce contamination during emergency repairs leading to an increase in accuracy and reproducibility of results. Out of hours operation will make the use of automatic start-up and shut-down procedures hence automation has been divided to be provided with proper attention. Automation for the settlement is summarized in the following chart:

Section 5.0: ROBOTS FOR ARESAM'S FACILITY: This part of 5.0 is described in more detail in sub-sections 5.1, 5.2, 5.3 and 5.5 with designs, dimensions and how they perform their tasks.

SERVERS AND COMPUTING DEVICES:

Different types of servers and their quantities are listed below:

Name of server	Use	Specifications
Application server	It occupies a large chunk of computing territory between different servers (as shown) and connects them. This allows users to obtain the requested data.	Storage Capacity :1000 TB Quantity: 2 Processing speed: 4 GHz Processing Cores: 8 (35pm)
Multi-Media server	They bring multi-media capabilities to the system. It enables users to exchange information. It broadcasts information and allows chat, voice talk and video calls.	Storage Capacity :300 TB Quantity: 8 Processing speed: 4 GHz Processing Cores: 4 (35pm)
Industrial server	Stores information regarding consumables, materials and research labs.	Storage Capacity : 500 TB Quantity: 10 Processing speed: 5 GHz Processing Cores: 6 (35pm)
Database Server	Records the data of offices, hospitals, markets and various places of the settlement.	Storage Capacity: 100 TB Quantity: 15 Processing speed: 3 GHz. Processing Cores: 5 (35pm)

Different types of computing devices and their quantities are listed below:

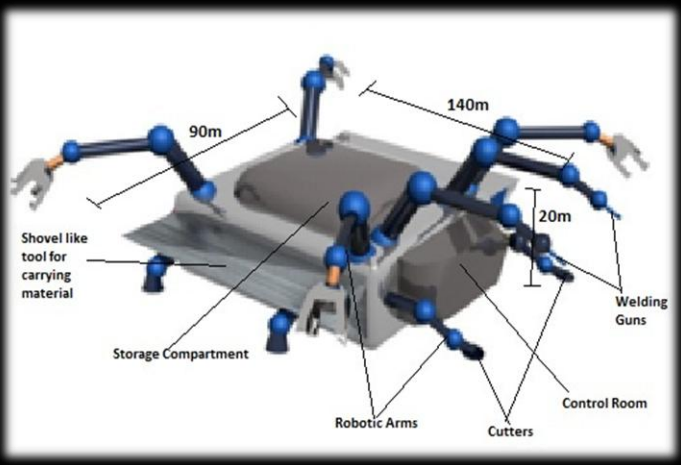
Computing device	Use	Storage capacity	Quantity	Pictures
Are palm	Web browsing, news alerts, emergency alerts and communication.	350 GB	19600	

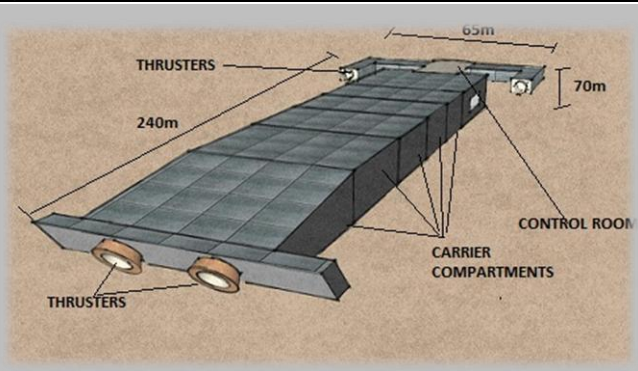
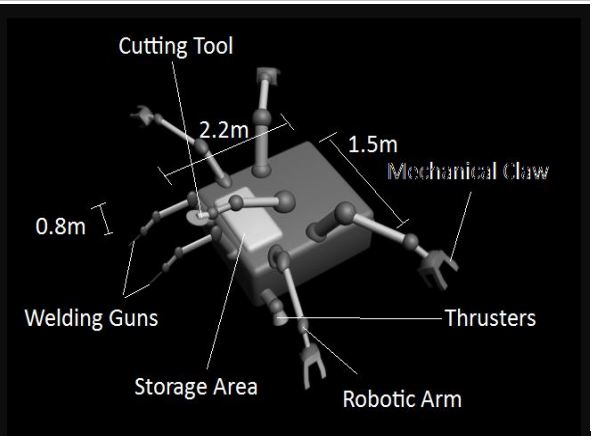
Core computers	At homes for Web browsing, Data processing, Games, movies etc.	1200 GB	10000	
Professional Consoles (PORTABLE)	For employees in offices, hospitals, markets and industries to do managerial and other tasks.	1000GB	12000 but will only be available to offices and employees and quantity will be upgraded with time	
Master computers	Gathers data of a particular location e.g. offices.	5TB	Will be brought according to the number of offices (ratio 3:1)	
Super Computers	Used by Aresam IT team to monitor functional system of the settlement and inform emergency situations at different locations	500 TB	20	

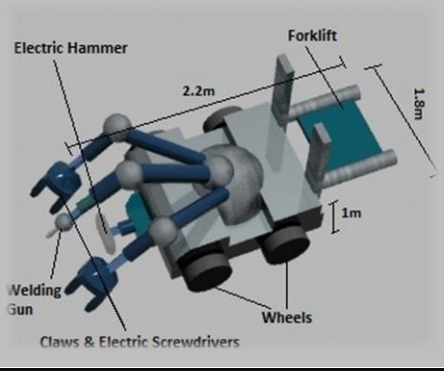
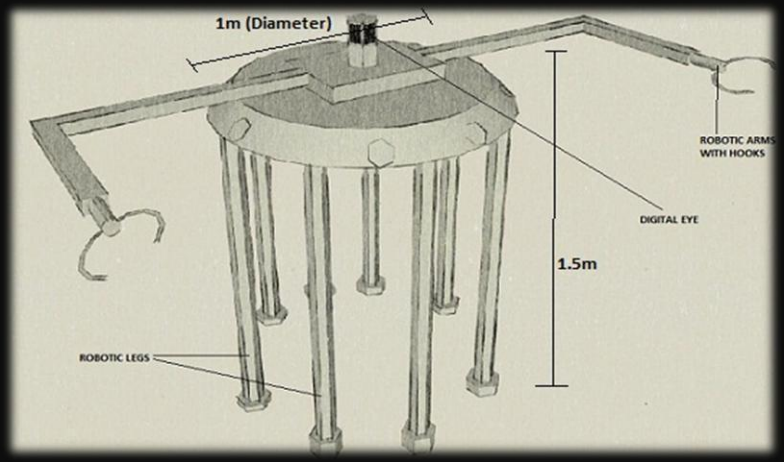
NETWORKING DEVICES:

Refer to sub-section 5.4 for details regarding the network and devices being used along with respective quantities of data storage and to sub-section 5.2 for details regarding data security.

SECTION 5.1 CONSTRUCTION MACHINES:

Name	Description
Main Construction: **The Builder Ship**	• Specifically designed for the construction of space settlements. • It is a multi-purpose machine: it will perform the primary assembly construction operations for the space settlement. • Each ship is equipped with 6 giant robotic arms, 2 welding guns and 2 welding arms. • The robotic arms can be used for positioning and implanting of heavy metal structures. They can be elongated or even shortened according to the construction requirements. Two of these robotic assembly arms will also function as cutting drills. These mechanical arms will be built from a mixture of Aluminum and Platinum which will give them the required amount of 

	strength and durability. The welding arms have a smaller cross-sectional area which will allow for penetration into narrow areas. • The welding guns are scissor-shaped and are fixed midway between the robotic arms. These high-powered guns will be useful for melting strong rigid structures and their scissor-like shape will allow for angular movement and concentrated beams. • The Builder ship will contain a central control room which can accommodate around ten people. The mechanical arms will be controlled by sensors as well as the people in the control room. The sensors will be installed on each arm and signals carrying information about the angular and translational position of the arms will be sent directly to the control room. • The builder ship will also be incorporated with a spacious storage room. This storage space can be used for storing the heavy construction materials. During construction, this storage compartment is exposed and robotic arms along with two giant shovel-shaped containers can be used to carry the materials. • The ship will have 2 large thrusters for speedy propulsion while two smaller thrusters will be used for the positioning of the ship.
ii: The Transporter Train	• It will serve as the primary machine for transportation and delivery of materials and equipment. • Its basic shape will consist of a smaller cylindrical front compartment connected to a series of large rectangular compartments.  • The front compartment will have a capacity of around 5 people who will control the transporter train. • The rectangular compartments will be used to carry the bulky materials as well as the heavy structures required in the construction process. These will be thus called the carrier compartments and will be designed to contain maximum amount of materials and withstand enormous pressures. • The compartments can also be disassembled from the train if necessary. • Four large thrusters will be attached to this giant train while each rectangular compartment will have its own smaller thruster. • Ideally, the transporter train will have 6 carrier compartments, two of which will be designed specifically for carrying grain-like materials.
Interior construction: **I: Worker X:**	• Worker X is a crafty interior construction robot. • Technical features include two small thrusters used for positioning, 2 robotic arms designed to carry out construction tasks, 2 welding arms, a mechanical cutting tool, two claws used for firm gripping of objects and a small storage compartment. • It has a unique ability of rearranging its components and 

	reducing its size considerably. This way, the robot can access isolated areas and perform its tasks more skillfully.
ii: Worker Y:	• It is a construction robot designed specifically for ground-based activities. • It has four automated wheels for quick movement on the ground. It also consists of two large robotic claws for holding heavier equipment and a large welding gun. The robot is also equipped with an electric screw driver, a robotic hammer and a forklift for lifting heavy objects. • This robot is ideal for installing machinery and also serves the purpose of transporting bulky components during internal construction. 
iii: Worker Z:	• It is a spider-like construction robot and its primary function is to complement the construction operations performed by Worker X and Worker Y. • It has six robotic legs which can adhere to metal structures thus allowing the machine to reach to any part of the constructed structure. It is equipped with two mechanical arms to which hooks are attached. • Worker Z has a special function of taking images of the constructed designs through a central digital eye and processing them. It can therefore be used to correct any faults in the construction or even visualizing possible designs. • This robot also plays an important role in guiding the other two construction robots through infrared signals.  **Figure 5.1e: A 3-D shape of Worker Z**

SECTION 5.2:

SETTLEMENT MAINTENANCE, REPAIR AND SAFETY FUNCTIONS:

Appropriate environmental conditions are necessary for life, improved crop yields, and efficient use of water and other resources. Automating the data acquisition process of the soil conditions and various climatic parameters that

govern plant growth and the life on the station allows information to be collected with microprocessors with less labor requirements. The monitoring systems employ PC or SMS-based systems for keeping the user continuously informed of the conditions inside the greenhouse and taking steps according to the situation so no havoc is created. The monitoring systems design is a simple microcontroller-based circuit along with Programmable Logic Controllers (PLC) to monitor and record the values of oxygen level, pressure, temperature, humidity; soil moisture, water level inside and sunlight of the natural environment that are continuously modified and controlled. **(See Appendix for Complete Detail)**

Devices for Operation of the settlement	Methods
Air pressure sensors, temperature sensors, radiation level sensors, water level sensors, oxygen level sensors, light sensor, humidity level sensors, and current measuring sensors.	Micro controller circuits combined with Programmable logical controllers (PLC) to **process data respond accordingly**. Actuators and motors to switch on the devices such as sprinklers for **water level.** Air conditioners for **temperature**. Alarms to alert regarding changes. Lights for **accurate light** to ensure better plant growth and a self repairing control system to replace actuators automatically and **avoiding any time delays during maintenance.**
Custom made robots, RFID technology, wireless transmitters and receivers	Custom made robots that are easily available on nearby planets with a special ability to switch end effectors like grippers, screw drivers and welders for **emergency external repair**. RFID technology along wireless transmitters and receivers and computers to control robots and carry out **settlement repairs.**
Biometric devices, Interactive voice recognition software, high storage main server, backup server	Biometric devices, Interactive voice recognition software and devices, high storage main server linked directly to the main settlement system, backup server **to avoid any havoc in case of emergencies**, microphones, alarms **to alert security** and a virtual sound system **guiding the user how to use the system.**

SECURITY:

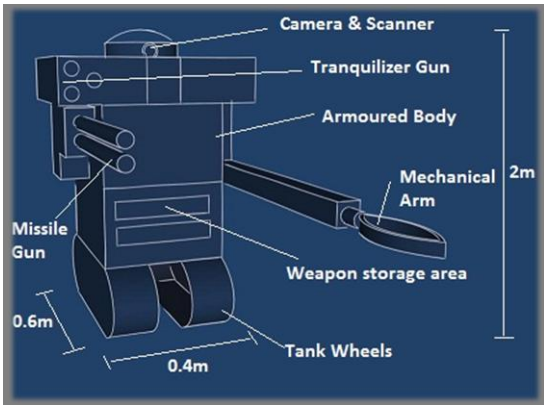
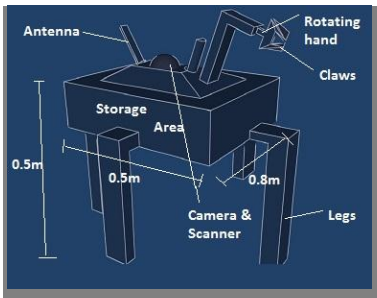
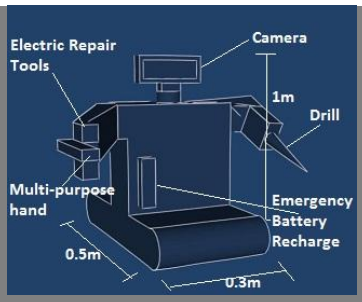
In one embodiment, the system includes an interactive voice recognition system, biometric scanners, and servers storing data and linking to different robots. Data will be divided into 2 levels with each level having its own method of authorization. Level 1 comprises of that data that can be accessed by the normal staff and requires a low level authorization that includes username and password.

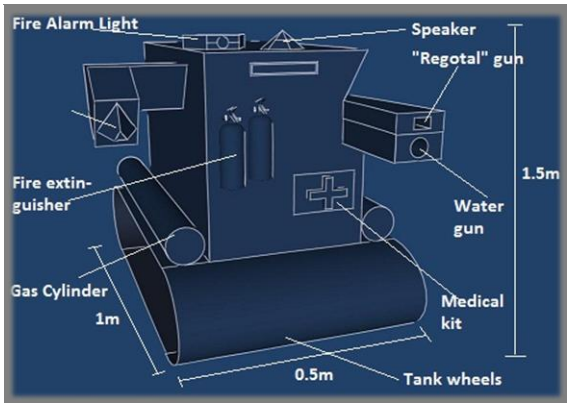
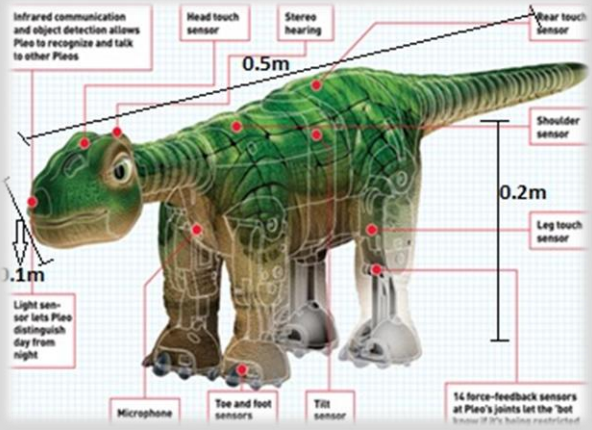
Level 2 comprises of the data that can be only accessed by authorized personnel only. This system makes the use of interactive voice recognition (IVR) system and biometric in combination. The biometric systems verify the identity of fingerprints using fingerprint features, it is critical to extract the correct feature information. After the extraction, a particular password for authorization provided to the authorized personnel is requested which is verified by the interactive voice recognition (IVR) system.

The system not only matches the voice but also verifies the password to authorize access. To increase the level of accuracy and also to prevent any sort of unauthorized access, number of codes are assigned to each member. One code used to alert security in case of an intruder alert or emergency. Each code assigned is supposed to do a different job. The system also makes the use of virtual sound systems telling users how to make use of the new system and a backup server which makes backup of data regularly so that incase the main system falls or is under maintenance the backup server provides enables continuation of data interrogation facility.

High-level security zones include Docks, Control rooms, Power generation units, Human Resources units, Communication hubs and central computer units. Biometric testing such as Iris scanning and fingerprint scanning will be conducted before any person is allowed access to important areas. High-level security zones would have a dedicated security system consisting of surveillance cameras, intrusion detectors, face scanners as well as data-tampering detectors.

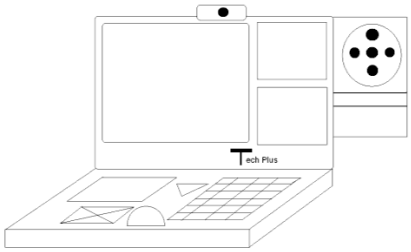
5.3: Interior Construction Robots:

Name	Description
i: Robo-Protector (SECURTY ENHANCEMENT)	 To enhance the effectiveness of the Security facility, a skillfully designed robot, ROBO-PROTECTOR, is employed. It will have a built-in directory containing ID information of residents along with criminal records. It will also have the ability of identifying disguised individuals and taking measures to subdue criminals. It is engineered to successfully counter attacks and fight against law-offenders.
ii: Technotrons (AUTOMATED MAINTENANCE & REPAIR)	  In order to carry out maintenance and repair tasks quickly and effectively, two robots have been designed. These robots are equipped with a wide range of repair tools and possess the technical knowledge of experts. They can skillfully tackle all sorts of technical constraints and can work consistently without being discharged. Their bodies are heat-resistant and they have been carefully designed to fix in compact spots. For emergency situations, these robots are also equipped with batteries and photocells. The robots can fix faults in machinery, networks, power supplies, and sewerage pipes and can prove instrumental in performing maintenance operations. Additionally, these machines can also perform disaster management tasks such as evacuating buildings and alerting concerned authorities.
iii: X-SPRINTER 6.0 (AUTOMATED HUMAN TRANSPORT)	For human travel inside the settlement, a space vehicle called X-SPRINTER 6.0 has been manufactured. This space-vehicle has a capacity for six passengers and serves as the most convenient mode of transporting people around the settlement. Equipped with the latest navigation system, this vehicle has a built-in artificial intelligence system which can perform useful functions for its passengers. A high-tech entertainment system and a multi-tasking supercomputer are also major features of this machine. Moreover, the X-SPRINTER 6.0 has been designed to withstand all sorts of temperatures and weather conditions and can transport its passengers safely and quickly. The X-SPRINTER 6.0 will also be used to pick up and transport different materials across Aresam. It has a custom built compartment to store goods for transportation making it multipurpose.

iv: Inferno Kill (AUTOMATED FIRE-EXTINGUISHING SYSTEM)	 Fire hazards can cause enormous harm to the machines, industries, households etc. In order to ensure that such situations do not arise, a powerful fire-fighting system has been built. Heat-sensors and smoke detectors are installed in a variety of places around the settlement. Fire-alarm switches are also positioned in commercial buildings, industries, docking areas, computer rooms. Whenever these switches are turned ON, signals are sent to the Fire-fighting department and a team of skilled firefighters is routed to the concerned location via speedy fire-vehicles. In addition, specially programmed fire-fighting robots, INFERNO-KILL, are used to effectively suppress fire hazards. These robots are equipped with water guns, fire-extinguishers and pressure pumps. Their bodies are coated with heat-resistant chemicals and their internal machinery can bear extremely high-temperatures. INFERNO-KILL also has a built-in medical kit which can be essential in many situations. Additionally, these robots have a special gun which squirts out REGOTAL, a liquid compound synthesized specifically for extinguishing fires in mere seconds.
v: Hygo-Bot (AUTOMATED CLEANING SYSTEM)	Hygiene robot (Hygo-Bot) will clean the dust and waste substances from the Aresam facility. Hygo-Bot's one arm acts as vacuum cleaner to remove dust particles from the place. The other will pick up trash materials and save them temporarily in its lower compartment to dispose them at disposal plant. The blue and grey section are in front and back to allow the rotation of arms at 360 degrees. It has an eye which can take the view of 360 degrees and can recognize trash or dust anywhere. It will be used in offices, streets, homes etc. It also has sensing devices which will collect data at every instant to inform operations administration about humidity and heat levels.
Iv: Robo-dinosaur (Pleo)	 To remove lonliness and to entertain people Aresam introduces a interactive robotic pet known as Pleo. The robot makes the use of Interactive Voice Response technology (IVR) and touch technology in combination with different sensors to interact with the user according to the type of input made. The robo-dinosaur has the potential to be useful in many ways not only having the ability to be a good companion but also reminding the elderly to take their medication. Also the robot can be operated from a short distance using infrared technology. The robot has the ability to show different moods to their masters and to act and behave according the mood. Their mood will depend upon different factors of which one will be the speech of the user, for e.g. Pleo will act sad if the master shouted at him.

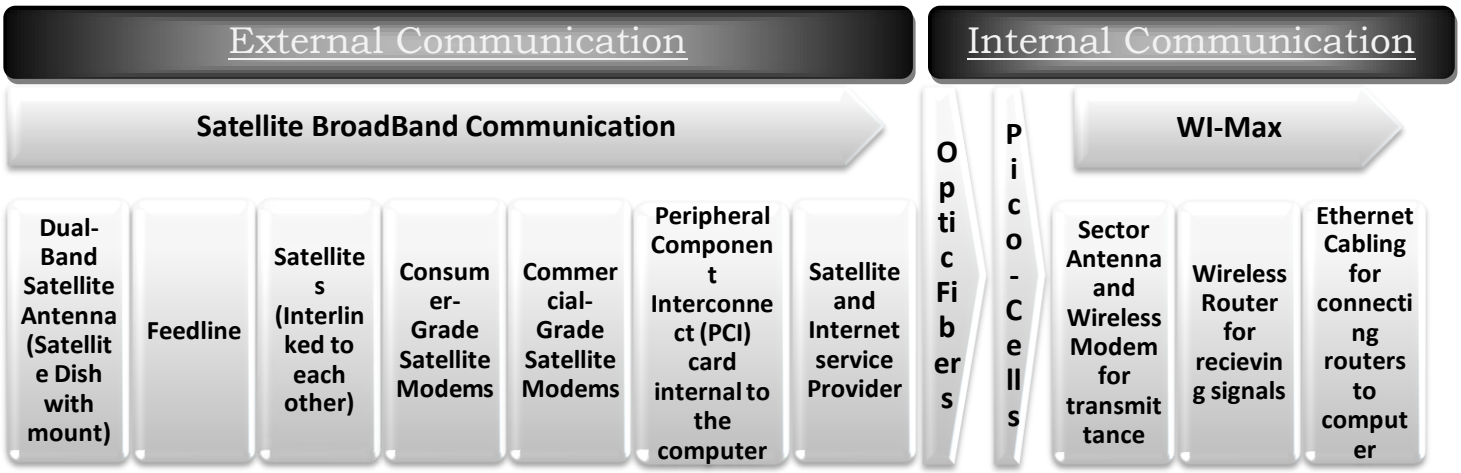
Vi:Ago-Bot (AUTOMATED GARDENER)	Areius is a multi function agricultural robot. It can store 100kg of the material in 4 containers attached on the upper side. Ago-Bot can sow the seeds stored in upper containers according to the requirement or input from the user. It has two threshing blades attached on its back side which will be used during cutting of grass. Its two arms on front can judge the ph of the soil through sensors and direct these readings to the microprocessor. The Ago-Bot has inbuilt ADC and DAC convertors and therefore it takes the action accordingly. It measure the water in the soil, if low then sprinklers on the bottom spray water or chemicals according to the ph value.

Networking and communication:



COMMUNICATION DEVICES: Ensuring healthy communication between the residents of the settlement is vital. This will make numerous tasks convenient for them and will also enhance productivity in work environments. Each resident will be given a gadget TECHPLUS which will serve as the basic communication device and will also perform several other functions. It will actually work as a miniature computer designed according to the needs of the settlement inhabitants. It will offer such important facilities as TELECOMMUTING, VIDEOCONFERENCING, NAVIGATION, INTERNET ACCESS, GRAPHICS DESIGNING, ROBOTIC CONTROL and even VIRTUAL BANKING. Moreover, the gadget can also be used to track down individuals and collecting important information about them as every TECHPLUS will hold information particular to its owner. In case of disasters or emergency situations, messages can be sent by the Central Control Unit on these gadgets in order to alert the residents. Thus, these will also function as a medium of communication between the Central Authorities and common people.

A diagram showing requirements for the network and broadband communication (Internal and external communication)

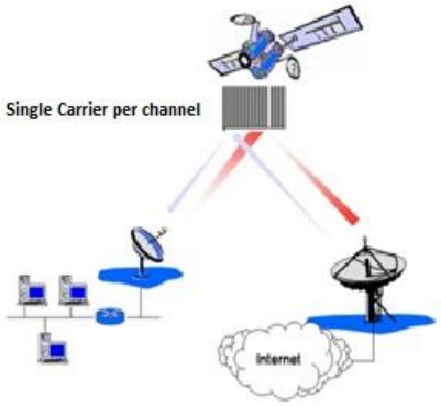


Refer to section 3.2.12 for the minimum requirement (i.e. a diagram of network) and sections 5.4 for further detail on networking.

Figure 5.4a: Consumer Grade Satellite Modem

Figure 5.4c: Dual-band satellite antenna to be placed on each area for communication

SECTION 5.4: NETWORK DEVICES:



Aresam will make the use of satellite-based Internet access for broadband communication along with special commercial-grade and consumer-grade satellite modems also allowing email and data access to any facility on the earth. The biggest factor slowing the data speed is the very nature of satellite communications. Since data will be transmitted from the one satellite to other, than data will be accessed by the user, this will introduce problems and time delays during data transmittance. Consumer Grade satellite modems will be used for wireless access and contact with the Internet Service Provider. When an attempt to access a Web page is made, the URL will be sent to the main Internet service provider which is linked and in contact with the satellite service provider. The packets containing the URL that will be entered will be routed from the Internet service provider to the satellite provider using the satellite. During the process, the packets will be encapsulated. This process will add several bytes to each packet resulting in each packet to carry less data than normal in order to make room for the routing information.

When the satellite provider receives the packets, the encapsulation data is stripped away, leaving original data (in this case, a URL). The satellite provider will then send a request over land-based lines to get the Web page being asked for. Once the satellite provider has received the requested Web page, it transmits the page to the satellite and hence every member receives the page that requested. Special IP stacks and proxies will be used along with ad-blocking software not only reducing the satellite latency but also increasing the efficiency of the communication. **(See Appendix for Further Detail)**

Data security during the transfer of data in broadband communication and internal communication: To enhance the security of data over a distance that is being sent during broadband communication will make the use of Encoded messages or information will be sent by using a linked key method. On one end, the message is encoded with a private key. The recipient uses the sender's public key to decode the message after it arrives. If the message was tampered with in any way, the public key doesn't decode the message correctly alerting the recipient that the information shouldn't be trusted. This is a safe method of receiving payments through credit cards etc. Verifying that confidential messages are intact when they arrive about that shouldn't be read by anyone but the intended recipient Refer to section 5.2 for details on data security associated with authorized personnel.

Networking systems for internal communication are also described below:

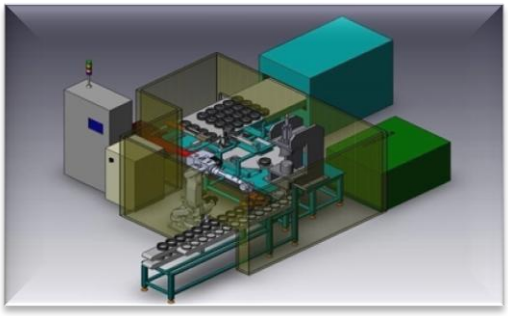
Networking Systems	Specifications	Use
WI-Max	70 Mbps. Transferred at 4 GHz. Low frequency is chosen because it is least affected by physical bodies in the path. Wireless mode of communication. Line of sight is corrected by using array of antennas. It covers a wide area and is not restricted to a particular space like WI-FI	To allow user access to internet for the whole settlement.
Pico-cells	Installed on roof tops of 2-3cm thickness.	To provide wireless communication system typically covering a small area, such as in-building (offices, shopping malls, train stations, etc.) where outdoor signals do not reach well.

Optical Fiber	32 channels. Transfer rate of 5.3 GBPS per channel. Total transfer rate of 170 GBPS	For communication between central cylinder and Towers as micro waves cannot pass through metals.

Users will not only make use of different forums for reviews, special websites dedicated to Aresam but will have full access to earth based internet facilities but also make videoconferences with the people of the earth which involves the use of micro waves (described above). Also people can do online shopping using their credit cards and buy different software which they can download or will be sent to them. They will also have the access to facilities like online banking and can make transactions from Aresam. To access authorized data on Earth that is only available for specific people, special username and passwords will be given to authorized personnel **A table displaying different user responses is shown below:**

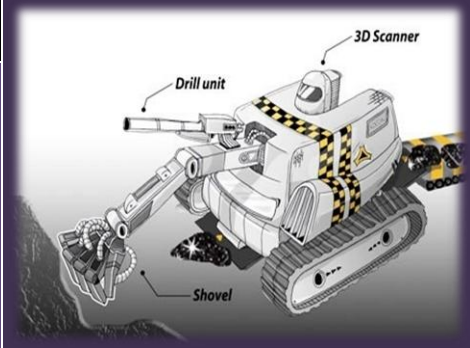
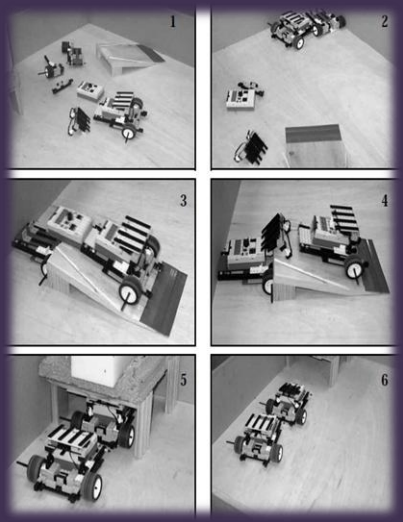
User name	Response
Jimmy Clark	Broadband is slow compared to broadband facility on the Earth, we don't experience Gigabyte connections here but the Aresam broadband service has explained and assured better speeds in future. We also experience time delays but that is an exceptional case because we are accessing earth internet based facilities from space. I hope something is done in future.
David Jones	I am currently working in electrical department of the settlement and with the use of robots my work load has decreased and also I have more flexible working hours now and can spend much more time in meetings taking between Earth and Aresam.
James McDonald	Well after looking at the facilities in Aresam, I am really proud to be a member of the settlement. Almost everything is automated for example we find biometric scanners to access doors and broadband facilities are great.
Jenny Clark	I am currently working in the main server area and have to access data regularly. Facilities like biometric along with IVR technology to access important data has lead to a great security. Retina scanning in few facilities has also improved security and use of different codes to access levels and alert security is also impressive

Time Delay: We have identified the fact that we will face times during the year when there will be possible loss of communication and certain cases where our signal will experience a lot of noise. These times are those when the Sun comes between earth and the settlement. Along with this there will be times when mars comes between earth and the settlement. As the sun emits a lot of radio waves we will experience a very low signal to noise ratio. Our solution to this problem is simple. We will deploy 3 satellites in orbit near another planet, which will relay our signal to earth. This method will result in a larger time delay; however, this is the only way in which we can communicate during such times. Other than this our method of reducing the delay between mars and earth communication is once more simple. We must use cache systems to store unchanging data thereby reducing the time in which we receive such data at the settlement. However, it must be noted that as the signal speed can never be greater than the speed of light, we will face a certain delay which can never be reduced. Therefore, the system of storing unchanging data will never work for real time data and all systems operating upon and using real time data will take the required time to transfer data.



SECTION 5.5: Production line: The production of the robots will be fully automated. Various section in the Industrial Pseudo-Torus will act together to ensure seamless production. Various parts to be used in the robots and the prefabricated base will be manufactured within the industrial Pseudo-Torus; the materials to be used will be brought from Mars and its moons. After passing the quality control they will transported to an assembly line by the use of dedicated haulers. The assembly line will be housed in a large area and will be manned by robots that will be able to carry out all the required tasks. Once the assembly sequence is completed the robots will be packed in there containers and they will be ready to be shipped to Mars and beyond.

ROBOTS TO BE USED ON PHOBOS/DEIMOS:

Name	Description
Operation Assisters	
I: Areius Loader (HARVESTER)	 Areius loader is a multi functional robot designed to be used on any type of terrain. It has two adjustable arms to overcome hurdles and slopes up to 45 degrees, Areius Loader will be used to extract and carry loads of up to 1000 kg. Its load carrying tray has positioning sensors which prevent the load from falling. Also the robot has 18 sensors attached the tires on both sides allowing it to know if it's stuck and to locate the exact position where the Sector R is located. It can be remote controlled or preprogrammed to move by a GPS route. The robot comprises of different 3D scanners, cameras located on the head, a drill unit and a shovel for picking up the material.
Iv: Cresius (Multi end effectors robot)	Cresius is a state of the art robot designed for the assistance of people who will work outside the space station on the surface. With 3 drills attached to it also with to arms which can fix bolts as well to make sure that the traveler is not faced with any life threatening situation during his travel. This robot will carry tools which will be required by the astronauts who will be helping in preparing the base. Cresius also has sensors the check the oxygen levels in the suit so that the traveler has sufficient supply to have a safe journey which can span for a lengthy amount of time. The Drills and Bolts help the traveler to fit into his astronaut suit which is given to the traveler by another pair of Cresius's Arms.  **Figure 5.5d: Diagram showing Cresius**
Ii: Sector R (ROBOTIC BASE)	Sector R is a robotic industrial base that will deploy itself on Phobos/Deimos and assist in operations being carried out over there. It will make the use of portions of the lunar surface for material collection and then refining and processing and then the resulting materials can be transported   The Self-Replicating Process of the Sector R. Sector R consists of five subsystems. Two fixtures are used: a ramp with constrained shape which is fitted to the controller and the connector; and a tunnel-like cave with an attached wedge on the ceiling used to physically force the connector in place. The process begins with the original robot dragging the right part (which consists of half of the chassis, the right wheel and the right motor) to a wall. Then the left part (which consists of half of the chassis, the left wheel and the left motor) is pushed to connect with this right part. The left and right parts of the replica are securely merged by adding the bumper which has interlocks to both subsystems. The connector is fixed in its place in the same fashion. The last step is to physically force the connector to be in contact with the controller by pushing the replica in the tunnel-like area with a wedge on the ceiling. This will force the connector to be in place. After pushing the replica several times, the electronic connectors on the replica finally make contact. The replica is able to operate in the same way as the original does.

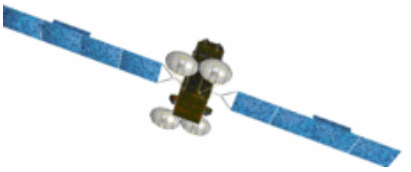
back to Aresam using the Transporter Train. The key to unlocking space resources is the autonomous development of the lunar surface using the special feature of the base, the self-replicating robotic system that propagates over the lunar surface. When self-replicating robotic factories take hold, the moon will be transformed into an industrial dynamo. The resulting refined materials and energy produced on the moon will then provide capabilities for the exploration and colonization of space.

SETTLEMENT MAINTENANCE, REPAIR AND SAFETY FUNCTIONS: Appropriate environmental conditions are necessary for life, improved crop yields, and efficient use of water and other resources. The monitoring systems employ PC or SMS-based systems for keeping the user continuously informed of the conditions inside the greenhouse and taking steps according to the situation so no havoc is created. The monitoring systems design is a simple microcontroller-based circuit along with Programmable Logic Controllers (PLC) to monitor and record the values of oxygen level, pressure, temperature, humidity; soil moisture, water level inside and sunlight of the natural environment that are continuously modified and controlled.

The system communicates with the various sensor modules in real-time in order to control light, environmental conditions, water levels in soil. The system makes the use of actuators in accordance with A Self-Repairing Control System Based on Switching Actuators. Such a system makes the use of different sensors and measures and fault in the current actuators. If faults are detected the faulty actuator is switched with a healthy one to prevent any sort of time delays and other havocs in the mean while. Actuators are used to turn different electrical equipment and control the conditions.

Lights, Sprinklers, drainage, air conditioners are turned on according to the current conditions of the settlement.

Also in regions where robots cannot work in such areas expert systems and problem solving systems are used along with engineers guiding them in not only identifying different problems but also helping them solve them in repairing systems wireless RFID technology is used.



Such a system uses wireless communications to establish a connection via specific Active RFID packets. The engineer with a restricted access activates the robot to perform the specific program stored in its memory. One of the features available is that robots can be shutdown easily if an emergency occurs and problems arise. All the robots on the grounds can be enabled simultaneously with a flick of a switch. Robots are not only used in internal repairs like machinery but are also used for external repairs that are mostly needed in emergency. Such robots will be made of **Iridium** metal as the most corrosion-resistant metal, even at temperatures as high as 2000 °C, low density and is easily available on other planets as strong metal. Aresam will also make the use of automated system fitted to each house and working place which will make the use of actuators and motors automatically aligning the dish to the satellite according to the rotation, elevation and azimuth. Two or more satellites will be linked to each other to reduce time delays generated in between data access.

6.0 Cost & Schedule

Construction Phase:

	Phase	*Unit Cost$*	*Schedule (15 years) 1 Box Represents 3 Years*	*Cost$*
Construction of cylinder	1.0-1.1	1.1×10^{10}		3.3×10^{10}
Construction of spokes	2.0-2.4	$3 \times (1.1 \times 10^{9})$		3.3×10^{9}
Construction of Pseudo-Torii	3.0-3.2	$3 \times (1.1 \times 10^{10})$		3.3×10^{10}
Transport of materials	1.0-3.2	$3 \times (2 \times 10^{9})$		6×10^{9}
Materials	1.0-3.2	See Table below		5.07×10^{12}
Number of People (1000)	1.0-3.2	13000		1.3×10^{7}

Automation Phase:

	Phase	Unit Cost$	Schedule (5 years) 1 Box represents 1 Year	Cost$
Robots		10000		1×10^8
Server System		$4 \times (3 \times 10^5)$		1.2×10^6
Satellite Systems		$4 \times (4 \times 10^7)$		1.6×10^8
Computers		3.02×10^7		3.02×10^7
Fibre Optics		8.1×10^6		8.1×10^6
Number of people (10000)		13000		1.3×10^8

Residential Phase:

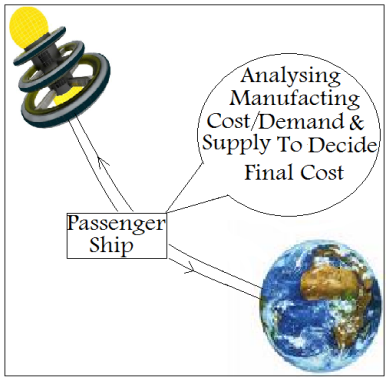
	Phase	Unit Cost$	Schedule (5 years) 1 Box Represents 1 Year	Cost$
Houses		10000		1.25×10^8
Research Labs (10)		2×10^6		2×10^7
Food & Survival9 (22500)		4.2×10^8		4.2×10^8
Entertainment (22500)		7.6×10^6		7.6×10^6
Number of people (22500)		13000		2.9×10^8

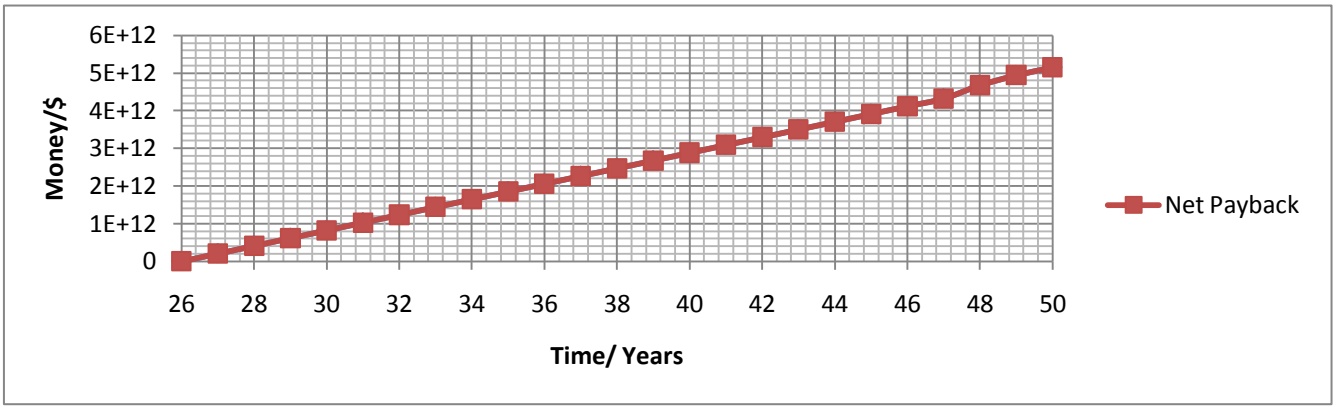
The Settlement will be Complete in 25 Years, in 3 Major Phases. Total Cost will be = **$5.15 X $10^{12}**

6.1: Payback & Profit:

Cost criteria for selecting commercially viable products

1. The product to be analyzed is first sent to Earth in a passenger ship to be sampled and tested.
2. The product is sold/tested by handing over the samples to people at random and in various parts of the world.
3. The response for that product is then used to determine the market value and cost.





Appendix A

Section 2

Layering of cells for debris protection:

We will have a layer of cells. The layering will consist of a titanium wire mesh, aluminium, super adobe in Kevlar cloth. We will have two layers of aluminium and our titanium wire mesh will be sandwiched between them. The spacing in the wire mesh will be covered with super adobe which will be wrapped in Kevlar. We will have sensors lined throughout the surface of the structure underneath our layer. These sensors will also be superconducting. This ensures that we have an excellent electromagnetic field around the settlement because superconductors expel their entire field due to the Meissner effect. Our next layer shall be our shape memory alloy, after which there will be a lining of Lead. This will be the second last layer after which we will have unreactive tank armour plates. The unreactive tank armour works to absorb the momentum of the projectile.

Docking & Transport: The docks will cater for all types of space craft including V-STOL and conventional landing and takeoff ones. The VTOL spacecrafts will not need a large space as they will take off and land vertically and don't even need a runway. Hence they will land at the ramp directly the neighboring aircraft will be protected from their wash by a series of walls which will emerge when an aircraft is landing or taking off and will go back in the ground when the aircraft is not in use.

A control tower will also be built in Aresam to facilitate the aircrafts as highly skilled ATC will be able to guide the pilots who are new to the settlement and don't have much experience in taking off and landing in settlements.
The conventional aircrafts will take off by the use of a catapulting system which will be based on MAGLEV trains; it will employ powerful superconducting magnets to propel the aircraft to its takeoff speed in the limited space of the port.
Arrestor cables will be used to stop the aircraft which must engage its tail hook in one of the wires to ensure its stopping in time. If the pilot fails he can deploy his magnetic braking system, the aircraft will generate a powerful magnetic field the runway will then generate a field of the reverse polarity locking the aircraft in its place gradually.

Details on Hydroponics and aeroponics

Hydroponics: Non-soil mediums, such as clay, perlite and rock are employed instead of soil. It has been found out that soil is only necessary for cultivation as a medium which houses nutrients in solutions which the plant then takes up actively through the roots. If a nutrient solution base is present beneath the non-soil medium, the need for soil is removed and virtually all plants can be conveniently cultivated. In fact the yield per acre of the same variety of crop is several times higher for hydroponics when compared with soil cultivation. Moreover, when using soil, the problem of air pockets becoming waterlogged hence starving the plant's roots of oxygen arises. Moreover, using sub-passive irrigation means that plants will only take up requisite amounts of water, effectively dealing with over and under-watering. This can also case the roots to rot. Such problems are avoided and output hence increased when using soilless cultivation. The concentrations of the following inorganic ions amongst others must be precisely regulated in the nutrient solution, so as to prevent it from becoming excessively hypertonic or hypotonic. The pH must also be controlled for optimum growth. The regulation is especially important because the lack of micro or macronutrients can significantly depress crop yields, or account for unfavorable characteristics such as mottled and yellow leaves.
Aeroponics: This technique involves spraying the roots of plants, suspended in a mist of air, regularly with an atomized nutrient solution. This ensures that the roots are constantly aerated, ensuring healthy development and respiration in the roots. Moreover, the requirement for water is 65 percent smaller than that for hydroponics, and

also plants grown this way increase their biomass much more rapidly, accounting for quick and higher yields. Water as a medium in hydroponics can only hold a certain quantity of air, hence limiting the oxygen availability for the roots. This is avoided is aeroponics. Also, due to the absence of a medium such as water of soil, bacterial or fungal attack is unlikely; removing the need and expenses of pesticides. The employment of these agricultural techniques coupled with 12 hour sunlight cycles in a thermostatically controlled environment in greenhouses will maximize crop outputs for the settlement.

Protection & Safety of Residents: The safety of our residents is of the utmost importance. We will have rescue ships at various points in our settlement. These rescue ships will basically be kept towards the outer edges of the settlement and in case of an unforeseen emergency which may cause the loss of lives; we will evacuate our residents using these ships. These ships will run on mini nuclear reactors, because we can always rely on such fuel to run and it will not consume a lot of space and won't depend upon things such as oxygen or other reactants for its operation.

For protection and safety within the settlement we will have a small block within the Administrative district in all 3 residential sectors. This block will contain teams for fire protection, crime protection and health emergencies. Each team will have humans and robots working in collaboration. A special set of transport vehicles will be used for health emergencies and for fire protection purposes.

For fire protection we will use three methods of protection i.e. Passive fire protection, active fire protection and education of citizens. In passive fire protection we will construct our residential area in such a way that floor and wall assemblies are made so as to compartment and limit the spread of fire. For active fire protection we will have the Inferno Kill robot designed to handle fire emergencies (ref 5). We will make sure that all our citizens are well educated in the safety plan created for them and that they are aware of the methods of active and passive fire protection created for them.

Health emergencies will be dealt with by the Robo Protector robot (ref 5) the consumer chip attached in each residents arm will keep track of their health and this will be fed into a database. Whenever there is an anomaly in the health report of a resident at any moment it will be addressed by our Robo Protector robot and special transport vehicles will carry the resident to the hospital of his/her designated sector if necessary.

For crime protection we will use humans, because robots cannot make reasoned decisions like humans can. However, once we have identified a threat robots can be used to eliminate that threat or to ensure that the threat is contained. For juvenile crime we will make sure that those children are sent to a psychiatric facility (ref 4) for adults we will have a detention area within our administrative section and these citizens will be deported to Earth as soon as possible.

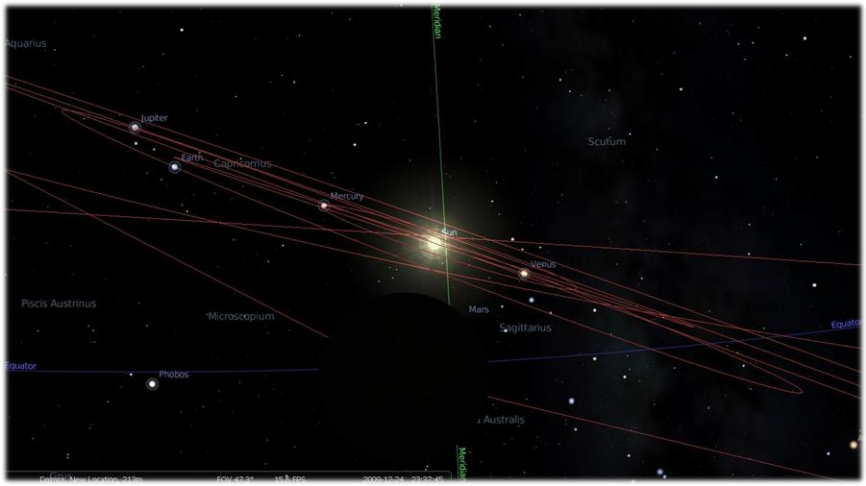
Electromagnetic field

Our layer of superconducting sensors will expel their entire field which will create a strong electromagnetic protective field. Our settlement will be protected from the inside by the double layer of aluminium as it is diamagnetic.

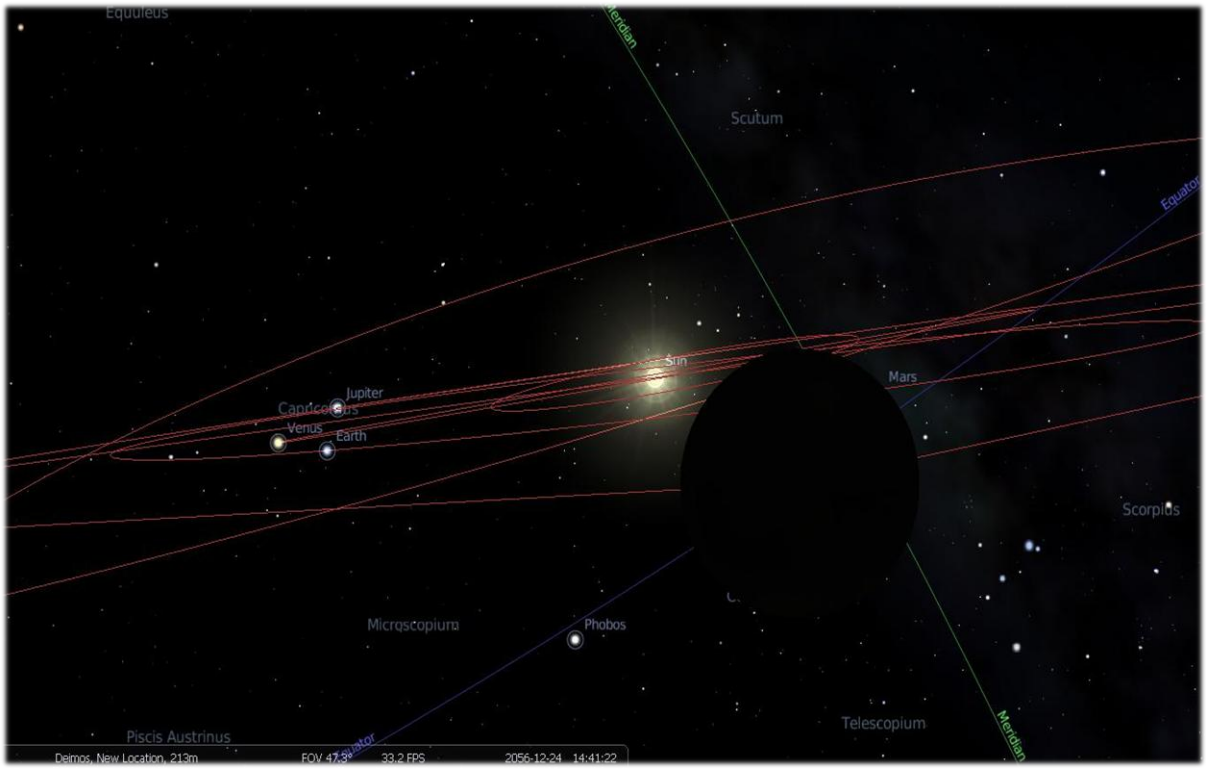
Orbital Calculations

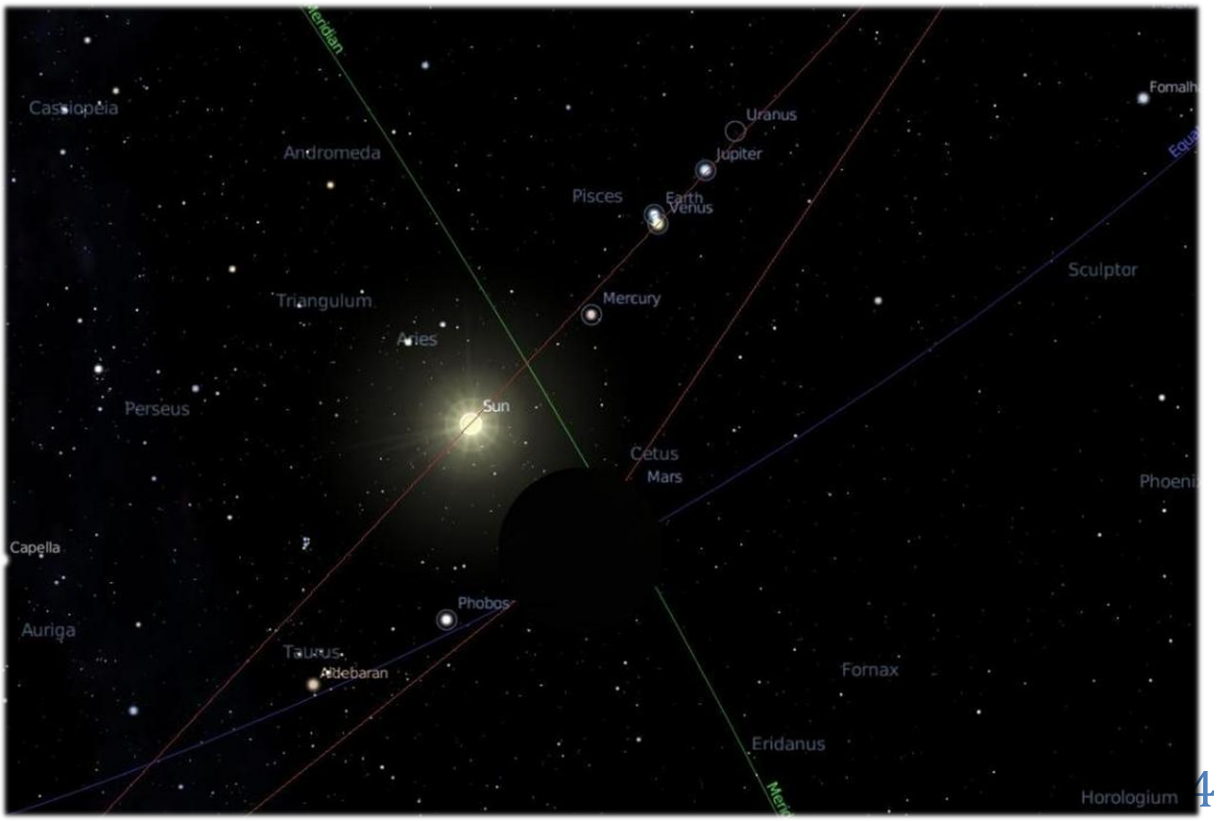
Our orbital calculations are based on Kepler's laws. Our settlement behaves exactly like Deimos and even with our approximations the ratio of orbital radius to time period between Deimos and our settlement is equal to 1.2.

We have calculated that our settlement will be blocked from the view of the sun by Mars, for a maximum of 1 hour 20 min and this will happen in



decreasing time periods for four months everyday per year. Our power production system which works as a regenerative heat exchanger will not work efficiently during this time. Keeping this in mind, we have kept backup systems which have also been described in the proposal. The following are images when mars is about to block our settlement. This also plays a major role in communications as our signals will be blocked during this time and we will have to use relay satellites as a redundancy for communications.





Prefabricated Base

***** In exhaled air, there is 21% oxygen and in exhaled air there is 16% oxygen. So the net difference in percentage of oxygen in exhaled air and inhaled air is 5%.

** Inhaled air contains 0.03% of carbon dioxide but exhaled air contains 3.5% of carbon dioxide. The difference in both percentages comes out to be 3.47%.

Balancing Air composition

Removal of Carbon Dioxide from air

CO2 is removed from the air by the process called Solid Amine Water Desorbed (SAWD). An apparatus is used to remove carbon dioxide from air by using a regenerative solid amine material arranged in beds. Air is directed through a first bed to adsorb the carbon dioxide there from. Steam is impelled by a compressor into the first bed to desorb that bed, the steam forming a condensate on that bed. The compressor then creates a vacuum in the first bed which vaporizes the condensate therein, dewatering the first bed so that it may be reused to adsorb carbon dioxide. The compressor impels the vaporized condensate into a second bed to desorb the adsorbed carbon dioxide in the second bed.

Oxygen Replenishing

$$2H_2O \rightarrow 2H_2 + O_2$$

Our prefabricated base is also supported with an electrolysis apparatus to break down water. The water that is used by those people living in the base is used for this purpose. It is first passed through filters to get rid of solid suspensions. Then it is electrolyzed and oxygen used for providing breathable air. For any increased amounts of CO in atmosphere inside base, oxidation of the gas would convert it into **safer** CO_2.

A process called Bosch process combusts the CO_2 with H_2 to give water and solid Carbon.

$$CO_2 + H_2 \rightarrow 2H_2O + C$$

The Hydrogen from the electrolysis and excess CO_2 are in this way also used to replenish **water**. The used water can also vaporized by heaters to contribute to the maintenance of air humidity.

It is hitherto known (by the Viking Probes) that oxygen can be extracted from the thin Martian atmosphere and it is estimated that 750 watts of energy would successfully result in 22 pounds of Oxygen. So far no sufficient equipments are available for this process for which we cannot rely on this method.

Water

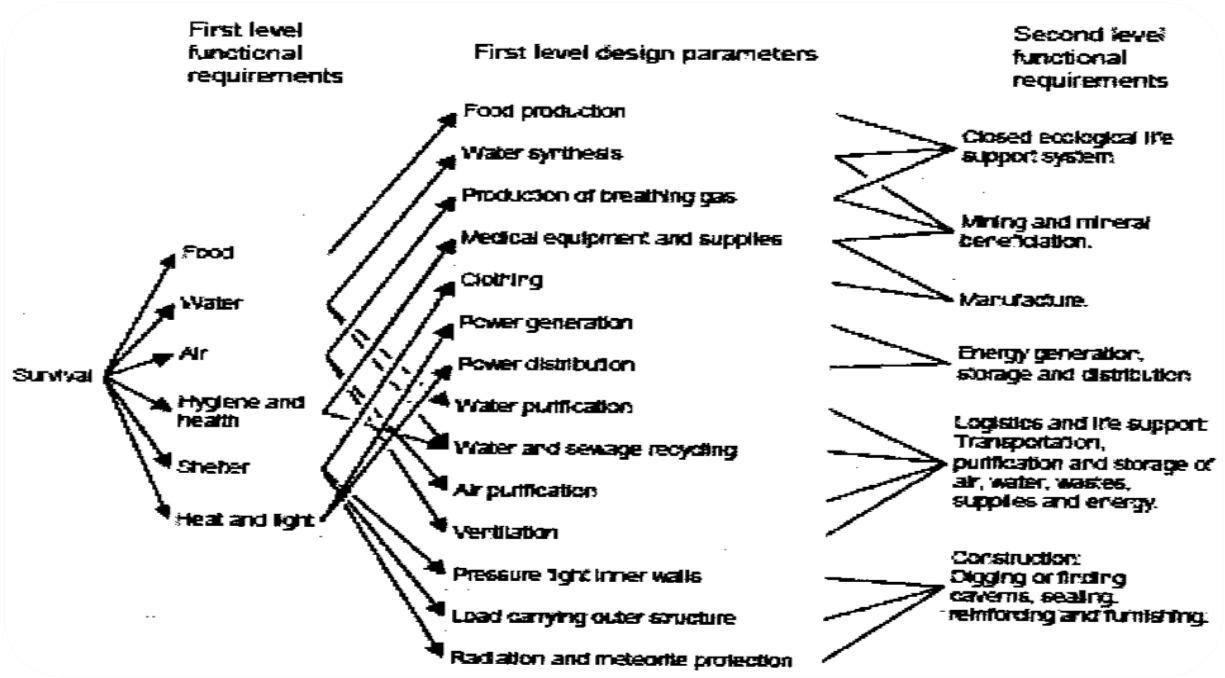
On Earth an average person uses around 50 liters of water daily but lowering this value to save water, a person in the prefabricated base can use up to 40 liters of water per day and fulfill his/her needs. The calculated amount of water in above table shall be brought along with the assemblies and sub-assemblies of the base.

Circulation and Air purification

The air in the base is circulated in the tubes and the domes with the help of blowers using motors of 5 Horse power. These blowers not only circulate air but also direct it to heaters where the air is heated to a comfortable temperature. Before that, air is passed over thin mesh to filter any solid particles and a charcoal bed to remove

odoriferous impurities. This helps us maintain the internal environment. The air composition is checked at regular intervals by computers which also calculate the amount of CO2 and O2 that needs to be absorbed and/or released. In case of any leakages of air, to maintain the pressure, nitrogen and helium are stored in cylinders which can be released into the base.

HUMAN FACTORS:



counter to serve the food, a beverage counter for the drinks and a small kitchen to prepare the food. A school clinic would also be available for first aid assistance to any kind of emergency or accidents faced in the premises.

High School Section

Grades 9 to Grade 12

12 classrooms with a capacity of 30 students in each class 2 libraries 2 computer labs 2 physics, chemistry and biology labs 1theater 1 auditorium 2 cafeterias 1 gymnasium Clinic

The high school is divided into two parts: one section is from grade 9 to 11, and the other grade 12. One of each facility would be used by the students in grade 9 to 11 and the students in grade 12. The theater in the high school would have a seating capacity of 200 people. It would be equipped with complete set of lightings for the stage, surround sound system, multimedia projectors, an audio visual control room, 3 dressing rooms and a store room. This theater would be used by the students for expressing their talents of performing arts. The auditorium would have a seating capacity of 200 people, equipped with a sound system and multimedia projectors. The auditorium would be used for any kind of assemblies and addresses. The physics, chemistry and biology labs would be able to accommodate 35 students, each working on an individual work station, equipped with the latest required apparatus.

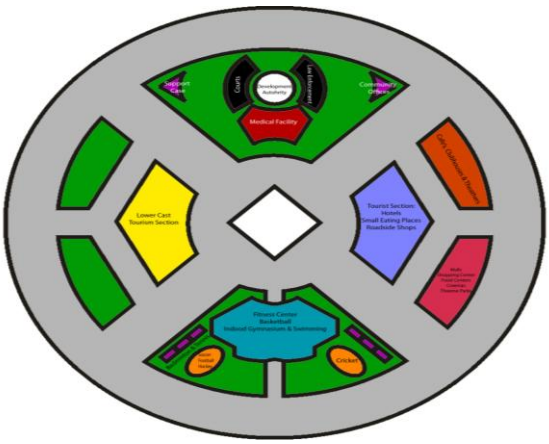
University: The university section would have its facilities on a much wider scale more advanced with a higher capacity. In the university, classes are replaced by auditoriums.

100 auditoriums with a capacity of 90 students 10 classrooms for independent studies 1 computer lab with a capacity of 250 students 1 library with a capacity of 200 students 2 physics, chemistry and bio labs extended to a capacity of 50 students

1 cafeteria with a capacity of 150 students

The university would also have a separate sports complex, which would have different sections for sports fields, courts, gymnasium, swimming pool and other indoor games. The library would also have a separate building, with a capacity of 300 students, divided into sections to provide reading material for each department. The teachers and students would have their accommodation facilities in the adjacent residential sectors.

4.1.3 Community Sector:



The residential Pseudo-Torus contains two of the community sectors which would be accessible by both classes of residencies. The main idea of the community sector contains all kinds of recreation, entertainment, tourism, sports, medical, law and enforcement and development facilities. The sector is divided as such that two opposite sides shall have the entertainment and tourist areas whereas the other two shall have a sports complex on one side and a development authority, law enforcement, medical facility and the support offices on the other. The tourist sections are divided such that on one side there is the higher class entertainment and tourism facilities which are more luxurious, attractive and expensive compared to the other section, located on the opposite side, which is of a lower class. Each tourist section would contain tourist hotels, guest houses of the companies located in Aresam, restaurants, cafes, clubhouses, malls, shopping centers, food centers, cinemas, theme parks, road side attractions and theaters.

The sports complex provides the best recreation and fitness facility for the tourists and the settlement residents. It compromises of a fitness center, section for all kinds of indoor games including table tennis, squash, karate, chess and such, a swimming pool, a basketball court and a gymnasium. The sports complex would be surrounded by a golf course. Also there would be two multipurpose sport fields which can be used for athletics, football, soccer, cricket, hockey and rugby. Courts for badminton and tennis would also be there. The last section of the community sector is a multipurpose section. It would have a medical facility, compromising on 500 rooms: 20 operation theaters, 100 doctor's check up rooms, 5 X-Ray rooms, 5 ultrasound rooms, 10 emergency wards, 50 labs and the rest as recovery rooms.

The law enforcement section would compromise of a police station and a prison facility, 3 high courts and a supreme court. The support center and the development authority would have 50 offices in total.

4.1.4 Agriculture:

There are a variety of options available for choice of cultivation medium for the settlement. First, nutrient-rich spoil which supplies most of the minerals needed for healthy plant growth could be brought from the earth and used as a medium. Secondly lunar soil, (from the Earth's moon) which contains particularly high amounts of Oxygen (42 percent), Silicon, Iron and Magnesium could be brought in for cultivation in the agricultural Pseudo-Torus. Thirdly, aeroponics and hydroponics could be employed as cultivation techniques, in a way similar to that on earth, when fertile soil is not available or for roof gardens. It should be noted that practicality issues will be most pronounced in using soil from Deimos and Phobos, because these moons are only a few kilometers wide, and because the composition of the soil is not certain. Hence this possibility should be excluded for cultivation. Here's a cost-benefit analysis for the remaining possibilities:

Agricultural Pseudo-Torus: Crops

Due to the limitations of area, and for providing the inhabitants of the settlement with a variety of food and commercial crops for consumption, the following varieties will initially be cultivated. However, as per the changing requirements and demands of the citizens, the types of crops will regularly be modified. Some factors which nutrionists and dieticians will consider when advising on crop selection are:

Ease of cultivation, for example, watermelons can be cultivated successfully hydroponically

Calorific value, for example, potatoes are rich in carbohydrates and an excellent source of sugars

Constituents of a balanced diet, for example, greens such as spinach and fruits such as tomatoes are excellent sources of multiple nutrients and trace elements.

Similarly, varieties of peanuts and soy beans will also be cultivated in the sector, as these are essential components of a balanced diet and are also useful sources of cooking oil. The same will be true for grains and cereals, such as

wheat, barley and maize. The relevant nutritional data for these is below. The table is not exhaustive; sorghum, rye and other cereals may also be cultivated, as per need.
It is also important to give plants such as Aloe Vera, chamomile and cotton importance in the agricultural sector. These are essential to the provision of raw materials for several industries, such as cosmetics, pharmaceuticals, fabrics and food. A balance between an array of food and commercial crops will contribute to the healthy, comfortable life of the settlements citizens.

Agricultural Sector: Orchards

Alongside hydroponically grown fruits and vegetables, the agricultural sector will also feature areas especially dedicated to fruit trees. These will contain a variety of trees such as lemon, orange, apple and berries to add to the scenic beauty of the region. Therefore, the settlements agricultural Pseudo-Torus houses not only a centre of production, but also serves as an area where residents can come for a breath of fresh air. In fact, with the requisite funding and development, and the addition of amenities present in parks, Aresam's orchards can potentially be developed in tourist attraction sites. The same can be said for animal farms.

Animal Husbandry: Meat

Meat will undoubtedly be a popular and essential component in the diet of Aresam's inhabitants. Therefore, substantial amounts of meat (in the form of single cell proteins) will be produced, largely through fermenters, for the inhabitants. This involves the commercial use fungi, which, when cultured in an nutrient solution in a vat, which is aerated. Mycoprotein will then be textured and flavored as per the needs of the citizens. Single cell proteins have several advantages over meat. First, it contains a larger variety of essential proteins. It contains virtually no fat/ cholesterol, and does not contribute to meat-related diseases such as cancer (if meat is contaminated). This excellent source of proteins has been called as 'perfect nutrition.' The table below explains why:
However, alongside single cell protein, Aresam will also offer its residents the option of meat from slaughtered animals.

Quarantine, airlock designs and safe human access: During the exploration of Mars some evidence of life may be found, if that happens then it will be sent to the research centre for further investigation. Initially we will not know if the substance contains some bacteria or other substance that maybe hazardous to human life so it will be kept in quarantine. The quarantine chamber will consist of a room with thick dual walls with a multiple doors each with its own airlock system. No one will be allowed to enter the area without proper biological and radioactive hazard suits. The quarantine chamber will be self sufficient in terms of disaster relief. It will have its own fire management system and will be build of exceptionally strong materials to ensure no damage to the structure if even the building in which it is housed is damaged. The walls will be lined with lead to ensure containment of the radioactive materials. Any waste from the quarantine e.g. the clothes of the researchers will immediately be sent to the incinerator for safe disposal and minimize chances of hazardous waste to be exposed to the public.
When people will have to go outside the settlement into space or in the zero g areas there first line of defense against the harsh environment will be there space suit. The modern design is build in such a way so as to ensure that it is worn and removed just like a normal diving suit, it's safe even if damaged unlike the regular ones which can become a life hazard if punctured.

The people will have other tools at their disposal when they have to work outside. The outside of the settlement will be covered with a system of handrails; they will allow people to clamp on to them preventing them from drifting in space while inspecting or repairing. They will also allow easy movement to people in case of propulsions system failure, this feature will save lives in such a scenario.
To stay outside the settlement for extended period of time people will use a space capsule which is like a "Caravan" in space. It will be fully equipped with all amenities needed for a short stay. And with added safety features like a faraday cage to protect against solar flare activity. Capsule will have its own ion exchange engine to facilitate easy movement in space. It will also be equipped with a pair of robotic arms to carry out minor repairs while the people are in the safety of the Capsule. A figure showing the structure is shown below:

IMPROVEMENTS

Human Factors Improvements:

- AIR PURIFIER used in homes for better health of residents. To achieve it we use multiple technologies to remove pollutants of different types.
- **1 Pre-filter for larger particles**
  2. HEPA traps 99% of dust/allergens
  3. Chemical/odor carbon filters
  4. TiO2 filter destroys pollutants
  5. Germ-killing UV lamp
  6. Air-purifying ionizer and Super-Powerful Fan (180 cfm) to maximize air exchanges, increasing air-filtering capacity.
- Traffic surveillance due to increasing transit population over the years.
- Protecting and enhancing the artificially built natural environment.
- Amenities like parks, playgrounds and courts will be built along the same symmetrical path for maximum line of sight and reduced Coriolis Effect.
- Prefabricated base will be planted with plantation on top to help maintain climate in the base for the workers to work efficiently.

AUTOMATION IMPROVEMENTS

- Make the use of different robots that have ability to penetrate into small spaces
- Make the use of biometric and voice control in vehicles leading to a greater level of security.
- Make the use of greater number of processors and install hardware having greater storage capacity in servers.
- Make the use of infra-red burglar detection systems in homes.
- Robots which respond to the users verbal commands and isn't dependant on commands fed inside it. (auto updating)
- Install retina scanning door systems for accessing different places.
- Divide the Aresam into different zones with respective security levels
- Have special emergency shuttles for emergency procedures
- Robotic maids
- Robotic police
- Greater bandwidth available to the user
- Systems can be operated from earth
- Radiation level detectors in every part of Aresam
- Reduce time delay
- Pet robots that have ability to change shapes from one animal to another (restriction: can be some selected animals provided that they have a similar size)
- Robo-bikes

Business Development
Transport of Robots:

Transportation of robots and equipment to Mars will be done through an updated version of the Pegasus rocket. The equipment will be placed in the Pegasus and after it arrives at the base it will be reloaded with anything which has to be sent back to the settlement, Due to its autonomous function.

Production line:
The production of the robots will be fully automated.
Various parts to be used in the robots and the prefabricated base will be manufactured within the industrial torus; the materials to be used will be brought from Mars and its moons.

Once the assembly sequence is completed the robots will be packed in there containers and they will be ready to be shipped to Mars and beyond.

Research center:

Location:

The research center will be located in the commercial center of the residential torus to facilitate the researchers in an environment which is according to their needs

Facilities:

These laboratories will be basically used to study the materials from Mars, so they will be fully equipped with state of the art analytical tools

Space will be reserved in the labs for future expansion and addition of other equipments

The research centre will be continually developing new materials while refining and improving the existing ones. As soon as some major breakthrough is reached which has some commercial potential, the industrial segment will be informed and the blue prints will be loaded into its database and if the proper equipment needed for the manufacturing is available the production will start forthwith.

Quarantine:

The quarantine chamber will consist of a room with thick dual walls with a multiple doors each with its own airlock system. No one will be allowed to enter

The area without proper biological and radioactive hazard suits. The quarantine chamber will be self sufficient in terms of disaster relief.

Any waste from the quarantine e.g. the clothes of the researchers will immediately be sent to the incantatory for safe disposal and minimize chances of hazardous waste to be exposed to the public

TRANSPORT NODE AND PORT

Docks will have to be constructed away from the residential area so that the residents are not put at an unnecessary risk.

the two docks in the residential torus will be used for spaceships carrying passengers, One of those will cater for those coming to the Aresam and the other one for those that are leaving it; the

Third dock will be for space ships bringing in goods that do not need to be stored i.e. to be transported to the Mars or the other settlements. This dock will also handle the transportation of goods from Aresam to Mars or other settlements hence minimizing the cost of transportation;

The final dock will be used by the ships Carrying materials to be used in the settlement e.g. food or repairing materials. This dock will also need a system of ware houses for storing those materials.

The two docks for goods will be further divided into two sections: one for space ships carrying light freight and the other one for those carrying bulky freight.

Docking

The docks will cater for all types of space craft including V-STOL and conventional landing and takeoff ones.

A control tower will also be built in Aresam to facilitate the aircrafts as highly skilled ATC will be able to guide the pilots who are new to the settlement and don't have much experience in taking off and landing in settlements.

The conventional aircrafts will take off by the use of a catapulting system. Arrestor cables will be used to stop the aircraft which must engage its tail hook in one of the wires to ensure its stopping in time.

If he fails he can deploy his magnetic braking system, the aircraft will generate a powerful magnetic field the runway will then generate a field of the reverse polarity locking the aircraft in its place gradually.

Cargo Handling and Warehousing: If the cargo is for the settlement it will be stored in permanent warehouses situated next to the docks, hence minimizing transport costs.

The light weight equipment will be carried out of the space ship by robots that will put them onto rolling belts which will take the goods into the warehouse. When the goods are required to be transported the computer will guide the robots to the place where it is stored.

If a good has to be transported from the Mars to the earth via Aresam it will first arrive at the dock meant for cargo not to be used in Aresam. After removal from the spaceship by automated robots it will be kept in temporary storage areas until the time when it is transported further on. This will reduce transport cost as well as traffic congestion if goods had o be transported from one dock to another.

Passengers

The space ships bringing in passengers will land at a separate dock from those who are going to leave the Aresam.

If someone needs to transit between the two docks he will use the Maglev train running between the two ports, while his luggage will be transferred via a series of high speed conveyer belts between the two docks.

Medical center

There will be a medical center where passenger will be checked for any symptoms of infectious diseases.

If any passenger coming to Aresam is found with some severe illness, he will be immediately shifted to the central hospital where he will be kept in quarantine.

The medical centre will also cater for any passenger suffering from travel sickness and a staff of medical doctors and nurses will be present round the clock to provide immediate relief in case of a disaster.

Repair

The cargo ports will be used for the repair of the damaged vehicles. The space craft or Mars surface Landers will be towed into a repair hanger there automated machines will perform all checks on the vessels to determine the nature of the fault.

Repair centre will also be used as a repair depot for the fleet of Mars surface landing and launching vehicles, ships from Mars will bring the damaged vehicle with them and after they are repaired they will be launched back to the Mars so that they will continue with their jobs.

Cleaning

Ships arriving from Mars are dusty, due to its environment and surface. Hence an autonomous system of cleaning robots will be used to keep the landing and docking areas of the port clean and free from dust.

These robots will detect any foreign containment and will clean it automatically they will also break any large material into small pieces for easy removal.

The dust will also try to enter enclosed areas in the Aresam. Hence all the opening in the settlement will open with an airlock which will be equipped with a static dust removal system called AIRPURA. It is guaranteed to remove 99% of all the dust present in the area and it also kills any bacteria or virus present.

Appendix B (BIBLIOGRAPHY)

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Images taken from History Channel documentaries “The Universe”

Some material used from last year’s school project

Images taken from planetary software “Stellarium”

Compliance Matrix

Section Reference	Minimum Requirements	Fulfillment/Description	Page Number
1.0	Executive Summary	Summary showing all important features of Aresam. Exceptional features of settlement mentioned.	1-2
2.1.0	Overall exterior view of the settlement	Diagrams of external view of the settlement	3-5
2.1.1	Sealable Volumes	Description of sealable volumes	3
2.1.2	Pressurized and non-pressurized sections	Locating areas with high and low pressures(vacuum)	3
2.1.3	Settlement Dimensions	Table showing calculations.	5
2.1.4	Materials used	Chart showing Materials used in the structure	6
2.1.5	Rotational and non-rotational areas	Location and description of rotational and non-rotational parts of the settlement	8
2.2	Land allocation	Pie Chart Showing percentage allocation	Appendix
2.3.0	Phases of construction (construction sequence)	Showing sequence of construction and construction modes	7-9
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2.4.1	Future expansion	Expansion of pseudo torii and evacuation of sectors	8
2.5.0	Design of prefabricated Base	Description of the prefabricated base	9-11
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2.5.4	Deployment of prefabricated base	Installation/inflation of pre fabricated base on Martian surface	11
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3.2.3	Weather control	Controlling internal temperature and other atmospheric conditions inside the settlement	15-16
3.2.4	Food production	Methods adopted for food production	16-17
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3.2.6	Water management	Recycling and distribution provision	17
3.2.5	Storage, packaging & delivery of food	Table showing processes of packaging and delivery	17
3.2.7	Solid waste management	Table showing the types of solid wastes that can be anticipated and how is it managed	17-18
3.2.9	Internal & external	Communication facilities to connect people of Aresam within	18

	communication	the settlement and to other areas	
3.2.8	Internal transport	Description of vehicles used to provide low scale mobilization to residents and workers in the settlement	18
3.2.2	Day/night cycle provision	Hourly distribution of night and day in a total of 24 hour period	15 + Appendix
3.2.10	Protection & safety of Residents	Description of safety measures for residents	18 + Appendix (1,2)
3.2.11	Protection of Settlement	Description of measures taken for settlement safety	19
3.2.12	Networking Architecture	Chart showing network architecture for the settlement	19
3.4.0	Harvesting Operations	Description of harvesting operations and disadvantages and solutions	20
3.4.0	Manipulation of raw material into finished form	Flow chart showing processing of material	20
3.4.1	Illustration of mining base	Diagram showing the structure and shape of mining base	20
3.3	Equipment and functioning	Description of the equipment used and how it will function	19-20 + Ref 5.1
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4.0	Basic necessities	Basic comforts described	21-22 + Appendix
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4.1.1	Transport	Description of resident transport	21
4.1.2	Furniture requirements	Table showing amounts and types of furniture	22
4.1.3	Community designs	Illustrations depicting community designs	22 + Appendix
4.1.4	Agriculture	Chart showing types of crops and nutritional values	22 +Appendix
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4.1.7	Land area allocation	%age areas allocated to different roads and paths	25 + Appendix
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5.5	Robots for pre-fabricated base deployment	Robots to be used in deployment of the base	37-38
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7	Cost Criteria	Describe cost criteria for selecting commercially viable products: value of products on Earth vs. transportation costs from Mars	40
7.1.1	Docking	Shows docking ports and describes port facilities	9 + Appendix
7.1.2	Storage	Location of warehouses	9 + Appendix
7.1.3	Cargo handling	Robots to be used on the docking stations and in transporting the materials to warehouses	9 + Appendix
7.1.4	Refueling	Integrated in sec 2	9 + Appendix
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7.1.6	Medical services/hospitals	Integrated in sec 4	9 + Appendix
7.2.1	Manufacturing center	Integrated in sec 5	37 + Appendix
7.2.2	Vehicles transport	Integrated in sec 2	9 + Appendix
7.3	Research center	Describes the center and its functioning to perform research	Appendix