Aresam
Space Settlement

Trinity Christian Academy

Lexington, Kentucky
United States of America
10 March 2010

17th Annual International Space Settlement Design Competition
Proposing Team Data 2010

Name of responsible teacher/advisor: Jayne Everson
School (or other Group Name): Trinity Christian Academy
School Address: 3900 Rapid Run Drive
School City, State, Zip or Postal Code: Lexington, KY 40515
Country: USA
Daytime Telephone at School: 859 (887) 2513
Message Telephone:
Fax: (859) 887-2468
e-mail address: jeverson@tcalex.org
Last day of school in Spring 2010: May 28, 2010

Contact information for responsible teacher/advisor when school is not in session:

Name if different from above: Jayne Everson
Address: 2559 Eastpoint Dr.
City, State, Zip or Postal Code: Lexington, KY 40516
Country: USA
Telephone (also evenings / weekends): (859) 489-1610
e-mail address: jeverson@tcalex.org

Information for alternate contact person (may be a student): Jack Rockaway
Telephone X day X eve X weekend: (859) 779-2587
e-mail address: jackrockaway@gmail.com

Names, [grade levels], and (ages) of 12 students currently expecting to attend the Finalist Competition:
(we request that participants be at least 14 years old, and not older than 19)

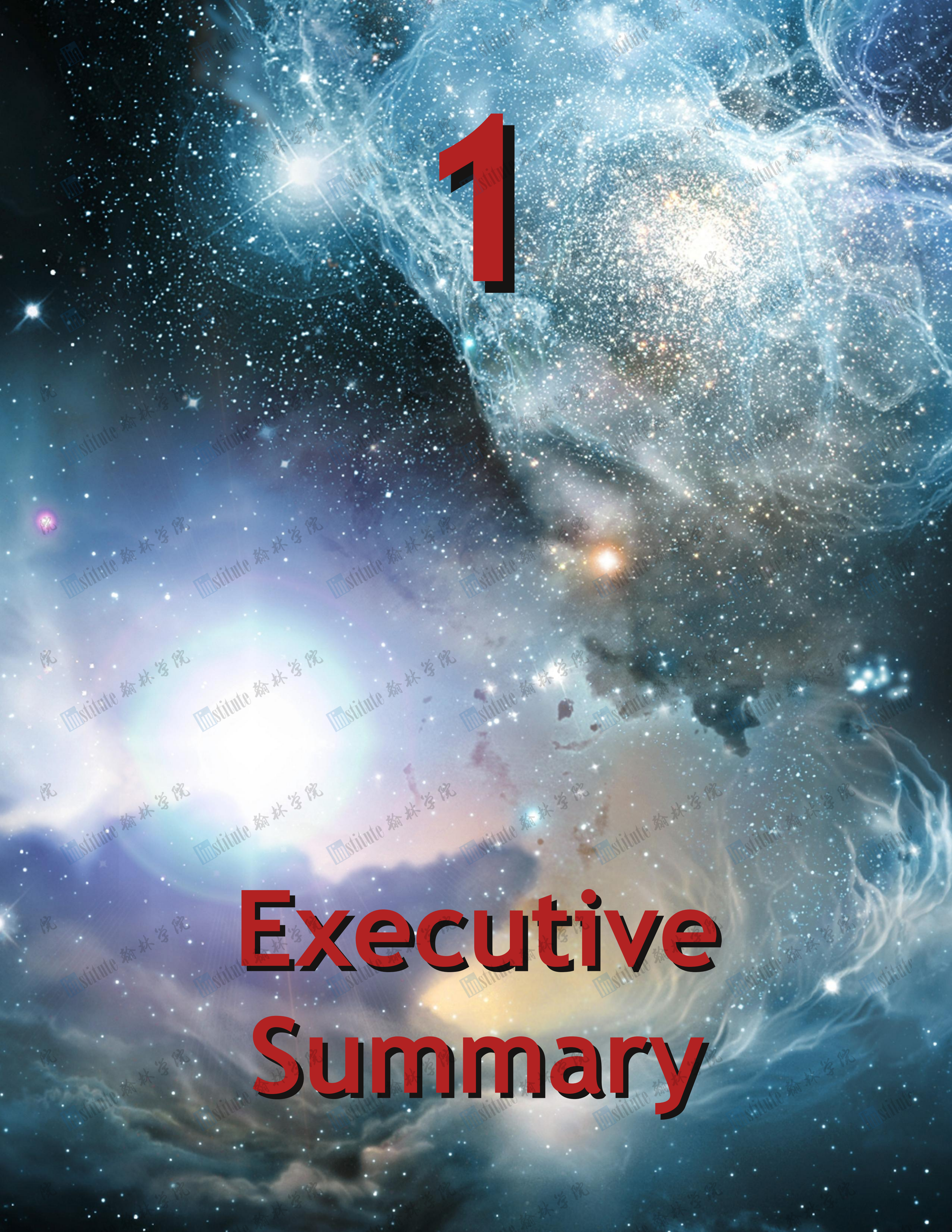
Jack Rockaway	[12](18)	Sarah Kinnicut	[12](18)
Paul Rockaway	[10](16)	Sam Davidson	[9](15)
Joel Cowan	[11](17)		[ ]( )
Caleb Voss	[10](15)		[ ]( )
Joshua Miller	[10](16)		[ ]( )
Mykalin Jones	[9](15)		[ ]( )

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

Jayne Everson Bonita Voss

I understand that if our Team qualifies for the 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.

Jayne E. Everson 3/5/2010
Responsible Teacher / Advisor Signature Date



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Executive Summary

1. Executive Summary

With a history as a leader on the forefront of developing commercial launch services, Northdonning Heedwell has been a major supplier and partner of the Foundation Society. Fulfilling this legacy, we are proud to answer the Foundation society's call for a design for a Mars orbital facility. Northdonning Heedwell is pleased to offer a complete, proficient design to compete for the “Aresam” Space Settlement Contract, after considering the Foundation Society's Request For Proposal issued January 3, 2055.

Table 1.1 Description of Design	
Component	№
Habitation Capsules	30
Torus Superstructure	1
Central Hub	1
Transfer Station	1
0-G Capsules	40
0-G Superstructure	1
Docking Bays	9

Northdonning Heedwell's design for Aresam will be a model for off Earth standard of living. With inclusion of such areas as a Central Park/ Town Square to provide a nucleus for the 900 person communities that make up the society of the station, life on Aresam will be both pleasant and low stress. Highly automated, the station will provide for all of the needs of colonists and allow them to service spacecraft headed for mars with their full industry. The following are many of the important features of the proposal:

- Built in separate interchangeable components, Aresam will be both quick and simple to build, and the construction process's quality control will be much simplified
- Built in small, community capsules arranged around a rotating torus, the Pseudo-Gravitated areas will be both comfortable, but large enough to allow full agricultural production, recreation, and plenty of hospitals to provide for the large society present on Aresam.
- Different parts of Aresam can be built at the same time, and final assembly does not occur till the last stages of construction, allowing for several teams of robots to work independantly on the project.
- The station is designed to provide the maximum comfort to the population at minimum cost, through use of space manufactured materials and simple yet effective construction methods.
- The interior of the settlement provides a small but complete ecosystem, based around a central tree, which will provide a comfortable scene to settlers.
- The settlement is designed to provide the maximum safety to all residents. The torus can be divided into 30 separate parts which can operate autonomously for short periods, and provide living conditions until rescue is available.
- Most industry is performed in an area separated from the living spaces by several airlocks, and in a non-rotating part of the settlement. This will provide a clean, safe environment in the habitation areas, and the microgravity will allow the most efficient industrial production techniques.
- Nine Dry Docks provide the colonists for a simple and effective way to service spacecraft without using slow, bulky space suits or robots. Fully pressurized, the dry docks will allow a shirtsleeves environment for servicing spacecraft.

Table 1.2 Key Information	
Avg. Distance From Mars	3396.2 km
Avg. Distance from Phobos	9365.9 km
Pseudo Gravity	0.8 Gravitys around rotating torus
Rotation Rate	0.85 rotations per minute
Mass	9.629×10^{9} kg
Separate Compartements	80
Pressure	0.8 atm in habited areas, variable in others
Electricity Production	100 MW
Docking	9 Dry Docks, 10 Attachment ports

Northdonning Heedwell is confident that they have provided a proposal that offers all that the Foundation Society has requested. We are eagerly anticipating working with the Foundation Society again to provide advanced and effective habitats in the furthest reaches of exploration. Through partnership with Northdonning Heedwell on Aresam, the Foundation Society will gain a valuable and safe station in Mars orbit, and a dedicated corporate partner for future projects.

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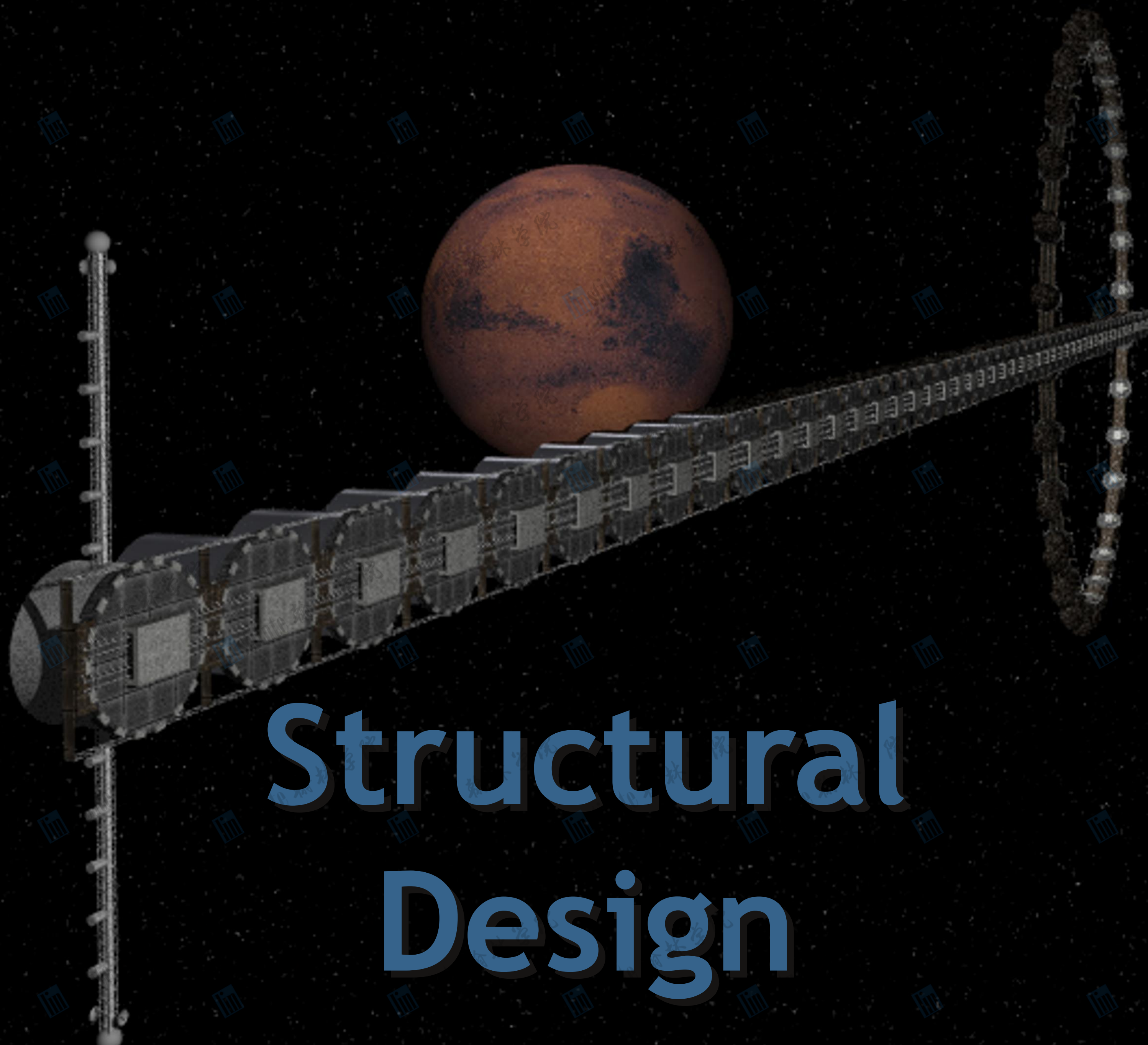
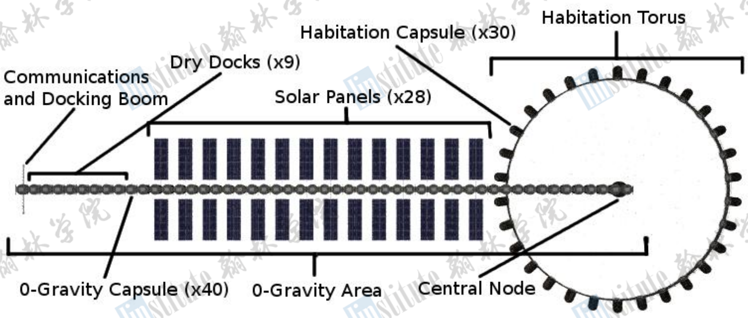


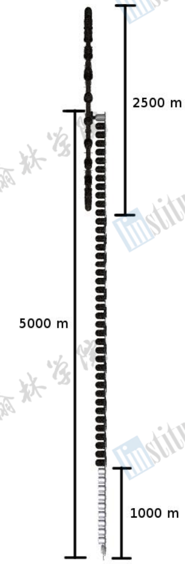
Structural Design

2. Structural Design

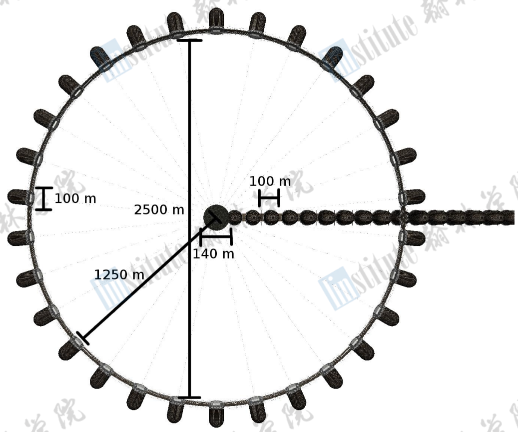
Aresam will be an enjoyable, safe environment for all of its 20,000 full time residents, and up to 2000 transient residents. The station will be large, have much room for expansion, and be able to provide facilities to harbor both heavy industrial and scientific activities, while maintaining its main role as a port of Mars.

Structural Overviews





2.1 External Configuration



2.1.1 Basic Structure

The basic structure of Aresam will be a large beaded torus attached to a length of pressurized volumes sustained in microgravity. Each "bead" is a pressurized area which houses up to 900 persons, which will be referred to as "capsules". The Torus is held together by a large external configuration made up of connecting materials and a rail road. Transportation to the center of the torus is provided by elevators extending from each of the capsules, to the central node, which serves as the terminal between the rotating torus and stationary microgravity areas of the station.

The beaded torus design provides considerable advantages over other station designs which provide gravity in the form of Centrifugal force., such as the dumbbell, cylinder, Bernal Sphere, and the common Stanford Torus.

1. The Torus structure allows easy transportation between different areas with gravity, unlike the Dumbbell
2. It has a reasonable down surface area to volume of atmosphere ratio, unlike the Cylinder
3. It has constant gravity when stationary anywhere on the Torus, unlike the Bernal Sphere
4. The structure can be manufactured in parts, unlike the Stanford Torus
5. Each Capsule can be easily isolated in case of emergency, unlike all other single volume structures

2.1.2 Design Features

The pressurized capsules on the torus will each be relatively self sustainable areas, each of which will grow food for its own residents. Each torus capsule will also have a central, open park area in the center, which will provide a needed change of scenery from manufactured walls. A day/night cycle in

Structural Component	Amt.	Shape	Surface Area (m^2)	Volume (m^3) Mass (kg)	Use	Location	Gravity (g's) RPM Pressure (atm)
Habitation Capsules	30	Bullet	4.71×10^4	1.05×10^6 2.43×10^7	Multipurpose Pressurized Facility	Studded around Torus Superstructure	0.8 0.76 0.8
Torus Superstructure	1	Torus	N/A	4.445×10^5 1.98×10^9	Structural component of Torus	Large rotating base	0.8 0.76 N/A
Central Hub	1	Cylinder	4.96×10^4	6.28×10^5 5.09×10^8	Central Cargo Transfer Station	Center of Rotating Torus	0 0.76 0.8
Transfer Station	1	Curverd Cylinder	2.98×10^4	3.92×10^5 2.95×10^8	Secondary Cargo Transfer Station	Attached to Center Hub	0 0 0.8
0g Capsules	40	Bullet	4.71×10^4	1.05×10^6 2.43×10^7	0g Pressurized Facilities	Studded on 0g Superstructure	0 0 0.8
0g Superstructure	1	Linear Structure	N/A	6.08×10^4 4.26×10^8	Structural component of 0g Area	Extending linearly from Central Hub	0 0 N/A
Docking Bays	9	Cylinder	3.015×10^4	4.02×10^5 5.815×10^8	Transport Stations	Studded on 0g Superstructure	0 0 Fluctuates

Table 2.1.1 Overview of Major Structural Components

Component	Amount	Shape	Location	Sub-structure	Radius (m)	Secondary Radius (m)	Height (m)	Width (m)	Length (m)
Habitation Capsule	30	Bullet	Studded around rotating torus	Cylinder	50	20	100	N/A	N/A
				Half-sphere	50	N/A	N/A	N/A	N/A
				Short cylinder	52	N/A	6	N/A	N/A
Torus superstructure	1	Band	Main structure of rotating torus	None	1260	1250	10	106	N/A
Central Node	1	Cake	Center of rotating torus	Main cylinder	70	N/A	50	N/A	N/A
				Secondary cylinder	20	N/A	10	N/A	N/A
				Tertiary cylinder	50	N/A	100	N/A	N/A
0g superstructure	1	Bridge	Extending from central node, away from rotating torus	None	N/A	N/A	10	106	3000
0g pressurized facilities	25	Bullet	Studded on 0g superstructure	None	50	N/A	100	N/A	N/A

Table 2.1.4 Dimensions

the central park will be maintained by simple light fixtures at the top of the park, and the various small animals will provide a bit of a taste of earth every time a resident steps out the door. Ten Docking ports will be built in the non-rotating section of the station, at the farthest point possible from the inhabited torus, to avoid any accidental collisions with living areas. Nine dry docks will also be provided by the company, which can be pumped or drained of atmosphere, but can also open into space. These will provide an area where Residents of Aresam can either service, load, and unload space craft in a pressurized, shirt-sleeves environment, or build new space craft without needing robots or space suits. Several Solar panels arrays will extend from the stationary part of the space station with 28 panels each measuring a total of 372881 m^2 to provide the station with a total of 88 Megawatts of electrical power. Though Aresams orbit will keep it exposed to the sun 90% of the time, an Solar Power Satellite will be in a trailing orbit, and provide Aresam with power via beaming energy to Aresam with a maser beam. In the Stationary Section of the station, 40 different capsules will provide an area for manufacturing and research in a pressurized 0-Gravity environment. Finally, a high powered Doppler radar array will provide the colony with tracking of all space debris within Mars Orbit.

2.1.3 Construction Materials

Table 2.1.2 Superstructure Construction Materials

Material (Composition)	Area to be Used	Properties	Strength (MPa)
Carbon Nanotubes	▪Torus Superstructure ▪Elevator Cables	▪Structurally Strong ▪Resistan to Heat	1500
Aluminum Alloy 201 (Aluminum, Copper, Manganese, Magnesium)	▪0*g* Superstructure ▪Torus Superstructure ▪Capsule Locks, Elevators ▪Docking Bays	▪Light ▪Relatively Strong	485
Grade 37 Titanium Alloy (Titanium, Aluminum)	▪Capsule Locks ▪Torus Superstructure	▪Extreme Strength ▪Chemically Inert	1241
Steel Alloy 21-6-9	▪Central Node ▪0g Superstructure ▪Torus Superstructure	▪Superior Strength ▪Superior Toughness ▪High Malleability	795

Materials making up Aresam will work together to provide an incredibly strong, durable, and radiation proof environment for residents of the colony. The Capsules shall each be assembled in Earth Orbit, out of materials made available from various Foundation Society Conlonies already in place, to ensure quality construction with human supervising. The structure and some of the more automated areas will be built in Mars orbit out of materials from Phobos, and the construction of these areas will be largely automated.

2.1.4 Radiation and Meteorite Protection

The capsules, being the human habitation, agriculture, and industrial facilities, will have the best radiation protection. Built in Earth Orbit, the capsules will be sheathed in a Kevlar Weave supplied by Bellivistat's manufacturing facilities. Within this sheath, a layer of nanobot solution supplied by Alexandriat will provide immediate debris damage repair. This will ensure that in the event of an

Table 2.1.3 Shielding Layers

Materials	Properties	Uses	Tensile Strength	Thickness
Carbon Fiber Kevlar (49) Weave	▪impact resistant ▪deflect slow-moving objects	▪shock and radiation absorption	1250	▪2 layers ▪each 2cm thick
Nanobot Solution	▪water-based solution, filled with nanobots ▪quickly seals hull breaches	▪quick impact repair	0	1 cm
Polystyrene-based Radiation Shielding	▪high attenuation to mass	▪cosmic radiation shielding	45	2.5 m
Aluminum Alloy Grid	▪relatively strong ▪relatively light	▪blocks low-frequency radiation	485	1 cm

impact, the hull will reseal itself within seconds, minimizing loss of atmosphere and depressurization. The nanobots inside the petroleum-based solution will act similar to their counterparts vacuum sealing super adobe structures. Gamma, Cosmic, and other harmful radiation present in outer space will be shielded from the colonists by a 2.5 meter thickness Barium Sulfate based Polystyrene foam. The foam will be inflated with carbon dioxide from the martian atmosphere, and provides six halfing thicknesses from radiation. This should reduce Colonists exposure to 12 milli-Sieverts per year, with an estimated lifetime radiation exposure to well under 1 Sievert of Radiation, the recommended maximum career exposure.

Table 2.1.5 Layers of Major Hull Components

Component	№ of Layers	Depth (m)	Layer Composition
Habitation Capsules	5	2.56	0.02 m Kevlar Weave, 0.01 m Nanobot Solution, 2.5 m Expanded Polystyrene Foam, 0.02 m Kevlar Weave, 0.01 m Aluminum
Carbon Nanotube Band	2	0.1	0.05 m Titanium, 0.05 m Kevlar Weave
Transport Capsules	4	0.2	0.02 m Steel, 0.01 m Nanobot Solution, 0.16 Expanded Polystyrene Foam, 0.01 m Kevlar Weave
Central Node	3	0.5	0.05 m Titanium, 0.01 Nanobot Solution, 0.44 m Steel
0g Capsules	5	2.56	0.02 m Kevlar Weave, 0.01 m Nanobot Solution, 2.5 m Expanded Polystyrene Foam, 0.02 m Kevlar Weave, 0.01 m Aluminum

2.1.5 Artificial Gravity

The rotation of the Beaded torus around the central node will provide the affects of gravity to the residents within. Studies have shown that high rotations, over 2 to 3 rpm, produce negative results on the human body, including nausea, disorientation, claustrophobia, and dizziness. The relatively slow rotation period of 0.756 rotations per minute will reduce the effects of producing gravity via centrifugal force. A comfortable gravity of 0.8 *g*'s will be sustained throughout the torus, which is high enough to prevent significant negative physiologic affects, but makes construction of internal structures easier. There are multiple thrusting sections arrayed around the perimeter of the torus, which can be used to both increase or decrease rotation speed, or produce thrust to combat any wobbling motions that might begin to occur in the torus over time. The thrusters will be fired automatically by referencing gyroscopes placed throughout the torus.

Table 2.1.6 Gravity and Pressure Justification

Structure	Gravity (g's)	Justification	Pressure (atm)	Justification
Habitation Capsules	0.8	▪Studies show that humans can survive with little to no adverse physical or mental effects in 0.8 g ▪Agriculture most productive at 0.8 g ▪Lower gravitry makes structure simpler and easier to build	0.8	▪Quite viable for human occupation
Transport Capsules	0 to 0.8	▪Gravity varies as elevators move around the settlement	0.8	▪No need for change in pressure between work and living areas
Central Node	Microgravity	▪Transport operations easiest under microgravity	0.8	▪Human transport through node needs comfortable pressure
0g Capsules/Docks	0	▪Industrial operations easier under 0g ▪Reduces wear on facilities ▪Allows for 0g recreation and entertainment facilities	0.01 to 0.8	▪Lower pressure may be needed for certain industries to make the processes simpler

2.1.6 Pressure

Pressure will be maintained at 0.8 atmospheres throughout most of the habitable areas of Aresam. This is a supremely habitable pressure, and several mountainous areas on Earth have significant populations living comfortably in 0.8 atmospheres. The Dry Docks will have pressure varying whenever the structure opens up to release or receive space craft. The 0-Gravity capsules will also have the ability to lower the pressure of the entire capsule, in order to ease Industrial processes for perform vast scientific research in low pressure.

2.1.7 Emergency Precautions

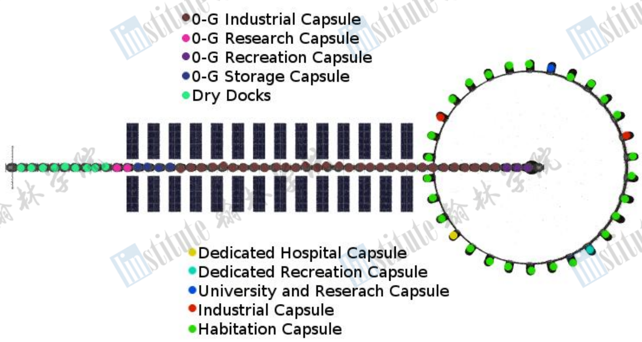
The structure of Aresam itself will lend itself very easily to safety. Each of the thirty habitation capsules is connected to the others only by rail or elevator. The pressure of each is maintained separately, so in the case of a large hull breach in any one of the capsules, the single capsule, holding only 5% of the population, is significantly affected. Also, in the case of a severe emergency with little to no notice, such as a very large asteroid impact, nuclear detonation, or biological warfare, each capsule can be released from the Torus itself, and be flung into space. The chances of this being necessary are incredibly small, but in the event that this occurs the capsules will also include an airlock and parts to build a solar panel, powerful communications equipment, and large provisions of preserved food.

2.2 Internal Layout

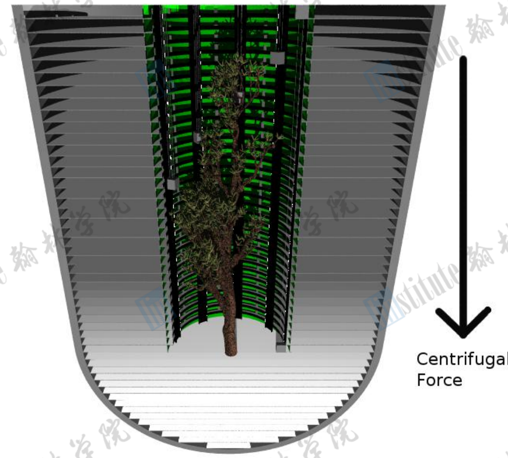
Table 2.2.1 Volume and Area Allocation

Use	Space Per Person	% of Capsule	Total Per Capsule	% of Total Habitaion Area	Total Space
Total Habitation Area	334 m^3 335 m^2	100% 100%	1047197 m^3 301077 m^2	100% 100%	31415910 m^3 9032310 m^2
Living Spaces /Dwellings	300 m^3 100 m^2	25.8% 29.9%	270000 m^3 90000 m^2	21% 24.4%	6601500 m^3 2200500 m^2
Agriculture	375 m^3 125 m^2	32.2% 37.4%	337500 m^3 112500 m^2	26.3% 30.5%	8251875 m^3 2750625 m^2
Recycling	225 m^3 75 m^2	19.3% 22.4%	202500 m^3 67500 m^2	15.8% 18.3%	4951125 m^3 1650375 m^2
Open Public Space	139.6 m^3	12%	125664 m^3	9.8%	3072485 m^3
	*The Central Park is a changing, undefined area, addressed in Human Factors				
Business (Shops, Offices, etc.)	40 m^3 13.3 m^2	3.4% 3.9%	36000 m^3 12000 m^2	2.8% 3.2%	880200 m^3 293400 m^2
Station Operations	40 m^3 13.3 m^2	3.4% 3.9%	36000 m^3 12000 m^2	2.8% 3.2%	880200 m^3 293400 m^2
Hallways/Paths	16.8 m^3 5.6 m^2	1.4% 1.7%	15000 m^3 5000 m^2	1.2% 1.4%	366750 m^3 122250 m^2
Recreation	13.5 m^3 4.4 m^2	1.1% 1.3%	12000 m^3 4000 m^2	0.93% 1.1%	293400 m^3 97800 m^2
Education	6.6 m^3 2.2 m^2	0.57% 0.67%	6000 m^3 2000 m^2	1.9% 0.54%	586800 m^3 48900 m^2
Hospitals	3.3 m^3 1.1 m^2	0.28% 0.33%	3000 m^3 1000 m^2	0.93% 0.27%	293400 m^3 24450 m^2
Religious, Community	3.3 m^3 1.1 m^2	0.28% 0.33	3000 m^3 1000 m^2	0.93% 0.27%	293400 m^3 24450 m^2
Miscellaneous	N/A	0.0005% N/A	533 m^3 N/A	0.04% N/A	13026 m^3 N/A
Expansion	N/A	N/A	N/A	18.5% 21.5%	5817761 m^3 1939253 m^2

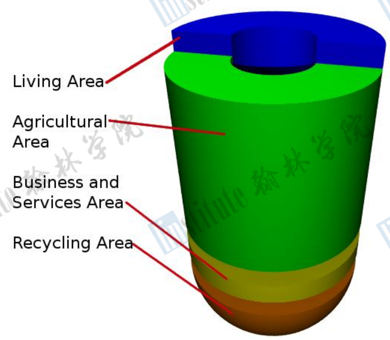
Station Allocation



Downsurface Orientation



Capsule Allocation



2.2.1 Capsule Layout

Each Capsule is in the shape of a cylinder, with a curved portion at the bottom. The Capsule is laid out around a central space which acts as both park and community area. The "Central Park" will contain one or several genetically engineered super trees, which will provide the framework for community areas such as small ball fields, shops, and recreational facilities. The central area also houses a small but self sustaining ecosystem mainly made up of pollinating insects and small birds. There will be a total of 50 floors, each 2.5-2.7 meters high, with a 0.5-0.3 meter area between each floor to contain Environmental Maintaining infrastructure, plumbing, floor supports, etc. Each resident of Aresam will have a minimum of 100 m^2 living space. The living areas open up into hallways that lead to the central park, where elevators and walking areas allow residents to move around the capsule. Each capsule will provide its own 100% recycling of all waste, and also produce most or all of the residents' food through hydroponics in the capsule.

2.2.2 Zero Gravity Areas Layout

The Central Node at the center of the rotating torus simply provides a transportation hub between the living areas and Zero Gravity areas. It is largely automates, and personnel never leave their elevator car. It contains a total area 6.28×10^5 m^3. There are 40 separate 0*g* capsules, in which various industrial and scientific processes can be performed. Their usage will be described more in depth in the Business and development section. There are also 9 Dry docks at the far end, in which fully pressurized spacecraft servicing and construction facilities will be present. Finally, Several normal spacecraft docks, along with communications and radar arrays will take up the space station instrument boom.

2.3 Construction Sequence

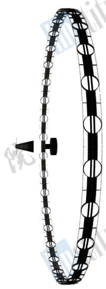
2.3.1 Pre-Construction Procedures

Before construction on Aresam can begin, much researching and testing must be completed to determine the best methods and procedures and to verify that the specified materials will withstand the conditions on the settlement. Also prior to construction, the construction robots themselves must be built in Earth orbit. In the initial stages, all the robots and 15 people to supervise the construction will be launched for travel to Mars. Then, the mining robots will need to begin prospecting the surface of Phobos for suitable mining locations. Then, construction on Aresam itself will commence.

Time For Completion: 3 Years

2.3.2 Construction Phase 1

Phase 1



In Mars Orbit, the settlement construction will begin by building the framework of the torus and 0*g* superstructure. This will involve the use of AMARF, which will provide the individual structural components via refining the material of Phobos. Then, CRES will bring the components to the desired area in orbit, where SCAD will assemble the pieces into the torus superstructure, and then the 0*g* superstructure. Framework for the dry docks, instrument boom, and Central Node will also be assembled by SCAD.
Time For Completion: 2 Years

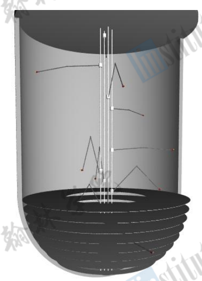
2.3.3 Construction Phase 2

Phase 2

In Earth Orbit, construction of the 70 capsule facilities will begin by CBAR. The hull will be inflated by CIR, and the Polystyrene plastic will be stored on board for later use in mars orbit. An ICAR will be inserted in each capsule, along with all the necessary materials for internal construction. As they are completed, each capsule will be attached to a Solar sail constructed by Bellivistat, and the capsules will begin the journey to mars orbit.
Time For Completion: 1 Year

2.3.4 Construction Phase 3

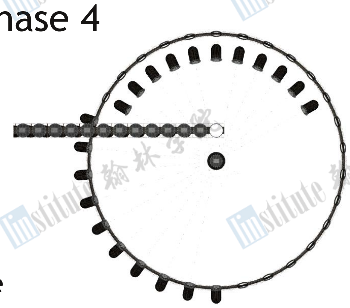
Phase 3



During the journey to mars, ICAR will construct the internal structure of each capsule, and attach necessary recycling and environmental regulation equipment. During this time, MRAD will be gathering water and CO_2 from the martian surface for use in extruding the Polystyrene foam in the capsule walls and part of the atmospheric composition.
Time For Completion: 3 Years

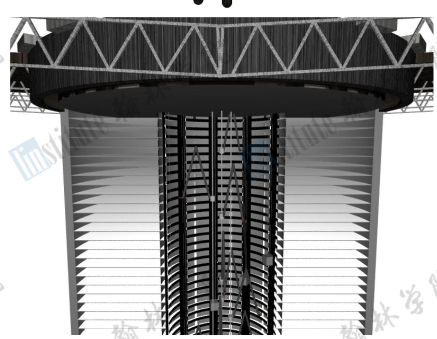
2.3.5 Construction Phase 4

Phase 4



In Mars orbit, all the parts of the Station will be united. The Capsules will be guided into their Yokes on the Torus and 0*g* area, and firmly attached by SCAD. The rail and elevator Transportation system will be completed, and internal and external finishing work will be begun by FAD. From earth, necessary sensitive equipment and certain nutrients and compounds for a sustainable environment will be shipped. Interior wall and floor surfaces made from materials from Phobos will be installed by FAD, and then SCAD and ICAR will be broken down for its parts.
Time For Completion: 2 Years

2.3.6 Construction Phase 5

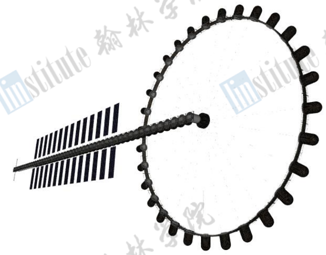


Phase 5

Finishing work by FAD will be completed, and the Capsules will be filled with a normal Earth Atmosphere and automated hydroponics systems activated. The Torus will begin rotation by using the thrusting sections arrayed around the torus. Also, in the Central Park of Each Habitation Capsule, a Nutrient gel will be laid in the bottom, and a genetically engineered super tree will begin growth. The Tree will only take 5 years to grow to its maximum height of 90 meters, because of a combination of lower gravity, no plant

competition, a perfectly tailored nutrient base, and its own genetically engineered nature. The Station will begin readying itself for colonists
Time For Completion: 3 years

Phase 6



2.3.7 Construction Phase 6

The first wave of colonists will begin transportation to Aresam. Upon Arrival, they will finish any necessary construction, and build the recreation portions of the central park according to their taste. Final quality checking of all systems and facilities will also occur at this time. They station will be ready for human habitation, and the full population will arrive over the next four years.
Time For Completion: 2 Years

2.4 Expansion Capabilities

The Aresam Space Station is very open for expansion. Population is expected to rise considerably after initial habitation, and North Donning-Heedwell is well prepared for this eventuality. The Station has 30 rotating capsules, each capable of supporting up to 900 persons, including recycling and agriculture. This provides a total maximum population of 27,000 persons on board the station, though standard of living might decline at that high of concentration. A permanent population of 20,000 is easily sustainable, and op to 3,000 transient population will also be well accommodated on board Aresam. In an extreme scenario, a second rotating torus could be built directly On the opposite side of the central node from the normal rotating torus, doubling its population capacity.

Aresam is also very able to accommodate an increase in the need for zero-gravity facilities. The 0*g* superstructure is built from interchangeable parts, and the rail system is very open for expansion. Needed facilities could simply be attached to the end of the 0*g* superstructure, and the rail system would easily provide transport to and from the new areas. New, larger docks could also be attached in this area, though the current dry docks, are very accommodating of any large spacecraft. With an entrance diameter of 100 meters, any craft constructed in the present or next few decades will most likely easily fit within its berth.

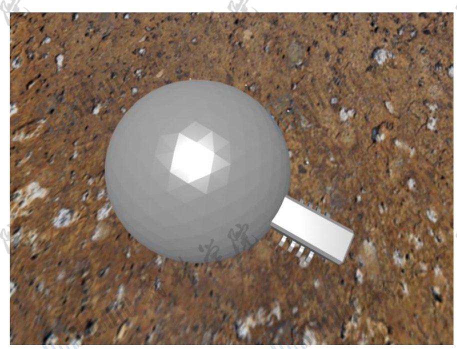
2.5 Prefabricated Mars Base

2.5.1 Design

The Prefabricated Mars Base (PMB) will be a simple, but highly adequate part of mars surface exploration and research. The PMB will provide a large area for research and living space by simply inflating a large volume to be used as both living space and storage for equipment. The inflatable area will be made of an opaque, highly resistant Kevlar Fiber, which will be sufficient to block any harmful radiation. The Kevlar weave fiber will also deflect particles blown into it by the high power storms on the surface of mars, and provide a safe haven for astronauts exploring the surface. On the side of the PMB not inflating, environmental sustaining equipment an airlock, and necessary equipment and materials.

2.5.2 Setup

Constructed PMB



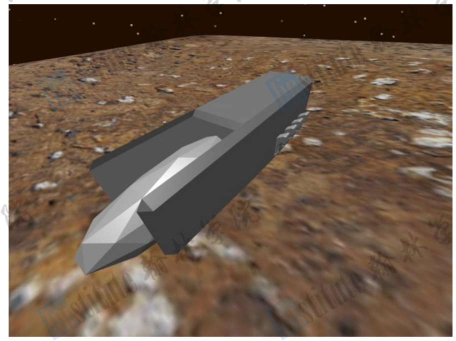
The PMB will be set down on the surface of Mars longways. It will automatically lower legs onto the surface of Mars. Two Astronauts will then proceed to operate a drill mechanism to drill each leg firmly into the surface of Mars. Then, The astronauts will open up the shell containing the inflatable Kevlar weave. Once open, the Kevlar bubble will begin inflating automatically, from compressed atmosphere stored in the PMB. While inflating, the Astronauts will Drill secure fastenings into the ground, around the outer perimeter of the soon to be inflated area. They will then attach lines from the inflatable

area to the fastenings, and winch them as far as possible. AS the inflatable areas continues inflating, they will continue to winch the lines. Once Full Inflated, the astronauts will enter the airlock on the PMB, and set up the interior of the newly inflated area with articles unloaded from the uninflated area.
Time For Set-Up: 4 hours

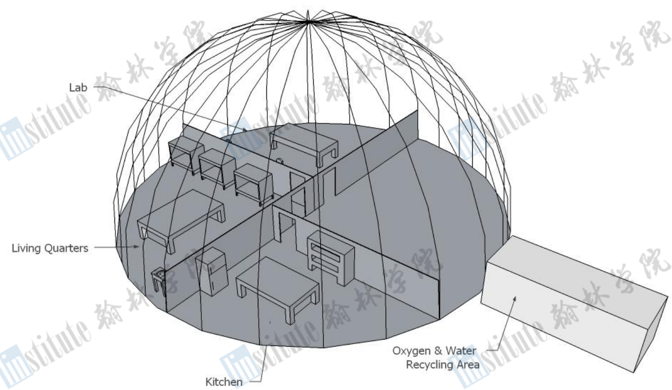
2.5.3 Operations

Secured tightly to the surface, and with over 450 m^2 living space, the PMB will be a relatively comfortable research facility. If it can be supplied continually with food and CO_2 filters, there is no reason that the base could not operate indefinitely. During the astronaut's stay, they will have access to full water recycling facilities, and the enjoyment of occasional showers. Stints on the Martian surface will be aided by two Mars Buggies, and equipment to prospect, record meteorological conditions, and place permanent autonomous sensors, which can send information back to the PMB or station via in orbit satellite.

Uninflated PMB



Interior of PMB



3

Operations & Infrastructure

3. Operations and Infrastructure

The operations and infrastructure are an integral part of the space settlement design. The responsibilities of the goings-on within, outside of, and during the constuction of the settlement, as well as its maintenence, repair, and upkeep fall here. Plans for every scenario, expected and unexpected, must be prepared for. Operations include both daily functions and long-term cycles. Aresam would simply be a static, empty shell without a sound infrastructure, which we have provided.

Table 3.1.1 Information about Location

Semi-Major Axis	Mean Distance from Phobos' Surface	Altitude from Mars' Surface	Inclination from Equitorial Orbit	Mean Orbital Velocity	Period of Revolution
9377.2 km	9365.9 km	3396.2 km	1.093°	2.138 km/s	7.65 hrs

Table 3.1.2 Reasons for Selection

Stability	Since the mass of Mars (6.4191×10^{23} kg) is greater than 24.96 times the mass of Phobos (1.08×10^{16} kg) and the space station, L4 and L5 are stable Lagrange points.
Proximity	At L4 (and L5) the station remains 9377.2 km away from the resources of both Mars and Phobos (a D-type asteroid containing carbon, silicates, and anhydrous silicates).
Contingency	Should something catastrophic happen to Phobos (eg, an impact that leaves large pieces of debris in the orbital path), the station has over six hours to react at L4—five times longer than at L5 because L4 lies 60° ahead of Phobos' orbit, while L5 is 60° behind it.
Efficiency	Very little energy will need to be expended to keep the station at L4 because this Lagrange point is stable.
Transportation	As seen from Mars, the station will rise and set about twice a day*, thus facilitating transportation to and from any place on the Martian surface.

**A Martian day is approximately the same length as an Earth day.*

3.1 Orbital Location

We have chosen to place the settlement at the Mars-Phobos L4 libration point. Located on Phobos' orbital path, 60° ahead of Phobos, L4 gives a constant, optimal distance from both Phobos and Mars. Being a stable Lagrange point, very little energy will need to be expended in keeping the station here. This path lies below synchronous orbit, meaning that the settlement will orbit faster than Mars rotates. (Note that tidal forces will not destroy Phobos or the settlement within the next several million years.)

3.2 Community Infrastructure

The community infrastructure is primarily concerned with daily functions and cycles that directly affect the residents on Aresam.

3.2.1 Atmosphere, Climate, and Weather

Humans require a clean atmosphere, with sufficient oxygen for survival, as well as suitable temperature, pressure, and humidity. External plants (i.e., those in the capsule, but not in an enclosed building) require plentiful rainfall, and these plants and humans, alike, require a sun-like light source, with an intensity comparable to that which reaches Earth. Finally, if only for the sake of variety, meteorlogical events will be induced.

The original composition of the atmosphere will simply be the standard 76.7% nitrogen, as on earth, but the remainder will be CO_2 retrieved from the Martian atmosphere. After the capsules are sealed and filled with these gases, plants will begin the process of converting the CO_2 into oxygen until the oxygen makes up about 23.2% of the

Table 3.1.1 Sustention of Atmospheric Composition

Requirement (per capsule)	Method of Sustention
Nitrogen (434558 kg)	▪Original supply will not diminish
Oxygen (128001 kg)	▪Plants and open bodies of water will replenish ▪Fans and vents will circulate
Water Vapor (11461 kg)	▪Transpriration and evaporation from the same plants and bodies of water will resupply it
Trace Gases (60 kg)	▪Unnecessary, but will inadvertently be released

Table 3.1.2 Climate Control		
Condition	Requirement	Method of Control
Temperature	-2 to 32 °C	▪light source of capsule will alter its intensity ▪ventilation system can heat/cool air as needed
Humidity	1-4 %	▪natural processes of plants and open bodies of water supply humidity ▪dehumidifiers will retain it at the appropriate levels
Clouds/Precipitation	80-150 cm/year	▪temperature and the same natural processes mentioned above provide potential for these weather events ▪cloud seeders at the top of the capsule will induce these events
Air Pressure	0.8 atm	▪highly pressurized tanks containing surplus air will be filled/emptied
Circulation/Wind	calm to moderate gale (0-30 kn)	▪structurally integrated ventilation system will provide circulation ▪large fans at the top and bottom of the capsule will provide wind
Air Filtration	clean air	▪the aforementioned ventilation system will cleanse the air of toxic/unwanted chemicals and solid particles

atmosphere. Only then will the settlement be populated.

Six major features will make up the Climate Control System. Covering the ceiling will be a large expansive light source, emitting radiation equivalent to what reaches the surface of the Earth from the Sun, but with less of the harmful UV radiation. The lighting can be turned on and off, and it can be dimmed to simulate a day/night cycle. An open body of water, skirting along the perimeter of the capusle floor will slowly put water vapor into the atmosphere because of the evaporation caused by the light, and it will put additional oxygen into the air. An oasis, consisting of a massive tree and much other plant life, will be in the central cavity of the capsule. These plants will use the overhead light and the body of water to photosysnthesize and convert excess CO_2 back into oxygen. Additionally, transpiration will return water vapor to the air. Large fans at the top and bottom will circulate air outdoors, and provide wind during meteorlogical events. Cloud seeders at the top will be scheduled to induce adequate rain (or snow if the temperature permits). Finally, a ventilation system controls both outdoor and indoor air conditions. It can remove excess humidity, filter the air, circulate air inside structures, and alter the temperature of the air if it is not adequately controlled by the temperature of the water body, which is, in turn, controlled by the light source. Also included in the ventilation system are pressurized tanks of air, used to regulate air pressure.

Hydroponics

3.2.2 Food Production

Table 3.2.2.1 Crops					
Crop	Requirement (g/person/day)	Yield (g/m²/season)	Season Length (days)	Area (m²/person)	Total Area (m²)
Wheat	1000	885.7	120	135	2970000
Rice	600	1327.1	100	45	990000
Corn	400	1133.1	70	25	550000
Vegetables	1200	~4000	~90	27	594000
Total	3200	N/A	N/A	232	5104000

Table 3.2.2.2 Meat					
Meat	Requirement (g/person/day)	Growth Rate ($g/m^3/day$)	Area ($m^3/person$)	Area ($m^3/capsule$)	Total Area (m^3)
Beef	24	1200	0.02	20	440
Pork	15		0.0125	12.5	275
Chicken	18		0.015	15	330
Fish	12		0.01	10	220
Misc.	6		0.005	5	110
Total	25		0.0625	62.5	1375

Table 3.2.2.3 Food Provision	
Growing	Plants will be grown using an NFT hydroponics system in every capsule. No livestock will be kept aboard the settlement, as all meat will be grown from stem cells, independant of an actual organism.
Harvesting	Harvesting the plants is a simple matter of a robot removing them from their channels and planting new ones.
Processing	All food will be purged of bacteria before it reaches the residents, either via irradiation or pasteurization.
Packaging	Some residents may choose to have the food delivered fresh to the Commons Market, while the rest of the food is cryogenically frozen until it is needed.
Storing	Cryo-storage facilities will be located near the hydroponics systems. Being frozen, the food can be stored indefinitely.
Delivering	An ample supply of food packages will be sent from storage to the Commons Market for distribution.
Selling	Food, being a necessity, is provided to the residents free of charge. They may electronically place a request and pick up their order at the Commons Market.

Each capsule will have two sources of food: an NFT hydroponics system for edible plants and *in vitro* meat production. Hydroponics have been chosen in place of traditional soil-based agriculture because the system is easier to automate and there is an increase in crop yield ranging from 50% to 1500%, depending on the plant, thus minimizing the space requirement. The in vitro process of growing animal biomass, particularly meat, eliminates the need for additional plant material necessary for animal feed, the need for space for animals to live in, and the need for an additional system to take care of the livestock. As an aside, it also appeases some animal rights advocates, because no animals must be slaughtered.

Table 3.2.3.1 Water Consumption	
Purpose	Usage Rate (L/hr)
Industrial	15000
Aesthetic Plants	68137
People	277595
Hydroponics	15312000
Total	15672732

3.2.3 Water Management

Provided that electrolosis is kept to a minimum, the water supply in Aresam will remain constant. Aresam will need approximately 62638928 L (or kg) of water in order to function. Water will be used for a variety of things. The most obvious are for human and plant comsumption, human use, such as bathing, washing clothes, dishes, etc., and recreational use, such as swimming. However, water will also be used in Aresam's industrial functons as a solvent, a coolant, a lubricant, etc., and, most importantly, the majority of the water will be used in Aresam's hydroponics systems. The settlement will need to recover the water from liquid waste very quickly because of the

Table 3.2.3.2 Water Management	
Task	Solution
Recovery from liquid waste	an intensive system of sedimentation, filtration, and irradiation
Purification for non-human use	bacteria and chemicals harmful to humans and plants are removed
Purification for scientific use	all sediments, chemicals, and bacteria are removed
Purification for human use	bacteria and chemicals harmful to humans are removed
Addition of vaious substances	chlorine to kill bacteria; fluoridation for teeth; other vitamins/minerals

rate at which water is consumed. Through evaporation/transpiration, condensation, and precipitation, the atmospheric water supply will cycle naturally. The hydroponics facility will filter, treat, and enrich its own water because of the specific nutritional needs of those plants. Water used in industries will be kept isolated from human-use water for health reasons. Industrial water will be filtered, have harzardous chemicals removed, and most bacteria irradiated. A small portion will be further treated to remove all sediments and bacteria and will be set aside for laboratory use. Human-use water will be filtered, irradiated, and have harmful chemicals removed before having small amounts of fluoride and minerals added. Excess purified water and waste water will be stored in tanks at the bottom of the capsules adjacent to the purification system until it is required.

3.2.4 Solid Waste Management

As any functioning society, Aresam will output a significant amount of solid waste, both household and industrial. Fortunately, most, if not all, of the solid waste can be either recycled into a new product or reused for a different purpose (this includes extracting minerals from biodegradable waste for use in plant nutrition). Being limited on the amount of space the settlement can utilise, there will be no room for a landfill, or a space-settlement equivalent, on Aresam. As such, unusable waste faces two ends: incineration and subsequent introduction as a mineral source for the hydroponics, or relocation to a moon-based landfill on Phobos or Deimos to occupy the empty space created during the mining process. All other waste will find a purpose on Aresam. Of the household wastes produced, food and "green" waste will be used for their minerals in the hydroponics systems, and the metals, glass, and plastics will be recycled and cast into new products. As for industrial waste, scrap materials, slag, and electronic parts can be salvaged for reuse and/or recycling. Ash and sludge, the mostly solid portion of waste water (i.e., sewage), can be reintroduced into the hydroponics as minerals. Some inert waste and harzardous materials can be reused, while the rest will be sent to the moons.

Table 3.2.4.1 Household Waste

Type	Amount (kg/person/day)	Total (kg/day)	Biodegradable?	Recyclable?
Food Scraps	0.272	5984	Yes	No
"Green" Waste	0.974	21428	Yes	No
Metals	0.128	2816	No	Yes
Glass	0.116	2552	No	Yes
Plastics	0.260	5720	No	Yes
Hazardous Mats.	0.246	5412	No	Some
Total	1.996	43912	N/A	N/A

Table 3.2.4.2 Industrial Waste

Type	Biodegradable?	Recyclable/Reusable?
Scrap Material	No	Yes
Slag	No	Yes
Ash	Yes	No
Sludge	Yes	No
Inert Waste	No	Some
Electronics	No	Yes
Hazardous Material	No	Some
Total: 293 g/m^2/day × 157,325 m^2 = 46,096 kg/day		

3.2.5 Electrical Power Generation

The simplest way to generate electricity in outer space is to harness the energy in solar radiation. Other methods of generation require complex machinery and the use of fuel. Solar energy is freely delivered anywhere within resonable range of the Sun and can be harnessed with static (i.e., not changing or moving) devices. Aresam and a sattellite at Mars-Phobos L5 will will have solar panels on them for this purpose. The sattellite will consist of two large solarl panel arrays, which will be reoriented throughout the orbit so they are always facing the Sun, and a central body, from which a

Table 3.2.5.1 Power Allocation

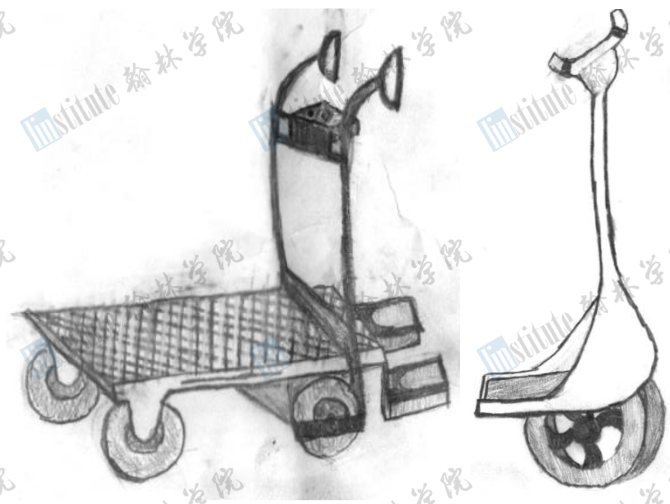
Purpose	kW per person
Living/Office Space	1500
Electricity (wall outlets, &c.)	600
Public Transportation	150
Industry/Infrastructure	1000
Food	800
Total	4050

Table 3.2.5.2 Electrical Power Supply Sources

Method	Supply Generated	Reasons
Solar panels on Aresam	88 MW	▪Aresam will have plenty of its own surface area exposed to the Sun about 90% of the time ▪Aresam's surface would otherwise be unitasking by only blocking radiation when it could be using it
Satellite with solar panels at Mars-Phobos L5 Lagrange point	12 MW	▪Satellite will be also exposed to the Sun approximately 90% of the time ▪Satellite will not change its location relative to Aresam, thus the energy supply can transfer uninterrupted to Aresam via microwave radiation ▪Contingency upon Aresam solar panel failure; Aresam's exposure interval overlaps half of the satellite's time

beam of radiation created from the collected energy will be sent to Aresam. Aresam will have its own on-board solar panels as well. Because of the increased distance from the Sun at Mars instead of Earth, the solar panels will not produce as much electricity as at Earth; however, it is still quite sufficient. The main power supply will be Aresam's panels; however the sattelite is essential for use as a buffer.

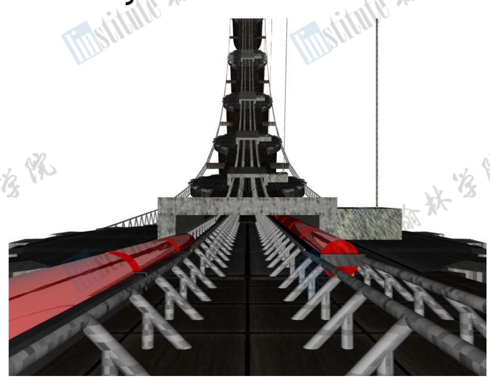
Cargo and Human Transport Vehicles



3.2.6 Internal Transport Systems

Aresam has fives different modes of public transportation and methods of private transportation. Each capsule will have a system of elevators for vertical transportation, and because of the small size of each capsule, there is no need for public horizontal transport. For those who do not wish to walk across their capsule, electrically rechargeable segways will be provided. Transport stations will be at the top of each capsule. Ten trains, five in each direction will be circling the settlement, running through each of the capsules' stations. The trains, suspended between two rails with superconducters, will consist of empty frames will are in constant motion around the settlement (to eliminate acceleration and deceleration times) and the cars, which are designed to either carry people or cargo, will slide in and out of the frames at the stations (much like merging traffic and exit ramps). Transport between capsules and the central node will be through large elevators travelling along carbon fiber cables. Finally, the same train system which traverses the circumference of the settlement will also be implemented as a shuttle in the 0*g* section.

Train System

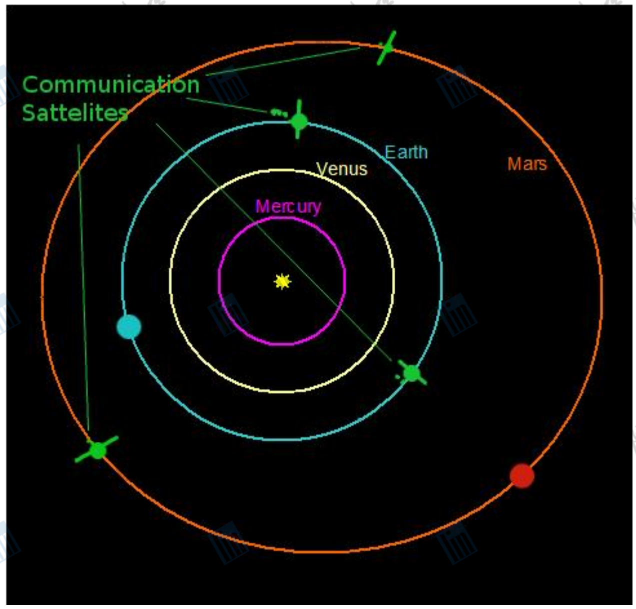


3.2.7 Communication Systems

3.2.7.1 External Communication

The long communication delay created by the speed of light limit is regrettable, but unavoidable. Aresam will have two communication satellites orbiting the Sun at the Sun-Mars L4 and L5 Lagrange points. This way, if another celestial body is obstruction Aresam's view of Earth, information can be rerouted through the other satellites. Again, this increases communication delays, but that is not a significant problem. Extending off of the 0*g* section will be a large communication array to support a bandwidth of 100 Tbps. High security data will be transferred via entangled particles as well as conventional communication so that quantum encryption can be implemented. Every day, the most commonly trafficked internet sites will be copied to Aresam's servers for immediate access. Aresam will also have its own internet based on the servers on the settlement. For any other information on Earth's internet, residents can request a temporary dump of another Earth server or a file download onto Aresam. It is impractical to support live Earth web browsing because the communication delay ranges from 6 minutes to a whopping 76 minutes there and back.

Satellite Placement



3.2.7.2 Internal Communication

As mentioned before, Aresam will have its own very large set of servers to provide internet access to all of the residents. A series of routers will be distributed throughout each capsule so that all populated areas have a wireless internet connexion. So as not to seem too communistic, each denizen will have his own personal computer. The wireless internet also supports audio, and optionally video, communication calls with other denizens of Aresam. Each capsules' central communication hub will be hardwired through the elevator cables to the central node so the capsules can communicate with each other and Earth.

3.2.8 Day and Night Cycles

Because of Aresam's method of mimicking Earth climate, day and night weather cycles will follow naturally from simply shutting off the overhead light source in each capsule. Aside from this, there are no more day/night cycles necessary for the settlement. Aresam will have a very active, engaged, and, in some cases, a 24/7 community.

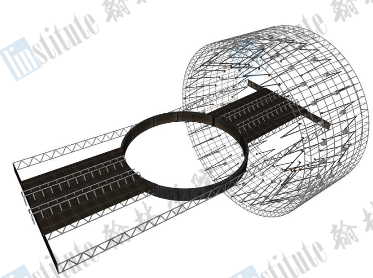
3.3 Construction Machinery

The settlement will be constructed by four different main robots. Several of the first type will build and link together the circular frames in which the capsules will sit. The second type will contruct the central node. En route to the settlement location from Earth, 55 of the third type will be unfolding and solidifying the capsules' fabric. Finally, after everything is in place, the fourth type will begin construction of the interior of the capsules. All of these machines will be disassembled for parts after they have fulfilled their purpose.

3.3.1 Exterior Construction

The main structural frame, around which the capsules will be studded, will be assembled in 30 small segments, one for each habitation capsule. These segments will be constructed and assembled into a superstructure by the robot which surrounds a section and travels along it. Additionally, 20 segements of a similar type will be assembled in a line as the 0-g section of the settlement. The central node of the settlement will be constructed by another robot. On the way from Earth to Mars, one machine for every capsule will unfold the capsule's kevlar weave, inject the radiation blocking foam between the layers, and seal off the top of the capsule with the large robot explained in section 3.3.2. Finally, the capsules will lock into place on the main structure, and smaller

Structure Assembly



multifunctioning robots will perform tasks such as linking the central node to the main structure with carbon fiber cables and installing the trains onto their tracks.

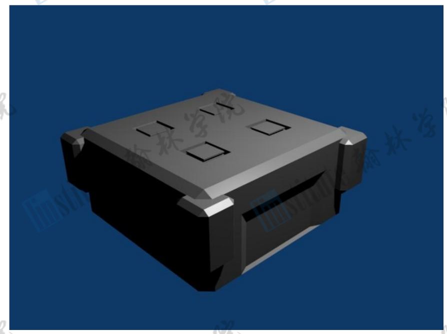
3.3.2 Interior Building Construction

The top of each capsule will be a large robot which extends into the capsule and builds the interal structure: walls, floors, installation of major machinery, &c. After completion, the device will retract, construct the train station on top, and fill the capsule with CO_2. Next, the multifunctioning robots previously introduced will again take care of details such as wiring, plumbing, and tweaking.

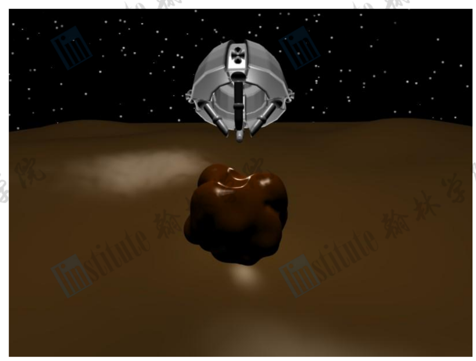
3.4 Materials Harvesting

All of Aresam's construcion materials not brought from Earth will be harvested off of Phobos and Deimos. Several large mining bases will land on the most mineral-rich areas of these moons. From there, they will dispatch many smaller mining robots which will drill out blocks of raw material and deliver them to the bases. Back at the facilities, the raw materials will be processed and loaded onto fabrication and delivery ships which will create parts from the materials and deliver them to the construction robots.

Mining Machinery



Materials Harvesting



3.4.1 Mining Operations

Created and launched from Earth, the mining bases are an important part of both the construction proccess and the industrial operations on Aresam. These large facilities will depart from the main envoy upon reaching Mars and land on the two moons, Phobos and Deimos, ideally in places with a high content of usable material. They will release a swarm of small agile robots with laser drills, which will harvest raw material blocks and relocate them into the mining base.

3.4.2 Refining Operations

At the mining bases the the influx of material will be separted into its individual, usable, compounds via a refining process. Waste material will be deposited back onto the surface of the moon by the same drilling robots which harvested it.

3.4.3 Preassembly and Delivery Operations

A stream of carriers will shuttle back and forth between the construction site and the moons. The transportation rate will slow down after the construction is completed, but will still supply Aresam with the necessary resources. These carriers will preassemble many of the materials en route to the settlement so that the parts will be ready for use by the construcion machinery immediately upon arrival. These parts, which will be carried externally by the carriers once fabricated, will be anything from long steel beams to carbon fiber cables. The carriers also serve the secondary purpose of bringing power to the mining bases with capicitors charged by on-board solar panels. The mining bases in turn allocate power to their drilling robots.

3.5 Prefabricated Base Systems

The prefabricated Mars bases (PMBs) will need to sustain 4 people for 30 days. This means having a sufficient supply of air, food, water, and electricity.

Table 3.5.1 PMB Requirements	
Nitrogen	2823 m^3
Oxygen	1122.6 m^3
Water	1340 L
Food	272.4 kg
Power Capacity	500 F

3.5.1 Air System

Pressurized air tanks (the same ones that inflated the PMB upon deployment) will additionally contain enough extra oxygen to last the 4 people for 30 days as it is not practical to bring a device (or enough plants) to convert CO_2 back into oxygen. These tanks will be connected to the ventilation system, which filters the air, removes excess CO_2 to empty tanks, and introduces more oxygen as necessary to maintain a healthy environment.

3.5.2 Food System

Again, it is not practical to bring an entire hydroponics system, or an in vitro meat production system down in the allotted area. As such, all the necessary victuals will be included in the original landing to set up the PMB. Most of the food will be preserved or nonperishable so that no special storage is required.

3.5.3 Water and Waste Systems

Because of the limited space, the water system in the PMB will simply be a small purification device that the people will retrive fresh water from and dump dirty water into manually. This eliminates the need for a complicated plumbing system. Household waste and solid bodily waste, will be thrown into an incinerator and reduced to a pile of ashes. The ashes will be deliverd to Aresam the next time a return launch is made so that Aresam can conserve as many resources as possible.

3.5.4 Power System

Each PMB will have a set of capacitors designed to receive and be recharged by quick bursts of energy. Aresam passes overhead frequently enough that it can simply send a beam of energy in the form of a laser down to the bases twice a day to recharge their capacitors. Thus, the capacitors will need to be able to store a half a day's worth of energy.

4 Human Factors

4. Human Factors

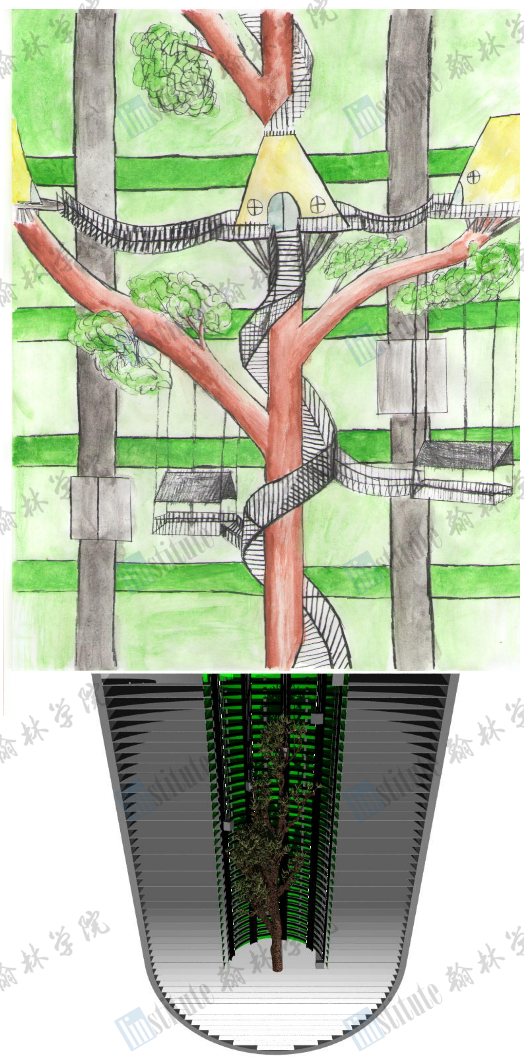
The purpose of the human factors department will be to develop an area in each pod that most emulates life on earth. Obviously there are some things that will not be able to be fully replicated in their originality, such as rolling landscapes, but with the right application of technology, these can be closely replicated. Public areas will be separate from living areas, but will be easily accessible to the residents. All of the floors of the living area will open up to the central area where the tree is contained. A view of the outside will be artificially replicated, so as to give the illusion of windows. Potential colonists will be thoroughly tested and screened, and the initial landing group will be carefully selected out of the people on earth based on qualities like compatibility with people of other ethnicity and worldviews, physical fitness, health, and ability to survive the exerting physical conditions on Aresam. Also the population will be divided up depending on what their occupation is, as you will see in section 4.1.1, and so people witht the correct physical, psychological, and occupational requirements will be selected to join the population.

4.1 Community Design

The basic community will be set up like a large apartment complex. Each capsule will have an overall height of 150 meters, but the part that will contain humans will only be 100 meters tall. Each floor will be 3 meters tall, with 0.5 meters being used for plumbing and electrical purposes, leaving 2.5 meters of head room.

There will be 30 floors devoted to living quarters on each pod. The remaining three will be used for public areas. In the center of the capsule there will be a cylinder with a radius of 20 meters where the central tree of the capsule will be. The living areas will extend for another 30 meters out from the center, and will only take up one half of the capsule. The central area will also be open for recreation, namely walking or socializing. The floor of the central area will have small decorative gardens and walking paths. The inside wall of the tree area will be covered with a one way mirror. This way, people walking along the hallway of the floors can look down into the central area, but people inside of the central area can not see through. This has the purpose of creating the image of being outside. Large scale projectors will project any desired image, such as the outside space, a forest, or an ocean, onto the walls so people will not feel quite so limited.

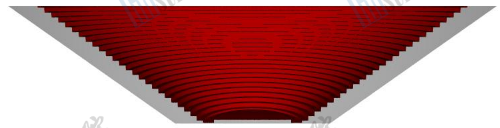
Internal Views



On each capsule there will be 900 permanent residents to begin with. Of this number, about 360 will be married adults, about 315 will be single men, about 207 will be single women, and 18 will be children under the age of eighteen. Obviously this demography will change over time, but to slow that process as much as possible, limits will be placed on births. If a married couple wishes to have a child, there is an application process that they must go through before they can be granted this privilege. This application must be submitted to the Council. (see section 4.1.2)

Underneath the 30 levels that will be set aside for living areas, there will be three floors that will hold all of the other necessities of human life. Whereas the living area took up only one half of the capsule, these three levels will completely encircle the capsule. Inside of these capsules there will be several categories of resources. First, because food will not be provided free of charge to the

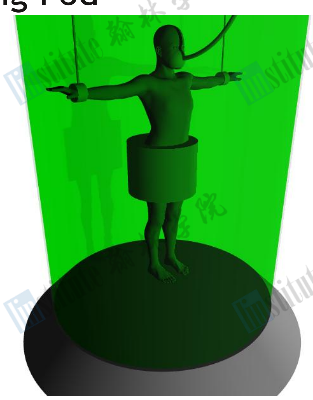
Amphitheater



residents, there will be food available for purchase. As on earth, the residents will be paid for as much work as they do. Families that have children will have an extra amount allotted to them to pay for the children's food until the children can support themselves. On each of the three levels there will be a bulk food store that offers nutrients necessary for a healthy, balanced diet. (see spreadsheet 4.1.1) There will also be spread throughout the three levels a variety of prepared food available like there would have been on earth. This will include one fast food restaurant that, thanks to a culinary robot with a large database, will offer a large variety of food from every culture represented on the space station. There will also be kiosks seeded throughout the floors that will offer coffee, tea, and other assorted drinks. Most of the materials for the restaurants, groceries and kiosks will be produced in the agricultural pod(s), but as many materials as possible will be grown in the small personal gardens located in the public and central areas of each capsule.
For the most part, the distribution and organization will be controlled by automotive services. There will be several of the above mentioned culinary robots on each capsule. Along with cooking and preparing food, these robots will be in control of organizing bulk food as it is shipped in, cleaning and preparing it, along with the sale and packaging of the food.

The public area will of course contain much more than simply food distribution. Entertainment will be a very important aspect of the design of Aresam to keep colonists happy. As you will see in the diagram of the public area, there will be several main avenues of entertainment. There will of course be a cinema on each of the floors in the public area. This will play movies that have recently come out on earth and have been streamed to the space station with the internet updates. Along with the cinemas there will be a theater on each floor of the public area. These will be used for whatever purposes the performers on the space station choose to utilize it for, whether that be for theater performances or musical performances. (see section 4.1.1 for structure of careers and job assignments)

Healing Pod

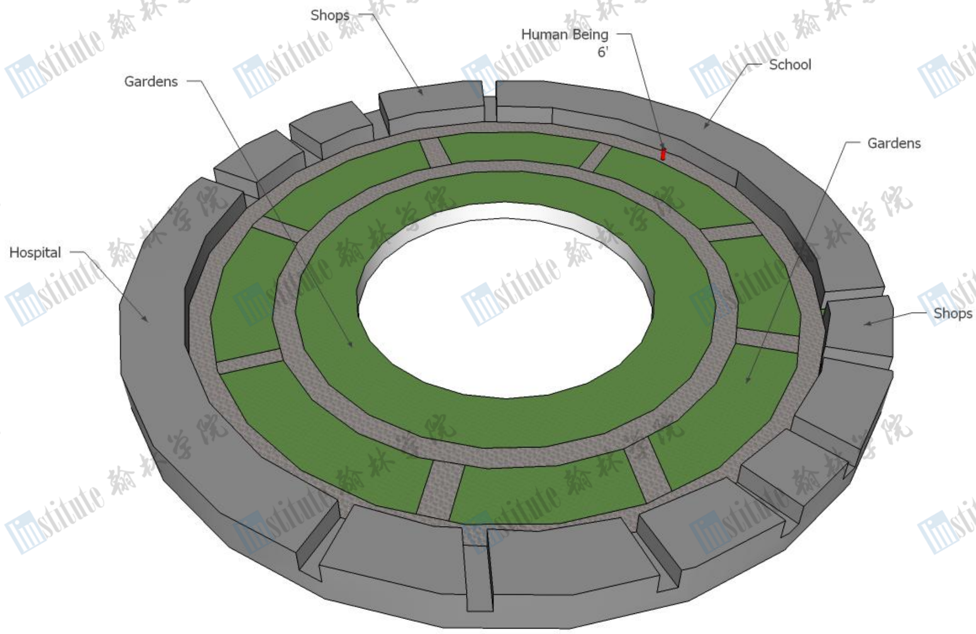


Outside of entertainment and food, there will be several basic requirements on each capsule. To satisfy the 900 people living on each pod, there will be a hospital on each floor of the public area. Each hospital will be equipped with three operating rooms, two emergency rooms, 10 rooms where doctors can see patients, and then 100 individual healing pods. These healing pods will be cylinders 6 feet in diameter that healing patients can be stored in and the robots installed with the pods will help bring them back to health. Also in each operating room and emergency room there will be an EMR, or Emergency Medical Robot. This robot will have the capability and knowledge to analyze patients and perform necessary procedures.

Table 4.1.1.1 Leagues
Medicine
Performing Arts
Culinary Arts
Engineers
Sciences
Theology & Philosophy
Agriculture

Because of the limited size in the individual capsules, there will be one pod devoted solely to sports and athletic activity. There will be personal gyms in the capsules, but the majority of athletic events will be held in this separate capsule. Whereas other capsules have sections devoted to human activity and a central area for a large tree, this capsule will contain athletic facilities. Out of the 100 vertical meters that are available in the capsule, 5 floors of 3 meters each, for a total of 15 meters, will be used for exercise equipment, free weights, and gyms. One floor will be devoted to a series of pool, saunas, and therapy areas, will take up 3 meters from the ceiling to the floor with an extra meter for the in-ground pools. The final 81 meters will be for sporting arenas and such. There will be 9 arenas, each with 9 meter tall ceilings. Each of these floors will be open areas carpeted with a form

Central Park



of Astroturf. These fields can be modified to the residents' liking, whether that be painting lines where they choose, setting up lights for a party or show that needs more space than they have, or simply setting up barriers and fighting with paintball guns. The Astroturf will be removable to allow for sports such as basketball that would need a hard floor or even sports like hockey and curling that would require an ice rink. Inside each capsule there will be gyms in the public area, one for each floor, which will have the sufficient equipment for any necessary health, fitness, and rehab, such as work out machines or free weights.

4.1.1 Labor Division

On Aresam, all able adults will be employed. Children still under their parent's care will fall under their jurisdiction, and will be supported by their parents until they turn 18, when they will support themselves while possibly pursuing higher academics. The labor division in reference to jobs will be decided by an apprenticeship system. If there are not any shortages in job areas, children and their parents will choose which field of work the children will go into training for. If, however, any given field is lacking in persons, Aresam's government (see section 4.1.2) will test every child that applies for an

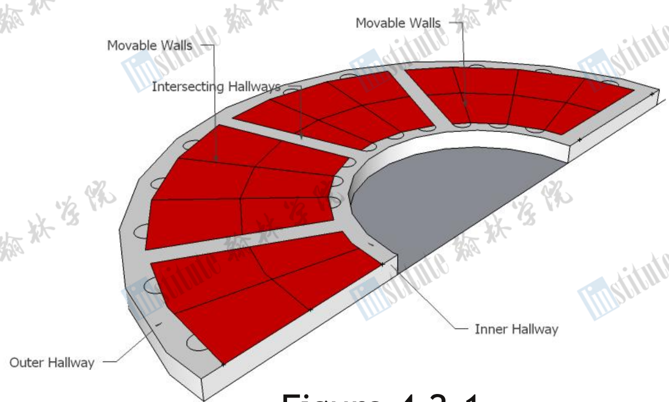


Figure 4.2.1

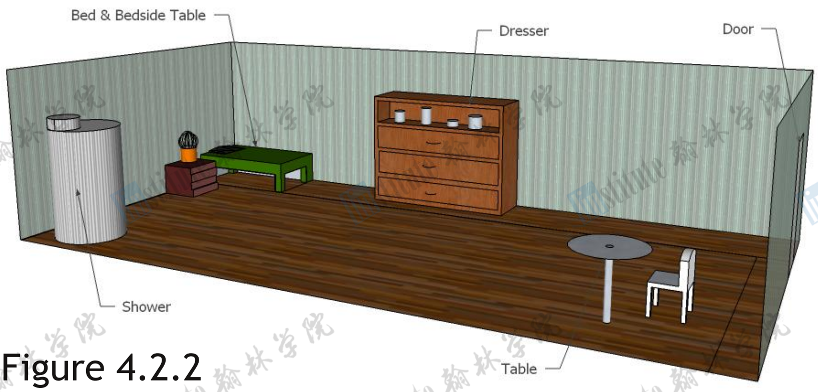


Figure 4.2.2

Living Needs
Stove
Microwave
Table
Dishwasher
Storage
Bed
Desks
Shelves
Couches/chairs
Entertainment
Bathroom facilities

Table 4.2.1 Living Quaters Dimensions				
Family Type	Area	Width	Length	People/Capsule
Single Man/Woman	74.32 m^2	6.096 m	12.192 m	315 men, 207 women
Married Couple	111.48 m^2	9.144 m	12.192 m	342 individuals
Married w/ Children	185.81 m^2	15.24 m	12.192 m	18 parents, 18 children

Total Required Living Area	70678.41 m^2
Total Usable Floor Area	108856.1854 m^2
Space Available for Other Use	38177.77545 m^2
№ People per floor	30

apprenticeship to see which are field the child would fit best. At the age of 5 it would obviously be difficult to determine specific personality traits that would make them better suited for a career, but basic things like judgement, decision making skills, and ability with one's hands would give the government an idea as to what career would suit the child best.

Robots
Medical
Manufacturing/Loading
Repair/Maintenance
Culinary
Security
Janitorial
Construction

Requirements
Entertainment
▪Movies
▪Exercise Areas
▪Performing Arts, et. al.
Eating
▪Restaurants
▪Bulk Food Stores
Education
▪Elementary
▪Skills Training
▪Low Profile Manufacturing
Medical
▪Surgery
▪Seeing Rooms
▪Recovery Areas

The work force will be divided up into Leagues. Each League will concern a specific area of work that will provide its services for the other residents of Aresam, and train apprentices. Apprentices will remain in their apprenticeship from the age of 5 to the age of 18, when they will be granted a League membership and allowed to practice whatever field of work they have been trained in. Different Leagues will require different amounts of education and different forms. (see table 4.1.1.1 for list of Leagues) Leagues concerning the sciences and other forms of high education, such as medicine, engineering, and agriculture will spend the first 7 years of their apprenticeship in education, learning the building blocks that they will need before they can practice. Beginning the 8th year, those apprentices will begin to slowly move from the realm of education into the realm of training and will begin interning with an older member of the League they are training with.

Other careers, such as the performing arts, culinary arts, and religion will have a different approach, and will focus much more heavily on the hands on aspect of the apprenticeship, as there will be fewer things that need to be taught in a classroom and more things that need to be taught through experience. At the age of eighteen, if their mentor feels it appropriate, the child is accepted into the League that they have been training with.

This system of Leagues will keep labor running smoothly on Aresam. Everyone who is able will be working, and they will be paid for their efforts. Since they must support themselves, this ensures that work is accomplished. Every different necessity on Aresam will be provided by either one of the Leagues or robots. Food will be prepared, robots will be maintenanced, textiles will be manufactured, and religious services will be held. In essence, the Leagues and the robots will join together to create a symbiotic reality that is completely self-supporting.

4.1.2 Government

Government on Aresam will be simple. Each League will select a member of their League to be their representative on the Aresam Council. These 7 representatives will elect one High Council Leader, who will act as a captain in emergency situations. All of the representatives will be granted the right to vote the opinion of their League. The benefit of having one leader who makes the final decisions is that, in the case of an emergency, there would not be time to vote on a decision, so power must in times of need rest in the hands of an individual.

4.2 Residential Design

The housing design where permanent residents will live at Aresam will be separate from the public areas. Subtracting the 3 floors that will be used for those areas, there will be 90 meters left over for housing. Out of the donut that will encircle the tree area in the center, only half will be used for housing, as you can see in image 4.2.1. This will leave 30 floors encircling half of the central tree area. Each of the floors will be designed to look similar in appearance, but will have the ability to change drastically. Each floor will have a diameter of 30 meters. On the outside and the inside of the floor, circling the perimeter, there will be two hallways each of which will be 2.808 meters wide. The hallway on the inside will look into the center of the capsule, and be covered with a one-sided mirror. The hallway on the outside of the housing section will in actuality face solid material, but it will be covered with a flexible computer screen. This screen will display an image of whatever the resident would be looking at if there were in fact windows on the station, These images will be provided by a host of ERB-2s, scattered at regular intervals along the outside of the station. These cameras will provide a 3-dimensional video stream of the outside view.

ERB

The rooms will be set up with expansion in mind. Because there will be initially 900 people per capsule, and that number will fluctuate over time, room design has been set up so that any floor can have any number of rooms. Inside of the two hallways there will be two half-donuts that will travel the length of the living area. These will have spaces that can be turned into doorways periodically along the edge facing a hallway. There will be three hallways that connect the outer and inner hallways. Inside of the sections that are separated by connecting hallways, there will be walls installed that have the ability to move along the section, to create larger or smaller residences. We have allotted approximately 100 m^2 per person, and with 30 people on each floor, that amounts to 3000 m^2 of space per floor that will house the initial group. This will leave 2000 m^2 of extra space that can be used for expansion.

Inside each room there will be necessary furniture for comfortable living and some entertainment. There will be as many beds as there are residents in that room, along with bedside tables, and one shower for 1-2 people and 2 showers for 3-4 people. There will be one dresser for each person for clothing, an entertainment set to hold a computer, and then a small kitchen area. This area will have a DCR, or Domestic Culinary Robot. This robot has the ability to prepare food and clean dishes. There will be a table that is large enough for up to four people, a food storage area, sections of which can change temperature, and a running tap for drinkable water. Residents can select the furnishings for their rooms.

4.2.1 Nutrition

The consumables on board Aresam will provide an adequate and varied diet for all residents. The food is almost entirely grown in hydroponics facilities contained in each capsule. Through almost complete automation, and advanced growing techniques, it will only take 125 m^2 of hydroponics per person for their entire diet. Because the food is all grown within each capsule, it will be fresh, and the menu can be tailored for community preferences.

The plant consumables on board the station will have enough variation for a vegetarian diet to be possible.

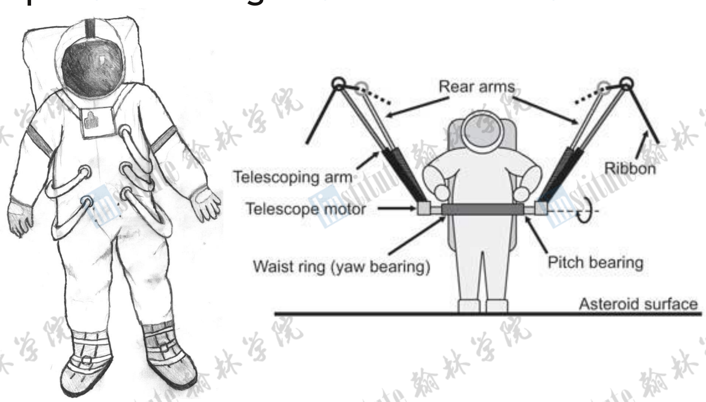
Plant	Resource	Growing Location
Grass	Aesthetic Values	Public Lawns
Fruit Tree	Apples, Oranges, Kiwi	Public Gardens
Aloe Vera	Laxative, Antiseptic	Hydroponics Lab
Ginseng	Tonic, stimulant	Public Gardens
Lemons	Antibacterial, antioxidant	Public Lawns
Sugar Cane	Sugar	Hydroponics Lab
Tea	Tea	Public Areas
Coffee	Coffee	Public Areas

Meat protein onboard Aresam will be very plentiful, for any carnivores aboard the station. The meat will, admittedly, be grown in vats. This will save significantly on space required for food animals, and no unnecessary by products or waste will be produced. The meat will still be quite edible, and since it is suspended inside a scientifically designed cocktail of chemicals, the exact qualities of meat desired can be produced.

4.3 Safe Access

The image shown here is of a space suit and propulsion device that can be used in unpressurized and non-gravitational areas.

Spacesuit Design

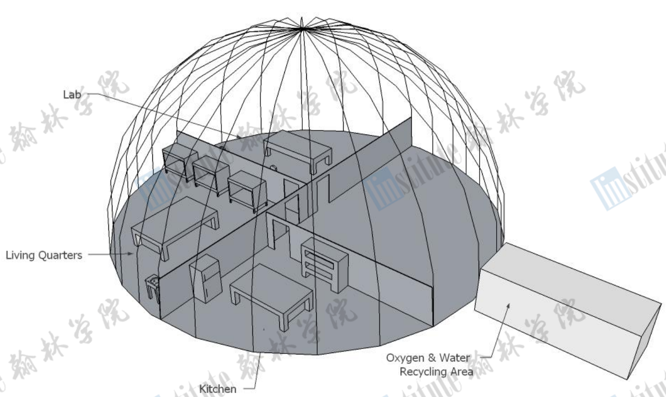


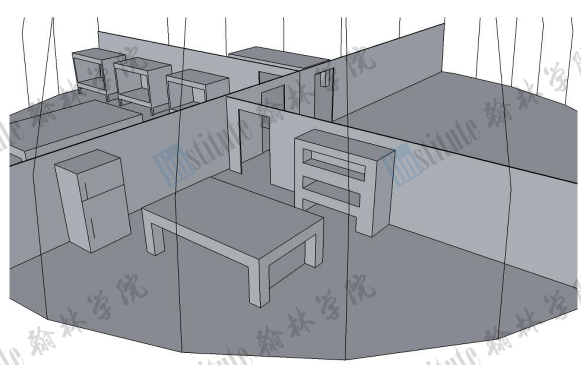
4.4 Flexible Housing

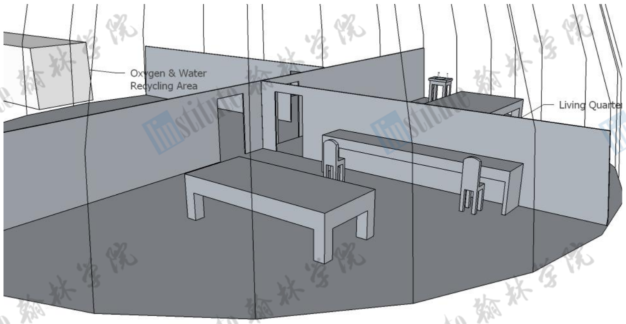
The will be a few extra habitation capsules after the settlement is completely set up. They can be used to accomadate any influx of residents with a different demographic than the one accounted for here.

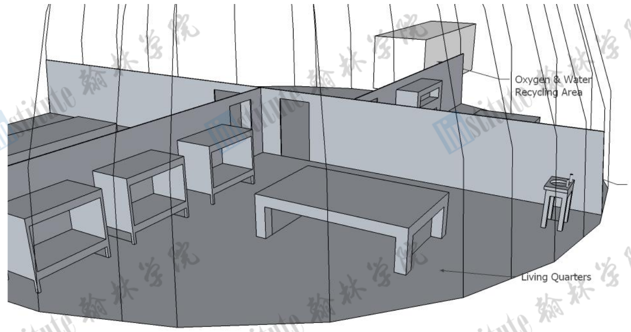
4.5 PMB Design

See the images for the internal configuration of the pre-fabricated Mars base.






Oxygen & Water
Recycling Area
Living Quarters


Oxygen & Water
Recycling Area
Living Quarters

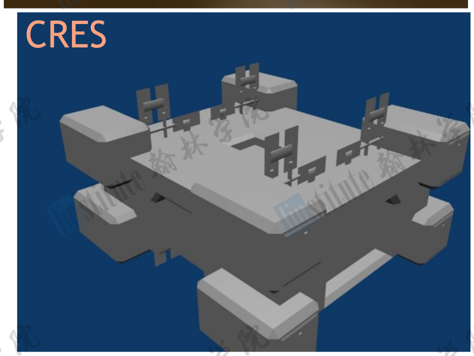
5 Automation Serivces

5. Automation Design

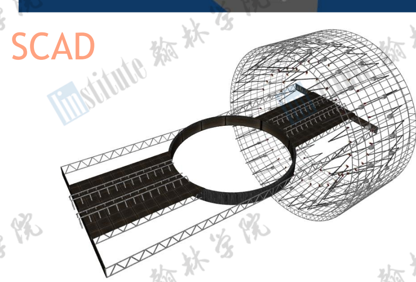
5.1 Construction Automation: The construction of Aresam will be almost completely automated, to reduce the amount of expensive human oversight in Mars orbit, and because robots are much more efficient in a 0-gravity, vacuum environment. They will mine, refine, and extrude resources found on Phobos to create structures needed to assemble Aresam.

5.1.1 AMARF- Automated Mining And Refining Facility. This is a completely automated resource processing facility. two will land on Phobos, and attach themselves to the surface. It will release a host of MER's, to gather the material found on Phobos, and bring it back to the AMARF. The AMARF acts as sort of a "hive" as the depository for resources, and also the repair area for the MER's. The AMARF proceeds to refine the material, and extrude basic parts to be used in construction. After completion of Aresam, AMARF will continue to provide resources for the colony.

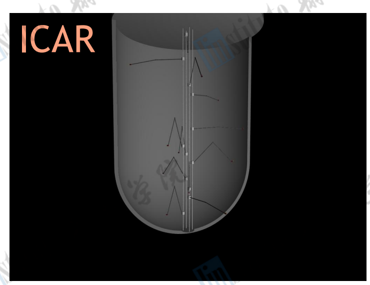
5.1.2 MER- Materials Extracting Robot. While the AMARF refines and processes materials found on Phobos, the MER's will be found gathering the material. They operate by using their thrusters to move around in the microgravity around Phobos, and gather the loose particles on the surface, to take back to the AMARF. The robot mainly consists of a large open ended cargo holding bay, and several arms to scoop in the regolith of Phobos. The MER uses ion thruster to push its way around Phobos, and uses supercapacitors to produce a charge. The supercapacitors are recharged when it returns to the AMARF to drop off its load. This system is the most efficient, as it eliminates the need for either expensive solar panels or batteries for routine use in mining. The MER's will be interchangeable, and very expendable, and will run mainly autonomously, though traffic control near the AMARFs will be necessary.



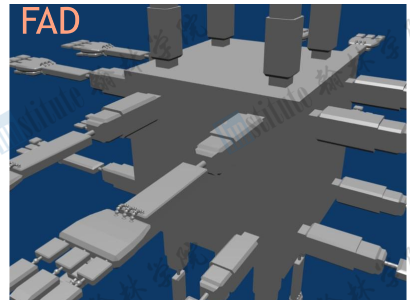
5.1.3 CRES- Cargo Relocation Ship. The CRES is the basic automated transport for the construction of Aresam. Using Ion thrusters, the CRES will attach cargo as needed, and shuttle it to another part of the construction area. They also run off supercapacitors, which will be recharged at various stations around the construction yard, including AMARF and SCAD.



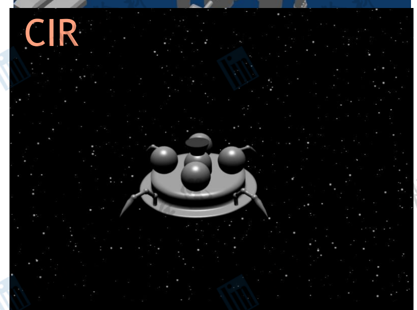
5.1.4 SCAD- Superstructure Construction and Assembly Device. The SCAD robot is a large, cylindrical robot which consists mainly of arms. The arms will attach different parts of the superstructure manufactured by AMARF, and brought by CRES robots.



5.1.5 ICAR- Internal Construction Robot. The ICAR is a large robot with multiple arms which assembles the internal structure of each capsule. This will be performed completely while the capsule is sailing to mars, during which time the basic structure of the capsule will be built. The robot will be powered by the backup generator provided in each capsule.



5.1.6 FAD- Final Assembly Droid. The final assembly droid is a multi purpose machine which acts to finish the small scale construction of internal parts of Aresam. It has 24 arms, which act interchangeably as either legs or multipurpose tools to add walls, appliances, equipment, or any other finishing procedures.



5.1.7 CIR- Capsule Inflating Droid. The CID is a simpler machine, that simply attaches different parts to each capsule to send it on the way to Mars. The CIR first is attached to the Kevlar coating of the capsule, and gases are pumped into the envelope. After the Kevlar coating is inflated, polystyrene foam is pumped between the two layers of the capsule. Finally, the ICAR and all the materials it needs is inserted, and the Solar Sail is attached. Then the CIR uses rockets to give the capsule a boost out of Earth orbit, and it begins its journey.

5.1.8 MRAD- Mars Resource Acquiring Droid. The MRAD is a automated rocket which will provide the settlement with most of its water and gases. The MRAD descends to the Mars polar cap. Once landed, the MRAD extends heated appendages into the ice, and lifts a chunk back into the rocket. It then lifts off into mars orbit, and electrolyses the water into liquid hydrogen and oxygen, and any extra is moved by CRES module to the Aresam space station. If gases are required, the MRAD will acquire less ice, and pump Mars atmosphere into its tanks.

5.2 Facility Automation

Due to the many hostilities of outer space, it is necessary to have safety plans and robots which can respond to damages immediately and repair crucial parts of the settlement. As such, these systems will need to have access to all parts of the settlement and, thus, can become a danger themselves if their security is compromised. Aresam will therefore, need a method of isolating these systems from unauthorized personnel.

5.2.1 Maintenance Systems

To minimize actual damage, settlement operations must take preventative measures and excercise proactive actions. Moving parts will be automatically relubricated and evaluated at scheduled intervals. The heating and cooling systems for indoors locations will be capable of running self-diagnostics and reporting them to repair crews as needed. Periodically, the transportation vehicles (trains, elevators, &c.) will be rotated in and out of use to be examined for damages or weaknesses. In addition to checking for physical soundness, there also needs to be an automated digital maintenance system. This will include regular software updates, antivirus scans, and defragmentation processes for all governmental and residential computing devices and servers.
Human health also must be maintained, so the air and water filtration systems will check the pathogen levels to help give to doctors warning about potential outbreaks.

5.2.2 Repair Systems

Should the maintenance systems fail to prevent damage, several repair mechanisms must be in place. Aresam's hull does not need a failure detection system because the nanobot solution the comprises part of it will immediately repair it should a part of it become compromised.

5.2.3 Safety Functions

To ensure structural integrity, a system of low-intensity lasers aligned along the important structural features, such as cross beams, support columns, &c. Fixed detectors can then determine if any warping or shifting is occurring within the structure. Skilled analysts will then be immediately notified of these problems so that they may determine if a repair is necessary. The water pipes will have pressure checkpoints all along them to detect abnormal pressure drops indicative of a leak, and they will automatically shut off the flow if that happens. Similarly, circuit breakers and fuses will placed all throughout the electrical wiring system.

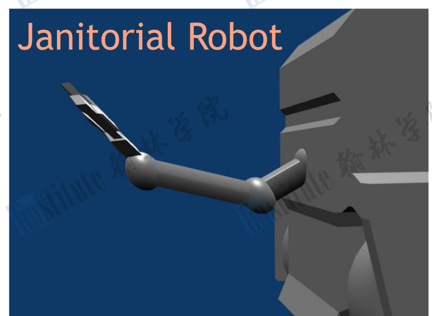
Because of the self-repairing nanobot solution in the hull, very little external repairs will ever need to be done. The exception, of course, is possible repairs on the tracks for the trains. Because this does not need to be done immediately (there are two tracks and the trains can operate in a shuttle mode if necessary), there is no need for emergency external repair robots (emphasis on emergency), and therefore, they do not need to be capable of surviving solar flares.
Periodic capsule evacuation drills will be held so that everyone can safely relocate to another capsule in the case of a dangerous conflagration or a minor air leak, &c. If, God forbid, a massive hole is blown open in a capsule, since the capsule is a wide, open space, it is very difficult to save much of anything or anyone in it; however, the train and central elevator systems will refuse access it, and the remaining 69 capsules will be perfectly safe.

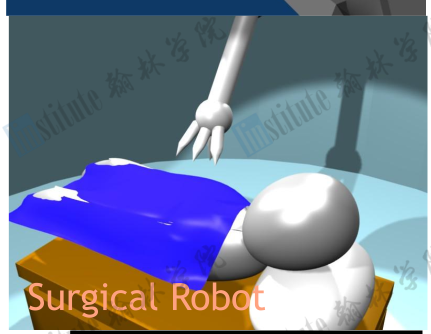
5.2.4 Security

Access to the alarm and notification systems, as well as the repair robot system will be given only to authorized personnel. This is accomplished by keeping all the computers and communicators invovled on a separate network from the rest of Aresam that uses quantum entanglement as a security measure to ensure safe delivery of untampered and unintercepted messages.

5.3 Habitability and Community Automation

In addition to the necessary robots which maintain the settlement, it is always convenient to the residents to have robots and devices of their own the work for them at their command.





5.3.1 Routine Tasks

Households have robots or automated machinery that takes care of things like dishwashing, clothes washing, cleaning, and even cooking. With these devices and robots in place, space requirements can be significantly reduced. For example, and automated washer and dryer system would no longer need an entire room for itself, only an opening to put clothes in and take them out. The same applies to the dishwasher. The cook can have all of its equipment stored internally, and residents can use a simple touchscreen interface to request meals.
Businesses will also have access to robots to be janitors, secretaries, deliverers. The secretary robots can type up a dictated letter, automatically schedule events and appointments, and take messages. Deliverers can be responsible for package transportation. Additionally, some robots will be need to maintain the gardens and cleanliness of public areas.

5.3.2 Human interface and Communication Devices

Aresam will have two main methods of communication: a small portable device and a large fixed device. Residents will often need to contact others while they are performing activities throughout the settlement. As such, they will each have a small flexible sheet acting as a monitor for their computer as well as a touchscreen interface. They can take it wherever as it is light and compact, and they can use it for anything from making a video call to a friend to accessing their home computer to watching entertaining media on the internet. At home and at desk jobs, there will be large versions of this same device that are not flexible and are fixed onto a wall or table. Both of these devices are not actually the computers themselves, which can be stored conveniently out of the way, they are only interfaces which may communicate over the entire breadth of the settlement.

5.3.3 Personal Robots

Finally, residents will be allowed to own their own robot to do with as they please, if for no other reason than pure entertainment. Of course, they will be programmable and customizable. They will be able to do anything from serving as an live, interactive interface for a computer to shuffling cards, depending on the attachments the owner chooses to give it.

5.3.4 Security

Each household and business computer/robot system will be isolated from the others except through standard communication methods like emails and calls. Administrators of Aresam will respect the privacy of the residents and the information they might store on their computers; however, if a situation arises such that this must be compromised, such as a rogue programmer sending out viruses, they reserve the right to search through the residents' digital data.

5.4 Access to Earth's Data Repositories

Residents of Aresam will probably want access to the abounding information on Earth's internet. The communication delay makes it very difficult to have a live connection to Earth; however, the alternative solution is quite simple.

5.4.1 Aresam Clone Servers

Aresam will have a massive system of servers (approximately 1 petabyte's worth of memory) which will hold a copy of much of the most commomly accessed parts of the internet on Earth. Earth will be scheduled to send an updated copy twice a day. Of course, after the initial data upload, only some sites will need to be updated that often. This way, Aresam residents will have immediate access to much of Earth's internet without the long communication delay.

5.4.2 Aresam Net Servers

In addition to these clone servers of Earth's internet, some of Aresam's servers will be allocated for use as its own internet specifically for its residents. Here, residents can create their own webpages, engage in social networking, read news headlines about Aresam, and access Aresam's own data repositories.

5.4.3 Direct Link to Earth

Even with these two vast libraries of information, some residents may occasionally desire information on the Earth internet that has not been copied to Aresam. In this case, the residents can either request a specific file or site to be temporarily upload to Aresam's servers or for an entire domain to be uploaded. Because of the communication delay, after initiating this command it will take anywhere from 6 to 76 minutes for the request to start being fulfilled, depending on the relative locations of Earth and Mars. As such, the residents must place their requests well in advance; however, this method of communication not intended for a live, interactive, or continual use.

5.5 Robotic Assistance in Mars Pre-Fabricated Structures and Phobos Mining

5.5.1 Mars Prefabricated Base Assembly

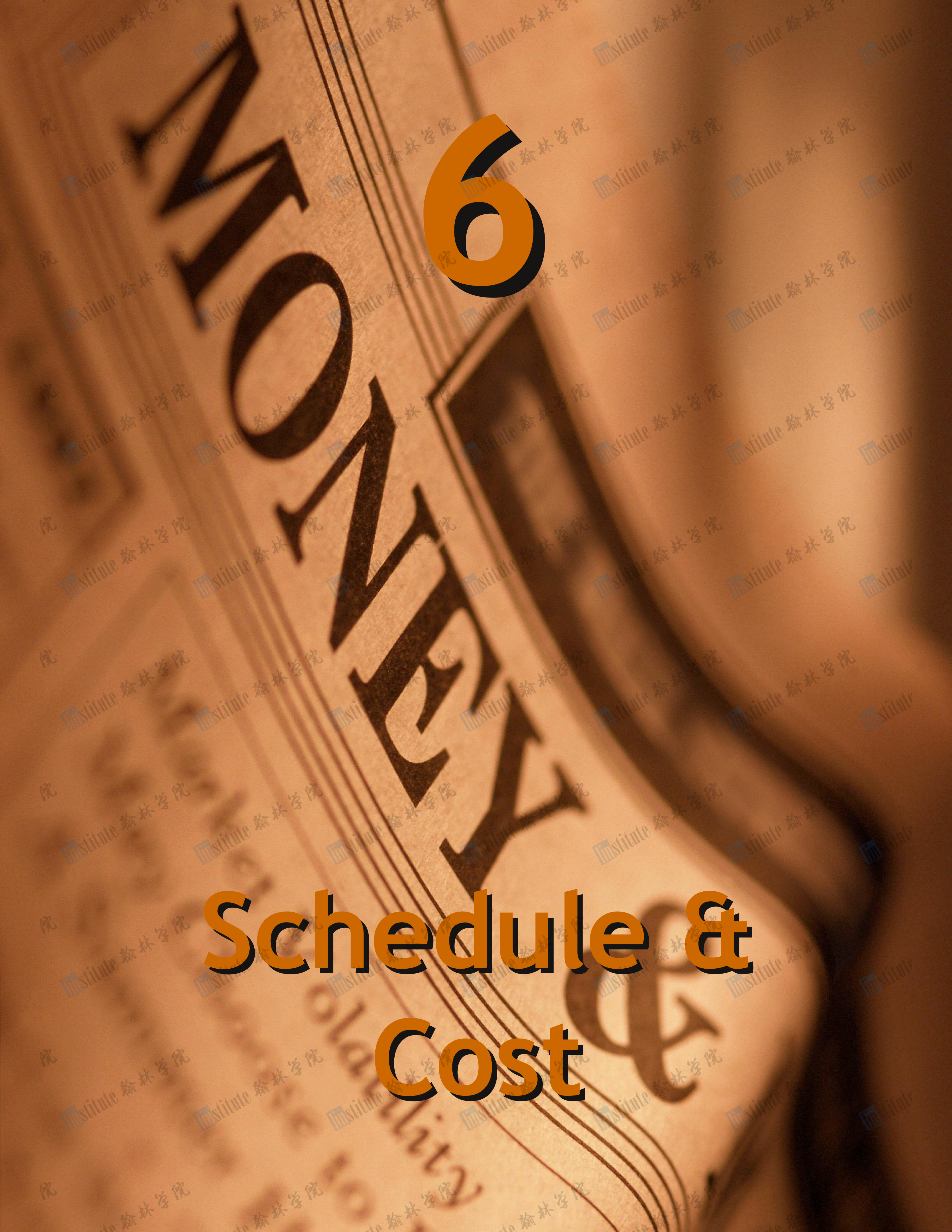
The prefabricated base that is to be used on Mars is set up mainly by astronauts on the surface, as it is inflated, and the only necessary construction procedures are to drill stakes into the ground to attach the "bubble" portion. This is rather simple, and requires little manual labor. The base will regulate the rate of inflation, and also regulate atmospheric and water recycling. But otherwise, automation is not needed, and will not be included.

5.5.2 Phobos Mining

The mining of Phobos, at least initially, will be completely automated. As soon as construction robots arrive at Phobos, the AMARF robot will attach to its surface, and begin the harvesting of resources. The AMARF will be the central refining and collection facility. The MER will mine and return minerals to the AMARF, where the resources will be refined and construction elements manufactured. After completion of Aresam, the mining robots will continue to supply Aresam with material for the making of equipment and products.

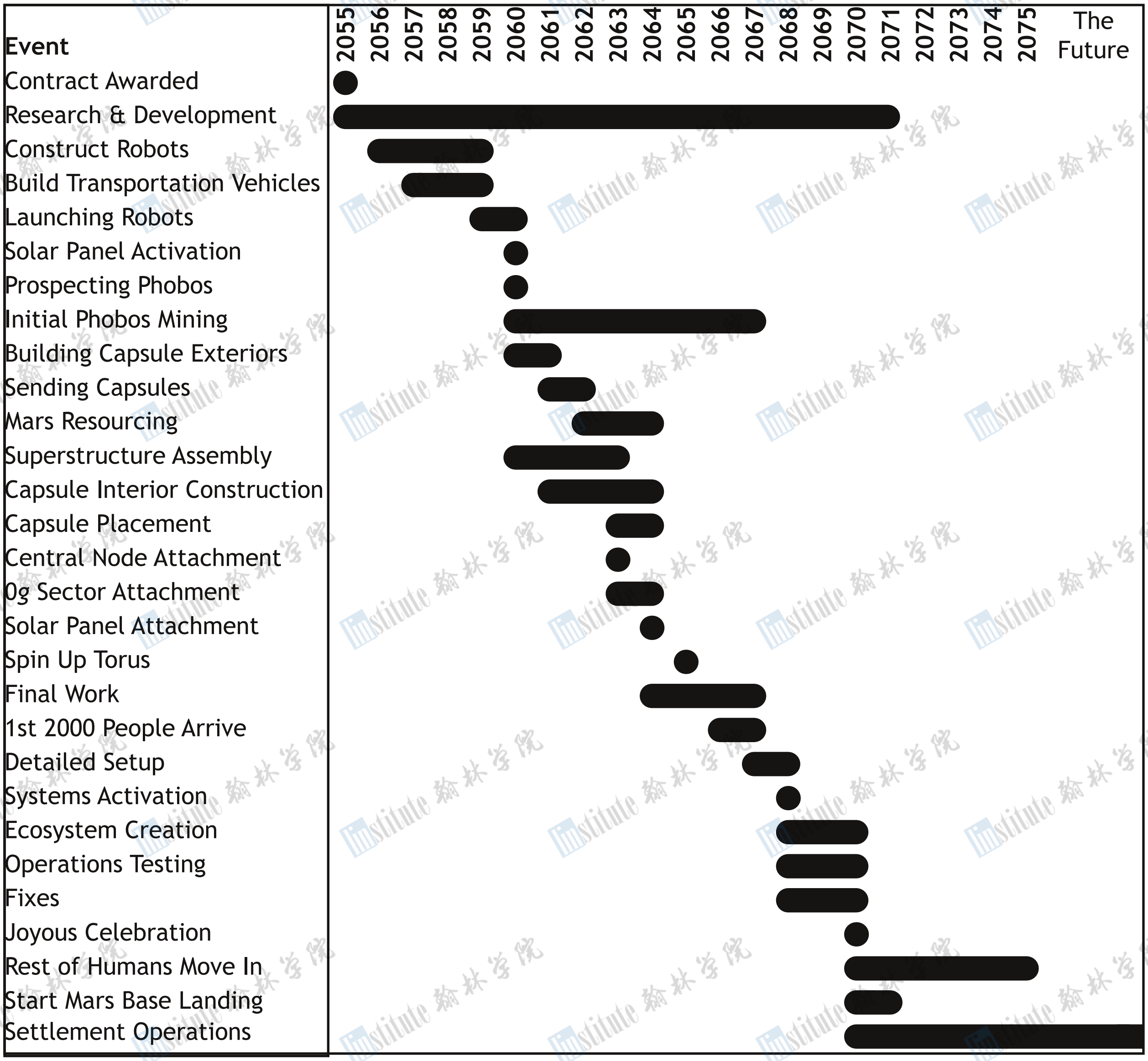
6

Schedule & Cost



6. Schedule and Cost

6.1 Schedule



6.2 Costs

Raw Materials

Material	Cost ($/kg)	Quantity	Total Cost (Billion Dollars)
Carbon Nanotubes	75	5.23×10^{8}	39.2
Aluminum Alloy 201	3	2.79×10^{8}	837
Titanium Alloy Grade 37	50	1.56×10^{8}	78
Steel Alloy 21-6-9	2	1.60×10^{8}	320
Carbon Fiber-Kevlar Weave	500	3.06×10^{8}	153
Nanobot Solution	200	7.14×10^{7}	1.43
Polystyrene Foam	2	4.06×10^{8}	212

Salaries				
Job Type	**Job**	**Annual Salary ($)**	**Man-Years**	**Total (Million $)**
Engineers	Design	80,000	500	40
	Automation	95,000	700	66.5
	Rockets/Transportation	85,000	350	29.75
	Operations	75,000	325	24.4
	Agricultural	75,000	300	22.5
	Biological	70,000	300	21
	Electrical	90,000	250	22.5
Researchers	Societal	60,000	75	4.5
	General	70,000	20	14
	Medical	90,000	100	9
Management	General Management	125,000	320	40
	Engineering Managment	120,000	50	6
	Public Relations	120,000	100	12
Misc.	Facilities Upkeep	30,000	100	3
	Communications	60,000	50	1.5
	Astronauts	170,000	600	102
Total			4320	418.65

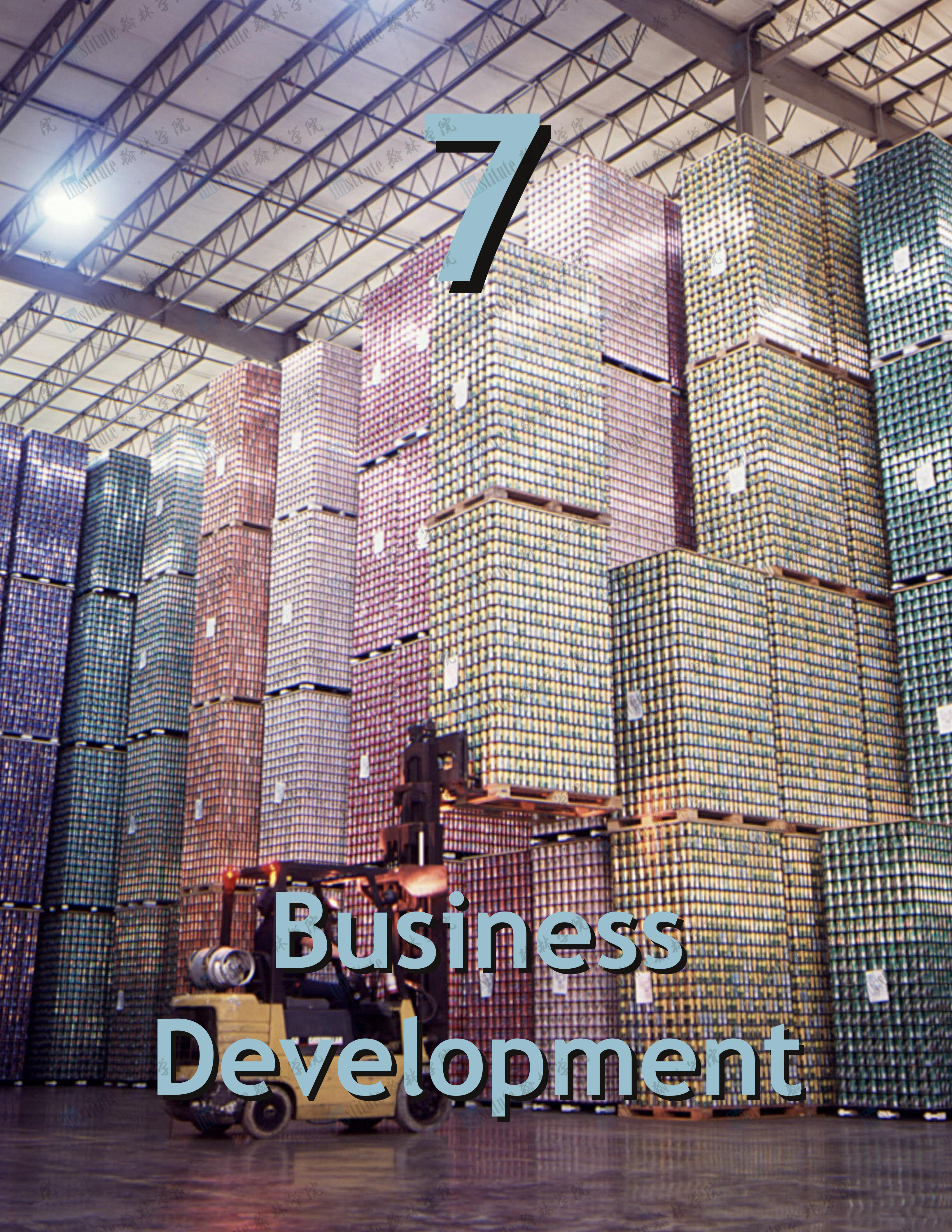
Transit Costs	**Transit Type**	**Price**	**Amount**	**Total Cost**
Mars	Personnel	$200,000/person	20,050 people	$24 B
	Equipment	$3000/kg	80,560,000 kg	$241 B
	Robot	$4500/kg	111,650,000 kg	$500 B
Earth Orbit	Personnel	$50,000/kg	20,050 kg	$1 B
	Equipment	$250/kg	80,560,000 kg	$20 B
	Robots	$250/kg	111,650,000 kg	$28 B
Earth to Orbit	Personnel	$350,000/kg	20,050 kg	$7 B
	Equipment	$1540/kg	105,000 kg	$162 B
Total				$983 B

Equipment Costs	**Type**	**Price**
Robotics	Electronincs	$45 M
	Motors	$56 M
	Misc. Parts	$160 M
Agriculture	Nutritional Gel	$12 M
	Hydroponics	$960 M
	Misc.	$44 M
Instruments	Communications	$110 M
	Computers	$560 M
	Radar	$20 M
	Scientific	$1.5 B
Others	Ion Thrusters	$50 B
	Solar Panles	$22 B
	Fuel Tanks	$1 B
Total		$76.467 B

Oribital Assembly Costs	
Robots	$56 B
Orbital Vehicles	$21 B
Surface to Orbit	$30 B
Earth to Mars	$45 B
Misc.	$60 B
Total	$156 B

Total Costs	
Salary	$418.65 M
Raw Materials	$1640.63 B
Orbital Assembly Costs	$156 B
Equipment Costs	$76.467 B
Transit Costs	$983 B
Total	**$2856.56 B**

7 Business Development



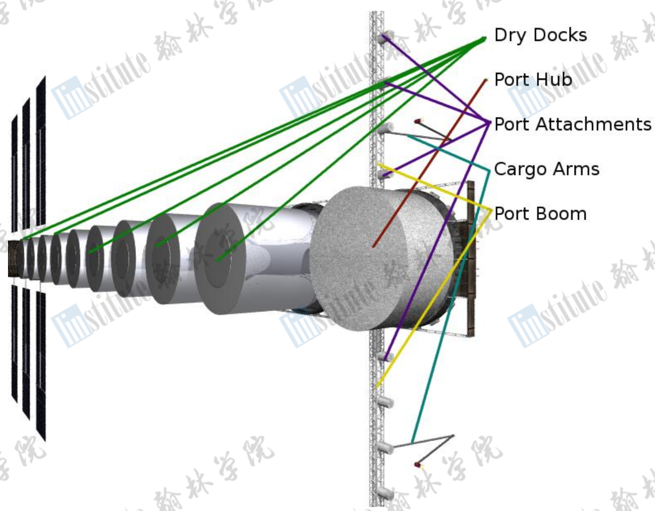
7. Business Development

7.1 Transportation Node and Port

7.1.1 Docking and Warehousing

The Aresam space settlement will be perfectly capable of handling large amounts of spaceship traffic through its many ports and cargo handling facilities. Nine different dry docks will adequately provide service from small to relatively large spacecraft, and all others can be serviced while attached to the port areas. For cargo transportation between ships, a large service arm will be able to move cargo between docked ships. All other cargo can be brought through the port into Aresam itself, and manually transported to its destination. Once inside Aresam, train transport will be able to quickly and efficiently move around materials to the desired destination. With train transport and external movers such as the arm and the CRES automated transport, cargo transportation will be quick and efficient.

Port Facilities



7.1.2 Passenger Facilities

The port area of Aresam will serve as a comfortable region to stay while waiting for continual transportation to areas on and around Mars. The port hub will contain several waiting areas for short term residents, complete with sleeping and dining areas. For longer stays, areas in both the 0-G area and the habitation torus will be adequate to service any travelers during their stay on Aresam.

7.1.3 Spacecraft Provisioning

The servicing of spacecraft will be a major priority of the settlement. Refueling while attached to the port, the craft will be attached to a fuel pipe by the arm, and provisioning will take place via the attachment. If the craft is dry docked, refueling and provisioning can be performed relatively easily, though cryogenic propellants will be forced to refuel at the port. The fuel will mainly come from water electrolyzed from the martian polar caps, while food provisions will be grown in the habitation torus. To prevent a permanent and continual drain on resources, it will be mandated that spacecraft must deposit their waste within the station, to be used as fertilizer and growing material for plants. Other provisions will be manufactured from gases harvested on mars and material from Phobos.

7.1.4 Mars Vehicle Service Depot

The vehicles sent to the surface of Mars will need a solid base from which to work. Aresam will be a secure and readily available settlement which will provide all the servicing the craft require. Craft going to the surface of Mars will mainly require fuel, though maintenance will also be a major requirement. The dry docks of Aresam will be a very convenient place to both provision and repair surface craft, as a quick and full servicing can be completed in a shirtsleeves environment.

7.1.5 Production Line

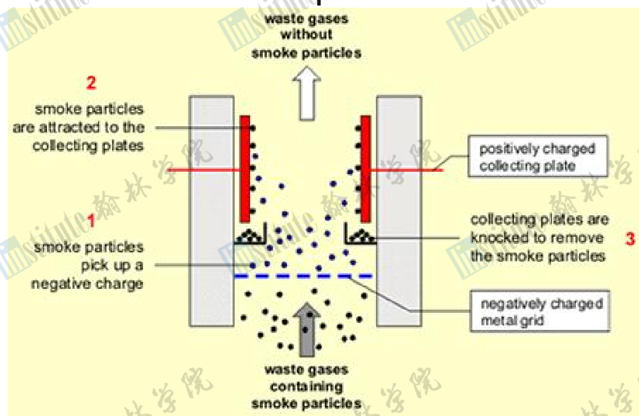
Businesses will create production lines and facilities as required but an example production line in a gravitated area might look like this.

Production Line

7.1.6 Anti-Contaminant Procedures

All vehicles returning from Mars surface or Phobos will have to go through a set of procedures. First off, the craft will enter the dry dock, and an atmosphere will be pumped in. The air will be cycled for 4 hours with electrostatic precipitators cleaning the air, before any equipment or personnel enter the area. Afterward, the dock will extend arms with charged wands to attract any dust, and the entire craft will be negatively charged. Finally the air cycling system will begin again, with the arms brushing the craft as well. After theses procedures, the craft will be clean of 99.8% of the contaminants, and the rest can be washed off of equipment and dock uniforms.

Electrostatic Precipitator



7.1.7 Quarantine

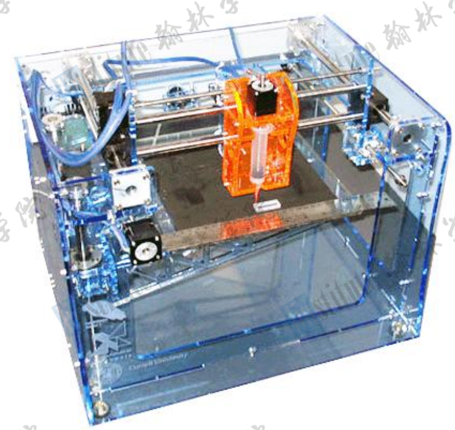
The terminal areas of the Port hub also double as quarantine areas. Encapsulated by airlocks, passenger service areas can support the quarantine population over long periods of time, though advances in the medical field should keep these quarantines to a minimum.

7.2 Manufacturing

7.2.1 General

The 0*g* capsules of Aresam will provide abundantly adequate room for all manufacturing necessary in the settlement. With 1,832,600 cubic meters in each capsule, and 40 capsules, there is a total of 73,300,000 cubic meters of manufacturing area. The fact that the manufacturing is in microgravity allows many novel manufacturing practices to become possible, and manufacturing should be, in general, cheaper, quicker, and more efficient. If gravity is ever needed, rotating structures inside the 0*g* capsules can provide the desired gravity. There is no limit to the types of products that can be created.

Example Fabricator



7.2.2 Resources

The materials will mainly come from the AMARF robotic refining facilities, and transported either directly to the pods (docking is provided on the roof of each 0*g* capsule, where the elevator is in a habitation capsule), or indirectly through the port and train system. Gases from mars and materials from Phobos should provide Aresam with all the resources needed to create a highly industrial society.

7.2.3 Industrial Processes

One of the beauties of Northdonning Heedwell's proposal is that all manufacturing is performed in a microgravity environment, and each capsule can be pressurized as needed. In microgravity, many processes, such as growing crystals, refining materials (no convection currents), and microbe growth. Many other processes will no doubt be found to be more efficient as more tests are performed. All other processes will be performed on rotating structures inside the capsules, at the desired speed to provide the desired amount of gravity. Process such which use liquids, and many others would be performed in low level gravity provided by the centrifugal force. Any large scale structures would, of course, be constructed in the vacuum around the station, with construction robots left over from the initial construction process.

7.2.4 Mars Vehicle Transportation

Specified orbit-to-surface lander vehicles will be built by the manufacturing sectors of the Aresam, which will provide a safe landing for all cargo headed for the surface of Mars. This lander will be able to transport cargo up to 3 meters by 3 meters by 9 meters, the size of the prefabricated Mars base. The lander will not be a return vehicle, it will only provide a safe landing through rocket motors placed on the downside. A separate rocket motor will be built which is placed in the lander, and can launch small cargoes from the surface to Orbit. Vehicles will be placed inside this lander, as well as robots.

7.2.5 Mars Surface Provisioning

All other provisioning can also be transported down in the Mars Lander, though placed in smaller containers.

7.3 Research

7.3.1 Laboratories

The laboratories will be placed in the 0*g* capsules along with industrial processes, where they can stimulate artificial gravity for experiments through rotating structures. Smaller laboratories will also be placed in the rotating torus, to provide scientists with a more comfortable work environment.

7.3.2 Quick Production Shifts

The large volume of the 0*g* capsules will be adequate to allow new production lines in different capsules, and the microgravity will allow easy fabrication of new structures and equipment.

7.3.3 Exports

Frankly, there will be very few exports to Earth, at least in the foreseeable future. Except for valuable minerals found only on Phobos or Mars, almost anything that can be produced on Aresam can be fabricated on Bellevistat from asteroid and moon materials, without the incredible transportation costs. Aresam will find most of its value in being the production center for almost all goods and services in the Mars area, as well as in servicing ships destined for more distant planets. Unless a material is found only in the area under Aresam's control, there will be no transport back to Earth. In the case that there is material only found there, it will of course be incredibly valuable, at least in small amounts, around earth, but only then will exportation commence.

7.3.4 Biological Hazards

If laboratories find new, exotic life on mars, the population will be very safe from infection. Again the beauty of a capsule design is shown. Each capsule can be sealed off completely from the rest of the station, and support itself. The laboratories themselves will of course be isolated in their own capsule in the 0*g* area, and quarantine can be easily applied.

8

Appendices

8.A. Detailed Assessment

Northdonning Heedwell's design for Aresam is designed around heavy manufacturing. The 0g area is made up of many very large enclosed spaces, which are completely isolated from each other. These enclosed spaces are also without gravity, making many more efficient manufacturing processes a possibility. Artificial gravity for some processes can be created by spinning the structures. Also, each capsule is isolated from the others, and can change pressure as desired, by pumping atmosphere into tanks inside the capsule.

8.A.1 Structural Engineering Factors

Manufacturing can take place free floating in the 0*g* capsules. This eliminates the need fro structural integrity of the areas where the industrial application is taking place, and, again, allows the gravity to be varied as required. Since each capsule is surrounded by a vacuum, depressurizing the entire capsule should not cause any stress on the structure, and in fact will make it stronger.

8.A.2 Operations Engineering Factors

Most industrial processes will be controlled by computer, and will be mainly autonomous. These will be low pressurized, low interference areas, and only require pressurization for human maintenance. Some industry will require more human interaction, and in these cases human workers, floating in the 0*g* will supervise and perform work. They will commute daily over the rail lines and elevators connecting the Habitation areas and 0*g* area.

8.A.3 Human Engineering Factors

0*g* work is slightly detrimental to human health, and human workers in manufacturing areas will be affected by this. The 0*g* and shifts in pressurization might also be uncomfortable. But when these workers are allowed to return to a 0.8 gravity living zone after work, and live in a comfortable and close community, they become minor problems. When this is compared to the rigors that full 0*g* life presents, the working conditions are in fact quite good.

8.A.4 Automation Engineering

Most of the manufacturing on board Aresam will be automated. The automated equipment will all be available for incontinence by humans, as they are enclosed within the 0*g* capsules. Each capsule can be fully pressurized fro routine maintenance checks, and then depressurized for more efficient manufacturing. Also, for transportation of materials, a train system at the top of every capsule provides a way to move large cargoes around quickly and efficiently.

8.B. Bibliography

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8.C Compliance Matrix