FOUNDATION SOCIETY

ARESAM

NORTHDONNING HEEDWELL

DURANGO HIGH SCHOOL

DURANGO, COLORADO, U.S.A.

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

Name of responsible teacher/advisor: Daniel Garner
School (or other Group Name): Durango High School
School Address: 2390 Main Ave
School City, State, Zip or Postal Code: Durango, Colorado, 81301
Country: U.S.A.
Daytime Telephone at School: (970) 259-1630 x 2211
Message Telephone: above
Fax: 970 385-1493
e-mail address: dgarner@durango.k12.co.us
Last day of school in Spring 2010: May 27 2010

Contact information for responsible teacher/advisor when school is not in session:
Name if different from above: Same
Address: 230 E. Park Ave
City, State, Zip or Postal Code: Durango, CO 81301
Country: U.S.A.
Telephone (also evenings / weekends): (970) 259-3792
e-mail address: dgarner@durango.k12.co.us

Information for alternate contact person (may be a student): Anna Ortega
Telephone ✓ day ✓ eve ✓ weekend: (970) 903-1360
e-mail address: grizzlybear1969@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)

Anna Ortega	[12]	(18)	Morgan Dorsey	[11]	(16)
Nick Skahill	[12]	(17)	Ethan Webb	[11]	(16)
Noah Fischer	[12]	(17)	Cory Kerns	[11]	(17)
Morgan Scarafiotti	[11]	(16)	Colin Mummery	[10]	(16)
Paul Deem	[12]	(18)	Katie Schneider	[10]	(15)
Gabrielle Massone	[11]	(16)	Will Zillich	[12]	(17)

Names of two adult advisors currently expecting to attend the Finalist Competition:
Dan Garner
Steve Powell

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.

[signature] 3/4/2010
Responsible Teacher / Advisor Signature Date

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"The best scientist is open to experience and begins with romance - the idea that anything is possible."

-Ray Bradbury

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The Team

President: Anna Ortega

Structure: Paul Deem

Operations: Morgan Scarafiotti

Human Factors: Anna Ortega

Automations: Noah Fischer

Business: Nick Skahill

Sponsors: Dan Garner, Steve Powell

1.0 EXECUTIVE SUMMARY

1.0 Executive Summary

"There was always a minority afraid of something, and a great majority afraid of the dark, afraid of the future, afraid of the past, afraid of the present, afraid of themselves and shadows of themselves" (Ray Bradbury). We at Northdonning Heedwell count ourselves among the minority; the dark is meant to be explored. The future exists for us to create and mold. Aresam stands as a beacon of light, expanding humanity's influence into the darkest of places, space.

Aresam is built for one purpose, to take advantage of the most economically promising location in the solar system. Mars orbit is the ideal place for mankind's next great endeavor, perfectly placed near myriad mining opportunities and the Main Asteroid Belt while its orbit allows the strategic capability to support future large-scale operations on the Martian surface. Northdonning Heedwell's Aresam has the vision, scale and development potential to ensure the Foundation Societies enduring success.

To best serve the Foundation Society, Northdonning Heedwell was guided by three major goals from the beginning of Aresam's design.

-Develop a settlement with the fastest and most substantial R.O.I in company history. Our streamlined structural design uses every possible resource Mars and his moons have to offer, allowing us to construct Aresam at a tiny fraction of the cost of importing materials.

-Establish the Foundation Society's influence in the booming economy of Mars. Aresam is the sole gatekeeper to the Red Planet, and the minerals hidden deep within the crust.

-Secure Aresam's position as the mining, shipping and economic hub of Mars, to support your ambition to reach far into our solar system.

With these bold goals in mind, Northdonning Heedwell has designed a settlement that is audacious in its vision and practical in its function, while maximizing its profit potential. Through careful balance of these ideals, Aresam clearly rises as the ultimate option for Mars.

Northdonning Heedwell's Aresam escalates settlement design:

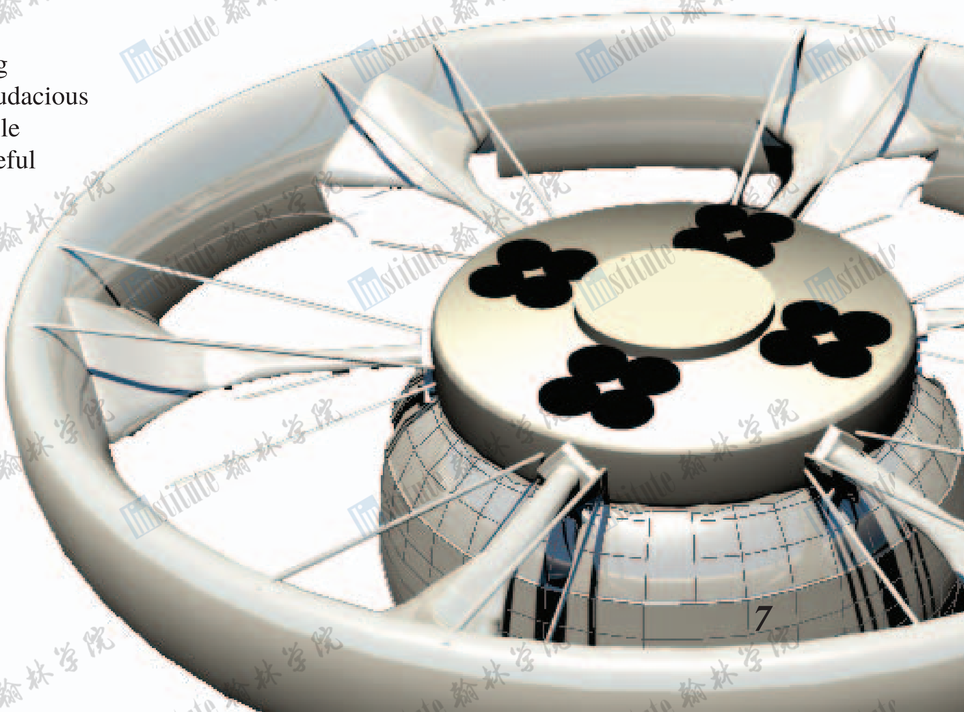
• Exterior structural layout has been greatly condensed from previous designs via complete removal of the "central conduit", which has now been replaced by direct connection from the residential torus to the operations core through major spokes.

•Aresam's construction sequence and construction infrastructure provide an unbeatable time frame, while minimizing the initial investment required from the Foundation Society. This is achieved by reducing the initial cost to a single self-contained construction unit, the Matriarch.

•Mining and refining infrastructure provides a virtually zero waste system. The same manufacturing infrastructure used to build the settlement is repurposed to create construction materials and refined ores for commerce.

•Through unique attributes and an organic community layout, residents, Foundation Society members, and visitors find Aresam a welcoming settlement modeled after that of Earth's Copenhagen and the surrounding Danish countryside. Various accommodations, including state of the art-education, dynamic forms of entertainment, and optimum living choices contribute to the overall comfortable and Earth-like atmosphere of Aresam.

We fear only the controlling inertia of timidity. Join us as we bring the bold light of innovation to the Martian sphere of influence.



2.0 STRUCTURAL DESIGN

"The ship came down from space. It came from the stars and the black velocities, and the shining movements, and the silent gulfs of space."

-Ray Bradbury

2.0 Structural Design

The structural design of Aresam features the latest in materials, design innovations, and construction efficiency. This provides the utmost in safety and unparalleled natural views of Mars, the moons, and beyond. An organic interior design of the torus creates a natural feel by weaving together residential, recreational, and commercial areas into a seamless and familiar environment. A rapid construction sequence minimizes the time to return on investment. The layout of the operations core has been designed to maximize the efficiency of cargo transport systems and expedite the refining and manufacturing process. Finally Aresam's Expansion capabilities make it a superb base for Mars exploration and growth.

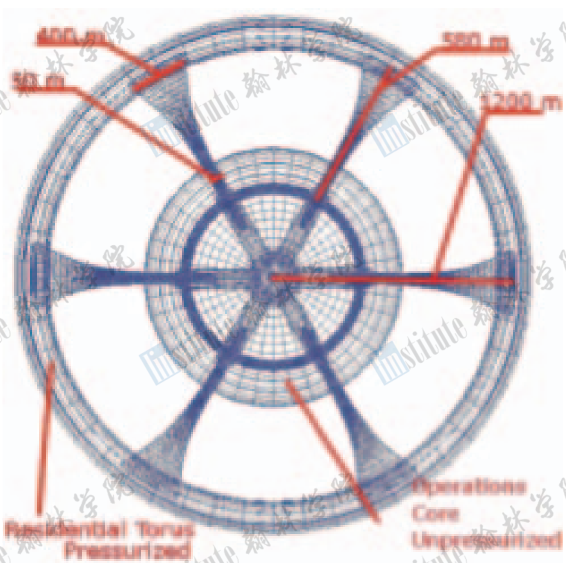
2.1 External Configuration

Northdonning Heedwell's Aresam combines a comprehensive structural design featuring the most effective use of materials to date and an effortless integration between rotating and non-rotating sections. These features thoroughly provide the Foundation Society with the safety, functionality, and innovation necessitated by the harsh environment of space.

Section 2.1.1 Settlement Layout

Aresam's design safely and comfortably houses over 20,000 permanent residents, as well as a transient population expected to exceed 2,000 people after 30 years of profitable operation. The settlement is comprised of two major components: the operations core and the residential torus. This simple and effective design creates the utmost in settlement capabilities while reducing the overall cost of the settlement. The operations core is non-rotating and houses docking, power storage, refining, storage, and manufacturing systems (Appendix 8 A); this is done to take advantage of micro-gravity operations. The operations core has a volume of over 900 million cubic meters (Table 2.1.1) providing a large amount of space for initial operations and future expansion (Section 2.4). The residential torus rotates to provide artificial gravity (Section 2.1.3). The torus has a radius of 1200 meters and providing a large amount down area for residents (Section 2.2.1) and a suitable amount of space for settlement operations within the torus (Section 2.2.1). Condensing the residential torus and the operation core has allowed us to greatly reduce material costs as well as the infrastructure necessary for mass transport systems.

The residential torus with its six major spokes rotates around the operations core on a system of magnetic tracks embedded in the operations core (Figure 2.1.4). This track minimizes physical connection to the Core,



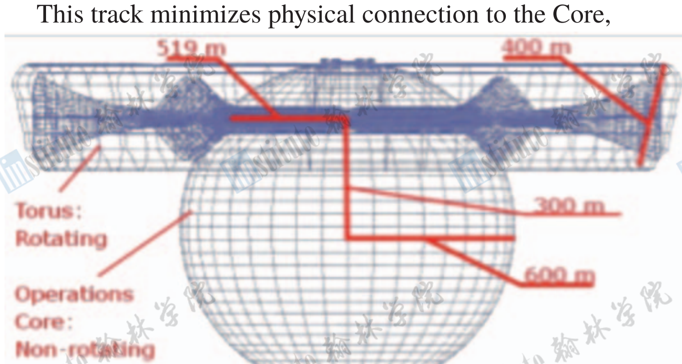


Figure 2.1.1 Aresam's condensed structure vastly reducing material costs and centralizing infrastructure.

Structure	Width (m)	Length (m)	Radius (m)	Surface Area (m^2)	Volume (m^3)
Operation Core	NA	NA	600	4,523,893	904,778,684
Residential Torus	400	NA	1200	7,320,768	294,053,000
Major Spokes	400	580m	NA	543,260	21,516,200

Table 2.1.1 Dimensions, volumes, and external surface areas of the major hull components

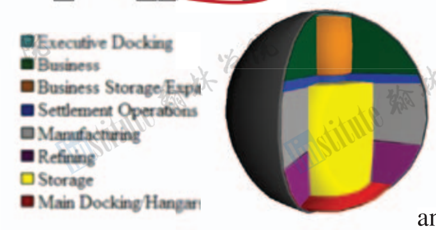


Figure 2.1.2 Aresam's Operations Core optimizing transportation systems and facilitating business development.

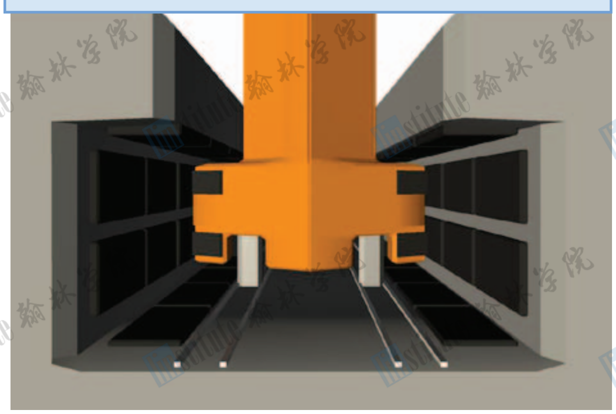
thus reducing frictional forces between the torus and the operations core, reducing overall energy requirements and minimizing wear. Humans and goods are transported between the two sections through a pod system (Sections 4.3, and 3.2).

Executive Docking	1%
Business	27%
Business Storage/Expansion	8%
Settlement Operations	5%
Manufacturing	18%
Refining	14%
Storage	25%
Docking/Hangars	2%

Table 2.1.2 Percentage allocation of the operations core

The residential torus can be isolated into 12 independent sections in the event of an unforeseeable incident, such as a hull breach. To accomplish this there are transparent bulkheads intersecting the residential torus (Section 4.1). The walls have passages through them on all major transport routes. These passages can be sealed with blast doors and can serve as air locks.

Figure 2.1.4 Rotating and non-rotating connection reducing wear and increasing longevity



Aresam's operations core has been developed to optimize transportation systems and facilitate business development. Industrial and commercial docking terminals are separated to provide for a more efficient docking system; this allows for each docking terminal to contain specialized cargo management infrastructure (Section 2.4). Cargo from the industrial port can either move directly to refining and manufacturing, or be placed into storage. Business infrastructure and storage is centralized within the top of the operations core to allow businesses quick access to their storage, the torus, and the commercial docking terminals. A rail system within the operations core provides primary transportation for humans and goods (Section 5.1.1). Settlement operations consist of a backup nuclear power plant, power conversion, and emergency sustenance storage (Section 3.2.4).

Section 2.1.2 Hull Composition

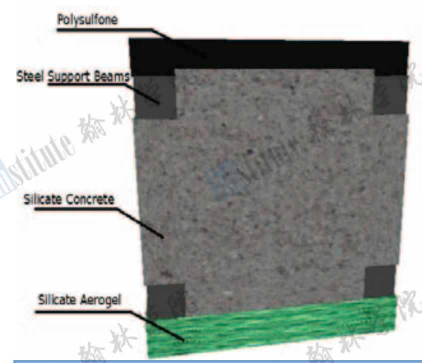


Figure 2.1.3 Cost effective hull composition, proving complete radiation protection as well as the latest and greatest in insulation

The hull of the settlement consists of a silicate concrete shell supported by a high carbon steel framework providing a secure base and maximizing the amount of material used from the ore shipments from Mars. The shell is constructed of 4m equilateral prisms of silicate concrete. Silicon concrete has been chosen as a primary construction material because of its availability on the moons (Section 3.2). Insulation for the settlement is provided with silicon aerogel. Transparent sections of the hull are made from silica glass while a polysulfone layer provides unsurpassed transparent radiation protection. Nontransparent sections of the hull use a more readily available RFX1 polyethylene providing an equivalent level of radiation protection as well as micrometeoroid protection in a non-transparent form. 2.1.3 Connection Joint Between Rotating and Non-rotating Sections

Material	Mass (kilo tons)	Purpose
SiO_2	80,953	Main Hull component
Iron	11,235.3	Structural Frame
Al_2O_3	31,136	Main Hull component
Polysulfone	12,172	Radiation Protection

Table 2.1.3 Basic material amounts of construction purpose

Table 2.1.4 Gravity levels for each terrace on the residential torus

Torus Level	Provided Gravity (Gs)
Level 1	.962
Level 2	.985
Level 3	1.007
Level 4	1.029

Section 2.1.3 Artificial Gravity

There are two docking facilities located on either end of the operations sphere. The first and smaller facility is located at the top of the operations core near the residential torus; this facility is mainly used for executive transportation and medical/emergency deployment.
The second and larger facility is located at the bottom of the operations core and is used for commercial applications and large-scale resource transportation. Each of the facilities contains two types of docking systems, a universal airlock system named the Lock-Well (Section 2.4) and a dry dock system that can handle nearly any type or size of ship. The industrial docking facility has 30 dry dock facilities; the commercial facility contains two dry dock and 18 Lock-Well devices (2.4).

Table 2.2.2 Interior dimensions of the torus

Area	Measurement
Total Down Area of Torus	3,016,000 m²
Radius of Torus	1200 m
Width of Torus	400 m
Width of Terrace	100m
Number of Terraces	4
Minimum Vertical Clearance on Torus	60 m
Maximum Vertical Clearance on torus (Located under the spokes)	170m
Height of Torus	90 m
Partial gravity Within major spokes	21,516,200m³

Section 2.2 Interior Design

Northdonning Heedwell has designed the interior layout of the residential torus to maximize volume, minimize material costs, and maximize efficiently in transportation of goods and humans throughout the settlement.

2.2.1 Torus Allocation

This is accomplished by employing a rolling terrace system on the torus. These terraces optimize the amount of natural views of space by allowing the upper terraces to have a line of sight that is slightly higher than the terraces below them. The terraces also increase safety by not having the sudden drops in terrain found in a standard terrace system (Figure 2.2.1). There are four terraces, and each terrace is 100 meters wide and encircles the entire torus. The zoning of the torus is set up so that commercial areas are located primarily underneath the spokes and more rural areas are located further away from the spokes (Section 4.1). This allows for the mass supply transport systems to be centralized. During initial habitation there are spaces set aside for expansion (Section 2.4.1); these areas resemble parks (section 4.1). Water processing, food processing, business expansion and rental, automation control, and agriculture for structural design (Section 3.2.2) is located in the space underneath the living space on the torus (Section 3.2).

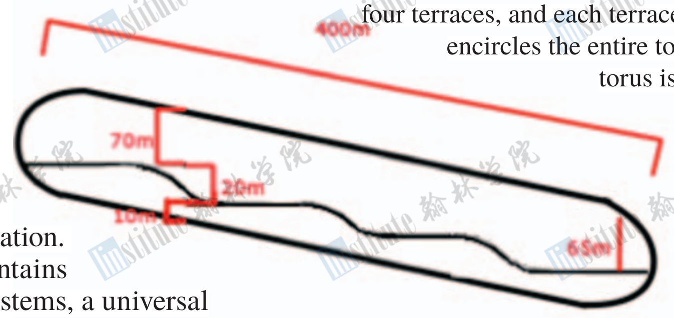


Figure 2.2.1 Torus cross section increasing safety and optimizing natural views of space

Zoning	Percentages	Area
Commercial	33%	995,280 m^2
Residential	34%	1,025,440 m^2
Recreational and Parks	23%	693,680 m^2
Expansion	10%	301,600 m^2

Table 2.2.1 Percentage allocation and down area within the residential torus

Agricultural operations are located within Major Spokes. The space allocated for Plant growth, is located in the section of the spokes that provides roughly three-fourths gravity of the torus. This is done to ensure that the maximum yield per m² of agriculture is achieved (Section 3.2).

2.2.2 Percentages of Space Allocation within Residential Torus

Section 2.3 Construction Sequence

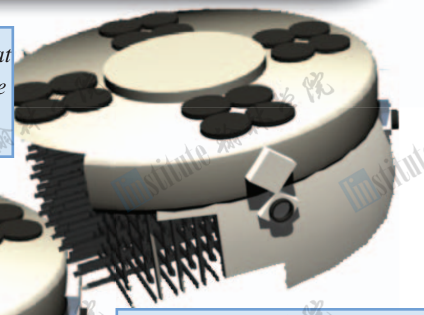


Figure 2.3.1 Construction of matriarch at Bellevistat, creating a cost effective base for Aresam to be constructed off of.

Aresam's construction sequence has been designed with speed and efficiency in mind. Everything from the design of the matriarch to the layout of the operations core has been developed to expedite the construction sequence and maximize efficiency

Figure 2.3.2 fully constructed matriarch in transit to Mars orbital location

10 days after the contract is awarded construction of Aresam begins. The first stage of construction is the Matriarch, consisting of 7 mining cores a solar satellite system and refining and manufacturing centers, (section 3.1) that is produced at Belevistat (Figure 2.3.1) and the deployment of a survey probe. The survey probe is sent to Mars orbit to collect information on possible mining operation locations. Production of the matriarch will take thirteen months; once the matriarch nears completion, Mars Automated Position Satellites (section 5.1.2) are sent to the Mars orbital location. This is done to create a three-dimensional grid system where Aresam will be constructed. This is directly followed by the arrival of the matriarch on location after an eleven month long journey. Once on location the matriarch deploys seven mining cores (Section 3.1), five to Mars and one to each of the moons, Phobos and Deimos (Figure 2.3.3). Once mining operations have been established, construction of the settlement begins. This starts with expansion of the refining areas within the operations core (Figure 2.3.4). The operations core is expanded with silicon concrete prisms placed on a steel frame by the construction robots (section 5.1.2). This is expected to take three years to complete. Next the construction of the major spokes begins (Figure 2.3.5); to construct the spokes the MCRs are deployed from robotic hubs that are located under the spokes initial construction area. The interior of the settlement is constructed with contour crafters (Section 3.3). The majority of buildings in urban areas are constructed of silicon concrete from the moons Phobos and Deimos. Once the major spokes have been completed construction of the interior and exterior of the torus begins (Figure 2.3.6).Once the torus nears completion construction of the business section of the operations core begins (Figure 2.5.7). The construction of the torus

Figure 2.3.3 Matriarch deploying self-sufficient mining cores to the moons Phobos, Deimos, and Mars, ensuring the most effective use of materials.

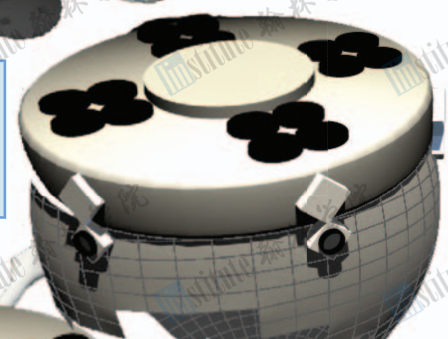


Figure 2.3.4 Expansion of the operations core to expedite final construction of the major spokes and residential torus.

Figure 2.3.5 Construction of the major spokes providing a base for the construction of the residential torus.

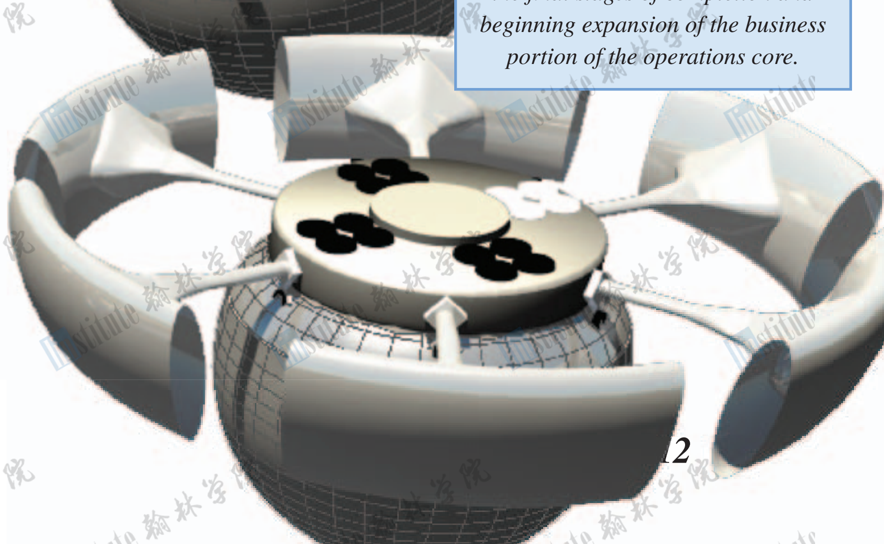


Figure 2.3.6 Residential torus nearing the final stages of completion and beginning expansion of the business portion of the operations core.

spokes and, business section of the operations core will take 6 years to complete. The final step in construction is to initiate rotation of the residential torus providing gravity; this is accomplished via a system of oscillating magnets. These magnets are also used to sustain the torus's rotation after habitation (Section 2.1). The entire construction sequence will take twelve years.

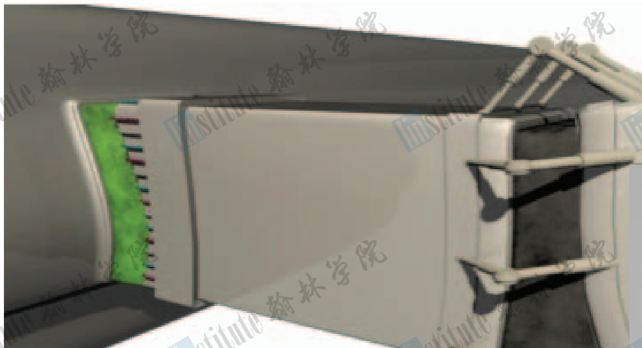


Figure 2.4.1 The Lock-Well system creating a new standard in universal docking systems, providing complete compatibility with every ship design.

Section 2.4.1 Expansion Capabilities

As Martian surface exploration and mining proves lucrative to investors, Aresam provides pre-designated industrial use locations to encourage and maintain growth without excessive construction costs associated with structural modifications. In addition to capabilities for expansion Aresam features an unsurpassed docking system allowing it to provide safe harbor for any and all ship types.

To reduce construction costs, Aresam's operations core is large enough to accommodate the required utilities necessitated by Martian surface expansion. Expansion of residential areas involves initially setting aside areas for expansion within the structure. (Section 4.4) This reduces preliminary expansion costs because it will be included in the initial construction of the structure. Aresam's universal Lock-Well ports and dry docks account for the transition from early exploration to large-scale operations on Mars. These ports utilize the new standard in universal docking techniques, The Lock-Well universal device, which accommodates all vehicles of all designs.

Section 2.4.2 Docking

There are two docking areas on Aresam (Section 2.1). These areas feature dry docks and the Lock-well device for docking. The Lock-well device utilizes polymeric gel actuators which conform to any orifice providing an airtight seal when electrically charged. The Lock-well's manipulating jet way arm is compatible with every ship design, as it features pivoting arms that can attach to any part of a ship and secure it to Aresam. Dry docks on Aresam are large airlocks setup to accommodate ships in need of repair, industrial purposes, and ships requiring emergency assistance. For standard cargo transfer the dry dock only serves as an enclosed area for the ship to reside. Aresam's docking areas can handle a total of fifty vehicles at any given time with eighteen vehicles utilizing the Lock-well and thirty-two vehicles utilizing dry docks.

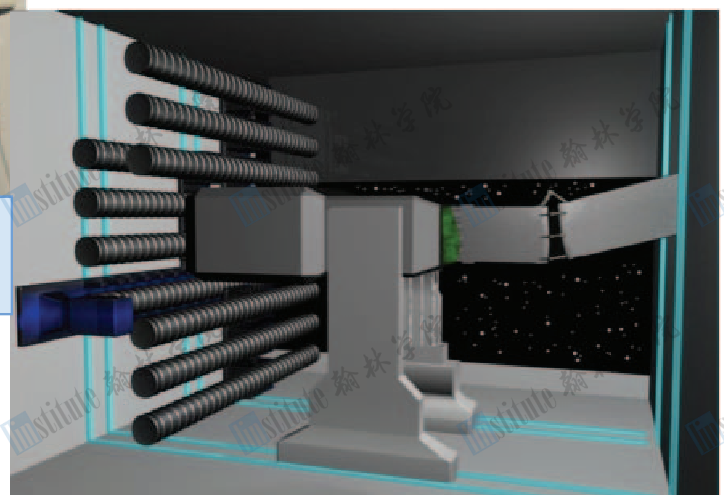


Figure 2.4.2 fully pressurize-able ship bay used for emergency repairs, industrial purposes, and mass cargo transit

Section 2.5 Prefabricated Base

Section 2.5.1 Prefabricated Base Design

The Rapid Assembly Mars Settlement, RAMS for short, has been engineered to provide a virtually "bulletproof" design. This is accomplished through a multitude of fail-safes and a straightforward design. The base consists of a hybrid-inflatable dome structure (figure 2.5.1).The external walls of the base consist of two layers of silicon fabric, a hydrogen bubble, polyethylene, and silicon aerogel (figure 2.5.2). The majority of the base is constructed from silicon because of its availability on Phobos/Deimos and its versatility. The structure is supported via two primary systems; first the hydrogen tubes that create the exterior walls and steel support beams located in key points within the structure (figure 2.5.2). This double support system provides for complete support even in the unlikely event that one of the systems fail.

The interior walls of the RAMS consist of silicon fabric and are put in place by the Joint robot (section 5.5). The interior of the base is separated into three areas (section 4.5). Each of these areas can be sectioned off from the rest of the settlement in the extremely unlikely event that there is a breach in the exterior walls.

The RAMS comes supplied with food and water for four people for up to 60 days and can accommodate up to eight for 30 days. The RAMS is powered by a trash can reactor (section 3.5). The base also comes with an exploration rover. In the unlikely event that one of the automated sequences necessary for base construction fails, the rover can be use to assist in constructing the base.

Section 2.5.2 Construction Sequence and shipment container layout

The RAMS is positioned within the shipment container to optimize space (figure 2.5.3). The exterior fabric of the base is located along the outer walls of the shipment container to ensure that all goods that would otherwise need to be transferred to the interior of the base are already within. This is also done to greatly simplify the construction sequence.

Construction sequence is fully automated via a system of hydraulic rams and through pressurization of the base. Construction sequence starts by unfolding the floor that encases the rest of the base (figure 2.5.4). Once this is complete the hydrogen tubes begin to pressurize and form the exterior walls of the base (figure 2.5.5). Next, the steel support beams extend and lock into place; this is directly followed by complete pressurization of the base. Once pressurized a series of diagnostic checks are run to ensure the base is ready for habitation. The entire sequence takes from four to five hours to construct and complete the diagnostic checks.

Figure 2.5.1 fully constructed Rapid Assembly Mars Settlement, providing a solid work and research base for four people for up to sixty days

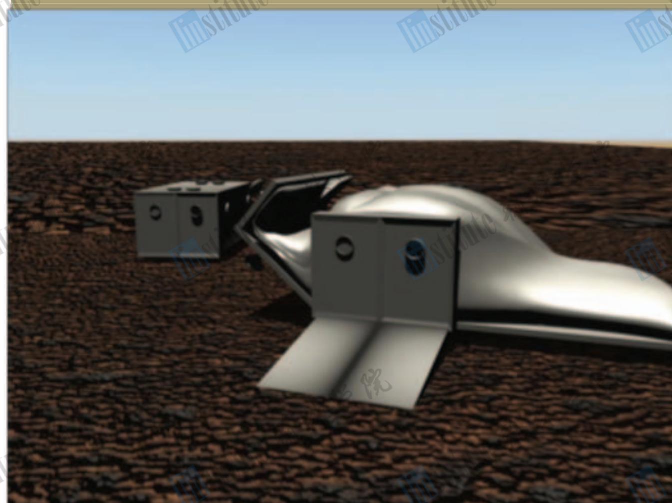


Figure 2.5.2 RAMS in the first stages of construction, once the floor has been secured the base will proceed to inflate and become fully inhabitable.

Table 2.5.1 Dimension allocation of the shipment container.

Figure 2.5.3 Utilities	Dimensions within shipment container
Power for base operation	.25m x .5m x 3m
Power storage for rovers	3m x .5m x 3m
Exterior fabric	.5m x 3.75m x 8m
Furniture / Living Commodities	1.5m x 3.5m x 3m
Exploration rovers	1.5m x 3m x 4m
Air / food / water Supply	1.5m x 2m x 3m
Airlock	1m x 4m x 4m
Supports	1.5m x 2m x 3m
Robots	1.5m x 2m x 3m

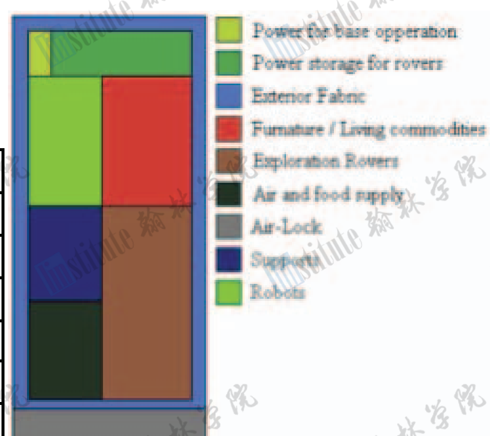
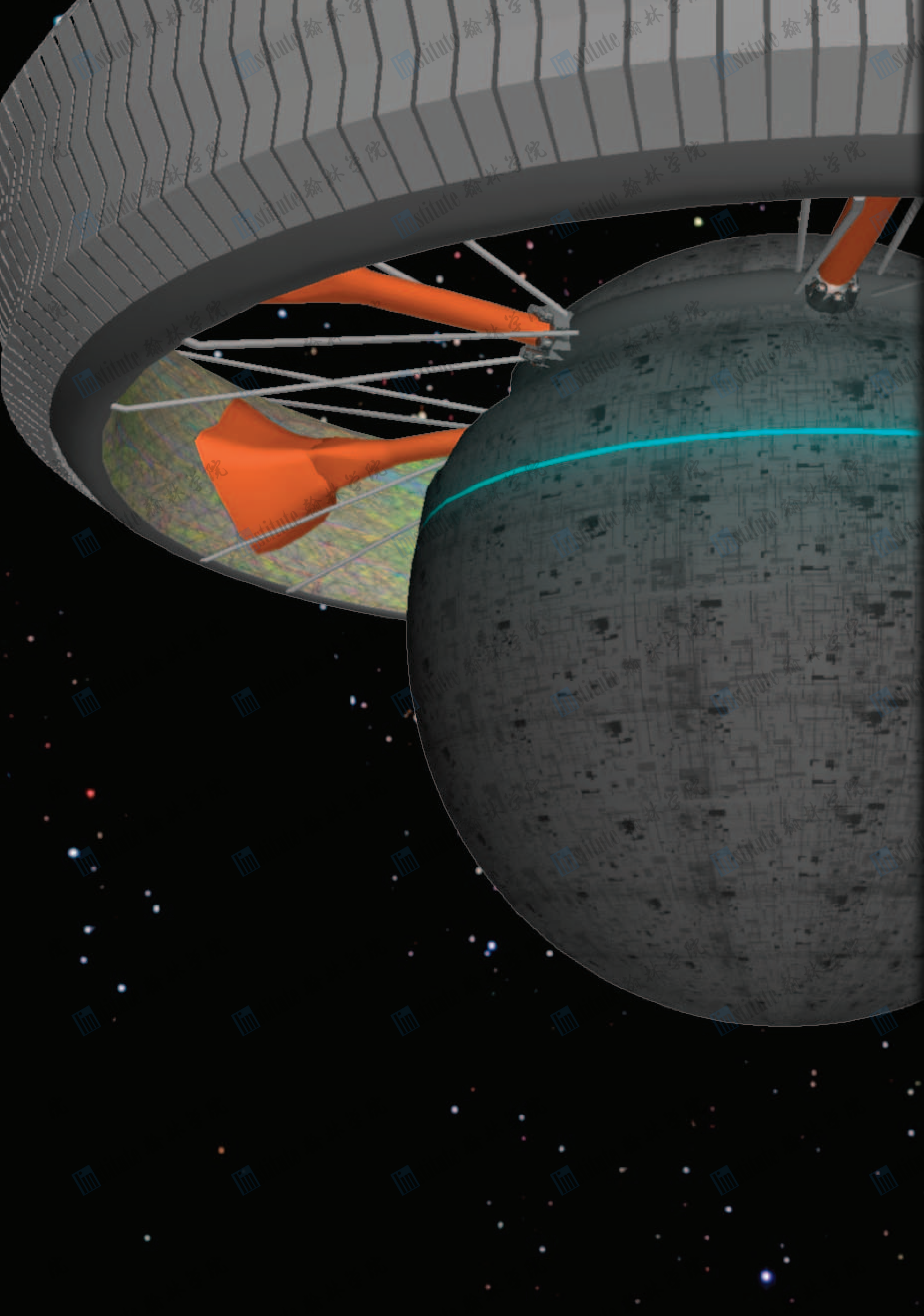


Figure 2.5.3 Interior layout of the shipment container providing an exploration rover, living commodities, and a multiple redundancy system

3.0 OPERATIONS AND INFRASTRUCTURE



“They came and made things a little less empty, so that others would find courage to follow. They put panes in hollow windows and lights behind the panes”

-Ray Bradbury

3.0 Operations and Infrastructure

By seamlessly coordinating various pre-existing resources in conjunction with unique and innovative Northdonning Heedwell designs, Aresam embraces a spirit of ingenuity and resourcefulness. Reflected in such systems as power generation and mining, the settlement capitalizes on maximum production from minimum investment. Every system is designed with redundancy and efficiency in mind, providing the Foundation Society with a unified and simplistically comprehensive operations system.

3.1 Settlement Location and Sources

Settlement location and resource management on Aresam maximize lunar resources, providing unparalleled access to the Martian surface. The use of the Martian moons dramatically reduces energy and fuel consumption to realistic parameters. Aresam's Martian orbit allows corporate interests ease of access to resources and constant monitoring of valuable claims.

3.1.1 Orbital Location

In order to effectively operate the large amount of mining cores necessary to construct Aresam, we strongly suggest that Aresam be placed in a unique polar orbit 8010.396 km above the Martian surface at an inclination of 23°. This allows the settlement to cover an exceptionally vast amount of the Martian surface. This also allows for easy exploration of Mars.

Raw Material	Source	Amount (kTonnes)	Purpose
CO_2	Phobos/Deimos	2,288.46	Cellulose, RFX1
N_2	Mars Icecaps	287.69	Atmosphere
H_2O	Phobos/Deimos	5,000	Water, Electrolysis = H_2, O_2
Silica (SiO_2)	Phobos/Deimos -bytownite	114,154.44	Glass Fiber (64%), Aerogel, Artificial Soil
NaCl	Mars Regolith	1,248.10	Na_2O = Glass Fiber (.3%)
Gypsum ($CaSO_4$)	Mars Regolith	Auxiliary	(See SO_2 Gas)
Alumina (Al_2O_3)	Mars Regolith -bytownite -anorthite	10,400.79	Glass Fiber (25%), *Bytownite yields NaCl, Water/Waste
Magnesia (MgO)	Mars Regolith	4,160.32	Glass Fiber (10%)
CO	MTO Process	4,101.86	RFX1
Methane (CH_4)	N Mars Hemisphere	Auxiliary	RFX1, Carbon Fiber
Cellulose	Algae (0-G), Bamboo	361.72	Carbon Fiber, Artificial Soil
Bamboo	Shoots from Earth	Variant	Interior Construction, Cell.
Iron	Mars Regolith	11,235.3	Steel Structure Frame
Artificial Soil	Mars Regolith	669.14	Pleasing Residents
SO_2 Gas	Mars Atmosphere	583.5	Electrolysis, S_6, Water/Waste

3.1.2 Source of materials and equipment

Phobos and Deimos supply most materials not included on the matriarch, drastically decreasing your initial investment. The small remaining portion of materials not found on the moons is available on Mars (Section 8A). The ore that is mined from the moons (81.1% of the station by mass) is jettisoned from the robots collecting it (Section 3.3, 5.1.), and then retrieved by ore collection vehicles. The rail gun systems (Section 5.5.1) launch necessities mined from Mars into orbit, which are subsequently gathered by collection vehicles (Section 3.4.1).

Robotics infrastructure involved in harvesting construction materials originates from the matriarch as specified by (Section 3.3). Bellevistat manufactures the matriarch and its contents; they are then propelled to Mars via solar-powered ion thrusters. The matriarch consists of a nuclear power plant, a large manufacturing center, a refining center, seven separate mining cores with nuclear power supplies, and one half of the total robotics necessary. (2.1._) This allows the Foundation Society to concentrate its total investment into one concise craft. After construction is completed the matriarch becomes a large part of the operations core, including the manufacturing, storage, emergency power, pod monorail transport system, and infrastructure for settlement operations.

3.2 Infrastructure

Aresam's infrastructure redefines efficiency and innovation through state of the art processes and cutting edge technologies. Simple, yet effective backup measures ensure constant operation and safety, saving the Foundation Society the hassle and revenue loss incumbent upon systems malfunction. Our high yield manufacturing systems in the Operations Core provide you with the greatest comfort in knowing all aspects of your investments are of the highest caliber.

Chart 3.1.1 - Nearly all materials used in construction originated from Phobos and Deimos.

3.2.1 Atmosphere / Climate / Weather Control

The atmosphere on Aresam is kept at 760 torrs, but maintains reduced oxygen content in order to significantly reduce the risk of fire. By diminishing the oxygen concentration on Aresam, the variable tchem in the equation for a combustion reaction's Damköhler number (Dn) increases. At 16.2% oxygen concentration, the Dn of most combustion reactions falls below the reaction threshold Dn*, whereby flame extinction occurs. Limiting oxygen prevents combustion thereof, so that general station safety increases. This allows for the use of lighter, stronger, and more available organic compounds. The atmosphere is comparable in oxygen content to an altitude of 7,200 feet on Earth.. Although altitude sickness rarely occurs below altitudes of 8,000 feet, all residents become gradually acclimated to this environment en route to Aresam, guaranteeing a very smooth transition.

Gas	Percentage Concentration	Amount (kTonnes)
N_2	82.77%	287.69
O_2	16.20%	64.35
Ar	1.00%	4.96
CO_2	0.03%	0.16

Chart 3.2.1 - At 16.2% oxygen levels, flame extinction occurs.

Integrated within the hull, a honeycomb piping system maintains an ideal ambient temperature range of 20-25°C throughout the torus. High-purity ammonia runs through the piping system at variable rates to provide in-floor temperature control. The system siphons heat from the main power cooling system by enveloping the main coolant pipeline with an ammonia-cooled heatsink. Having a dedicated cooling system for the torus significantly decreases the chance that a leakage of heavy water will occur. By recycling heat which would otherwise be a useless by-product, less energy is exclusively dedicated to temperature control.

Humidity on Aresam is kept at 30-40%. To maintain this level, approximately 1,779,020.65 liters of evaporated water partially compose the residential torus' atmosphere. Humidifiers and dehumidifiers in each section of the torus adjust the general humidity. Pressurized areas of the Operations Core have only trace amounts of humidity, in order to guarantee the integrity of stored products.

Figure 3.2.1 - Agri-bots moving across the aeroponics grid autonomously harvest crops, maximizing yield

3.2.2 Food

Suspended in a modular grid, Aresam's agricultural aeroponics system utilizes a sterile nutrient imbued mist environment, in place of a solid growing medium. The system is incredibly efficient, able to reduce consumption of water by 98%, of fertilizer by 60%, and of pesticides by 100%; total excess energy consumed is, therefore, greatly diminished. Therefore, the system greatly enhances growth rate and yield, while also preventing pathogen formation. Additionally, strips of LED lights provide an optimal light spectrum, and harvesting machines run along the rails of the grid, in order to maximize total yield.

Figure 3.2.2 - A modular aeroponics grid maximizes space in agricultural volumes

To reduce initial maintenance and production costs, all meat is cultured, or grown artificially from an initial sample of tissue cells. Ultimately, the process can be tailored to be far more efficient and nutritious than meat harvested from slaughtered livestock. Aresam residents are thus treated to a nearly infinite variety of meat,

	g/person/day	kg/22,000/day	Allocation of Space	
Sorghum	317	6,974	14.9 %	25,828 m^3
Wheat	225	4,950	10.59 %	15,129 m^3
Rice	125	2,750	5.88 %	11,200.8 m^3
Soybeans	470	10,340	2.21 %	38,307 m^3
Corn	50	1,100	2.35 %	6,826.5 m^3
Vegetables	687	15,114	3.23 %	55,990.2 m^3
Fruit	250	5,500	11.77 %	40,356.7 m^3
Total	2124	46,728	100%	193,639.7 m^3

Chart 3.2.2 - Food allocations.

poultry, and fish. The process is considered entirely vegetarian and can later be a meat source on deep space missions for a virtually inexhaustible food supply.

Soy, rice, almonds, and other artificial alternatives supplant traditional dairy products. Dairy production is integrated with crop growth, ultimately providing a more efficient production with comparable taste. The few products that cannot be adequately substituted, such as eggs, are provided by a small contingent of poultry and micro-livestock.

Packaging: A multifaceted and extremely renewable resource, bamboo provides a clean and efficient packaging material produced entirely in the agricultural volumes. Raw foods are packaged directly in agricultural centers and shipped to distribution centers. Foods requiring a measure of processing are first delivered to the Operations core, before undergoing subsequent manufacturing, packaging, and distribution.

Storage: Through periodical maintenance, each individual section of the torus maintains a 30 day supply of food (occupying 51,076 m3 of space below the terraces of each section), as well as an additional three month dehydrated supply in vehicles. If perishable items are not delivered directly to the distribution centers, they are frozen or dried and vacuum-packed for preservation. These food banks allow Aresam to be robust against interruptions in food production, and ensure the general safety of citizens. Aresam is designed to sustain nearly complete self-sufficiency for over eighteen months, negating the effects of potential ten month delays in shipments from Earth. Though almost all nutrients are reclaimed, some nutrients escape the system or stay within the residential torus. To guarantee against nutrient deficiencies, the Ops Core also houses a 1,000 m3 facility with a condensed nutrient bank, which allows food production to be maintained as normal for up to 10 months without assistance.

Distribution is facilitated by the Pod Monorail system, as described in Sections 3.2.7, 4.3.2. Processed goods are packaged in bulk and sent to distribution centers; goods are then sold to residents, as detailed in Section 7.1.

3.2.3 Power Management

Aresam generates power via Solar Power Satellites and an onboard 500 MW nuclear power plant; flywheels store energy produced thereby. 10 Solar Power Satellites orbit Mars, each beaming 50 MW to the station. Solar panel efficiency dramatically increases by use of a silica-based nanodome technology with 92% light absorption. Based on an estimated 7.5372kWh/m2/day collection rate, 4,114,000m2 of solar panels total generate energy for the station. Each SPS consists of four 10,285 m2 panels, which beam collected energy via a klystron microwave concentrator, and transfer the power to the station's rectenna. This rectenna is a large band covering approximately 2.25 million square meters on the Ops Core to facilitate the line-of-sight demands of vacuums. These solar panels transmit twice the energy required to operate the station; four large flywheels store one-half of the transmitted power. When the settlement passes into the shadow of Mars, the settlement draws energy from the flywheels to maintain power. As an additional precaution against system failure, the 500 MW nuclear generator is kept operational. In order to offset the excess generation of heat, the station is equipped with radiators along the outside of the residential torus, which can water-cool most heat generated by the station through the Reactor-Brayton Process. The transportation of rectenna heat and nuclear power generation are both managed by this system. Likewise, each solar panel offsets energy transfer with torus-based radiators. By use of the radiators under the influence of the Brayton Process, the station's cooling system gains mass/cooling efficiency by array size and sufficiently minimizes problems caused by excess heat at normal cycling speeds.

System	Location	#	Size	Rate (kW)
SPS	Mars Orbit	10	411,400m^2	50,000
Rectenna	Outer Ops Core	1	2,250,000 m^2	500,000
Nuclear Plant	Ops Core-Infrastructure	1	90 tonnes, plus cement	500,000
Flywheel	Ops Core-Infrastructure	2		250,000
Radiators	Outer Residential Torus	X	Covers 3,015,929 m^2	30 m^2 surface area/m^2 on torus

Chart 3.2.3 - Although the radiators only occupy three million square meters, ridges and a nanostructure increase the total surface area to over 85 million square meters total.

Purpose	Water Stored	Storage Space	# of Water Containers
Humans	5.9 million L	6.5 million L	130
Agriculture/EPU	6 million L	7.1 million L	203
Manufacturing	.34 million L	.37 million L	23
Misc.	.24 million L	.27 million L	14
Total	12.48 million L	14.24 million L	370

Chart 3.2.4 - Water storage.

Manufacturing is expected to take 56% of power supplied; 34% is used by infrastructure and operations, and 10% is used by residents.

3.2.4-5 Water/Waste Management

Aresam employs a state-of-the-art water and waste management system to ensure a clean, safe supply for all residents. Twelve water treatment centers – one on each individual section of the torus - recycle a total of 300,000 liters of water every hour to meet human and agricultural consumption demands; this allows all water for human consumption to be entirely processed in under 24 hours. A total of 1 million L is stored in each section, allowing for the autonomous function of the areas in the event of isolation. The plant recycles a total of 300,000 L per hour, accounting for all miscellaneous and agricultural water not processed in the residential torus. Storage containers below the terraces are reservoirs to fuel human use; the river flowing through the station provides additional storage.

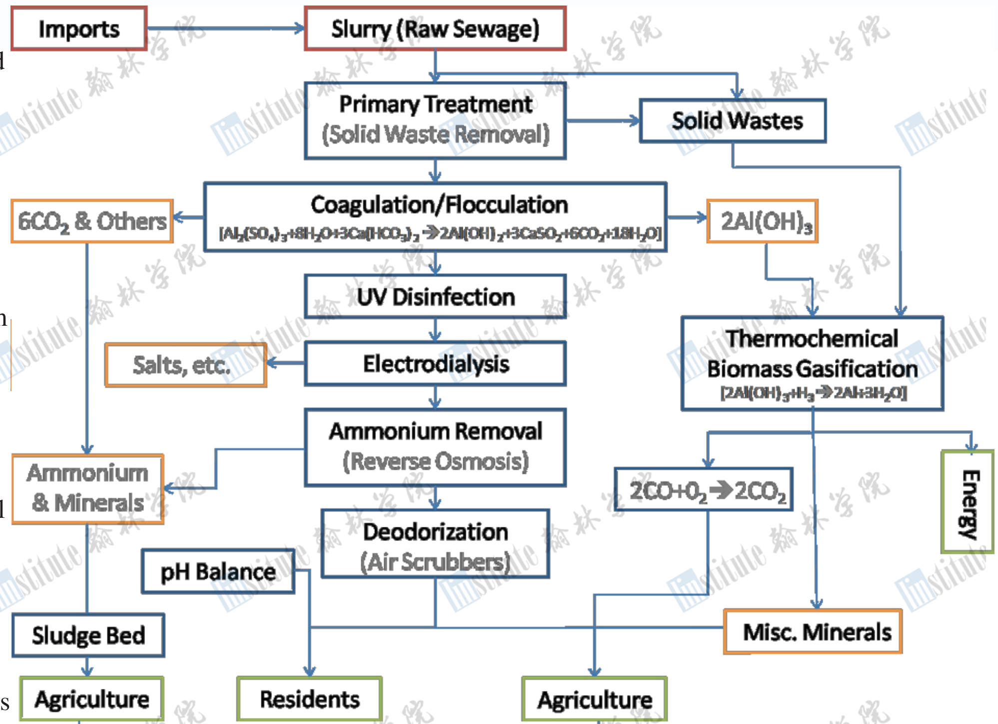


Chart 3.2.5 - Functions such as UV disinfection and reverse osmosis greatly expedite processes versus traditional standards.

Once a week, Trash Collecting Robots (5.3.4) gather household waste, all of which is highly recyclable; solid waste on Aresam is comprised almost entirely of silicate products or organic compounds. Organic compounds along with the chemical products from water treatment go to the thermochemical biomass gasification plant.

System	Volume	Number	Location	Rate
Water Treatment (with Sewage lines)	125,000 Liters	12	Residential Torus	300,000 L/hour
Biomass Gasification Chambers	45,600 Liters	7	Spokes	14,500 kg/hr
Glass/Fiberglass Recycling	34,920 Liters	1	Ops Core	3,500 kg/hr
Excess Salt	2,000 Liters	1	Spokes	300 kg/day
Trash Collecting Robot	1m x 1m x 1.5m	1,000	Residential Torus	319,200 kg/day, weekly

Chart 3.2.6 - Water and waste management quantities.

The plant incinerates organics in a deficiency of oxygen to produce carbon monoxide and hydrogen (syngas). In doing so, complex organic compounds condense and yield nutrients, ready to be reintroduced into the agriculture spokes or in trace amounts to the residential torus. While temperatures are high and the process takes much energy, the combustion of the syngas yields enough energy to make the process self-sufficient.

Silicates are most commonly either glass, fiberglass, or silica gel. Glass is highly recyclable, and can simply be reintegrated into the manufacturing process. Fiberglass can likewise be recycled after shredding and thermal purification, both of which steps are necessary in removing polymer impurities.

The industrial solid wastes produced most are organic compounds (which decompose in biomass gasification) and table salt, formed namely in the production of polysulfone. A race rigorous, multi-staged salt refining process removes amounts trace amounts of polysulfone; salt refined thereof is safe for resident consumption. 35,000 kg of salt are kept in storage along with other essential nutrients (3.2.2), which is enough salt for all residents over a 10-month period, should an import interruption occur.

Device	Bandwidth	Quantity
RADD	7 GBps	22,000
Personal Computers	1 Tbps	44,000
Station Transmitter	250 Tbps	1
SPS Transmitter	70 Tbps	10
Wireless Hubs	10 Tbps	12

Chart 3.2.7 - The settlement's transmitter sends data through similar transmitters on the SPSs to guarantee line of sight in space. There is one wireless router hub per torus section.

3.2.6 Internal and External Communication

SiO2-based Fiber optic cables provide efficient light-speed communication within the settlement. The fastest and most reliable known method of information transfer, a fiber optic cable greatly exceeds traditional electrical wires, and eliminates the possibility of sparks and

	Number	Dimensions	Average Speed	Max Occupancy	Max Transit Time	Location
Personnel Pods	256	3m x 1.5 m x 1.5 m	60 km/h	4-6	2.5 min	Operations Core/Torus
Cargo Pods	512	9m x 4m x .5 m	60 km/h	1 cargo container	2.5 min	Operations Core/Torus
Bicycles	20,500	1m x .8m x .2 m	Arbitrary	1-2	Arbitrary	Torus

Chart 3.2.8 - Transportation is made efficient through various systems.

other hazards. To maximize data transfer and efficiency, wavelength dimensional multiplexing allows all station computers to transmit and receive data on 160 channels per fiber optics line; while 10 Gbps data lines are the conventional cables provided to residents, multiplexing gives these lines up to a terabyte of data transfer per line. By using fiber optics, Aresam maximizes data transfer and parallel processing capabilities while basing data lines on Phobos' and Deimos' resources.

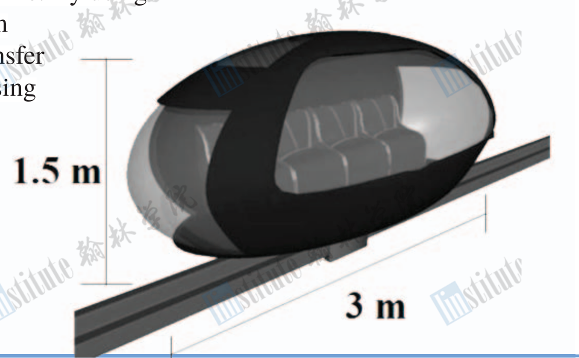
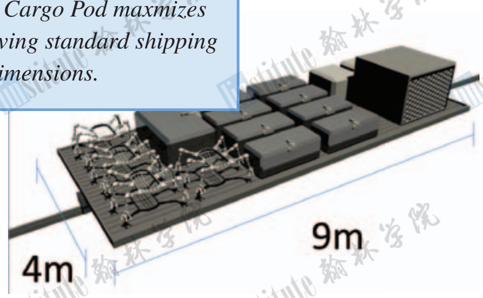


Figure 3.2.3 - Specialized pods accommodate all forms of cargo; occupancy ranges from 4-20 people.

The RADD, designed for less demanding tasks, connects to the station's wireless mainframe. Routers broadcast at 60GHz to give all residents 7 GBps wirelessly.

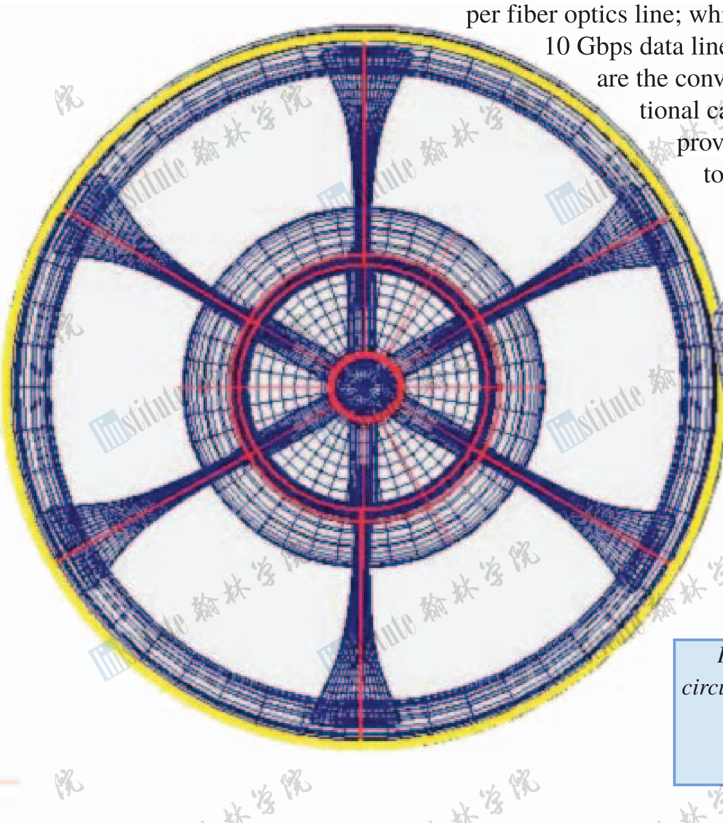
External communications are facilitated by laser communication systems (LCS). Lasers have the capacity to transmit 250 Terabits per second (5.4).

Figure 3.2.4 - The Cargo Pod maxmizes compatibility by having standard shipping crate dimensions.



Small communication satellites orbit at strategic points around Mars, Phobos, and Deimos to ensure at no time will data transfer between Aresam, Mars, or any external vehicles be interrupted by line of sight. A six-terabit line is maintained with each external vehicle.

3.2.7 Interior Transportation



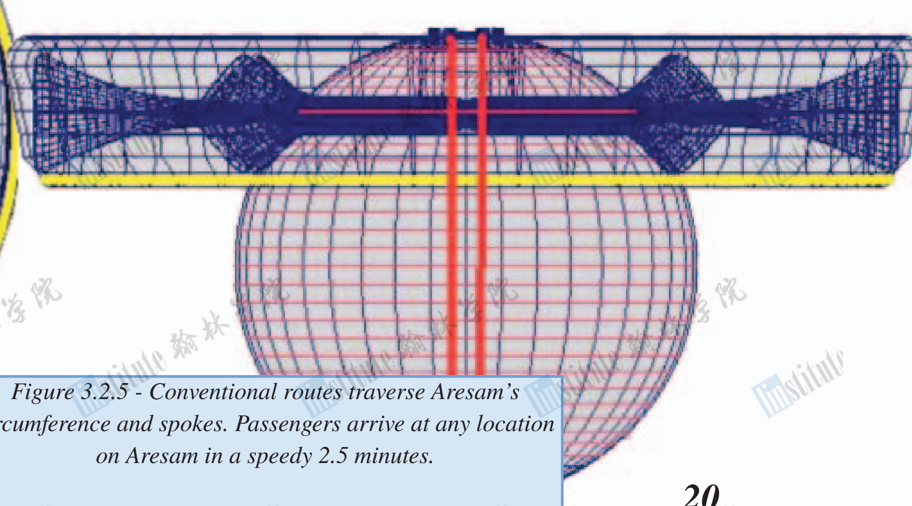


Figure 3.2.5 - Conventional routes traverse Aresam's circumference and spokes. Passengers arrive at any location on Aresam in a speedy 2.5 minutes.

Personnel and cargo pods traverse Aresam's Pod Monorail,a matrix of rail. The pod rails distribute electrical power to each pod's linear motor via physical connection. A linear motor lessens system complexity and power demands versus pneumatics and magnetic tracks. Pods have three monorail adapters- one on the bottom, top and back as opposed to human seating- so that a pod may switch rails where distance permits. These adapters create a system in which a pod does not have to travel on one unnecessarily long track. Instead, it is based off of a central route which is the diameter of the Operations Core and perpendicular to the Residential Torus, so as to unite transportation. This integration allows a maximum travel time of 2.5 minutes to any location in the torus or Operations Core. While expedience is a major advantage of the multidirectional adapters, uncurved tracks also grant fluidity to operations; transportation is not as spatially disorienting for humans and does not disturb fragile cargo. The adapters also allow the pod system to transfer between the Residential Torus and the Operations Core for the purpose of simplicity. Since the rails allow each pod the potential to access the entire storage facility on Aresam, the storage sector's Pod Monorail gives total flexibility in organization and method to the Foundation Society's preferences. In the torus, similar pods travel in train-like groups along the monorail tracks around the circumference to accommodate mass transit. For information on emergency contingencies, along with designs for bicycles, see 4.3.2

<u>3.2.8 Day Night Cycle</u>

Due to the 43%reduction in solar intensity around Mars versus Earth, little direct natural light reaches or enters the residential volumes. In lieu of sunlight, a curved band of OLED panels that surrounds the Ops Core provide unparalleled ambient lighting throughout the settlement. With the capacity to simulate the natural phases of the sun, OLEDs provide an optimal substitute for natural sunlight and require less energy than even traditional LED lights. A controlled lighting environment also offers residents unparalleled views of Mars and the "night" sky, and eliminates the need to block light during night cycles.

The length of each day is comparable to a day at equatorial latitude on Earth, consisting of 12 hours of day and 12 hours of night. Light waxes and wanes throughout the diurnal cycle, providing optimal circadian compliance and comfort. Occupants control in-house illumination, allowing the freedom to fine tune the light to their personal preferences. In the event of an emergency, the system is overridden to provide for optimal lighting conditions.

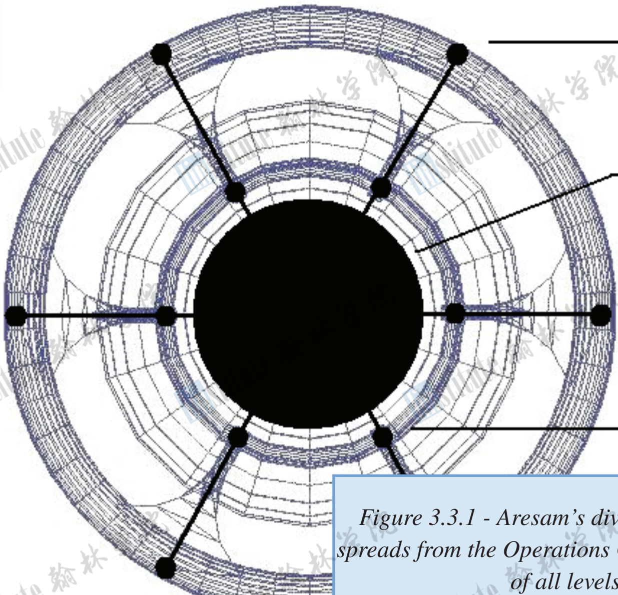


Figure 3.3.1 - Aresam's diverse manufacturing system spreads from the Operations Core to the torus to make use of all levels of gravity.

<u>3.3 Manufacturing Process</u>

In coordinating specialized automations for zero-g hull construction and contour crafters for interior assembly, Northdonning Heedwell maximizes construction speed and efficiency. Able to construct nearly two buildings per day, contour crafters facilitate interior construction at an unparalleled rate. Furthermore, rapid hull construction techniques maximize available resources, resulting in earlier operation of the settlement and a notably faster return on investment.

Figure 3.3.2 - Silicon concrete blocks provide the most structurally stable and durable hull material, able to withstand the rigors of space.

The matriarch (Figure 3.14), is the first ship to arrive at Mars after the MAPS (Section 5.1.3) system arrives and is an all-in-one manufactur-

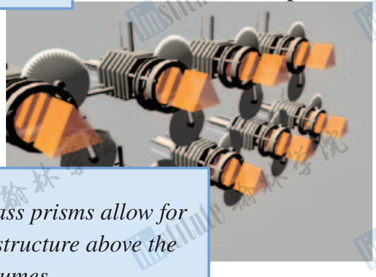


Figure 3.3.3 - Triangular glass prisms allow for an efficient geodesic glass structure above the residential volumes.

ing and mining vessel created for the specific task of constructing Aresam. The matriarch contains seven mining cores that separate from the matriarch upon arrival at Mars. Five of the mining cores descend to Mars and the remaining two go to Phobos and Deimos to conduct mining operations. The matriarch also contains a large zero-g manufacturing center

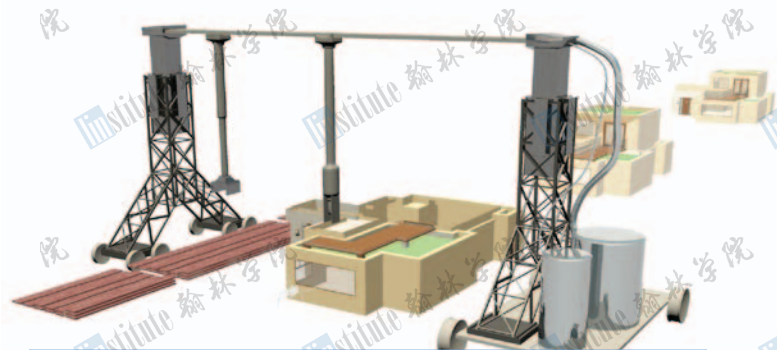


Figure 3.3.4 - Able to assemble nearly two homes a day, contour crafters revolutionize interior construction.

equipped for the construction of the station utilizing the ore collected from Phobos, Deimos, and Mars.

After basic refinement materials for construction are processed based on there need at the moment. This is dictated by requests for parts from OMRs and other construction vehicles. All machines used for construction can acquire the components necessary for the job at hand from one of 6 robotic collection ports on the external structure of the operations core.

Aresam is built of a high carbon steel frame. The steel beams for the frame are extruded and cut to length in the matriarch's manufacturing center and then floated through a tempering facility (Figure 3.15). The beams are then positioned and welded in to place by the OMR (Section 5.1.1) to construct the frame of the settlement in triangles.

A steam press (Figure 3.3.3) is used to form and cure silicate based four-by-four concrete triangular prisms, which are then used to fill in the steel frame of the station. The blocks are positioned and attached to the frame by a prism-laying robot (Section 5.1.1) creating the hull for nontransparent sections. Glass for transparent sections of the hull is extruded in a similar process as the steel for the frame (Figure 3.3.4), extruded in triangular prisms and then cut to length to create four by four triangular blocks that are positioned and attached by the same prism laying robot that is used for nontransparent sections.

For the construction of buildings and community décor, Aresam utilizes a fleet of 75 contour crafters. Contour crafters utilize a unique mixture of Martian regolith and bacteria to form a quick drying concrete substance that is mixed and then pumped out of a specially designed nozzle. They work in conjunction with OMRs to construct a whole building from the ground up. They utilize bamboo and carbon fiber for rigid components. They have a vast array of texturing tools and concrete dyes to increase the aesthetic value of all structures and add more diversity to the station interior design. After the necessary components for construction are depleted the Contour Crafters travel to a designated "base" under the residential area at each spoke where it can replenish its supplies and clean its tools and nozzles.

3.4 Mining Infrastructures on Phobos and Deimos

Northdonning Heedwell employs specialized drilling automations designed to capitalize on lunar resources. Subsequent collection mechanisms and manufacturing systems feature state of the art technologies which maximize output during every stage of production. Through superior techniques, Northdonning Heedwell assures a quality and expeditious mining process.

3.4.1 Lunar Mining

In an effort to maximize lunar resources and greatly diminish initial expense, Phobos and Deimos are mined for silicates, carbon, carbon dioxide, and ice; these resources compose most of the settlement (3.1.1). From the matriarch, a preliminary fleet of 100 Lunar Excavation Robots harvests the moons (Section 5.5, Figure 5.5.1). A decentralized style for harvesting regolith requires little stability on the sandy surfaces of the moons that a full base would require; numbers of robots may also fluctuate intuitively to meet demands exactly. One of 50 Orbital Collection Vehicles in orbit around the moons then transports mined ore to Aresam.

Lunar Excavation Robots mine the sandy surface of the moon for hydrated silicates and carbonates, each equipped with pneumatic compression and launching mechanisms. Both materials harvested provide essential structural components and a solid state of water. Every ten minutes a 2m x 1m x 1m ore bundle is launched to a collection vehicle, maximizing efficiency and expedience. The Orbital Collection Vehicles transport material to Aresam's Operations Core. Each vehicle departs the moons approximately once every 2 days with a shipment of 15 metric tones.

3.4.2 Refining

Continuous fractionalization of Phobos' and Deimos' regolith isolates water, nitrogen, carbon, carbon dioxide, silicon dioxide, trace metallic particles and other usable materials in a cheap and efficient process. Waste materials are returned to Mars with departing ore containers.

Hydrated silicates yield H2O molecules through minor heating to 100°C; the settlement collects the water as a source of water and as a source of oxygen through electrolysis. Excess hydrogen from electrolysis and the silica produced integrates into station-based refining (Section 8A). Carbonates are converted to CO2 for similar use. Through these processes, all materials originating from the Martian moons become essential elements to the construction of Aresam.

While applied throughout the settlement, silicon dioxide is primarily employed in production of silica concrete and S-glass fiber (section 2.1); the result is a far more available yet durable substance, able to outperform most other structural materials in the rigors of space.

Aresam refines iron ore into high carbon steel for construction (Section 2.1) with the Linz-Donawitz-Verfahren process. All other metal production is kept to a minimum, due to relative paucity or impractical energy demands for refining (as is the case with aluminum). However, Aresam has the ability to refine most metals to maximize business and economic potential.

	Composition	**Initial Amount**
Nitrogen	83.3%	184.2 kg
Oxygen	16.2%	40.7 kg
	Pressure	**Volume**
In-Transit Storage Tank	259,514.8 Torrs	1.12456 m^3
Interior RAMS	760 Torrs	384 m^3

Chart 3.5.1 - Atmosphere quantities in prefabricated base.

3.5 Prefab Base Operations

RAMS infrastructure capitalizes on high efficiency in a low-volume, closed environment. Water management occurs entirely on-site, and a condensed artificial photosynthesis mechanism deftly recycles 100% of the system's oxygen. Power production generates little waste while maximizing energy output, providing superior comfort and livability. Embodying the spirit of self-sufficiency, the RAMS becomes as close to a self dependent entity as possible for its contained environment.

3.5.1 Atmosphere

To maximize comfort, safety, and efficiency, the air composition within the base is maintains optimal levels of oxygen and nitrogen, mimicking those on Aresam (see 3.2.1). Carbon scrubbers effectively maintain low CO2 levels, and a compressor sustains normobaric atmospheric pressure.

Artificial photosynthesis replenishes oxygen. In the process, exposure to 640nm and 700 nm light wavelengths and CO2 induces photosynthesis in an isolated, dense collection of chloroplasts. The ensuing reaction photolysizes water, generating pure O2 and - through subsequent reactions - carbohydrates. Operating in a far more compact space than even traditional algae tanks, artificial photosynthesis recycles 100% of oxygen, making it ideal for a closed environment. Additionally, the resulting carbohydrates can supplement residents' food supplies.

In an effort to minimize contamination of Martian dust, the base utilizes an intelligent combination of silicon aerogel air filters and nano-scale liquid glass coatings. The pores of aerogel filters can be fine-tuned to accommodate the filtration of nearly any substance, making them ideal for safe and efficient dust mitigation (4.3.1). Applied to the exterior surfaces of all suits and equipment, liquid glass resists dust contamination, blocks nearly 99% of UV radiation, and can be cleaned with hot water, eliminating the need for caustic chemicals.

	Amount
Food Volume per Person	1.857 m^3
Total Food Volume	7.429 m^3
Food Mass per Person	180.53 kg
Total Food Mass	722.12 kg

Chart 3.5.2 - Food provisions.

3.5.2 Food

The RAMS is equipped with an optimal blend of freeze-dried and dehydrated foods, as well as condiments, allowing occupants the luxury of preparing "home-made" meals. A total of 7.429 m^3 is allocated for food storage, containing enough to sustain four people for twelve weeks. Supplemental nutrient capsules maintain maximum health of occupants, and include linoleic acid, calcium, magnesium, and vitamins A, D, and C. The average daily diet provides 2,225 calories and 94 g of protein to account for elevated physical stress.

	Amount
Thorium	1.1 kg
Power	10 kW

Chart 3.5.3 - Power allocations.

3.5.3 Power

A thorium reactor supplies all power for the RAMS. With an ability to be turned on and off, the reactor proves far more beneficial than other critical nuclear sources. Furthermore, thorium is more common in Martian soil than other common nuclear fuels, allowing for unparalleled ease of operation and manufacturing.

Total Water	7120 L
Volume of Water	7.12 m^3

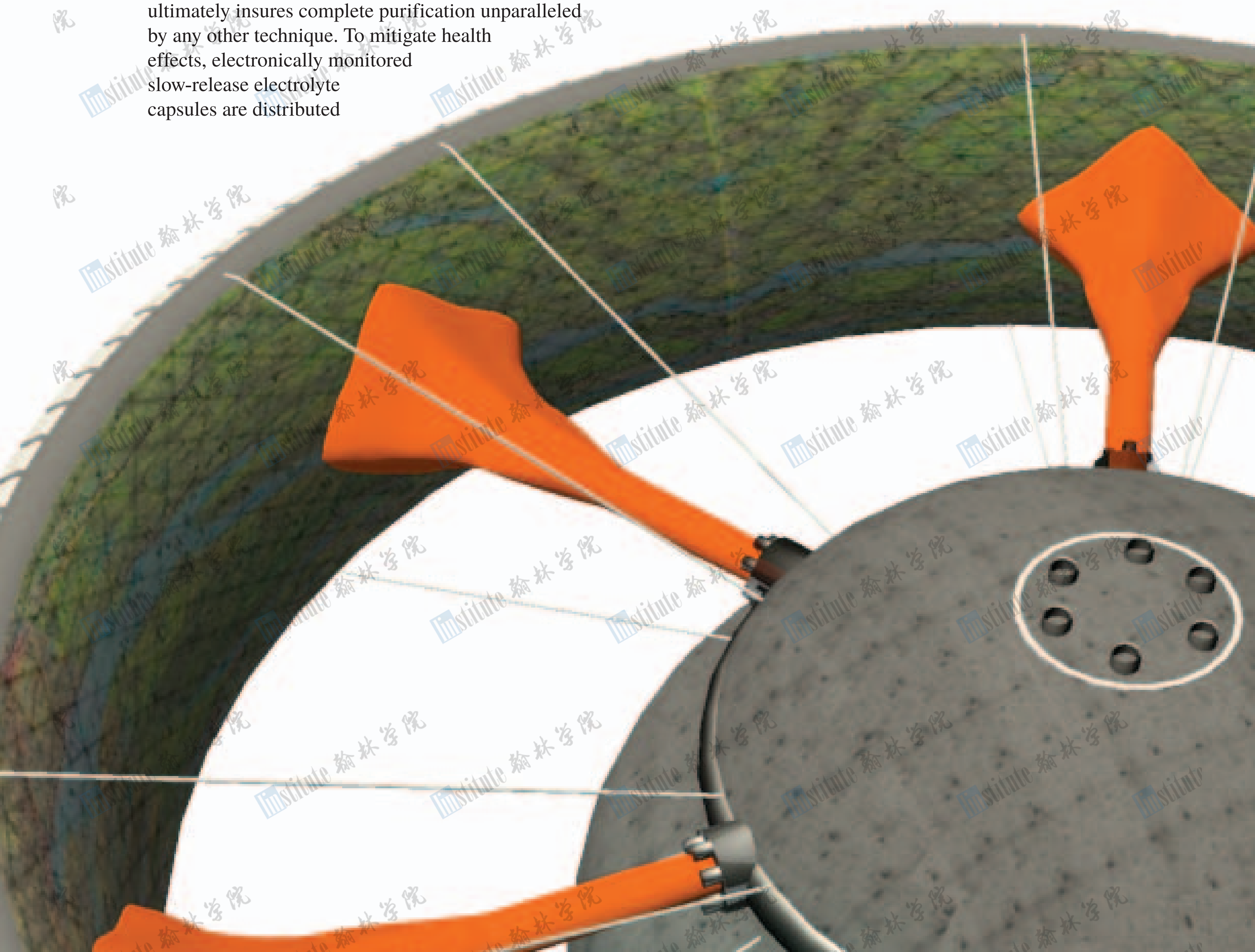
Chart 3.5.5 - Water quantities.

3.5.4 Water and Waste Management

Efficiency is paramount in the RAMS system. To eliminate waste contamination in potable water, all water is distilled and recycled following use. Despite the potentially unhealthy nature of pure distilled water, it ultimately insures complete purification unparalleled by any other technique. To mitigate health effects, electronically monitored slow-release electrolyte capsules are distributed through the distilled water supply. An inflatable septic tank gathers solid waste, as recycling waste in the small, contained environment is potentially hazardous; this containment ensures the sterility of the system.

3.5.6. Fire Protection

As an additional precaution should oxygen exceed 16.2% on the settlement, FWM (Fine Water Mist) Fire suppressors are utilized within the base. FWM systems suppress both smoke and flames, use less than 10% of the water of a sprinkler system, and are more effective by mass than CO2 systems. Furthermore, they can be used on electrical systems without fear of damage. Coupled with relatively low oxygen content in the atmosphere, the system ensures safety for all base residents.



4.0 HUMAN FACTORS

"He imagined the seeds he had placed today sprouting up with green and taking hold on the sky… until Mars was an afternoon forest, Mars was a shining orchard"

-Ray Bradbury

4.0 Human Factors

Aresam is a welcoming settlement where residents, Foundation Society members, and visitors can experience the unique attributes of the emerging Martian arena, all while residing in a comfortable, Earth-like atmosphere. In order to provide residents with more than mental stability and physical fitness, the Human Factors Department has incorporated various features into the design of Aresam. Residents will recognize an efficient, consciously designed landscape modeled after that of Earth's Copenhagen and the surrounding Danish countryside – including state-of-the art education, dynamic forms of entertainment, and optimum residential designs that fit harmoniously into their surroundings. In addition, Aresam's transportation systems allow residents an ease of travel that minimizes bodily motion, intentionally decreasing the impact of the coriolis effect. With natural light, views of space, and the bedazzling panorama of Mars below, Aresam invites you to envision your future thriving life style, while we explore what's possible in our expanding universe.

4.1 Community Design

Aresam's torus includes residential, commercial, and green areas, which intertwine over four rolling terraces to create an open, organic ambience. All residents have access to a multitude of amenities, living communities, urban centers, and a vast array of parks no matter where the resident is on the torus. Long lines of sight are also incorporated into the community layout. The small and slow moving Achelous River – 4 m wide and 1 m deep – runs peacefully through the various areas creating calming sounds and a pleasing environment.

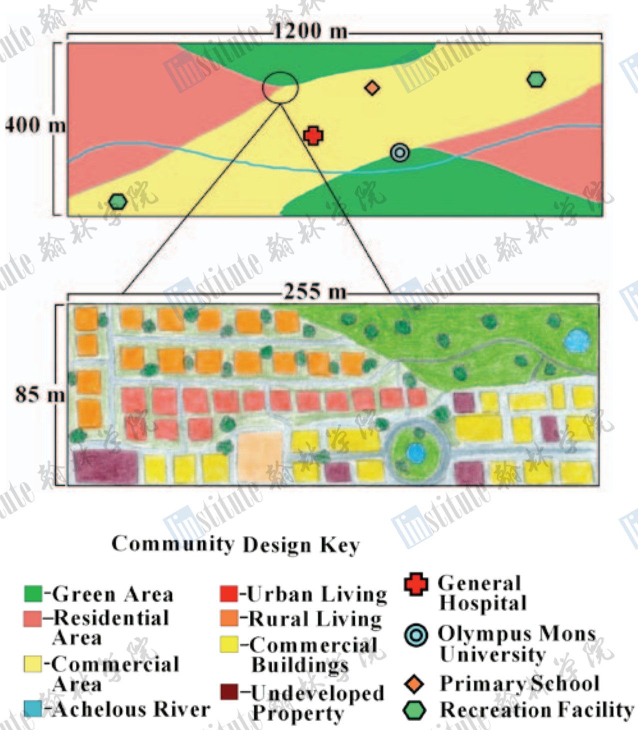


Figure 4.1.1 – Diagram depicting a section of the residential torus: residential, commercial, and green areas intertwine together to create an organic feel.

Aresam's micro-gravity observatory – luxuriously equipped with stationary telescopes and sitting areas – is one of the many attributes the settlement has to offer.

4.1.1 Neighborhoods

The architectural designs for residential living are separated into 4 different neighborhoods, offering residents access to different living communities to suit a multitude of demographic shifts. The Neoteric Home Style and Modern Loft (Section 4.2.1) are located near the commercial areas and incorporate less open space around the housing to create the excitement of an urban environment. The Territorial Style and Bamboo Design (Section 4.2.1) are located near major green areas and have more open space between the residences to accommodate individuals who wish to live within a suburban or rural setting. Large windows, beams, and an open air feel unify the designs and provide a pleasing common motif.

4.1.2 Roads and Pathways

Residents have access to a multitude of paths throughout the settlement – along the river and in and around the residential, commercial, and green areas. The paths allow residents to exercise – walk, run or bike – while providing a low-cost alternate transportation method, as well as promoting residents to engage in physical activity. Roads and pathways account for approximately 3% of the down area.

4.1.3 Parks and Recreation

An array of parks and green areas are incorporated into the design of Aresam, establishing an aesthetically pleasing environment. The parks include an abundance of vegetation and flora. All of the green areas offer a relaxing atmosphere for the residents and make up one fifth of the settlements down area.

Figure 4.1.2 - Green areas create an aesthetically pleasing environment for all residents

4.1.4 Medical Services

One general hospital and two smaller health care clinics are located within the residential torus where specialized departments carry out procedures from emergency care to annual check-ups. In order to supplement the actions of highly trained doctors and surgeons, a trio of automated systems performs preventative measures. Initially, all residents of Aresam ingest a pill containing millions of microscopic medical sensors that monitor vital bodily functions (Section 5.3.1). When the micro-medical sensors detect a medical emergency, the sensors notify both the medical authorities and the First Responder Robot (FRR) (Section 5.2.3). FRRs respond quickly and efficiently to medical emergencies and stabilize patients until a Medical Transportation Robot can transport them to a hospital facility (Section 5.2.3). Aresam's state of the art medical procedures ensure residents complete health and well-being.

4.1.5 Education

Northdonning Heedwell has integrated unparalleled educational institutions to promote the schooling and further education of both adults and children. Two primary schools provide education for children between 3 and 14 years of age. The primary schools are located on opposite sides of the residential torus, guaranteeing close proximity between the young students and their homes and families. Located within the urban center of Aresam, the Olympus Mons University (OMU) is dedicated to the instruction of high school and college students, as well as those adults seeking further education. OMU offers studies in general education, mining and engineering technology, business, and liberal arts and sciences. One high school building is located on the periphery of campus and provides students with the skills and knowledge they need to pursue higher education or move straight to a successful career. In addition, Aresam has a wide variety of dorm facilities to accommodate students from Aresam, Earth, and other settlements. Highly trained teachers instruct primary and high school students, creating a strong educational foundation for life. In addition to human teachers, there are varied educational automations to enhance to instructional techniques (Section 5.3.1).

4.1.6 Handicap Assistance

In order to establish a friendly and cooperative environment for all individuals, Northdonning Heedwell has made sure that handicap assistance is incorporated into every aspect of the settlement's design. Elevators and ramps are installed in every building to provide maximum usability and comfort. In addition, the Mars Rover, the Martian Off-Road Vehicle, and the pods of the Pod Monorail (Section 4.3.2) have additional room to accommodate for all individuals with disabilities.

4.1.7 Undeveloped Property

Undeveloped property – located within the residential torus and Major Spokes – not only provides open space to accommodate for demographic shifts, but also promotes a stream of revenue and a location where individuals may hold or participate in religious practices.

4.1.8 Entertainment

One of the unique attributes Aresam has to offer is the broad range of entertainment found on the settlement. Access to both Earth-related and space specific forms of entertainment further establish a vibrant and active atmosphere. The downtown area offers the residents

Figure 4.1.3 - Downtown areas offer a dynamic field of entertainment.

with dynamic day and night life, including walking malls and fine dining, as well as theatres and cinemas. Also found in the downtown district are several recreation areas designated for a variety of indoor and outdoor activities that include rock-climbing walls, swimming pools, and workout facilities. For scientists and individuals who enjoy observing space, a state of the art observatory is located on top of the Operations Core. Permitting a 360-degree view of space, this microgravity observatory offers residents an exceptional experience. In addition, residents can participate in microgravity sports, such as basketball and soccer, within the padded microgravity arenas located in the Operations Core. Also found in the microgravity arena is Polar Ball – a game that focuses on hand-eye coordination and physical activity. Two teams, each made up of 7 individuals, compete to throw a magnetically charged ball through counter rotating hoops, all while navigating magnetic hand holds that can change polarity in an instant. This game is unique to Aresam and creates an opportunity for residents to engage, either through participation or observation, in sporting events. Residents also have the opportunity to learn about and experience lava tubes and the environment on Mars through guided tours.

4.1.9 Consumables

All consumables are processed from raw materials in the Operations Core and subsequently shipped through the Pod Monorail (Section 3.2.7). Bulk cargo is delivered to distribution centers, which, in turn, facilitate the sale of consumables to Aresam residents. Mimicking an Earth-like grocery store environment, the PDS and distribution centers ultimately provide the most expedient method of delivery and a comfortable atmosphere for residents. In addition, open space is provided with houses, allowing residents the availability of gardening and producing their own organic food.

4.2 Residential Designs

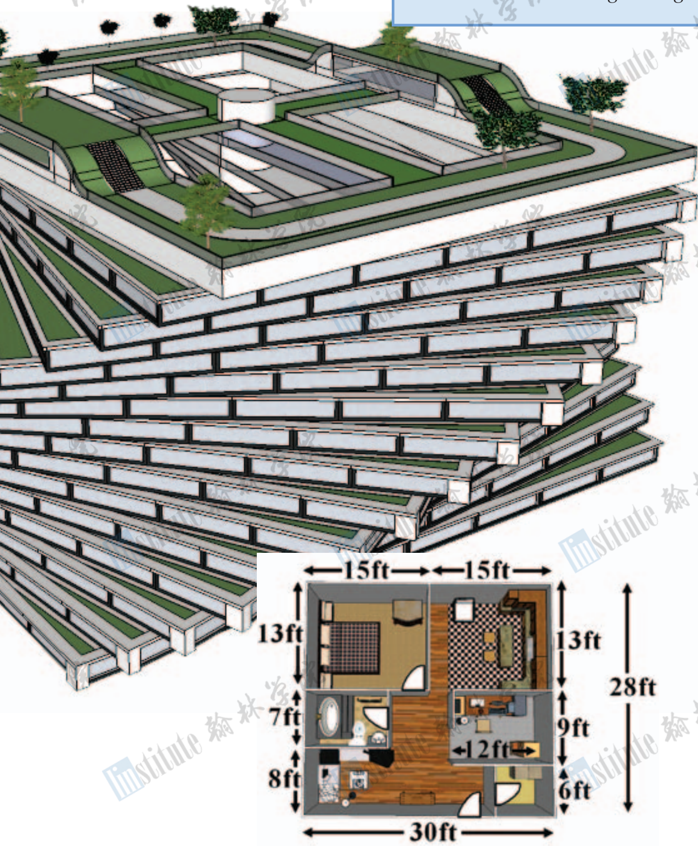
4.2.1 Housing Designs

Five different housing designs are available to residents and Foundation Society members to offer a wide variety of residential living options. All housing designs share a common open air theme and primarily use bamboo and Mars dust. We have taken advantage of Martian dust to create a safe and concrete-like substance made when lunar and Martian dust interacts with water and the bacteria bacillus pasteurii. This material is extremely efficient as it can be manipulated like a malleable substance, but then hardens into any conceivable shape or structure. On Aresam, the Martian concrete is utilized in residential structures and for a majority of the landscaping. In addition, houses include open space available for gardening, offering not only aesthetical facets, but also a system of food production (Section 4.1.9).

Consumable	Annual Replenishment of Raw Materials	Sources of Production/Method of Distribution
Food	1,329,240 kg per 22,000 people	*Production:* Meat (80% cultured, 20% livestock) Produce (100% standard agriculture through aeroponics) *Distribution:* Operations Core/Pod Monorail
Cloth	Bamboo: Cotton: Supplies are replenished according to need on a monthly basis	*Production:* 100% standard agriculture through aeroponics *Distribution:* Operations Core/Pod Monorail
Toiletries	All cosmetics, soaps, and other personal hygiene items are replenished according to need on a monthly basis	*Distribution:* Operations Core/Pod Monorail
Paper	All paper is replenished according to need on a monthly basis	*Distribution:* Operations Core/Pod Monorail

Figure 4.1.4 - Chart depicting replenishment and distribution of consumables (Section 3.2.2).

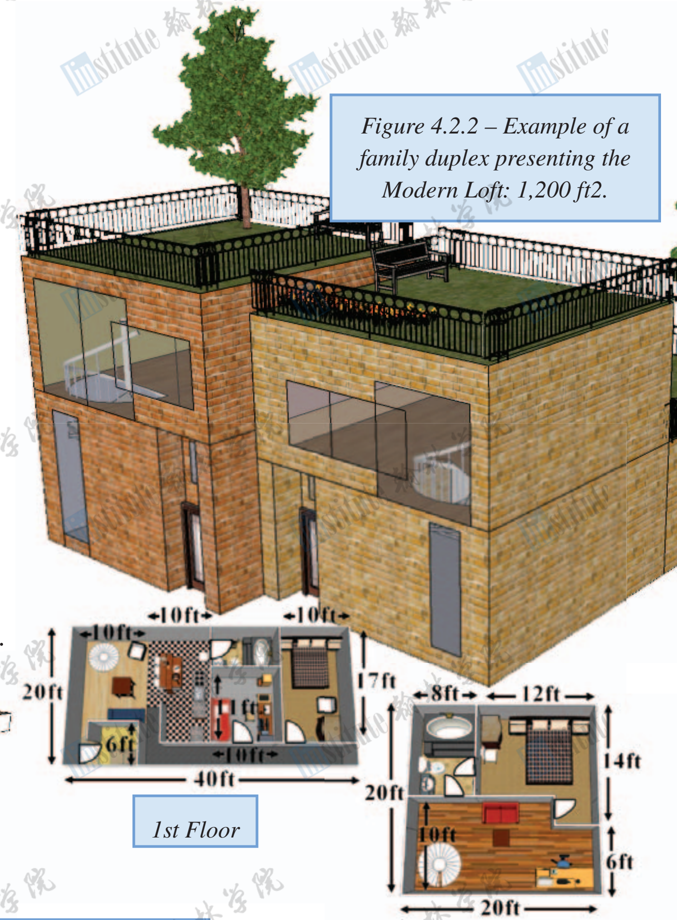
Figure 4.2.1 – Example of apartment complex presenting a modern design: single apartment is 840 ft².



Apartments: The settlement has multiple apartment buildings that provide varied living quarters for residents. The apartments are located in downtown areas and within the Major Spokes. The design incorporates the modern design advances of Aresam. Each room has majestic views overlooking the residential and green areas.

Duplex: Designed for two separate families or residents, this house conserves space by providing open floor plans and utilizing height. Decorated with corrugated metal and brick, this house is similar to a Modern Loft and has small rooftop gardens as these designs are located in more urban settings (Section 4.1.1).

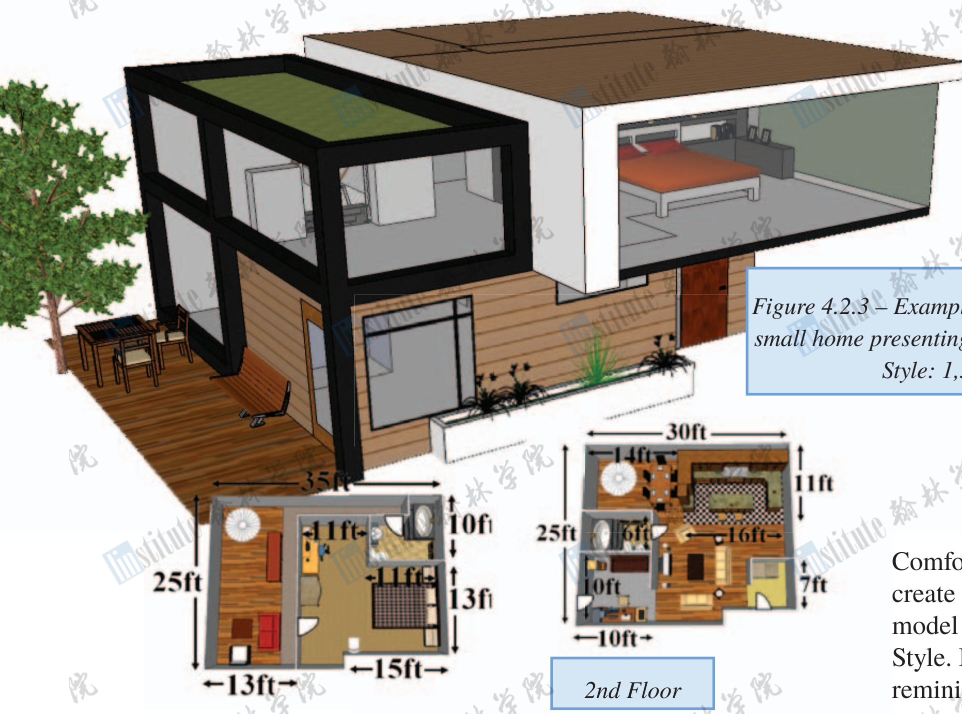
Figure 4.2.2 – Example of a family duplex presenting the Modern Loft: 1,200 ft2.



1st Floor

2nd Floor

Figure 4.2.3 – Example of a married adult small home presenting the Neoteric Home Style: 1,575 ft².



1st Floor

2nd Floor

Small Home: This house is the perfect size for a single resident or couple. Comfortable and cozy, it's an ideal place to create a personal sanctuary. This particular model also demonstrates the Neoteric Home Style. It utilizes spacious and geometric design, reminiscent of the early 20th century.

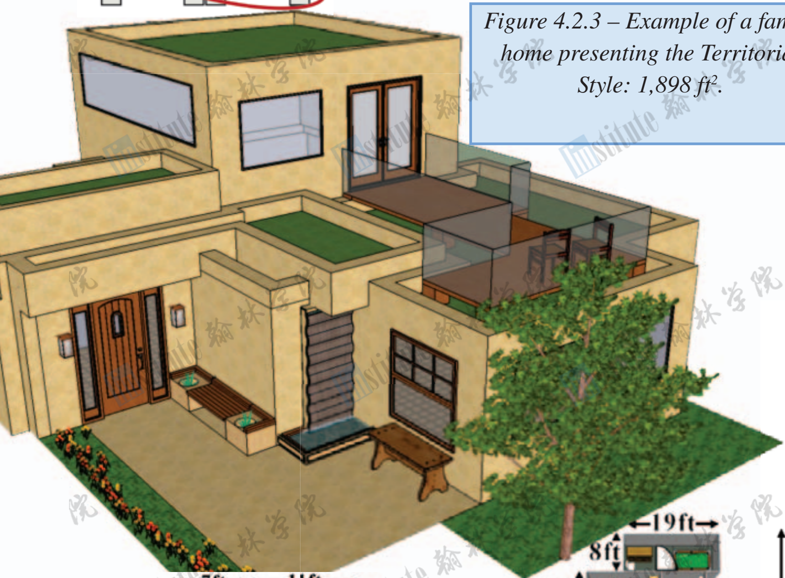
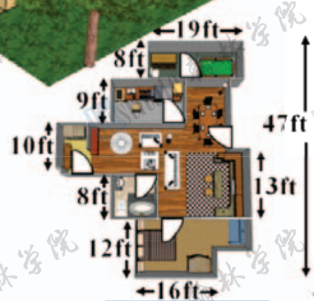


Figure 4.2.3 – Example of a family home presenting the Territorial Style: 1,898 ft².

Family Home: The home is comfortable, beautiful and most importantly, practical for a large family. This design provides an example of the Territorial Style. The home uses adobe (Introduction to 4.2) in a Southwestern style that is simple and efficient.

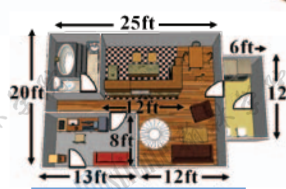
2nd Floor



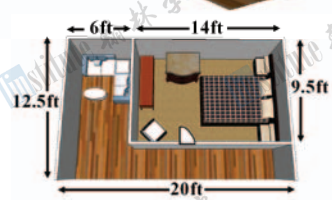
1st Floor

Figure 4.2.5 – Example of a single resident community living home presenting a Bamboo Design: 822 ft2.

Community Living: This design incorporates a quantity of homes gathered around a central courtyard, complete with communal gardens. The architecture incorporates large windows and open hallways, giving an open, airy feel. Bamboo is the primary material used in construction. Each house is one story with a loft looking down upon the central room.



1st Floor



2nd Floor (loft)

4.2.2 Demographics

Type of Residence	Quantity
Apartments	6,380
Small Home	4,590
Family Home	150
Duplex (per residence)	4,590
Community Living	1,470
Type of Architectural Design	
Apartment Complex	22
Neoteric	2,700
Territorial	2,700
Modern Loft	2,700
Bamboo	2,700

Figure 4.2.6 – Quantity of housing designs with consideration of demographic trends taken into account.

Furniture Item	Quantity
Couches	19,010
Arm Chairs	37,700
Miscellaneous Tables	54,800
Desks	19,010
Book Shelves	19,800
Dining Room Tables	17,180
Dining Room Chairs	68,720
Bed	17,600
Kitchen Appliances	85,900
Large appliances (i.e. washing machine, refrigerator, dishwasher)	68,720

Figure 4.2.7 – Furniture is manufactured in the Operation Core and is primarily made of bamboo (structure) and silica gel (cushioning). Kitchen and large appliances are also manufactured in the Operations Core and are primarily made of silica and electrical circuitry.

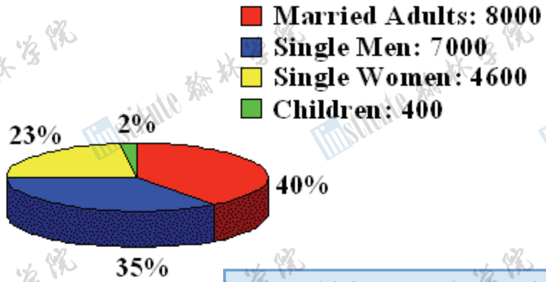


Figure 4.2.8 – Demographic chart

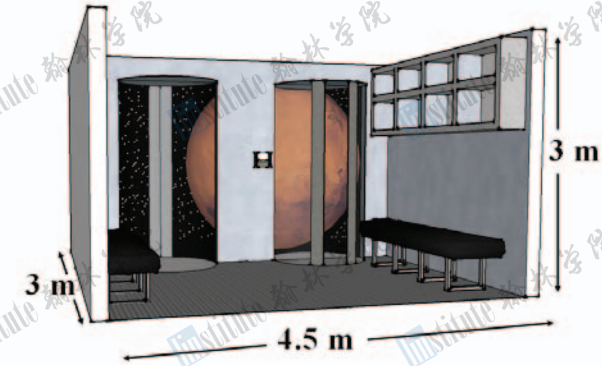


Figure 4.3.3 - The airlock provides a safe exit into space and entrance onto the settlement.

4.3 Safe Access

Northdonning Heedwell desires the best in safety for our residents. Our transportation systems feature the utmost technology not only to improve the productivity and transportation in micro-gravity areas, but also to ensure optimum safety.

4.3.1 Spacesuit And Airlock Design

To improve productivity and safety on extra-vehicular activities we have provided residents with a comfortable, flexible, and efficient spacesuit design. The Bio Suit, also known as the Mechanical Counter Pressure (MCP) suit, protects the occupant against harmful radiation, micrometeoroids, space dust, and other detrimental debris. The design consists of a thin undergarment, the Bio Suit, a hard torso, a helmet, boots, gloves, a life support system, and communication devices. Unlike the gas-pressurized spacesuits, the Bio Suit encompasses a counter-pressure system obtained through a firm-fitted suit, in which polymer fibers – electrically active – are aligned in a circumference pattern within the elastic layers. As a result of the life-supporting counter-pressure system, the amount of bottled oxygen needed is decreased. Therefore, a larger life support system of twelve hours is incorporated into the design to provide the utmost safety for an occupant. Gloves also have the counter-pressure design, enabling the occupant to have more mobility with the hands. The boots are slim-fit, similar to hiking boots, and have a strong soul to protect the occupant's feet against the rough terrain present on Mars, Deimos, and Phobos.

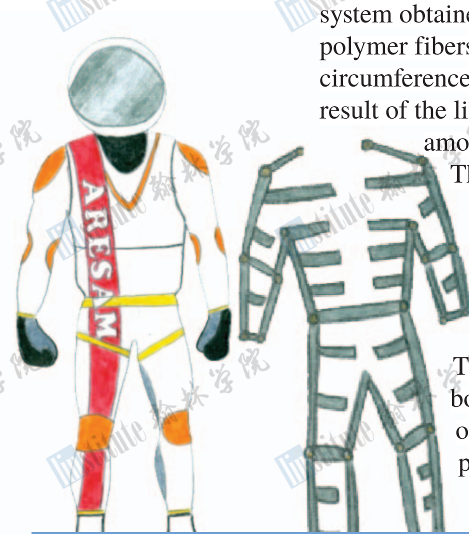


Figure 4.3.1 - Bio Suit with optional exoskeleton provides safe travel in non-pressurized volumes.

Undergarment (Semi-Permeable Layer)	
Polypropylene	Regulates body temperatures.
An organic layer of synthetic collagens	Wicks perspiration away from the occupant's body.
Bio-Suit	
Kevlar	Provides flexibility around the joints and protects the occupant when composed in the hard torso.
Nylon	Provides thermal control.
7 Layers of Elastic	Provides structural integrity and corresponds with polymer fibers to perform the vital function of life-support.
Biaxially-Oriented Polyethylene Terephthalate (BOPET) Film	Provides electrical insulation.
Thermal Micrometeoroid Garment (TMG)	Protects occupant from micrometeoroids, extreme temperatures, and solar radiation.
Outer Coating (Liquid Glass)	
Silicon dioxide, ethanol, and water.	Prevents dust contamination.
Exoskeleton	
Metal Foam	A strong and light material that enhances productivity.

Figure 4.3.2 - Chart depicting composition of spacesuit materials.

Figure 4.3.4 - The donning and doffing procedure is efficient and lasts only a mere 10 minutes.

Dust mitigation is another important feature we have recognized. Therefore, in order to shield the occupant from space and Martian dust, the suit is coated in a layer of liquid glass made from silicon dioxide. This particular material prevents contact from dust and will last as long as a year. However, in order to ensure dust protection, every suit is coated three times a year. An optional exoskeleton, also coated in liquid glass, is incorporated into the design to greatly improve the productivity of researchers and workers on the Martian surface and the two moons.

Designed to expedite donning and doffing, airlock procedures last a mere 10 minutes. The airlock is composed of one chamber. Within the first chamber, the occupant dons and doffs the Bio Suit, boots, gloves, hard torso, helmet, life support system, and harness (Section 4.3.2) Spacesuit stowage is met through a series of linked cubbies on a wall of the first chamber. Two enclosed revolving platforms perform as the exit into space and the entrance onto the settlement. When the occupant has donned the spacesuit, he or she walks into the revolving platform. The doors close behind the individual, and the platform moves 180 degrees, so when the door opens, the occupant is ready to step foot on the Ares Platform (Section 4.3.2). The second platform is the entering chamber onto the settlement from Extra-Vehicular Activity (EVA). Similar to the first chamber, the occupant walks onto the platform, the doors close behind him or her. Within the chamber, the occupant is sprayed with pressurized air as a way to remove any remaining dust that might be present. In order to further prevent dust contamination upon the donning and doffing operations, the revolving platforms and doors are coated in a layer of liquid glass and are re-layered once a month.

4.3.2 Means Of Safe Access In And Around The Settlement

Aresam's Pod Monorail provides safe and easily available transportation throughout the settlement (Section 3.2.7). The design includes enclosed and pressurized pods that run along a monorail. The pods within the Operations Core seat five occupants, while the pods in the residential torus seat up to twenty people. The Pod Monorail in the Operations Core (Section 3.2.7) travels along a grid system to provide the most vertical and horizontal access for residents. Personal and cargo pods are pressurized and have sufficient life support of up to 5 days, as well as evacuation capabilities. In addition to the system, walkways are provided along the rails, allowing residents to travel short distances to their destination. Residents must wear an adhesive cover, known as the Nano Pressure Adhesive, over the sole of their shoes when traveling on the walkways in the Operations Core and other micro-gravity areas. In order to aid residents with direction orientation in the Operations Core, the walkways are color coordinated: red is west, blue is east, green is north, yellow is south, up is orange, and down is grey. Color keys are posted throughout the Operations Core.

Residents can also obtain flexible transportation through the Open Air Smart Car (Section 3.2.7) – an electrically powered vehicle with occupancy of 2 people – which can travel along a 5 m wide road winding throughout the residential torus.

The ensure safety for those individuals on EVA, we offer the Ares Platform. Located on the outside of the residential torus, the Ares Platform offers occupants the capability of safely traveling around the settlement. The platform consists of a 1.5 m wide walkway enclosed by secure railing. Individuals are required to wear a harness on EVA. The harness, similar to a rock-climbing harness, has two strong carabineers, extended from the hips that lock around the railing. The carabineers easily slide along the railing, permitting

Figure 4.3.5 - The MORV enables residents to safely indulge in Martian and lava tube tour guides.

the individual to walk on the Ares Platform securely and safely. In addition, individuals wear the Nano Pressured Adhesive to remain on the platform and to provide the comfort of walking in micro-gravity.

To ensure safe travel for guided tours on the Martian surface, the Martian Off-Road Vehicle (MORV) is provided. The MORV offers two different tour guides – a tour with a pressurized cabin and a tour with a non-pressurized cabin. In a pressurized cabin, the residents remain and receive the tour from within the vehicle. However, in a non-pressurized cabin, residents are required to wear a spacesuit and have the option to interact with the Martian surface at designated sites. In addition, the non-pressurized MORV has a back up tank to pressurize the cabin if in an emergency to provide life support develops. Both MORVs have a strong structure to protect the occupants in the severe conditions of Mars. In the back of the vehicle, a compartment full of emergency supplies ensures the highest level of safety.

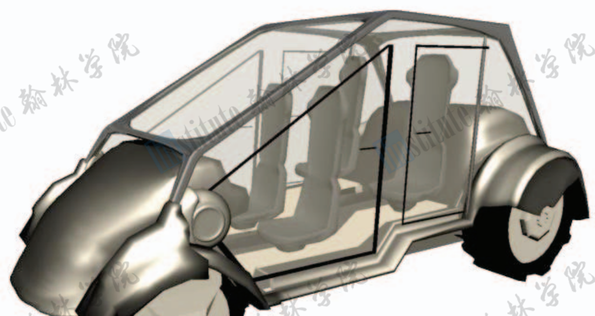


Figure 4.3.6 – The Mars Rover enhances the productivity of researches and workers.

The Mars Rover is a vehicle intended to enhance the productivity of workers and researches on Mars, Deimos, or Phobos. This vehicle comfortably seats four individuals. Occupants are required to wear spacesuits, as the interior of the vehicle is non-pressurized. Similar to the non-pressurized MORV, the rover has a back-up tank of air for necessary life support. The vehicle also provides protection against detrimental debris and winds that may occur on the Martian surface.

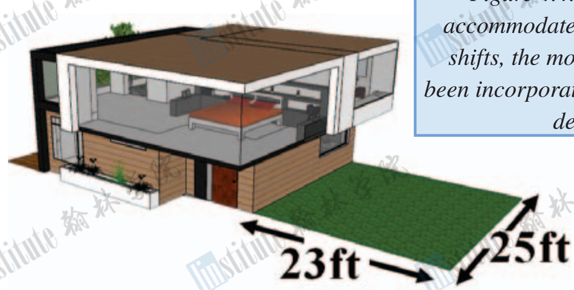
4.4 Accommodations for Demographic Shifts

Aresam is exceptionally prepared for the demographic shifts expected in the thirty years following the settlement's opening. We have provided a variety of accommodations to meet changing demographics – including modular housing designs and planned living communities – further enhancing Aresam's ability to accommodate a variety of different individuals and groups.

In order to accommodate for future demographic shifts, Aresam has incorporated a modular system into residential designs. The modular system not only provides expansion onto houses and other residential designs, but it also offers inhabitants the ability of choosing their residential layout. When new residents arrive on the settlement, they are able to choose the location of their home. Open space, excluding gardens and yards, are located next to residential designs to allow room for new residences, which are put in place through the modular technique.

In addition, Aresam has established amenities for a planned living community. The planned communities provide residents with a broad range of convenience and resources within one centrally planned area. These communities feature extensive recreational facilities which include fitness centers and jogging trails, as well as public parks and playgrounds. There are general shopping centers located within these communities, providing residents with convenient access to various amenities. Along with shopping there is a wide range of entertainment offered within these

Figure 4.4.1 – In order to accommodate for demographic shifts, the modular system has been incorporated into the housing designs.



1. Open space is incorporated into the design.

2. Modular system is put in place.

3. An extra bedroom and porch are added.

	Year 0	Year 5	Year 10	Year 15	Year 20	Year 25	Year 30
Married Adults	8,000	8,020	8,040	8,060	8,080	9,000	9,020
Single Men	7,000	7,018	7,036	7,048	7,066	7,084	7,202
Single Women	4,600	4,612	4,624	4,636	4,648	4,660	4,672
Children	400	401	402	403	404	405	406
Job Availability	19,600	19,649	19,698	19,747	19,796	19,845	19,894
Retirement of Original Population	0	5	11	57	112	246	300
Marrying Adults	200	202	204	206	208	210	212
Couples Having 1st Baby	100	102	104	106	108	110	112
Couples Having 2nd Babies	50	51	52	53	54	55	56

Figure 4.4.2 – Chart of future demographic trends with increasing number of individuals.

communities making the living style incredibly relaxed and tranquil. Most importantly these communities allow for a wide variety of house floor plans, building styles, lot sizes, landscaping styles, and pricing options.

4.5 Prefabricated Base

Northdonning Heedwell has equipped researchers and workers with a comfortable, safe, and efficient prefabricated base that will enable our customers to carry out advanced research while residing in a livable structure on the Martian surface.

Aresam's prefabricated base utilizes an innovative and ergonomic interior design to create a pleasing living and working environment for researchers and their teams. The floor plan consists of three sections – a central section for research purposes and two outer sections for residential living. The floor plan works with a modular design, establishing an organic atmosphere where the residents can personalize the interior layout with the aid of the Joint Positioning Robot (Section 5.5.3). Using the modular design, the various rooms can be arranged and modified at any given time in order to accommodate the number of residents, from 4 to 8 individuals. Each residential section features all of the necessary amenities found in a typical household. After entering the airlock (Section 4.3.1) the occupant enters a mudroom, marking the entrance to both living areas. The living room offers a peaceful room where occupants can relax and recover. The compact and energy efficient kitchen provides the residents with a variety of appliances that contribute to the ease and livability conditions of the base. In total, the base consists of four independent bedrooms that can be – using the modular design – rearranged into six bedrooms. The base has two bathrooms with full amenities, featuring efficient and streamlined appliances. A study room is also made available to provide the residents with additional research options. Similar to the furniture on a boat, the furniture within the base is compact and has the capability of folding into the walls to provide a floor plan with simplicity and optional open space.

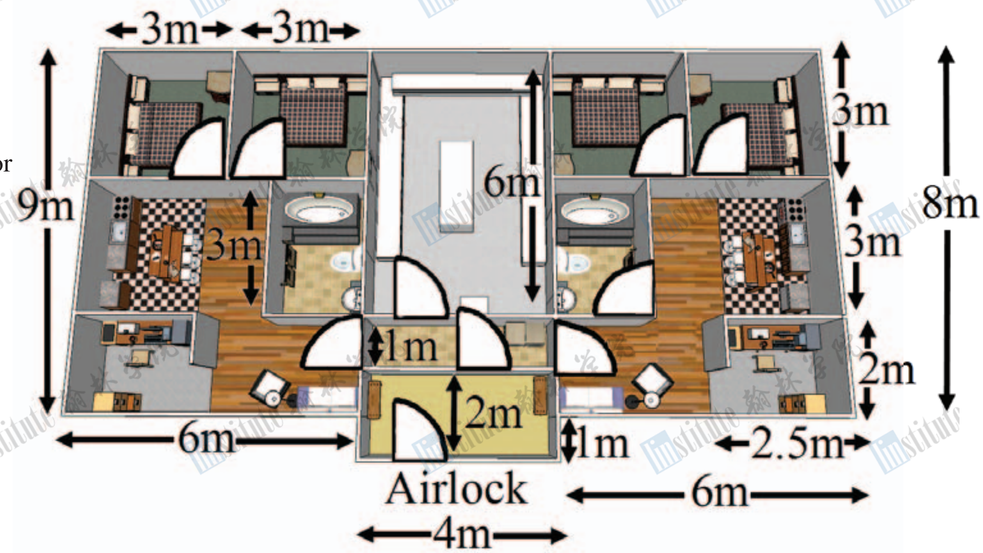
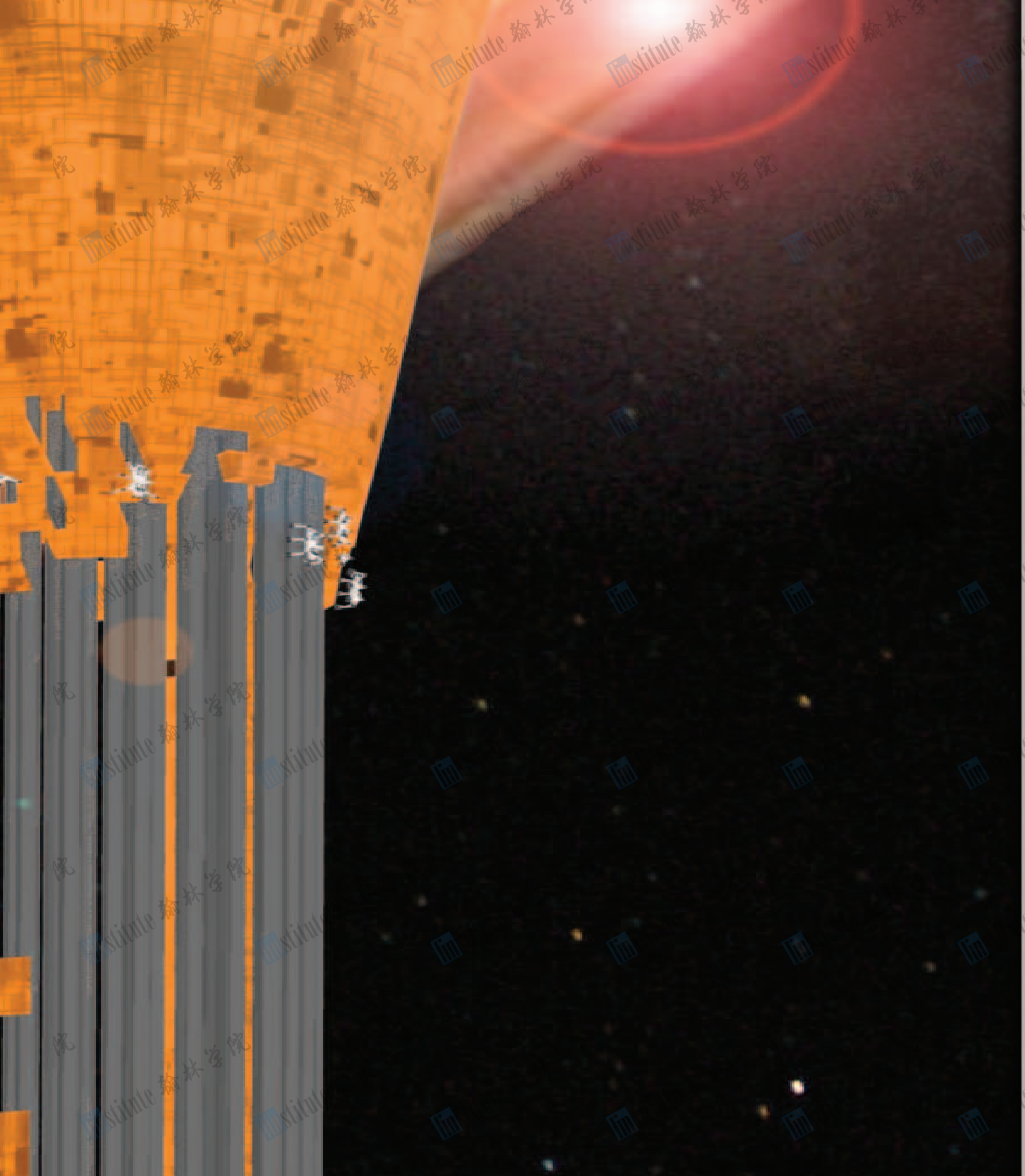


Figure 4.5.1 – The prefabricated base offers researcher maximum comfort and usability: 132 m2

5.0 AUTOMATION DESIGN AND SERVICES



"Five o'clock.

The bath filled with clear hot water.

Six, seven, eight o'clock.

The dinner dishes manipulated like magic tricks.

Nine o'clock.

The beds warmed their hidden circuits, for nights were cool here."

-Ray Bradbury

5.0 Automation Design and Services

The construction and operation of Aresam is a monumental task, and we at Northdonning Heedwell have designed numerous automated and robotic systems to both augment and replace previously human endeavors. Our innovative and efficient construction robotics ensure Aresam is built in a timely and cost-effective manner, while guaranteeing no humans are put in danger. The operation systems provided by Northdonning Heedwell provide safety and security for all inhabitants of Aresam. While residing on Aresam, residents can take advantage of our great range of community automations, allowing them a flexibility, freedom, and opportunity for enjoyment previously unknown in any space community. Finally, Northdonning Heedwell's state-of-the-art mining systems provide the Foundation Society with a great range of options when it comes to material resources, allowing them to pursue numerous business pursuits along with the construction of Aresam. These benefits and many more have been made available to the Foundation Society through Northdonning Heedwell's Automation Design and Services vision for Aresam.

5.1 Automation for Construction

The revolutionary range of construction robotics implemented by Aresam allows for more efficient use of materials, an accelerated construction sequence, and greater utilization of Martian, Phoban, and Deiman resources. This in turn ensures Aresam is built in a meticulous, cost efficient, and swift manner, making it the most ground-breaking space settlement built to date.

5.1.1 Automations for Exterior Construction

Northdonning Heedwell has developed revolutionary new construction automations in order to ensure the expedient and cost-efficient construction of Aresam. Initially, the Martian Automatic Positioning System aligns itself in a grid format around the construction site allowing it to broadcast communication pulse waves to all robotics informing them of duties and accompanying coordinates. Omni-functional Manufacturing Robots (OMR) form the backbone of the construction process. Using gecko-like nano-pressure adhesives on each foot

Robot	Function	Storage	Dimensions	Quantity
Transport Rail	Transfers construction materials between sections of the station. Utilizes a rail system spread throughout the matriarch and torus with flatbed containers to carry materials and robotics.	Adapted and utilized for Pod Monorail transportation system.	Encircles Aresam	1
Omni-functional Manufacturing Robot (OMR)	Multifunctional Robot with legs at each corner equipped with Nanoclaws for attachment to frame, arm-like extensions with tool attachments to complete tasks. Builds Hull, Frame, and Interior, as well as housing and layering station.	Ops Core, and strategically placed around Aresam for emergencys.	1m x 1m x 1m	500
Interior Finishing Robot (IFR)	Uses small arms to attach to different tools to paint, maneuver objects, and do other miscellaneous tasks. Executes duties such as, interior design, and arrangement of furnishings.	Ops Core	1m x 0.5m x 0.5m	300
Tile Laying Robot (TLR)	Places tiles into framework to construct exterior of the matriarch. Uses a tile-based shape to easily lay tiles within framework, as well as an arc welder to secure panels.	Ops Core	2m x 2m x 4m	300
Martian Automatic Positioning System (MAPS)	Satellites arrive on construction site and align themselves in a 3-Dimentional grid format to organize robotic construction. Utilizes pulse communications to transmit information to other robots.	Ops Core	1m x 1m x 1m	64
Utility Laying Robot (ULR)	Lays wires and fiber-optic cables as well as all tubing, ducts, and plumbing. Uses different spools to lay piping and wires in a pre-made trench.	Ops Core	1m x 1m x 3m	200
Contour Crafters	Use a combination of pressure molding, materials layering, and appliqué to construct and place all homes and building within the torus.	Ops Core	20m x 20m 10m	75

Chart 5.1.1: Aresam utilizes seven major automated components for construction.

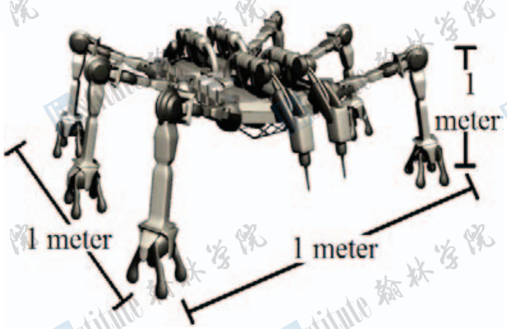


Figure 5.1.1: OMRs, Aresam's primary construction robotics, work together to construct the station in only nine years.

to connect with the settlement (Section 4.3.3), OMRs utilize multifunctional attachable arms including arc welders, positional claws, riveters, electrical tools, etc. This allows them to complete an array of construction tasks, such as the assembly of the settlement frame including the Ops Core, major spokes, torus, and terraces, cutting down on costs and streamlining the construction process. For the efficient and expedient placement of hull tiles, Tile-Laying Robots utilize a tile-shaped body chassis to transport and secure aluminum hull plates within the frame of Aresam. They position themselves over the panel space, drop the panel into place, and then arc weld it to the framework. By using this two tier process of Omni-functional Manufacturing Robots and Tile-Laying Robots, Northdonning Heedwell has ensured the exterior of Aresam can be completed in record time, saving the Foundation Society both time and money.

Section 5.1.2 Automation for Interior Construction

Interior finishing of Aresam is handled through the implementation of OMRs, Utility Laying Robots, Interior Finishing Robots (IFR), and Contour Crafters (Section 3.3.?). OMRs construct the terraces within the torus while Utility Laying Robots run infrastructure and wiring under the terraces and up into homes and buildings. Contour Crafters move through the torus crafting entire buildings from base materials using techniques such as pressure molding and materials layering. These contour crafters provide the quickest, cheapest, and most efficient way of interior finishing as each one can construct two houses or the equivalent of per day.

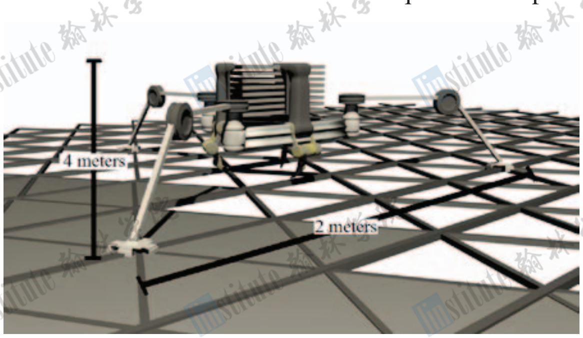


Figure 5.1.2: Tile Laying Robots create Aresam's hull in tandem with OMRs.

Finally, the Interior Finishing Robot can operate in small, constricted spaces such as within homes and buildings where it completes all final construction tasks such as the placement of furniture, installation of electronic devices, and any other miscellaneous small tasks.

Section 5.1.3 Automation for Construction Transportation

Aresam utilizes an automated rail system for transporting prefabricated sections of the settlement as

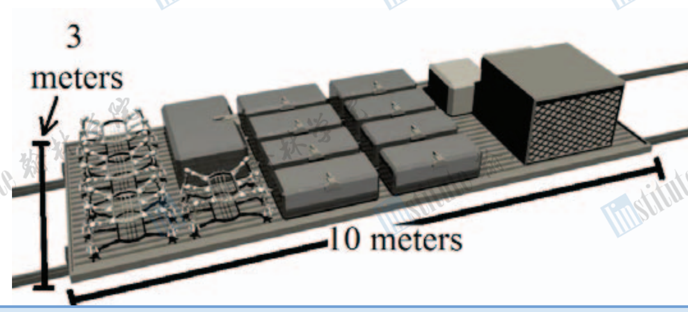


Figure 5.1.3: Transport rails from the construction process are refitted to form the Pod monorail, saving time and money.

well as smaller robotics and cargo. These transportation rails encircle Aresam in addition to running through the spokes and matriarch. Open topped cars travel along these rails and are loaded and unloaded by Omni-functional Manufacturing Robots. This transportation method creates a simple yet efficient way to transport different materials, robotics, and prefabricated settlement sections throughout the construction site. Additionally, the transport rail serves as the foundation for the Pod monorail (Section 4.3.2). When construction of Aresam is complete, the transport cars are replaced with Pods for resident transportation, saving the Foundation Society money and time by not having to design and build and entirely new inhabitant transportation system.

5.2 Automation for Maintenance, Emergency Repair and Security Systems

Once construction of Aresam is complete, Northdonning Heedwell's state-of-the-art operational automations, including the optical Quantum Computing Mainframe, collaborate to guarantee Aresam runs smoothly and efficiently at all times. Therefore, the Foundation Society can rest soundly knowing their investment is safe and secure.

Figure 5.2.1 A chart showing the robots and their functions

Robot	Function	Quantity	Size	Section
Refitted TLRs and OMRs	Exterior maintenance and emergency repairs	800	1m x 1m x 1m	5.2.2, 5.1.
Refitted IFRs	Internal maintenance and infrastructure repair	500	1m x 1m x 1m	5.2.2, 5.1.
Security response robot (Lurker)	Security and emergency management	500	.5m x .5m x .5m	5.2.3
First responder robot (FRRs)	Medical and emergency response	500	1m x 1m x .5m	5.2.3
Medical Transportation Robot	Medical and emergency transportation	250	2.5m x 1m x 1m	5.2.3
Quantum Computing Mainframe	All computing operations and data transfer	7	N/A	5.2.1, 5.4.

5.2.1 Automation for Settlement Operation and Computing

Due to Aresam's remote location and enormous computational requirements, all data processes utilize an optical Quantum Computing Mainframe (QCM) system because of the efficiency and versatility these systems provide. The QCM uses a distributed network to organize all automations and operations of the station, including medical, residential, security, and maintenance functions. This system standardizes the information transfer between all facets of Aresam to eliminate compatibility issues and increase efficiency. The QCM is a matrix of seven interfacing server arrays which process all computational demands on the settlement. Each array is strategically located in the station, one in each spoke and one in the Ops Core, providing efficient performance and backup as well as more stable operations. In case of emergency each section of the station is able to be independently controlled by one quantum computer which maintains life support and other critical functions. This assures that at no point would the settlement be in danger of an operational catastrophe.

5.2.2 Automation for Maintenance and Repair

Maintenance of Aresam is provided by an array of robots refitted from the original construction of the settlement. By refitting existing robots, Northdonning Heedwell can save the Foundation Society millions of dollars by not having to design and build new robots. Automations for interior maintenance include refitted Interior Finishing Robots while external maintenance and repair of the station is handled by Tile Laying Robots and Omni-functional Manufacturing Robots. During emergency situations, OMRs and TLRs can be dispatched to any area of the station to repair hull breaches and rebuild structures in the most expedient and effective way possible. If a hull breach occurs, the area is immediately sealed off from other sections and both interior and exterior repair robots respond to the damage where they immediately seal all layers of the hull with instant-cure epoxy foam. When the breach is no longer venting atmosphere, robots replace the exterior panels and repair or replace the interior as needed ensuring hull breaches are repaired with minimum hassle and in the fastest time possible.

5.2.3 Automation for Safety of Residences and Personnel

The safety of the occupants aboard Aresam is of utmost importance, and therefore Northdonning Heedwell has provided multiple security and medical automations that respond to any event. The Security Response Robots (Lurkers) form the basis of the settlement's security robotics. Shaped like small transparent spheres, Lurkers are able to roll through the station (figure 5.2.1). Lurkers are equipped with two internal cameras that provide 300 degrees of vision, ensuring the greatest possible monitoring view. Functioning in tandem with the QCM, Lurkers can identify both delinquent behavior as well as emergency situations, and respond to both. In order to deal with security threats, Lurkers are equipped with two extendable tranquilizer guns that fire small capsules filled with a potent tranquilizer to sedate unruly persons. Additionally, Lurkers are equipped with three extendable but powerful legs that can launch the robot up to 5 meters in any direction when in pursuit. If a dire threat occurs the Lurkers can be remotely operated by trained personnel in order to handle complex situations.

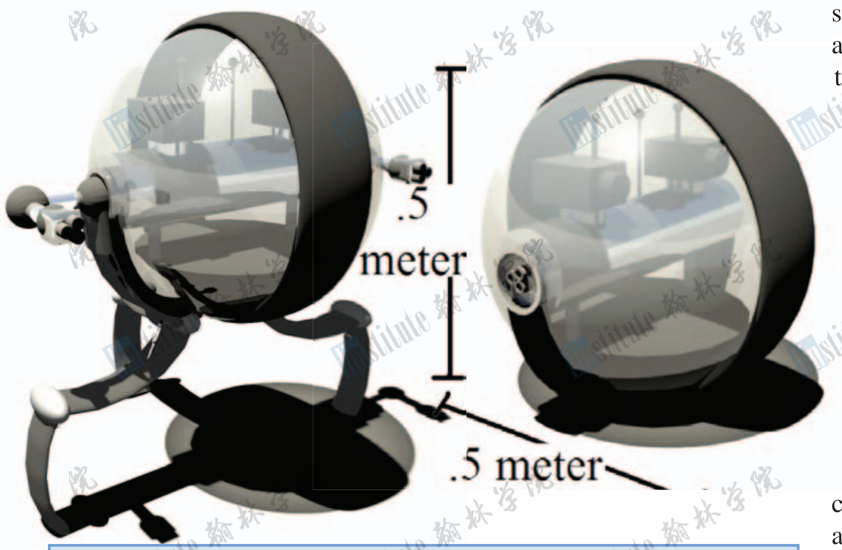


Figure 5.2.1: Security Response Robots provide for the continued safety and security of residents of Aresam.

Ensuring residents have healthy and productive lives is of the utmost importance for us at Northdonning Heedwell. Consequently, Aresam employs state-of-the-art medical automations. To monitor the health of each individual aboard the settlement, micro-medical sensors are ingested that can detect any internal health threat and notify the authorities (Section 5.3.1). However, if an inhabitant is ever injured or undergoes a medical emergency, a team of robots is ready and prepared to respond to the scene and take all proper medical actions. First Responder Robots (FRR) (Figure 5.2.2), are spread out around Aresam and can respond to any situation in under 60 seconds. These robots are equipped with an array of medical tools and sensors such as pulse monitors, defibrillators, IV lines, and a variety of medicines that are meant to treat and/or

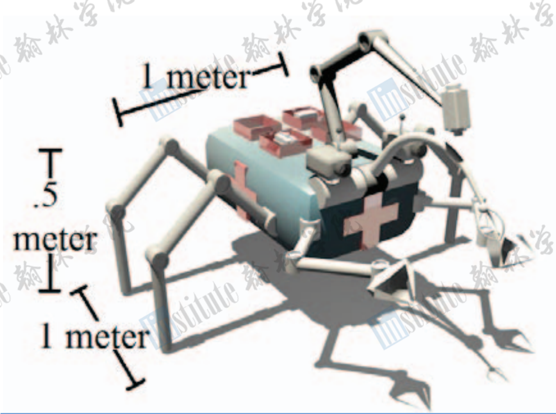


Figure 5.2.1: First Responder Robots respond to medical emergencies and provide preliminary medical care.

stabilize a patient. When more advanced medical attention is required, Medical Transportation Robots transport patients to the nearest hospital where they receive the best possible care from Aresam's highly-trained doctors and surgeons. The three-tiered medical system utilized by Aresam guarantees the health and well-being of all those on Aresam.

5.2.4 Protection from Solar Flare Activity

To protect all of Aresam's external robotic systems from solar flare activity, a series of cost-effective and proficient shielding methods are used. First of all, all computing, sensory and communication devices have been compressed into a smaller, more easily protected central area. As for actual radiation shielding, a layered blanket composed of RAGaurd, polyethylene sheeting, and a thin layer of lead surrounds the central processing package protecting it from harmful solar flare radiation.

5.2.5 Automation for Security and Access of Critical Data

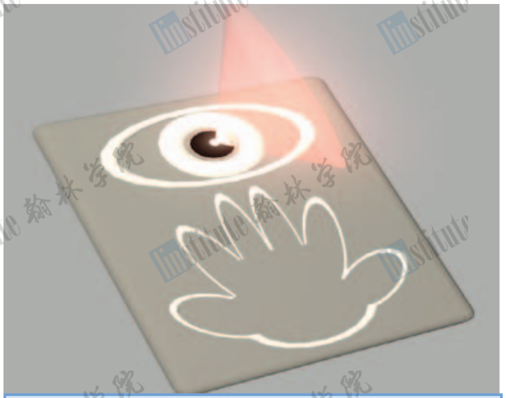


Figure 5.2.3: Security scanners ensure the security of data and areas on Aresam.

Aresam's operations are secured against non authorized access through a network of security measures. Every individual arriving on Aresam is given a personal account within the Resident Computing Complex (Section 5.3.1) and assigned a certain level of security clearance. Aresam's generalized security and access system is so advanced that we need employ no other secure access measures other than what is in place for general access. These measures include a two-part iris scan and facial vein-mapping scan. The chance of two iris' being identical is 1 in 1078, while no two people have the same facial vein structure. These near impenetrable security scans ensure that no one is able to gain access to areas or data they are not specifically allowed. A resident uses these scans to gain access to personal computers and files, work stations, etc., and for those allowed, secure and restricted areas housing settlement operations systems. In the rare chance that a device rejects a user access, the medical sensors in each person can act as an identifier. The medical sensors can also assure that the person is not being forced against their will, or that another person is using their body, through reading stress levels and vital signs.

5.3 Automations for Enhanced Livability

Aresam's vast array of community automations provides for both a streamlined business atmosphere as well as an enjoyable living and working environment. Consequently, residents on Aresam are happier and more productive, accelerating the Foundation Society's goals for Aresam.

5.3.1 Automation for Livability in the Community

In order to unify all facets of a resident's life on Aresam, numerous aspects of daily life have been integrated to form the Resident Computing Complex, or RCC. This network directly connects to the Quantum Computing Mainframe, amalgamating all the numerous devices and networks a resident may come into contact with during a day on Aresam. When arriving on Aresam, an occupant creates their own personal profile within the RCC which can then be used with the RADD (section 5.3.2), JEN (section 5.3.2), home and work computers, printers, public computers, ovens, dishwashers, refrigerators, house lights, entertainment devices, etc. The resident can control these devices through any computer terminal. A resident using the RCC can schedule functions such as food preparation, the laundering of clothes, vacuuming , retrieving work-related files from a home computer, and remotely toggling lights.

For maintaining the health and security of all inhabitants of Aresam, every month residents are required to ingest a pill containing millions of microscopic medical sensors that disperse through the bloodstream and do nothing but monitor vital bodily functions. When something is amiss, these sensors notify their host resident, allowing them to decide whether or not to seek medical treatment. At the end of each month, these sensors are naturally flushed from the body minimizing their effects on the immune system.

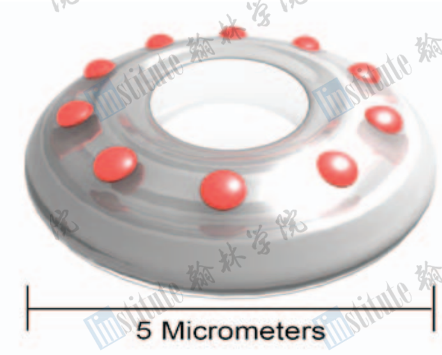


Figure 5.3.1: Micro-medical sensors flow through the bloodstream monitoring the health of all residents.

The education of both children and adults is of the utmost importance on Aresam. Accordingly, instruction automations have been designed to complement teachers and their lessons. Teachers can post anything from homework assignments to class notes to instructional videos on the Resident Computing Complex, making them available to all students at any time. Students can complete assignments and tests through any computer station and send them to the teacher for grading. All of Aresam's education automations are made to augment and enhance the first rate teaching of Aresam's highly trained teachers.

5.3.2 Automation for Productivity in the Workplace

With a population of around 20,000 working residents, Aresam is a thriving technical and business community. Therefore, Northdonning Heedwell has provided multiple workplace conveniences. Foremost of these is the RADD, or Resident All-Access Data Device, which each resident receives upon entering Aresam. RADDs are small, portable computers that utilize a fully interactive holographic display to provide residents a genuinely unique and efficient way of conducting both business and pleasure. Running entirely off of Aresam's Quantum Computing Mainframe, RADDs themselves contain only a wireless receiver, holographic projector, and touch and voice input sensors allowing them to be extremely compact and transportable. Most often RADDs are kept in pockets, on necklaces, or as wristbands, but a resident has unlimited options as to how to carry their RADD. Connecting directly to the Resident Computing Complex, RADDs allow residents to conduct their jobs, or any other task, anywhere on station, providing for increased productivity in business and lowered stress levels among

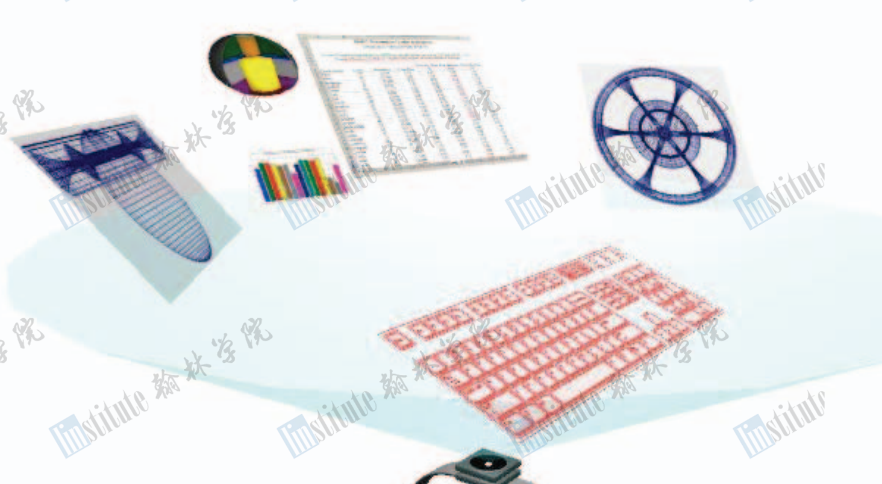


Figure 5.3.2: RADDs allows residents the freedom to conduct their business on the go, wherever they are in Aresam.

workers. Additionally, RADDs serve as the primary communication device around Aresam, eliminating the need for cumbersome communication devices.

For a primarily scientific community such as Aresam, the vast majority of occupations will be either entirely computer based or utilize computer control of automated systems. As a result, Northdonning Heedwell has created the Job and Entertainment Network, or JEN. Residents can connect to JEN through any public, private, or work terminal as well as through the RADD. Based in the Quantum Computing Mainframe, JEN allows residents to perform their jobs from anywhere on the station, giving residents a previously unheard of flexibility when it comes to working. Additionally, JEN allows inhabitants to access the station's Internet Databanks, opening up endless entertainment and informational opportunities for occupants. Residents are also able meet and collaborate in their job pursuits wherever they please within the station, such as the nearest park or pub.

5.3.3 Automation for Conveniences in Residences

Northdonning Heedwell strives to make home environments as luxurious, relaxing, and efficient as possible. Accordingly, all traditional or menial household tasks can be controlled through the RCC (see section 5.3.1). Anything from cooking dinner to cleaning clothes to vacuuming to washing dishes can be programmed in the RCC. Using robotic functions built into each residence during construction, the RCC can make certain that any chores a resident has planned are taken care of in an efficient and expedient manner before they become a hassle to the occupant. Finally, if an inhabitant wishes to complete household tasks manually, functions of the RCC can be activated or disabled according to an inhabitants wishes.

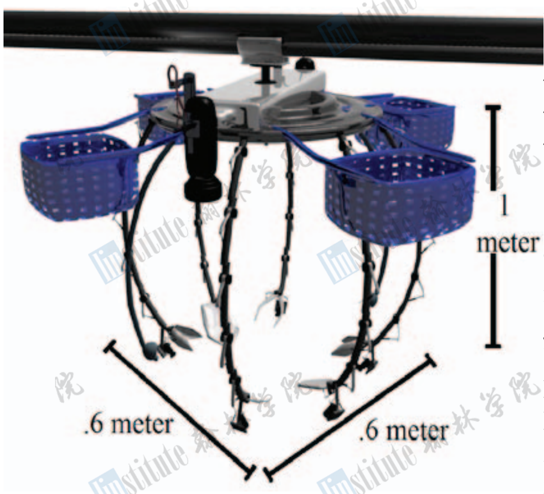


Figure 5.3.3: Agri-bots travel along aeroponics rails, harvesting crops in a precise and efficient manner.

5.3.4 Automation for Maintenance and Routine Tasks

Aresam is a safe and clean environment. Therefore, all maintenance, routine tasks, janitorial services, and labor intensive tasks have been automated. Maintenance of the interior of the station is provided through the repurposing of Interior Finishing Robots (see section 5.1.3) from the construction process. IFRs are small enough to complete any maintenance task within Aresam in the most efficient way possible. By reusing IFRs from the construction process, Northdonning Heedwell has saved time and money by not having to design and build an entirely new maintenance robot.

Janitorial services on Aresam are completed through a simple and efficient two step process. Infrared sensors placed in all fiber optic light outlets throughout the station identify and flag non-moving or otherwise unusual objects. Then, using the information from these sensors, janitorial robots (Section 3.2.4) 1m x 1m x 1.5m in size plan the most efficient route to reconnoiter the flagged objects and either dispose of them as waste or deal with them accordingly. As these operations are performed during the settlement's night, residents need not be hassled by janitorial services and are treated to a clean, hygienic settlement each morning.

Agri-bots harvest food grown in the agricultural sections of the station. Equipped with multiple jointed arms and collection bins, Agri-bots travel along aeroponics rails harvesting fruits and vegetables. These Agri-bots are entirely automated and can harvest from multiple layers of plants at once, providing the safest and most expedient food gathering method possible. Additionally, Agri-bots are totally sanitary allowing them to monitor crops for disease, fungi, or any other blight, ensuring Aresam has a consistent, safe food supply.

5.3.5 Automation for Personal Privacy and System Control

Privacy for residents of Aresam is a top priority for Northdonning Heedwell. Hence, in order to ensure personal privacy and control of systems in private spaces, all access to personal files or secure systems is granted through a combination of an iris scan and facial vein mapping scan. All terminals contain a simple camera with the sole purpose of performing these scans. Once a person has been scanned, identity is verified and access is granted. This system ensures that no one gains access to files or privileges that do not belong to them and that the security and well-being of Aresam is never in doubt.

5.3.6 Automation for Settlement Computing and Robotics

Settlement computing is handled by the Quantum Computing Mainframe (Section 5.2.1) which handles all of Aresam's computational needs and requirements. As for community robotics, residents can sign onto the Resident Computing Complex (Section 5.3.1) and request the use of a robot such as the Interior Finishing Robot for home improvement tasks. This allows residents great flexibility and a wide range of options when it comes to robotics on Aresam.

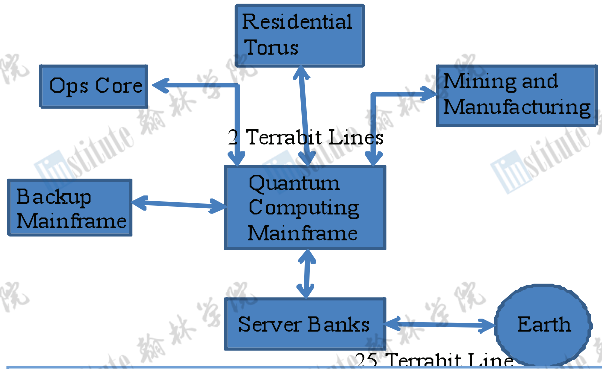


Figure 5.3.4 – Aresam's network and bandwidth capabilities allow instantaneous connectivity throughout the settlement.

5.4 Automations for Earth Communications

Through its use of massive, dedicated severs and bandwidth lines, Aresam is able to grant its inhabitants use of the Earth based Internet without the inconvenient time delay. This ensures occupants are able to search the web and stay up-to-date with current events on Earth and all other web based information, improving moral and productivity throughout the settlement.

5.4.1 Automation for Internet Connectivity

In order to provide for Earth-based systems connectivity on Aresam, links with the Earth based Internet and data repositories are kept open and updating at all times. Utilizing a dedicated 25-terabit bandwidth, the entirety of the Internet is drawn from Earth and kept constantly updated in massive server banks stored in the operations core. From there, residents may access whatever websites or documents they please. All pages are only as old as the time lag between Earth and Aresam, around eight to sixteen minutes, and are constantly updating. During breaks in communication due to solar flare activity or other occurrences, friendly messages explaining the problem and estimating the time until connectivity is re-established are sent to all inhabitants requesting access to the internet.

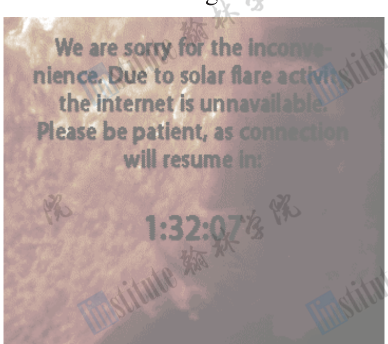


Figure 5.4.1: Friendly user message describing reason for lapse in Internet connectivity.

5.5 – Automatons for Mining, Refining, and Rapid Assembly Mars Settlement

Northdonning Heedwell has designed, tested, and implemented numerous automated systems for the collection of ore and materials from Mars and its moons. These systems work quickly and more proficiently than any contemporary mining method, guaranteeing Aresam the materials it needs both for construction as well as various business pursuits.

5.5.1 – Automatons for Mining and Transportation

Aresam gets the majority of its materials from Mars and its moons, and accordingly there are multiple robotic systems in place to ensure materials are collected in the most cost-efficient and expedient way possible. On Phobos and Deimos, Lunar Excavation Robots (LERs) are employed in the harvesting of material sources. These robots utilize large buckets to scoop up the soft, sandy soil of Phobos and Deimos were they then compact it using large metal plates within their structure and eject the packages into orbit for pick up with a hydraulic ram. On the Martian surface, the collection of raw materials is a three-step process. First, Strip Mining Robots (SMRs) bore holes into the surface of Mars and place high explosives. After detonation, Martion Ore Transportation Robots (MOTRs) collect the loose ore in large containers and transport it to the nearest Compression and Jettison Station (CJS). CJSs are situated strategically around the surface of Mars so they are within close proximity to all mining operations. These stations take the loose ore delivered from MOTRs, compress it into large elongated cylinders, and fire it into orbit using a railgun where it is then picked up by a Orbital Collection Vehicle (section 3.4.1). All surface robotics and automations are powered using the Microwave Power Transmission system (MPTS). The MPTS uses a flexible rectenna system to broadcast high frequency waves at 9-12GHz from Aresam's Solar Powered Satellites. Each robot robotic system receives these waves through an attached rectenna and converts them to a usable power source. The MPTS is the most efficient and effortless power system for surface robotics due to its great range and power capacity.

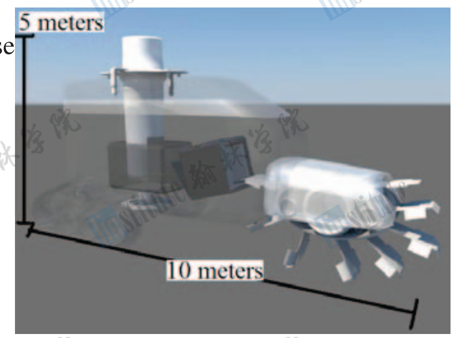


Figure 5.5.1: Lunar Excavation Robots integrate all aspects of Phoban and Deiman mining, streamlining the materials collection process.

Robot	Use	Function	Size	Number
Drilling and Pumping Station (DPS)	Drill to and extract Nitrogen and Water from deposits up to 300m beneath the surface of Mars and its moons.	Drill borehole to source. Melt source with high-powered laser. Pump liquid to surface for transportaion.	8m x 8m x 8m x	7
Strip Mining Robot (SMR)	Break up ground on Mars into ore for transportation.	Drill boreholes and insert explosives to break ground.	2m x 1.5m x 1m	50
Martian Ore Transportation Robot (MOTR)	Transport fresh ore from excavation site to CJS.	Collect ore in large containers and transport to CJS.	10m x 5m x 4m	75
Compression and Jettison Station (CJS)	Compress and jettison Martian ore into orbit for pick up.	Uses large compactors to compress ore and a railgun to launch ore into orbit.	100m x 15m x 30m x	8
Lunar Excavation Robot (LER)	Collect, transport, and jettison lunar ore into orbit for pick up.	Crawl across surface of moons collecting loose earth, compress ore with compactor, launch ore into orbit with small hydraulic ram.	10m x 4m x 5m	100
Joint Positioning Robot (JPR)	Construct walls and floor of bases. Place and/or transport operational equipment and other materials.	Maneuver objects and supplies using treads and multiple jointed, telescoping, arms.	1.5m x 1.5m x 2m	1 (per base)

Chart 5.5.1: Aresam's innovative mining methods collect ore and resources faster and more cost-effectively than any other contemporary mining technique.

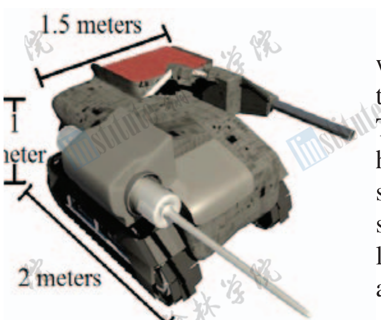


Figure 5.5.2: Strip Mining Robots and MOTRs work together to gather ore on Mars for construction and business purposes.

The harvesting of nitrogen and water is essential for the construction and operation of Aresam. Therefore, Northdonning Heedwell has designed a unique mining station for the collection of these substances. Firstly, surveying satellites scan both Mars and Phobos and Deimos for vast underground deposits of nitrogen and water. Once a pocket has been identified, a Drilling and Pumping Station (DPS) is sent to the surface and constructed above the pocket. This station then drills 300m down into the Earth until the deposit is reached, whereupon the water or nitrogen is melted using a high-powered laser. The liquid is then pumped up to the DPS where it is packaged and transported to a Compression and Jettison Station for launch into orbit. This process guarantees Aresam has a great excess of nitrogen and water for human and atmospheric use, while giving Aresam the opportunity to sell these commodities for a large gain.

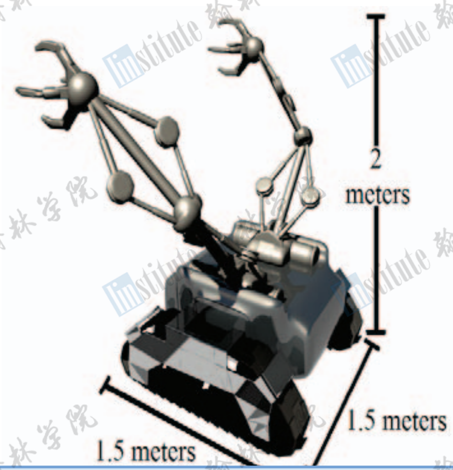


Figure 5.5.4: Joint Positioning Robots aid and abet humans in all their pursuits on the surface of Mars.

5.5.2 – Automatons for Rapid Assembly Mars Settlement

To aid in the construction and operation of the Rapid Assembly Mars Settlement, a simple yet strong and competent Joint Positioning Robot (JPR) has been designed and incorporated into the Rapid Assembly Mars Settlement's design. Employed in the construction sequence, the JPR uses its multiple jointed, telescoping arms to raise walls and floors while also positioning operational equipment and furniture. The JPR can also be utilized by inhabitants for any heavy lifting or transportation of materials they require during their stay on Mars. Finally, the JPR is used to deconstruct and repackaged the Rapid Assembly Mars Settlement when it is time for relocation.

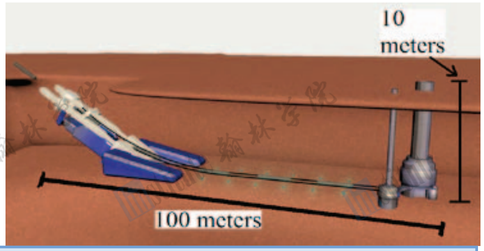
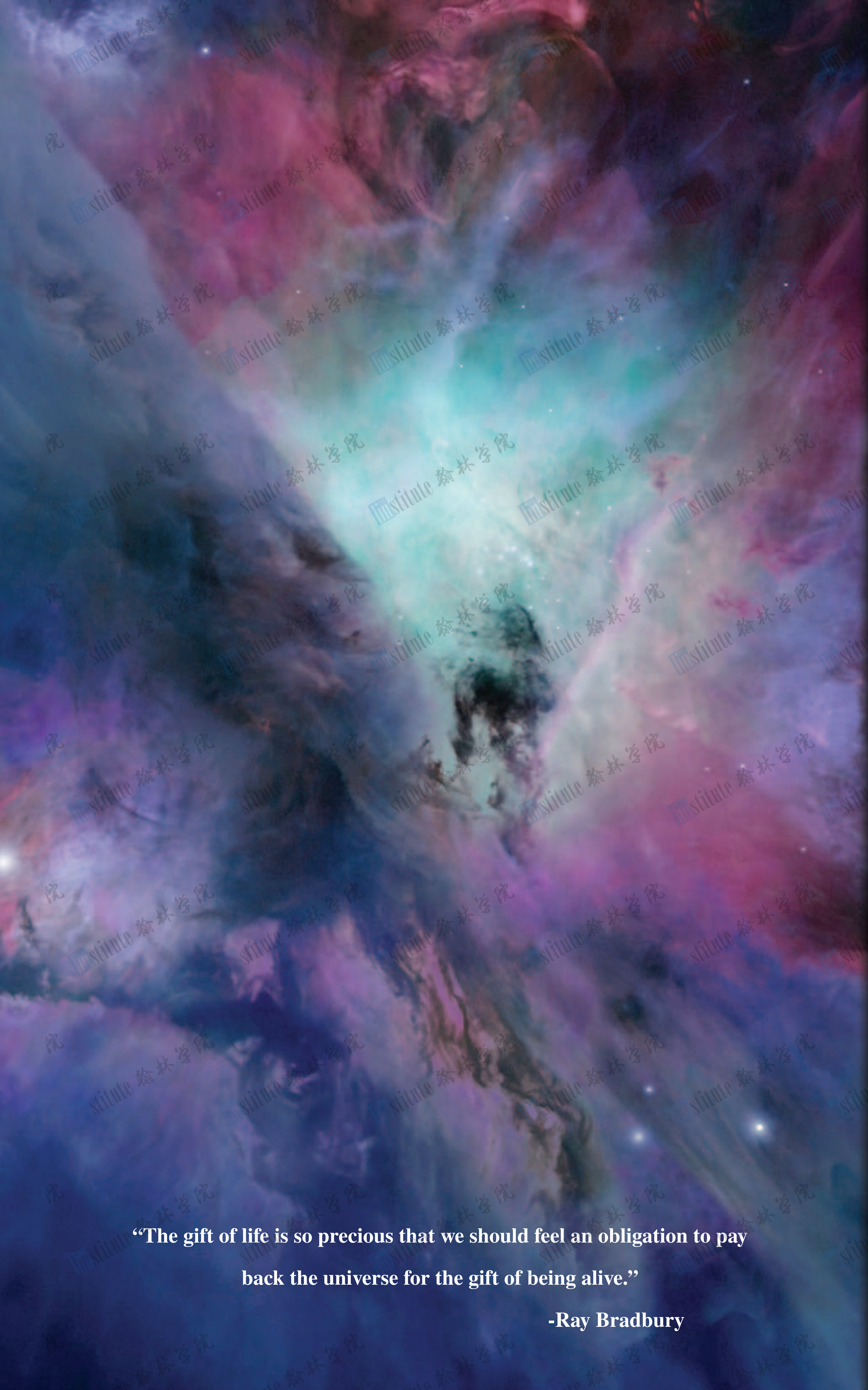


Figure 5.5.3: Compression and Jettison Stations launch ore and materials into orbit for pick-up.

5.5.3 – Automations for Refining

All refining processes, including automated and robotic aspects, are covered in Section 3.4.3.

6.0 SCHEDULE AND COST



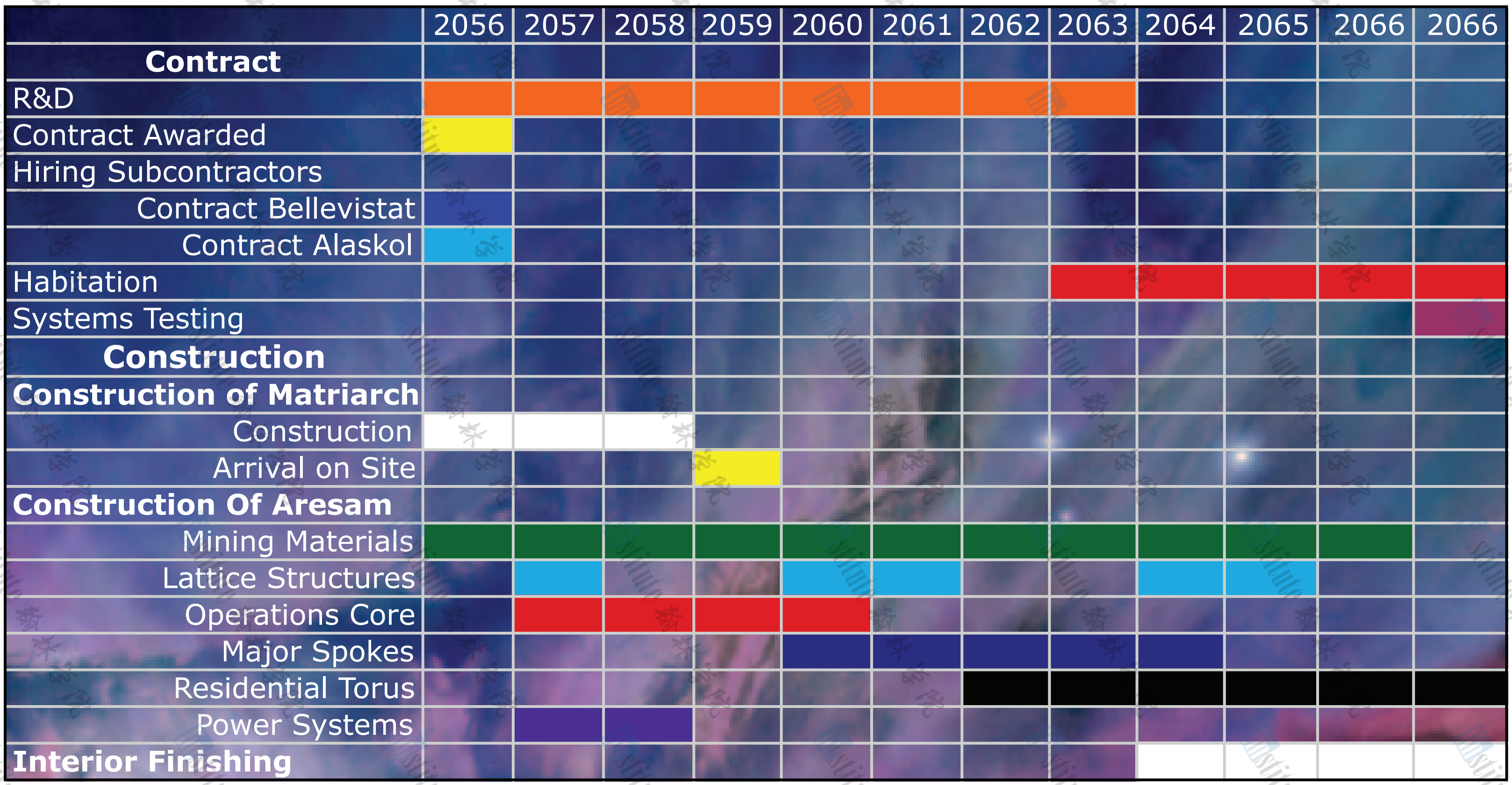
"The gift of life is so precious that we should feel an obligation to pay back the universe for the gift of being alive."

-Ray Bradbury

6.0 Schedule and Cost

As we well know, the construction of a space settlement is not easy or cheap. With this in mind, Northdonning Heedwell has developed a plan to not only reduce the cost of Aresam but also the time it takes for construction as far as we can without compromising quality. The key to our dynamic plan is our selection of subcontractors. Northdonning Heedwell has found the most reliable, hard-working, and cost-effective subcontractors to not only greatly reduce the investment required from the Foundation Society but also minimize the time before you reach a return-on-investment.

6.1 Schedule



6.2 Cost

Phase	Items	Cost of Items ($)	Employees
Research and Development	N/A	70,000,000,000	2,400
		Total Cost of Phase: 70,000,000,000	
Matriarch	Matriarch	170,000,000,000	550
	DSPS Satellites	20,000,000	
	Solar Satellite Production Units	80,000,000	
	Construction Robotics	7,400,000,000	
	QPM	600,000,000	
		Total Cost of Phase:178,100,000,000	
Operations Core Construction	Infrastructure Systems	10,000,000,000	1,290
	Manufacturing Systems	6,500,000,000	
	Docking Facilities	4,700,000,000	
	System Robotics	5,800,000,000	
		Total Cost of Phase: 27,000,000,000	
Torus & Major Spokes Construction	Agricultural Systems	2,000,000,000	2,045
	Transportation Systems	5,600,000,000	
	Additional Infrastructure	7,300,000,000	
	Cargo Handling Systems	800,000,000	
		Total Cost of Phase:15,700,000,000	
Major Spokes Finishing & Pressurization	Magnetic Track Installation	1,070,000,000	1,850
	Automation Infrastructure	2,500,000,000	
	Airlock Integration	1,470,000,000	
	Pressure Door System	2,600,000,000	
		Total Cost of Phase: 7,640,000,000	
Torus Interior Finishing	Contour Crafter Maintenance and Oversight	800,000,000	700
	Interior Finishing	2,000,000,000	
	Infrastructure Routing	500,000,000	
		Total Cost of Phase: 3,200,000,000	
Materials and Equipment	N/A	7,500,000,000	**N/A**
Transportation of Materials and Equipment and Matriarch	N/A	20,600,000,000	N/A
		TOTAL COST: 329,740,000,000	

7.0 BUSINESS DEVELOPMENT

"Predicting the future is much too easy. You look at the people around you, the street you stand on, the visible air you breathe, and predict more of the same. To hell with more, I want better."

-Ray Bradbury

7.0 Business Development

Northdonning Heedwell recognizes that Aresam is a multi-billion dollar investment, and has taken every possible measure to ensure that it is profitable. The financial future of Aresam stands firm upon the solid, dependable base of mining and manufacturing, granting the financial security needed to blossom into a diverse, fully realized economy as the settlement matures. Aresam presents the most varied portfolio of assets in the solar system, simultaneously shipping refined ore to Earth, encouraging small businesses to fill niche desires, while a fluid exchange of real estate creates a vibrant atmosphere of commerce and change. Aresam is an economic powerhouse, generating rapid returns and delivering the solid economic base that Foundation Society deserves.

7.1 Business Plan

The overall goal of the Business Division at Northdonning Heedwell is to construct Aresam as efficiently as possible, while opening thousands of potential revenue streams. These efforts have yielded the fastest estimated ROI that Northdonning Heedwell has ever provided, a mere 22 years. With this goal in mind, we present the overall business plan for the Aresam Space Settlement.

2056 - Upon acceptance of Northdonning Heedwell's proposal for Aresam, offices will be established in the major cities of Earth to begin the pre-sale of real estate and select mineral analysis services on Aresam.

2057 - After a short period to organize and work with our subcontractors, we will launch the first contingent of survey/assay probes to Mars and her moons. These probes will serve a duel purpose, to plot the most efficient places to mine minerals for the construction of the settlement, and after, to assay the entire surface.

2066 - Northdonning Heedwell has shipped the matriarch with several well-appointed assay laboratories, enabling the settlement to be inhabitable from the moment it arrives on site. This will provide a substantial amount of space for researchers to complete mineral analysis and other imperative operations that cannot wait for the station to be completely functional.

2066 - Foundation Society mining operations start, providing ore for the construction of the station. Mineral exploration and analysis operations have been completed. Martian mineral databases are opened, attracting Earth based companies to Aresam.

2070 - Ops core is complete and habitable, allowing the terminal facility, manufacturing and zero-gravity laboratories to operate at full capacity.

2075 - Major spokes are constructed, allowing the Foundation society to open these areas for initial habitation. Corporate activities starts, enabling the real estate market begins to function, even before construction of the residential torus is completed.

2080 - Aresam is turned over to the Foundation Society after final safety checks are complete. Aresam begins to show tangible returns as mining and manufacturing are turned away from construction, and toward production of profitable materials. The real estate market begins to mature as residents move into the main torus and spokes. Tourism and other indefinable revenue streams begin to operate in earnest and small businesses begin to appear, all promoting diversity and independence. Aresam begins striding towards her brilliant future.

7.2 Tangible Assets

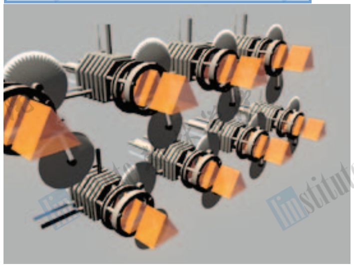
Proximity to resources; the most efficient and versatile manufacturing center in the solar system; the confidence to stake your claim on the Martian surface. Northdonning Heedwell has combined these into the most advanced economic dynamo ever.

7.2.1 Mining and Refining

Aresam is primed to take full advantage of the Martian surface. We guarantee profitable mining operations, through providing power systems, mining equipment, claim security and network connectivity. Due to our comprehensive approach to surface development and material handling, Aresam will become synonymous with Martian surface development.

The large transportation cost is a common argument against mining Mars. This may hold true for 90% of the minable minerals on Mars, most of which Earth presently holds vast reserves such as iron, copper, aluminum, water etc. Northdonning Heedwell has overcome this difficult problem with two separate and profitable plans for the minerals of Mars. First, we have classified materials by Earth-based prices (expensive items on Earth often overcome the high price of

Figure 7.2.1- Representative scene of production lines.



shipment from Mars), and have found the break-even point for materials. Items high on the list of potential profit, such as deuterium, will be marketed toward corporations on Earth. Ease of deuterium extraction provides impetus to initiate surface development and serves as a financial catalyst for expanded mining operations. The foundation society investors and corporations will see their future success in our deuterium endeavors. Reserves of germanium, hafnium, lanthanum, cerium, rhenium, samarium, gallium, gadolinium, gold, palladium, iridium, rubidium, platinum, and a host of other currently rare minerals are available on Mars, and will be transported back to Earth for a substantial profit. Reusable Mars-surface based single-stage-to-orbit vehicles (Palominos section 7.2) haul cargoes to Mars orbit for transportation to Earth via either cheap expendable chemical stages manufactured on Mars or reusable solar sail-powered interplanetary spacecraft, providing inexpensive, bulk transport from Mars to Earth orbit.

These valuable minerals are only the beginning. Mars and his moons hold an advantage that Earth does not: extremely small gravity wells. Northdonning Heedwell's revolutionary mining systems (section 3.4) makes transportation to space from the Martian surface extremely economical in relation to the prohibitive launch costs of Earth. Aresam will become the primary purveyor of construction materials to the entire solar system. Mars can provide raw iron, aluminum and other basic materials to Earth orbit and other space settlements at a fifth of the cost of exporting these materials from Earth- while maintaining large profit margins.

The Foundation Society will have an extensive mining operation on Mars, but will not be able to mine the entirety of the surface. This opens up mining claims for independent companies, facilitated and assisted by Aresam and the Foundation Society. Immediately after the contract is awarded, probes and assay laboratories are launched. These probes will serve two purposes: plot the most efficient places to mine minerals for the construction of the settlement, and after, survey/assay the entire surface and break it into 10 mile by 10 mile mining claim sections. All collected data will be logged in Foundation Society servers, ready to be sold to the highest bidder. This prospecting data is only one of a full suite of services perfectly tailored to attract mining companies to the thriving economy of Aresam. We provide secure systems for monitoring mining claim security, mineral shipping and delivery, and leasing and purchasing of existing mining infrastructure. All of these services will be selectively available before the settlement is completely online, granting large companies the time and information they need to bridge their operations into space. Northdonning Heedwell has cultivated the optimum full-service legal firm with expertise in the following categories: commercial litigation, energy law, environmental law, mining law, natural resources law, tax law and water law. Our firm also arbitrates mining claim disputes especially in regard to the Homestead Laws.

We understand the realities of free markets and therefore foresee the day where private corporations assume control of Martian mining enterprises. Our mineralogical databases, and specialized legal services and efficient, established transportation system ensures Foundation Society profit long into the future.

7.2.2 Manufacturing

The Matriarch ships with revolutionary automated manufacturing centers. The Manufacturing center is located in an optimum location within the matriarch this prime location provides several major advantages, for both construction and business pursuits. This location provides quick and efficient access to terminals, major spokes and the residential torus. Aresam has the capability to shift its production as demands fluctuate, adapting to any needs in a seamless manner. With simple automated refitting, the settlement shifts major production from hull panels to mining equipment in a matter of hours. This allows structural production to continue at full capacity, without storage and stockpiling of common materials. The rationale behind this unique location, and other factors considered in the manufacturing process are located in the detailed assessment in Appendix A.

Aresam single-handedly facilitates the mining of Mars, producing mining cores (section 3.3 and 8.A) and pre-fabricated bases from minerals extracted from the area. Mars surface landers (based on the Palominos used in previous Northdonning Heedwell proposals) transports mining equipment, pre-fabricated bases and humans to the Martian surface. These vehicles follow a proven design and are reliable and cost effective to operate. Aresam runs an entire fleet of Palominos, ensuring efficient on-demand provisioning, repair and relocation of mining and surface settlements.

Pre-fabricated bases will be one of the first products available for purchase on Aresam; bases (described in detail in all .5 sections) will be transported to customers desired location and outfitted with all equipment needed for the specific mission. Pre-fabricated bases offer the optimum environment for a four to eight person research team, merging a comfortable setting and perfectly appointed laboratory environment for an astounding sixty days. These bases will be constructed entirely from mined materials (section 2.5.1) while being reusable and easily transported. Bases will be available for purchase or for mission duration leases. Pre-fabricated bases will be transported to the Martian surface using the Foundation Society's fleet of Percherons, each capable of carrying 27,200 kg of payload to the surface. Personnel and provisions will be taken to the surface settlements using the slightly smaller Palomino; each Palomino is capable of moving 110 people to any destination while carrying a payload of 15,000 kg. Northdonning Heedwell has field tested these designs countless times, and they have proven to be an invaluable asset.

7.3 Transportation Node and Port

We designed our transportation systems and docking ports to enable the unimpeded flow of the Martian economy.

Aresam is a critical shipping backbone of the solar system. Northdonning Heedwell has taken multiple steps to decrease wait time and streamline all shipping, warehousing and docking procedures as detailed in sections 2.1.2,2.1.4 and 2.4.2). These steps have a profound effect on all aspects of work, minimizing time spent moving and locating goods while reducing overall cost of operation. Northdonning Heedwell anticipates rapid growth in the Martian sphere; our existing ports can handle shipping traffic at four times the expected growth rate resulting in no downtime, meaning your products and personnel move freely to and from the marketplace. Handling and storage fees are kept to a minimum for those who own property on Aresam. Aresam's cargo handling has set the industry benchmark. For instance, a standard payload of four containers takes 30 minutes to unload. If however, the cargo needs de-contamination, rapid dust mitigation incurs a 15 minute per container wait and a fee. Our industrial ports handle raw and in-process materials with ease. From OCV to storage or refining takes a mere 30 minutes per load. All cargo is tracked and inventoried upon receipt, using our RFID-based system, which we offer to our clients at a reasonable price based on volume.

As an incentive to our large volume clients, ships upgrading to the Lock-well system reap the benefits of prioritized docking sequence. Too, with Lockwell compatibility comes a faster dust mitigation service at a discount. Although our docking is a hallmark of our service, we would rather our customers do what they know best: mining and shipping.

Vessels docking with Aresam are greeted by a full suite of diagnostic, repair and dust mitigation tools; price varies by surface area and severity of dust contamination. All critical tasks related to the safety of Aresam and her residents will be completed by automated systems designed for total efficiency and low cost. This procedure includes a pass through a magnetic curtain, reversing the static charge on the dust, allowing it to be removed. This is followed by a thorough cleaning using pressurized CO^2 bursts and a powerful reverse pressure system to clean out sensitive air lock and other contact surfaces. This procedure is lengthened and is more comprehensive if a dry dock port is necessary. These tasks are not optional. Dust mitigation for a standard vessel would run approximately two dollars a square foot. For example a standard Percheron would run approximately 72,000 dollars to dock at our port. Vessels docking at Aresam's ports are also offered our unique liquid glass (section 4.3.1) dust mitigation service; this is an annual application that entitles vehicles to our high-priority, low dust mitigation ports. Liquid Glass Dust Mitigation will cost approximately 10 dollars a square foot and carry the distinct advantage of half-price dust mitigation at every Foundation Society Terminal. Every vessel docking with the settlement must complete a comprehensive dust mitigation procedure of some kind to ensure air lock function and longevity. After this critical step Aresam's port facility will begin basic provisioning tasks, loading all necessities required by the crew while performing basic cleaning tasks aboard the vessel. As in Northdonning Heedwell's previous settlements, a wide array of fuels will be available for sale, including nitrogen tetroxide, hydrazine, helium 3, and deuterium that together cover the entire spectrum of fueling needs. Aresam is equipped with a state of the art repair fleet, ready to take on any task (see auto section 5.2.2 and 5.3.4). Primarily robotic and autonomous, the repair system can access the vessels computers and assess any damage and fix minor problems with

Figure 7.3.1- Palomino Transport

no human involvement. Major structural problems or difficult to identify issues will be rectified by a highly trained human mechanic, aided by the repair fleet. This automated diagnostic repair system is a derivative of the maintenance system implemented on Foundation Society mining equipment, both in orbit and on the surface.

A productive settlement needs to be a healthy settlement. Upon arrival in Aresam all visitors are subject to a comprehensive medical examination by the Micro-medical sensors (section 5.3.1). If a threatening pathogen is detected the affected resident is guided to the operations core quarantine facility in a dedicated quarantine pod. Our quarantine facilities feature first-class amenities and feature spa like treatments. Quarantine residents and visitors are monitored for optimum health and are released revitalized and happy. Aboard Aresam, Northdonning Heedwell maintains an unprecedented level of biological security, while maintaining a quarantine process that is both simple and expeditious; this allows all customers and clients to enter the settlement with nearly no wait time, allowing fast and easy transactions and travel.

7.4 Soft Businesses

Aresam is a crowning achievement for the Foundation Society, both in terms of technical achievement and investment promise. The settlement is, like none before her, adaptable and dynamic, shifting and moving to meet the many and varied demands of her residents. Potential profits and purposes are vast, limited only by the ingenuity of the community gracing her interior.

Aresam is ready to become a booming mining metropolis, expanding her economy at a pace fueled by miners, technicians and students relocating to their new home. Every new immigrant brings new needs and opportunities for profit. Northdonning Heedwell has designed our business plan around this, providing simple and effective ways to identify needs and market goods and services. We can respond to demographic changes.

First and foremost, Northdonning Heedwell has created a flexible real estate market available to residents, entrepreneurs, and corporations. Initially real estate will be purchased from the Foundation Society, after which the customer is free to change or sell the property as desired. Every time a property changes hands, the Foundation Society charges a five percent transaction fee. This will become an ever-present source of passive income. This market will encompass residential and downtown areas as well as the operations sphere for industrial and scientific use. Implementation of the real estate market begins at date of S.O.W acceptance with establishment of offices in the major cities of Earth and Alexandriat, Bellivistat and Columbiat to begin the pre-sale of real estate on Aresam. Providing revenue streams directly into Foundation Society coffers before the station has been built, while establishing tangible interest and awareness of the station in its first years. These real estate offices will act as the marketing and sales for the settlement, coordinating advertising and bringing multinational companies into Aresam corporate space. Customers will be pleased by the option to customize original configurations (residential, corporate and industrial). Every aspect of property has the option to be changed and customized by uploading professionally designed blueprints and landscape designs to the Foundation Society, prior to interior construction.

Aresam is dynamic and adaptable, changing and evolving in response to the demands of the residents and customers. The settlement accomplishes this through a thriving small business community. Aresam is built upon the entrepreneurial spirit, and so we provide low interest loans and other incentives to potential small business owners. In order to jump-start Aresam's small business and entrepreneurial community, we have negotiated with Columbiat's Banking centers to provide low-interest loans to Aresam entrepreneurs. To further attract young, enterprising talent Olympus Mons University features a prestigious and rigorous degree in Mining Robotics and Advanced Assay Techniques among many others. For the top 100 applicants accepted into OM University Northdonning Heedwell offers a full ride scholarship because we believe in the power of young minds to transform our settlement. Major mining corporations aboard Aresam will court graduates, but Northdonning Heedwell's lucrative incentives make start-up opportunities both viable and profitable.

Conclusion

When Copernicus viewed Mars through his finely ground lenses, what did he see? A blood red satellite, embodiment of myth? He did not fear it. He wanted to seize it in his hands in wonder. Lowell envisioned a dieing civilization and Bradbury used Mars as a stage for our human fears. We share a vision with our predecessors, namely, that Mars is a mirror we hold to ourselves. We Northdonning Heedwell and the Foundation Society choose to see all that is possible in our daring Martian endeavor. Together, Aresam will get us indefinitely closer to Mars settlement, as is our dream.

APPENDIX 8A - DETAILED ASSESSMENT

"Now it was decelerating with metal efficiency in the upper Martian atmospheres. It was still a thing of beauty and strength."

-Ray Bradbury

Section 8A Detailed Assessment

In determining the structural layout of manufacturing infrastructure Northdonning Heedwell has taken the following factors into account:

- *Feasibility*
- *Transportation Requirements*
- *Impact on Humans*
- *Gravity and pressure variance*
- *Ease of access and maintenance*
- *Overall cost*
- *Human oversight capabilities*

Doing this has guaranteed us with the best possible location for the processes associated with manufacturing and construction.

	Torus-Ops Intersect	Progression from Docking to Storage	Entirely Within Spokes	Entirely Incorporated in Matriarch
Feasibility	2	9	2	5
Transportation Requirements	2	8	3	9
Impact On Humans (10 = Least impact)	6	9	2	6
Gravity and Pressure Variance	4	9	4	9
Ease of Access/Maintenance	7	5	7	5
Cost	3	8	4	1
Human Oversight Capabilities	5	5	5	5
TOTAL	29	**53**	27	42

Manufacturing Trade Study on Location of Manufacturing on Aresam

Rational Feasibility
- Torus-Ops Intersect
  - Near impossible due to constant movement and minimal space avaible.
- Progression from docking to storage
  - Clean and effective micro-gravity manufacturing
- Entirely within spokes
  - Variable gravity and minimal room
- Entirely incorporated within matriarch
  - Clean and effective but requires near full station completion by Bellevistat

Transportation Requirements
- Torus-Ops Intersect
  - Constant transfer between rotating and non-rotating parts
- Progression from docking to storage
  - Transportation is centralized but expansive
- Entirely within Spokes
  - Variable gravity transport and minimal space
- Entirely incorporated within matriarch
  - Completely centralized but expansive

Impact on Humans
- Torus-Ops Intersect
  - Located in a non-populated area but in a necessary transport line
- Progression from docking to storage
  - Virtually zero impact on necessary human infrastructure
- Entirely within spokes
  - Located directly above large living communities
- Entirely incorporated within matriarch
  - Virtually zero impact on necessary human infrastructure

Gravity and pressure variance

- Torus-ops Intersect
  - o Variable gravity and both pressurized non pressurized
- Progression from docking to storage
  - o Micro-gravity and zero pressure provides maximum efficiency
- Entirely within spokes
  - o Constant variable gravity and pressurized
- Entirely incorporated within the matriarch
  - o Micro-gravity and zero pressure provides maximum efficiency

Ease of Access/Maintenance

- Torus-ops Intersect
  - o Located in a vital position on the exterior of the operations core
- Progression from docking to storage
  - o Placed throughout the operations core, requiring many access ports
- Entirely within spokes
  - o Located with clear and easy access from the torus
- Entirely incorporated within the matriarch
  - o Placed throughout the operations core, requiring many access ports

Cost

- Torus-ops Intersect
  - o Complicated and expensive infrastructure due to constant movement
- Progression from docking to storage
  - o Majority is created post matriarch construction from materials gathered reducing total cost
- Entirely within spokes
  - o Created entirely after matriarch construction, but requires the ability to operate in variable gravity, thus increasing construction costs
- Entirely incorporated within the matriarch
  - o Entirely built by Bellevistat vastly increasing construction costs

Human oversight capabilities

- Torus-ops Intersect
  - o Constant movement and altering gravity
- Progression from docking to storage
  - o Scattered throughout the operations core requiring many oversight stations
- Entirely within spokes
  - o Extremely close to living areas
- Entirely incorporated within the matriarch
  - o Scattered throughout the operations core requiring many oversight stations

Steel Refining / Manufacturing

	On Mars	On Phobos/Deimos	On Aresam
Feasibility	6	1	7
Transportation Requirements	5	2	5
Impact On Humans (10 = Least impact)	10	10	7
Gravity and Pressure Variance	5	5	5
Ease of Access/Maintenance	3	2	7
Cost	7	5	5
Human Oversight Capabilities	2	1	9
TOTAL	38	26	**45**

If we were to refine our steel on Mars, once we shipped it to Aresam, it would have to be re-smelted. Therefore, it is better to ship iron ore straight to Aresam where we can refine and manufacture it all in one place.

Polymer Manufacturing

	On Mars	On Phobos/Deimos	On Aresam
Feasibility	2	1	8
Transportation Requirements	5	3	5
Impact On Humans (10 = Least impact)	10	10	5
Gravity and Pressure Variance	3	3	10
Ease of Access/Maintenance	2	2	6
Cost	5	3	5
Human Oversight Capabilities	2	1	8
TOTAL	29	23	**47**

Comments: Many essential components to polymer manufacturing, including CO2, can be easily and more cost-efficiently imported from Phobos and Deimos as opposed to Mars. Additionally, many other components, including CO and CO2, are produced through refining processes already taking place on Aresam (see refining diagram).

Glass Manufacturing

Comments: Almost all of the materials involved in glass manufacturing can be collected from Phobos and Deimos. However, refining on the moons would develop dust mitigation problems, ease of maintenance problems, and unnecessary adaptations to the unstable foundation conditions found on the moons. Conversely, refining on Aresam diminishes all of these probable issues, and the materials have to be transported to Aresam anyway, so it is easier to transport them in an unrefined state.

	On Mars	On Phobos/Deimos	On Aresam
Feasibility	6	3	7
Transportation Requirements	1	7	7
Impact On Humans (10 = Least impact)	8	8	5
Gravity and Pressure Variance	5	5	5
Ease of Access/Maintenance	3	2	8
Cost	1	6	9
Human Oversight Capabilities	3	2	8
TOTAL	27	33	**49**

Raw Silicate Manufacturing

	On Mars	On Phobos/Deimos	On Aresam
Feasibility	4	3	7
Transportation Requirements	1	4	6
Impact On Humans (10 = Least impact)	6	6	4
Gravity and Pressure Variance	5	5	5
Ease of Access/Maintenance	2	4	7
Cost	1	6	8
Human Oversight Capabilities	3	2	8
TOTAL	22	30	**45**

See glass rational above

Cement and Concrete Manufacturing

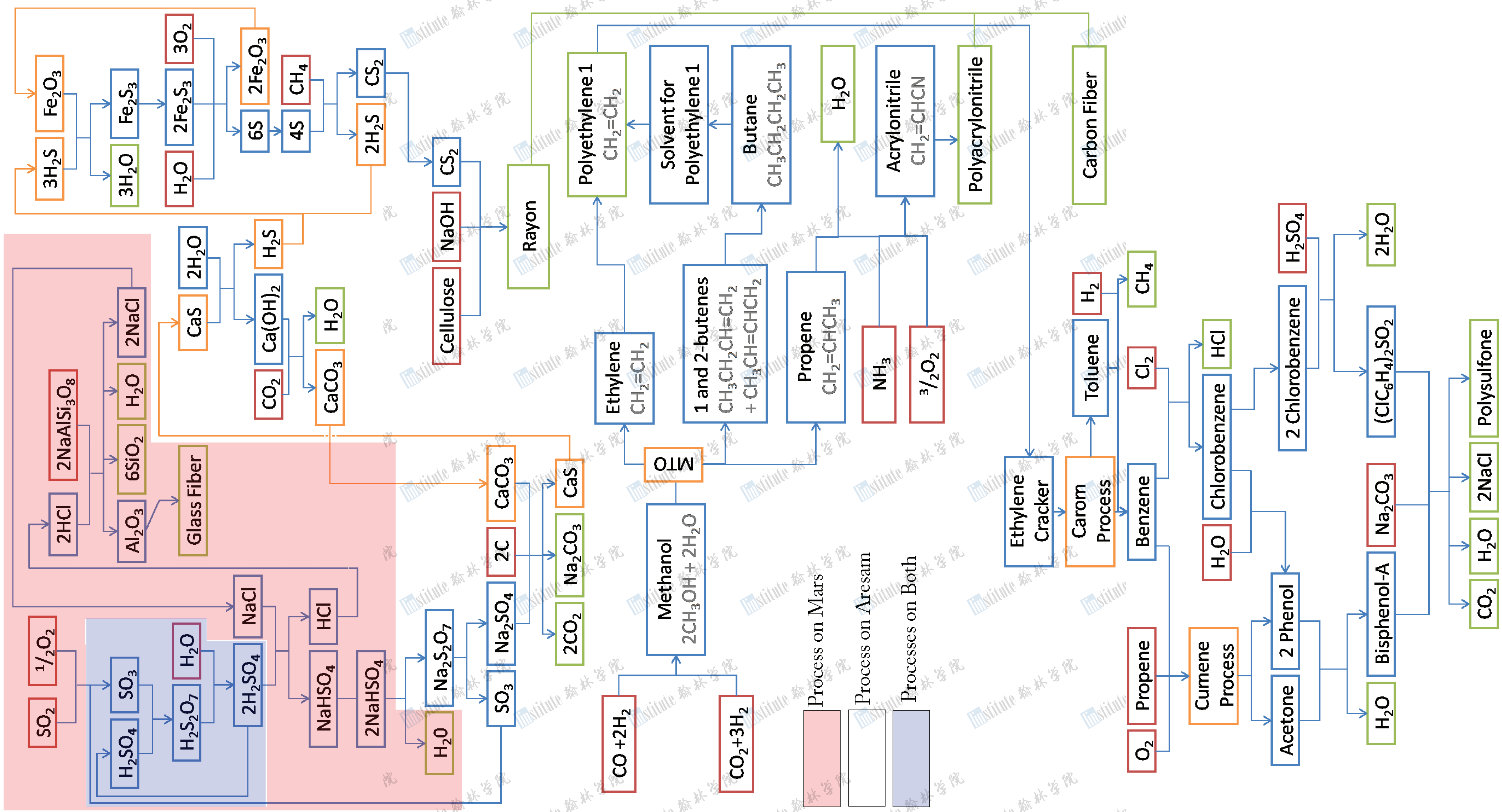
	On Mars	On Phobos/Deimos	On Aresam
Feasibility	2	2	9
Transportation Requirements	8	1	6
Impact On Humans (10 = Least impact)	6	8	2
Gravity and Pressure Variance	4	4	9
Ease of Access/Maintenance	4	2	7
Cost	3	8	4
Human Oversight Capabilities	5	5	5
TOTAL	32	30	**42**

Comments: If refined on Aresam, cement components launched from Mars could be dehydrated to reduce transfer weight, and would be able to conform temporarily to the rail-gun shipping containers' shape.

Carbon Products Manufacturing

	On Mars	On Phobos/Deimos	On Aresam
Feasibility	1	3	8
Transportation Requirements	1	5	7
Impact On Humans (10 = Least impact)	9	8	6
Gravity and Pressure Variance	3	3	9
Ease of Access/Maintenance	1	2	8
Cost	2	4	7
Human Oversight Capabilities	3	4	8
TOTAL	20	29	**53**

Comments: Many of the processes we use create main components for both carbon fiber and polymers. Catalysts and cycles extract all necessary chemicals to continue refinement of both materials, including CO and CO2. We can centralize all of our manufacturing and refining at Aresam by keeping cycles in one physical location and by keeping polymer production and carbon fiber production likewise. Transportation requirements are greatly decreased if the station's algae and bamboo cellulose sources (used in the creation of rayon) are readily available. Therefore, we minimize material transportation by locating refining on Aresam, and we are able to limit transportation of Martian materials to one chemical: Na2S2O7. (see refining diagram)



Fe_2O_3
$3H_2S$
Fe_2S_3
$3H_2O$
$3O_2$
$2Fe_2S_3$
H_2O
$2Fe_2O_3$
$6S$
CH_4
$4S$
CS_2
$2H_2S$
CS_2
NaOH
Cellulose
Rayon
$2H_2O$
H_2S
CaS
$Ca(OH)_2$
CO_2
H_2O
$CaCO_3$
$2NaAlSi_3O_8$
$2NaCl$
H_2O
$6SiO_2$
$2HCl$
Al_2O_3
Glass Fiber
$^1/_2O_2$
SO_2
SO_3
H_2SO_4
H_2O
$H_2S_2O_7$
$2H_2SO_4$
NaCl
HCl
$NaHSO_4$
$2NaHSO_4$
$Na_2S_2O_7$
H_2O
Na_2SO_4
SO_3
$CaCO_3$
2C
CaS
Na_2CO_3
$2CO_2$
Polyethylene 1
CH_2=CH_2
Solvent for Polyethylene 1
Butane
$CH_3CH_2CH_2CH_3$
H_2O
Acrylonitrile
CH_2=CHCN
Polyacrylonitrile
Carbon Fiber
Ethylene
CH_2=CH_2
1 and 2-butenes
CH_3CH_2CH=CH_2
+ CH_3CH=$CHCH_3$
Propene
CH_2=$CHCH_3$
NH_3
$^3/_2O_2$
MTO
Methanol
$2CH_3OH + 2H_2O$
CO +$2H_2$
CO_2+$3H_2$
Process on Mars
Process on Aresam
Processes on Both
Ethylene Cracker
Carom Process
H_2
Toluene
CH_4
Cl_2
Benzene
HCl
Chlorobenzene
H_2O
H_2SO_4
2 Chlorobenzene
$2H_2O$
$(ClC_6H_4)_2SO_2$
Propene
O_2
Cumene Process
2 Phenol
Acetone
Na_2CO_3
Bisphenol-A
H_2O
Polysulfone
2NaCl
H_2O
CO_2

COMPLIANCE MATRIX

"We are cups, constantly and quietly being filled. The trick is, knowing how to tip ourselves over and let the beautiful stuff out."

-Ray Bradbury

8.0 Compliance Matrix

Requirement	Where Addressed	P.#
1.0 – Describe the design, development, construction and operations/ maintenance planning for the Aresam space settlement in Mars orbit.	1.0 - Executive Summary	7
2.0 - 20,000 full time residents	2.0 Structure, Section 2.1.1 Station Layout	9-10
2.0 - 500 transient population increasing at 50 per year for at least 30 years	2.0 Structure, Section 2.1.1 Station Layout	9-10
2.1 - Exterior drawing identifying attributes and uses of large closed volumes	Figure 2.1.2 Operations Core Layout	10
2.1 - Dimensions and materials used in major hull components, design components of hull structure	2.1.1 Station Layout, 2.1.2 Hull composition, Table 2.1.1 Dimensions of hull components, Table 2.1.3 Hull Materials, 3.1.2 Source of Materials and Equipment	9,10,17
2.1 - Specify volume where artificial gravity is applied	2.1.1 Station Layout, Table 2.1.4 Gravity Differences between terraces Table 2.1.1 Dimensions of hull components	10
2.1 - Interface between rotating and non-rotating sections	2.1.1 Station layout Figure 2.1.3 Interface between torus and Operations Core	9
2.1 - Rational for selected rotation speed and gravity magnitudes	2.1.3 Artificial gravity	10
2.1 – Protection from radiation and debris	2.1.2 Hull composition	10
2.1 – Capability to isolate any two of at least ten separate volumes in case of emergency	2.1.1 Station layout	9
2.1 Minimum Requirements		
Overall exterior view of the station showing rotating and non-rotating sections	Figure 2.1.1 Overall view of condensed structure	9
Specify pressurized and non-pressurized volumes	Figure 2.1.1 Overall view of condensed structure	9
Indicate function within every volume	2.1.4 Operations core Figure 2.1.2 Operations core layout 2.1.1 Station Layout	10
2.2 – Percentage allocation and dimensions of interior down surfaces	2.2.1 Torus Layout Table 2.2.2 Allocation of Down Area Table 2.2.2 Interior Dimensions of Torus	11
2.2 – Drawings labeled to show residential, industrial, commercial, agricultural, and other uses	2.2.1 Torus Allocation Figure 4.1.2	11, 27

2.2 – Show orientation of "down surfaces" with respect to overall settlement design	2.1.1 Figure 2.2.1 Overall View of Condensed Structure	9
2.2 – Vertical clearance in each area	2.2.1 Figure 2.2.2 Torus Cross Section	11
2.2 Minimum Requirements		
Overall layout of interior land areas, showing usage of those areas	Figure 4.1.2 Torus Top Down View	27
2.3- Describe the process required to construct the settlement, by showing the sequence in which the major components will be assembled	2.3 Construction sequence, Figure 2.3.1-6	12
2.3 – Specify when artificial gravity is applied	2.3 Construction sequence	12
2.3 – Sescribe a construction technique for interior structures making use of materials from Phobos and Deimos	2.3 Construction Sequence	12
2.3 Minimum Requirements		
Drawing(s) showing at least six intermediate steps of settlement assembly	Figure 2.3.1 Construction Diagrams	12
Method for initiating rotation for artificial gravity	2.3.1 Construction Sequence	12
2.4 – Expansion capabilities during transition from early exploration to major surface exploration to large-scale operations on Mars	2.4.1 Expansion Capabilities	12, 13
2.4 – Show design features enabling expansion, emphasizing reduction of initial costs and later operations disruption	2.4.1 Expansion Capabilities	12, 13
2.4 Minimum Requirements		
Drawing(s)/map(s) showing interfaces(s) and/or other system(s) enabling future expansion	Section 2.4.1 expansion capabilities, Figure 2.4.1 Lock-Well System, Figure 2.4.2 Dry Docking	13
Port modifications to accommodate for currently unknowable vehicles	Figure 2.4.1 Lock-Well System, Figure 2.4.2 Dry Docking	13
2.5- Create a design for a prefabricated structure to be built at Aresam of materials from Phobos and/or Deimos, must fit within one cargo container (dimensions 4m x 9m x 4m)	2.5.1 Prefabricated base design	14
2.5 – Must be erectable by 2 space suited people in 10 or fewer hours	2.5.2 Base Construction Sequence	14
2.5 – Must be provisioned to supply 4 people for up to 30 days	2.5.1 Prefabricated Base design	14
2.5 Minimum Requirements		
Drawings of deployed/undeployed base configurations, plus at least one interim configuration illustrating the deployment process	Figure 2.5.1 Deployed base, Figure 2.5.2 Half Deployed base, Figure 2.5.3 Allocation of space in shipment container	14

3.0 Describe facilities and infrastructure necessary for building and operating the Aresam space settlement and associated communities	3.0 Operations and Infrastructure	
3.1 Specify Mars orbital location (altitude and inclination) for Aresam and the reasons for its selection	3.1.1 Orbital Location	16
3.1 Identify sources of materials and equipment to be used in construction, then in settlement operations after construction is complete	3.1.2 Source of Materials and Equipment	16
3.1 Specify the means of transporting materials to the Aresam location	3.1.2 Source of Materials and Equipment	16
3.1 Minimum Requirement		
Provide a table identifying types, amounts, and sources of construction materials	Chart 3.1.1	16
3.2 Specify atmosphere, climate, and weather control (identify air composition, pressure, and quantity)	3.2.1 Atmosphere and Climate Control	17
3.2 Show food production (including growing, harvesting, storing, packaging, delivering, and selling)	3.2.2 Food Production	17, 18
3.2 Electrical Power Generation (Specify kilowatts) Distribution and allocation for specific uses	3.2.3 Power Generation	18
3.2 Specify water management (required water quantity and facilities)	3.2.4 Water Management	19
3.2 Specify household and industrial solid waste management (specify recycling and/or disposal)	3.2.5 – Waste Management	19
3.2 Specify internal and external communication systems (specify devices and central equipment)	3.2.6 Communications	19-20
3.2 Internal transportation systems (show routes and vehicles, with dimensions)	3.2.7 Internal Transportation	20
3.2 Specify day/night cycle provisions (specify schedule and mechanisms/operations for providing it)	3.2.8 Day-Night Cycles	21
3.2 Define storage facilities required to protect against interruption in production of food or commodities needed for daily life (Supply lines for imports may be interrupted for ten months)	3.2.2 Food Production	18
3.2 Minimum requirements		
Charts or tables detailing systems which provide required infrastructure and as appropriate, their configurations	3.2 Basic Infrastructure	17-21
3.3 Show conceptual designs of primary machines and equipment employed for constructing the settlement, especially for assembling exterior hull and interior structures	3.3.1 Transportation of Raw Materials	21, 22

3.3 Specify materials, components, and/or subassemblies delivered to the machines and how the machines convert delivered supplies into completed settlement structure	3.3.2 Manufacturing Process	21, 22
3.3 Minimum Requirement		
Drawings of primary construction machinery, showing how it shapes and/or manipulates raw materials or structural components into finished form.	Figure 3.3.1, 3.3.2, 3.3.3, 3.3.4	21,22
3.4 Describe material harvesting operations on Phobos and/or Deimos mining base.	3.4.1 Lunar Mining	22-23
3.4 Minimum Requirement		
Provide illustrations of Phobos and/or Deimos mining base	(Reference section 5.5)	42
3.5 Describe essential infrastructure systems required for operation of a prefabricated base	3.5.1 Atmosphere – 3.5.2 Food – 3.5.3 Power – 3.5.4 Water/Waste Management – 3.5.6 Fire Protection	23, 24
3.5 Minimum Requirement		
Provide a chart or table detailing quantities of air, food, power, water, and waste	3.5.1-3.5.6	23-24
4.0 - Aresam offers the quality of life through various attributes of Earth's small cities in developed countries (i.e. education, entertainment, and residential designs)	4.0 - Human Factors	26
4.0 - Assure that natural sunlight and views of space outside and Mars below are readily available	4. 0 - Human Factors	26
4.0 -Ensure transportation systems decrease the impacts of the coriolis effect upon residents	4.0 -Human Factors	26
4.1 - Provide services that residents expect in comfortable modern communities (i.e. housing, parks and recreation, medical , education, and entertainment)	4.1 - Community Design 4.1.1 - Neighborhoods 4.1.3 - Parks and Recreation 4.1.4 - Medical 4.1.5 - Education 4.1.8 - Entertainment	26, 27, 28
4.1 - Supply variety and quantity of consumables	4.1.9 -Consumables	28
4.1 - Provide public areas designed for long lines of sight	4.1 - Community Design	26
4.1 - List major types of consumables and quantities	4.1.9 - Consumables Figure 4.1.4 - Consumable Chart	28
4.1 - Specify means of distributing consumables (i.e. food, cloth, toiletries, and paper) to Aresam residents	4.1.9 - Community Design Figure 4.1.4 - Consumable Chart	28

4.1 Minimum Requirements		
Portray community design and location of amenities with distance scale	Figure 4.1.1 - Community Layout of Aresam	26
Identify percentage of land allocated to roads and paths	4.1.2 - Road and Pathways	27
4.2 - Provided designs of typical residential homes, clearly showing room sizes	4.2.1 - Housing Designs Figure 4.1.1 through Figure 4.1.5	28, 29, 30
4.2 - Identify sources and/or manufacture of furniture items and appliances	4.2.2 - Demographics Figure 4.2.8	30
4.2 Minimum Requirements		
External drawing and interior floor plan of at least four home designs (in sq ft)	4.2.1 - Housing Designs Figure 4.1.1 through Figure 4.1.5	28, 29, 30
Specify the quantity of housing designs	4.2.2 - Demographics Figure 4.2.7	30
4.3 - Designs of systems, devices, and vehicles intended for use by humans outside of artificial gravity volumes that emphasize safety	4.3.1 - Spacesuit and Airlock Design 4.3.2 - Means of Safe Access in and Around the Settlement	31, 32, 33
4.3 - Depict spacesuit designs for safe access in non-pressurized volumes	4.3.1 - Spacesuit and Airlock Design Figure 4.3.1 - Bio Suit and Exoskeleton Figure 4.3.2 - Spacesuit composition	31
4.3 - Portray stowage and donning/doffing procedures	4.3.1 - Spacesuit and Airlock Design Figure 4.3.3 - Airlock Design 4.3.4 - Donning and Doffing Procedure	31, 32
4.3 - Show airlock designs for exiting/entering the settlement from unpressurized volumes	4.3.1 - Spacesuit and Airlock Design Figure 4.3.3 - Airlock Design	31, 32
4.3 Minimum Requirements		
Drawing(s) showing examples of handrails, tethers, cages, and/or other systems enabling safe human access to any location on or in low-g settlement environments	Figure 4.3.1 - Bio Suit and Exoskeleton Figure 4.3.2 - Spacesuit Composition Figure 4.3.3 - Airlock Design Figure 4.3.4 - Donning and Doffing Procedure Figure 4.3.5 -MORV Figure 4.3.6 - Mars Rover	31, 32, 33

4.4 - Show examples of flexible housing and community design to respond to anticipated demographic trends of Aresam	4.4 - Accommodations for Demographic Shifts Figure 4.4.1 - Modular System for Housing Designs	33, 34
4.4 Minimum Requirements		
Specify anticipated demographic trends for Aresam in a chart or table	Figure 4.4.2 - Chart of Future Demographic Shifts	34
4.5 - Show interior configuration of a prefabricated base	4.5 - Prefabricated base Figure 4.5.1 - Interior Layout of Prefabricated Base	34
4.5 Minimum Requirements		
Drawing(s) of base structure interior floor plan and amenities	Figure 4.5.1 - Interior Layout of Prefabricated B ase	34
5.0 – Show robot designs, clearly indicating dimensions and illustrating how they perform their tasks	5.0 – Automaton Design and Services	36-43
5.1 – Describe use for automation for construction	5.1.1-Omni-functional Manufacturing Robot 5.1.3- transportation 5.1.2-Interior Finishing Robot, contour crafters	36-37
5.1 – Describe automation for transportation and delivery of materials and equipment	5.1.3- Automation for construction transportation	37
5.1 – Describe automation processes for assembly of the settlement, and interior finishing	5.1.1- OMR 5.1.2-Interior Finishing Robot, contour crafters	36-37
5.1 Minimum Requirements		
Drawings showing automated construction and assembly devices both for exterior and interior applications and indicate how they operate	Figure 5.1.1, Figure 5.1.2, Figure 5.1.3, Chart 5.1.1, Section 5.1.1	36-37
5.2 – Specify automation systems for settlement maintenance and repair	5.2.2 – Maintenance is provided by repurposed robots used in the construction process.	38
5.2 – Specify automation systems for safety functions, including backup systems and contingency plans	5.2.3 – Security Response Robot, SRR 5.2.1 – Distributed QCM	38-39

5.2 – Describe means to protect robots required for emergency external repair that must survive and accomplish tasks during solar flare activity	5.2.4 – Smaller processors shielded with layers of RAgaurd, Polyethylene, and lead.	39
5.2 – Describe means for authorized personal to access critical data and command computing and robot systems	5.2.1 – Quantum Computing Mainframe. 5.2.3 – All robots are controlled by the QCM	38-39
5.2 - Include descriptions of security measures to assure that only authorized personnel have access, and only for authorized purposes	5.2.4 - Multiple layers of security systems, two-person verification.	39
5.2 Minimum Requirements		
Chart or table listing anticipated automation requirements for operation of the settlement, and identifying particular systems and robots to meet each automation need	5.2.1 – Chart of robots and their functions 5.2.2 – Maintenance and repair robots 5.2.3 – Security and medical robots	37-39
5.3 – Describe automation devices to enhance livability in the community	5.3.1- Resident Computing Complex	40
5.3 – Describe automation devices to enhance productivity in work environments	5.3.2- Resident All-Access Data Device	40
5.3 – Describe automation devices to enhance convenience in residences	Section 5.3.3, 5.3.3-RADD, RCC	40-41
5.3 – Emphasize use of automation to perform maintenance and routine tasks, and reduce requirements for manual labor	5.3.4- Janitorial services, Interior Finishing Robots	41
5.3 – Provide for privacy of personal data and control of systems in private spaces	5.3.5- Iris scan and facial vein mapping scan	41
5.3 – Describe devices for personal delivery of internal and external communications services, entertainment, information, computing, and robot resources	5.3.2- RADD 5.3.6- Resident Computing	41-42
5.3 Minimum Requirements		
Drawings of robots and computing systems that people will encounter in Aresam, and diagrams of networks and bandwidth requirements to enable connectivity.	5.3.1- Image of medical sensor 5.3.2- Image of RADD	40-42
5.4 - Describe access to data repositories on Earth, which are not instantly available	5.4- Dedicated 25-terabit bandwidth	42
5.4 – Describe access processes to Earth-based Internet/ website data, both for retrieving and posting information	5.4- Constantly updating database, two-way transfer	42
5.4 Minimum Requirements		
Table describing or images showing Internet user experiences on Aresam; including user messages to identify delays, and methods to create appearances of instant access	5.4- Automations for Earth Communications	42

5.5 – Provide robotic assistants for deployment of prefabricated base design	Figure 5.5.4 – Joint Positioning Robot	43
5.5 – Describe automation systems for conducting materials harvesting operation on Phobos and Deimos	5.5.1- Lunar Excavation Robots, Strip Mining Robots Martian Ore Transportation Robots	42-43
5.5 – Describe automation systems for refining/ processing of raw materials	(Reference Section 3.4.2), Detailed Assessment 8A	22-23, 52-55
5.5 Minimum Requirements		
Drawings of robotic base deployment and Phobos/ Deimos operations	(Reference Section 2.5.2)	14
6.0 – Include a schedule for completion and occupation of Aresam	6.0 Schedule	45
6.0 – Include costs for design through construction phases of the schedule	6.2 Cost	46
6.1 – Describe contractor tasks from the time of contract award (7 May 2055)	6.1 Schedule	45
6.1 Minimum Requirements	6.0 Schedule and Cost	45-46
List/chart/drawing of durations and completion dates of major design, construction, and occupation tasks	6.1 Schedule	45
6.2 – Specify costs billed per year of Aresam design through construction in US dollars without inflation	6.2 Cost	46
6.2 – Estimate numbers of employees working during each phase of design and construction	6.2 Cost	46
6.2 – Justification for contract costs to design and build the settlement	6.2 Cost	46
6.2 Minimum Requirement		46
Charts/tables listing separate costs associated with different phases of construction clearly showing total costs that will be billed to the Foundation Society	6.2 Cost	46
7.0 – Aresam hosts various commercial and industrial ventures, which may change over time	Section 7 Business	48-51
7.0 – Show that design is sufficiently flexible to add compatible business types with little configuration chang.	7.4 Soft Business	51
Transportation Node And Port Minimum Requirements	7.3 Transportation Node and Port	50
Provide docking, warehousing, and cargo-handling capability to transfer freight between spacecraft and industrial enterprises planned for Mars and the asteroids	7.3 Transportation Node and Port	50

Terminal facilities to handle passenger traffic in transit to and from Mars	7.3 Transportation Node And Port	50
Provide refueling and provisioning services for visiting ship	7.3 Transportation Node And Port	50
A base and repair depot for a fleet of Mars surface landing/launch vehicle	7.3 Transportation Node And Port	50
Include vehicles that spend time on the Martian surface and bringing materials from Phobos and/or Deimos to accumulate dust on exterior and interior surfaces	7.3 Transportation Node And Port	50
Show methods of dust mitigation on Aresam	7.3 Transportation Node And Port- 4.3.1 Spacesuit and Airlock Design	50
Provide medical and quarantine services	7.3 Transportation Node And Port	50
Manufacturing center for elements of Mars and Phobos/Deimos infrastructure Minimum Requirements	7.2.2 Manufacturing	48-49
Products include launch/landing and surface vehicle, tools, machinery, robots, and prefabricated transportable bases	7.2.2 Manufacturing	48-49
Specify source of materials for vehicle, robot, and prefabricated base construction	7.2.2 Manufacturing	48-49
Describe manufacturing processes to be conducted in pressurized, non-pressurized, rotating, and non-rotating volumes	Appendix 8A	53-56
Illustrate a representative scene from a production line	7.2.2 Manufacturing- Figure 7.2.1-7.2.2	48-49
Show how vehicles and robots intended for surface operations are transported	7.3 Transportation Node And Port Figure 7.3.1 and 7.3.2	50
Specify how food and other commodities are transported to the Martian surface	7.3 Transportation Node And Port Figure 7.3.1 and 7.3.2	50
Research center for development of commercial products from Mars resources Minimum Requirements	7.2 Tangible Assests	48-49
Supply laboratory(ies) for assay of and experiments with materials collected on Mars	7.2.1 Mining and Refining	48-49
Provide capability to rapidly begin production for product(s) identified as having commercial potential	7.2.1 Mining and Refining	48-49
Specify cost criteria for selecting commercially viable products (i.e. value of products on Earth vs. transportation costs from Mars)	7.0 Business Development	48-51
Provide labs configured to enable quarantine if materials hazardous to human are identified in the exploration of life on Mars.	7.2.1 Mining and Refining	48-49

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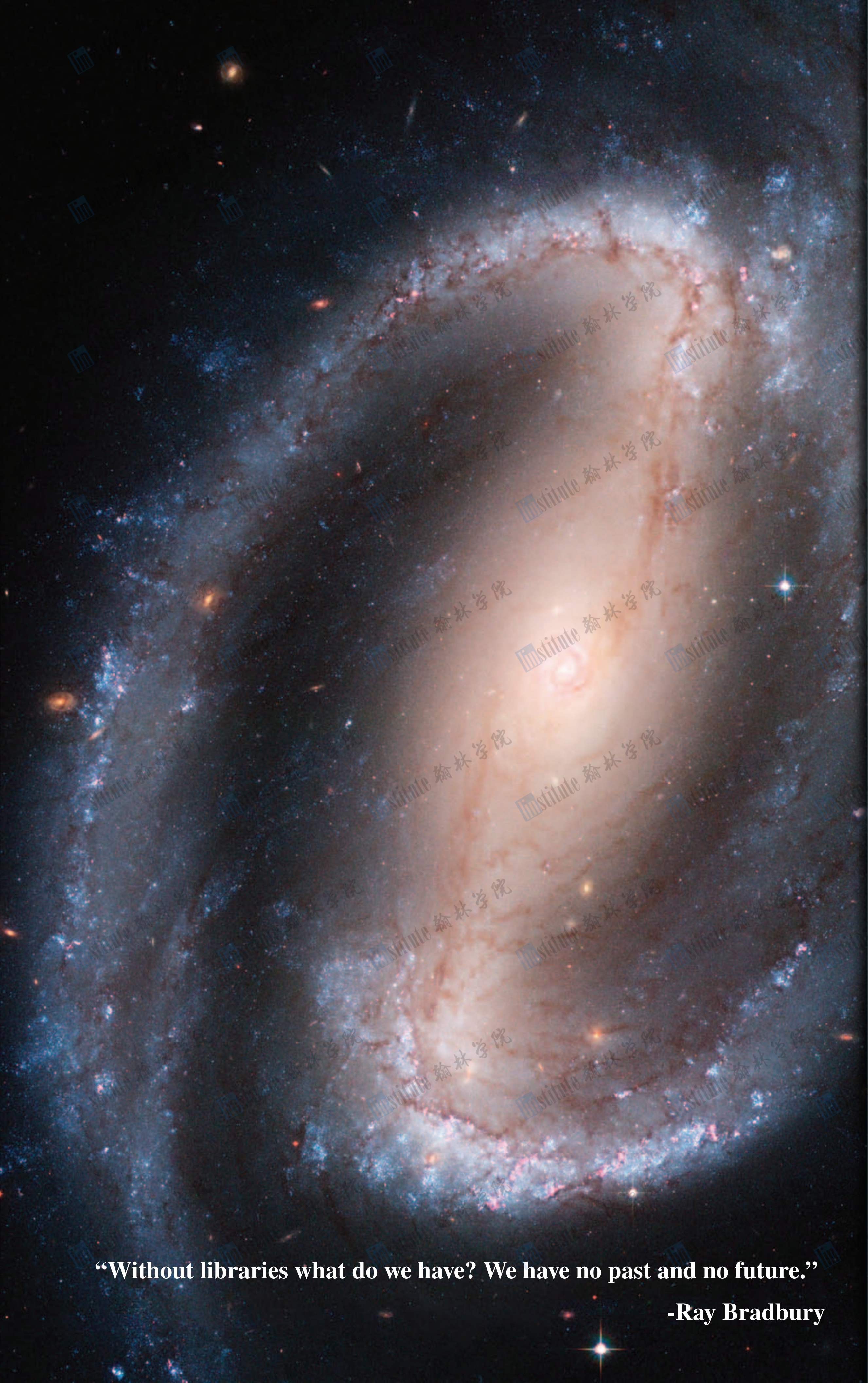

"Without libraries what do we have? We have no past and no future."

-Ray Bradbury

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