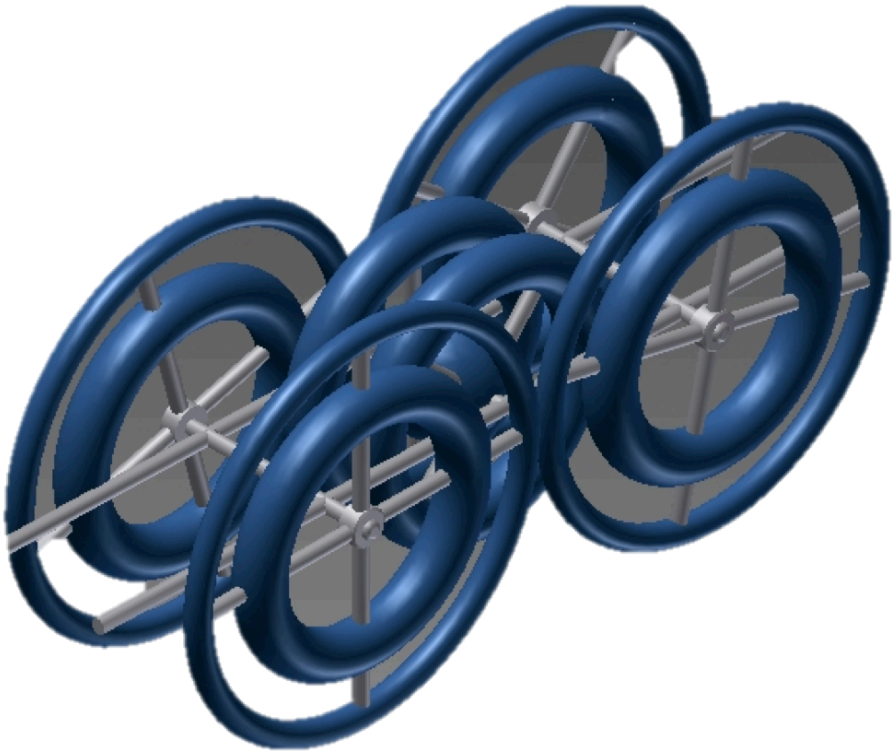
Space Settlement
Aynah



Cerritos High School
Cerritos, CA
USA

19th Annual Internatioal Space Settlement Design Competition
Proposing Team Data 2012

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Names, [grade levels], and (ages) of 12 students currently expecting to attend the Finalist Competition:
(we request that participants be at least 15 years old, and not older than 19)

Jimmy Tang 12ths grade, 18 yrs old	[ ] (
Vasun Mannar 12th grade, 17 yrs old	[ ] (
Chuck Chao 11th grade, 17 yrs old	[ ] (
[ ] ( )	[ ] (

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

Phil Turek	Christina Preciado

I understand that if our Team qualifies for the International Space Settlement Design Finalist Competition Jul
27 - 30, we will be expected to finance our own travel to/from Nassau Bay, Texas, USA.

Philip A Turek	31-Mar-12
Responsible Teacher/Advisor Signature	Date

1.0: Executive Summary

Space colonization has been a dream of many scientists and engineers since the beginnings of the space program in the 1950s and ‘60s. With the technology available to us today, this dream can become a reality. In fact, we can hypothesize that space colonies in our near future can offer residents the same amenities and prosperity that we can expect on Earth. Although popular destinations for space colonies have been in low-Earth orbit and the Moon, even the planet Mercury can be a habitable location. In fact, our design for the space colony Aynah will orbit the planet Mercury. In order to create this colony, we will utilize the metal Reordonium, a special metal that can withstand temperatures of 700 K to 100 K, and can offer protection from heat, cold, and radiation.

2.1: External Configuration

2.1.1: General Characteristics

-9 rings: 2 for agriculture, 4 for residential, 1 for commercial, 2 for industrial

1.3 revolution per minute.
- 0.6g ring(s): 317.3 m
- 0.7g ring(s): 370.2 m
- 0.8g ring(s): 423.0 m
- 0.9g ring(s): 475.9 m
- 1g ring(s): 528.8 m.

-15m left for sewage and wiring
-65 foot of room to allow for spaciousness.
-Building allowance 40 meters high
-74.83316774 meter width of flooring
-total surface area (one torus): 302,384.6 m
-total surface area (All rings): 2,721,461.2 m

2.1.2: Uses of Large Enclosed Volumes

Volume	**Gravity**	**Pressurization**
Residential Tori	.7g and ___ gravity	Pressurized
Activity and Development Tori	1g	Pressurized
Industrial Sphere	.1g - .5 g gravity. The use of a sphere for industrial uses makes use of the variation of gravity in a sphere to give variation needed to refine Reardonium. Such low gravity facilitates the movement of massive parts and machinery. A sphere is chosen for its minimal resource requirements allowing for early completion of industrial areas.	Pressurized
Major Commercial Tori	.7g and ___ gravity	Pressurized
Main Rod	Zero gravity because the volume is unable to rotate as it is the connecting point of all inhabitable volumes.	Pressurized.

2.2: Internal Arrangement

2.2.1: Interior Down Surfaces

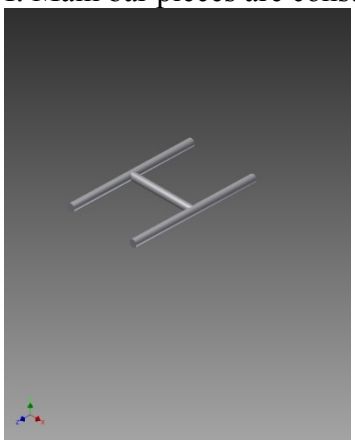
2.2.2: Percentage Allocation and Uses of Areas

2.3: Construction Process

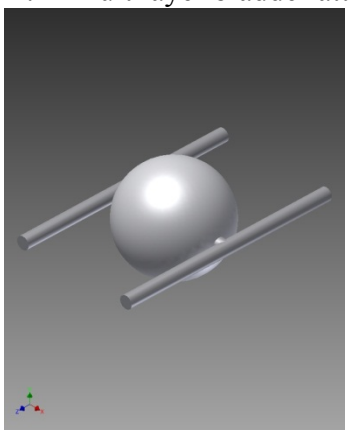
2.3.1: Sequence of Construction

Initial Phase: Construction of an industrial sphere.

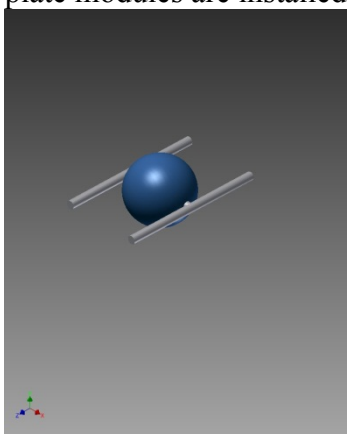
I: Main bar pieces are constructed on Mercury and sent to an equilibrium point to be joined.



II: A multilayer bladder attached and inflated.



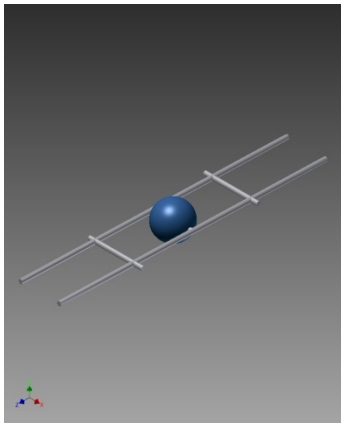
III: Triangular plate modules are assembled on the exterior of the inflated sphere while internal plate modules are installed inside.



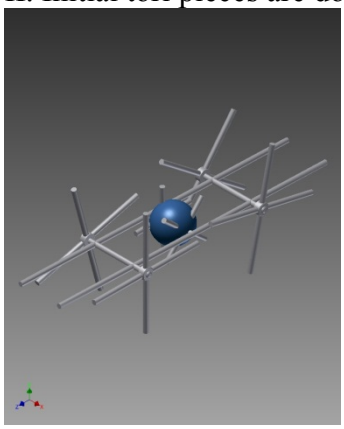
IV: Artificial gravity is supplied.

Secondary Phase and beyond:

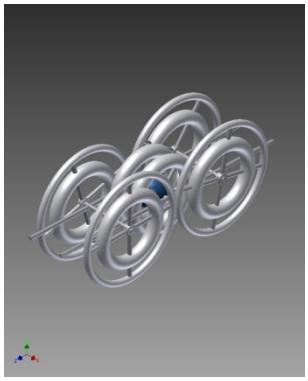
I. The main bar is extended to accommodate for more tori.



II. Initial tori pieces are docked and secured onto the main bar.



III. A main skeleton is constructed.



IV. A multilayer bladder is joined to the skeleton and inflated.
V. Triangular plate modules are assembled on the interior and exterior of the tori.
VI. Artificial gravity is supplied.

Multilayer bladder

A multilayer bladder is formed by gores made of alternating layers of Kevlar, and Nextel separated by strips of open cell foam. Interior layers will be constructed of layers of multilayer insulation comprised of kapton seperated by thin scrim. Ripstops will be incorporated into the fabric to maintain the structure of the fabric in times of impact. Reardonium rods running through layers allow for internal and external hulls to be joined together as well as enforce separation in the layers. The exterior layer of the bladder will be Such configuration with an

initial bumper constructed of reardonium allows the hull to act as an effective Stuffed Whipple shield to allow for the disruption and shocking of micrometeorites.

Triangular Plate Modules

Triangular plate modules will be initially manufactured in facilities on Mercury. As the industrial torus is completed, manufacturing will be shared by industrial areas on the colony. The modules made for the exterior are constructed with a layer of Reardonium for initial shock of space debris followed by a few layers of Boron Nitride nanotubes for radiation protection. Interior modules are constructed from a compartment of water sandwiched between a layer of reardonium and a layer of regolith from mercury again sandwiched between two layers of reardonium. Triangular plate modules are easily replaced in times when damage is too severe to repair.

The electrostatic shield stops most radiation before it comes in contact with the physical shield; however, any other radiation is either absorbed or reflected by the physical shield. If the electrostatic shield malfunctions or becomes inoperable, the physical shield will

Electrostatic Shielding

http://futureinnovation.larc.nasa.gov/docs/Thibeault_Final.pdf

Docking

Rotating volumes are securely attached to the main bar via a docking mechanism to allow for the maintaining of pressure inside the colony. Several arms on the active side of the mechanism on the initial spokes pieces reach out and capture the passive ring on the main rod. Once captured, the device aligns itself and pulls the two structures together to complete the docking. Following docking of the initial spokes pieces, Reardonium reinforcements secure onto the connection and make it permanent. Reardonium bearings on the active end of the docking mechanism allow for rotation of the tori along the docking and strength of connections.

Solar panels

This provides maximal exposure of solar panels to the sun and provides the secondary use of blocking direct viewing of the sun through windows. Solar panels located along the sides of the colony adjust themselves to follow the sun thus allowing effective gathering of solar energy at any point of the colony's orbit of Mercury

Impulse Engine.

A large structure orbits Mercury in the same orbital period as Aynah, trailing behind. This structure connects onto incoming spacecraft to slow it down by using kinetic energy from incoming spacecraft to turn motors converting that energy to electricity and using it immediately to launch a partner spacecraft in the opposite direction or send a satellite to orbit Mercury and essentially store the kinetic energy in the satellite for later use. The impulse engine slows a spacecraft enough to safely enable it to dock on Aynah and recycles the energy lost in the process.

Ship Docks

Docks will be located at either end of the central rod. Vehicles (and people) will enter an airlock for primary dust off and then secondary dust off with the latter being conducted as

detailed dust off by robots. Following dust off procedures, humans enter a chamber for suit off and vehicles are able to enter the colony after clearance.

Material	Purpose
Reardonium	Reardonium serves as the primary bumper in the Whipple shield and a major component of the hull. Its use as ball bearings takes advantage of its self-lubricating properties.
Kevlar and Nextel	These layers of the multilayer bladder provide structural strength of the colony and are able to stop 50% to 300% more massive projectiles in a Stuffed Whipple shield than a Whipple shield solely made of aluminum.
Kapton	Kapton layers create multilayer insulation for the interior layer of the multilayer bladder. This method uses the exterior layers to protect these fragile layers of insulation and has heat dissipate between several layers before reaching these layers.
Boron Nitride Nanotube Composite	With low density of 1.37 g/cm^3 and large neutron absorption, boron nitride nanotubes provide an effective radiation shielding material. With the low atomic mass of boron, the composites protect against various radiation types.
Regolith	Regolith is formed into tiles after the removal of elemental oxygen through *in situ* sintering. This provides for an effective heat and radiation shielding redundancy as it is one of the most interior layers. It forms a component of the rearwall of the hull.
Water	Material able to provide effective radiation shielding as an extra precaution to residential and commercial areas.

Windows

Treated Borosilicate Glass	The glass provides a transparent medium for viewing. The material is noted for its low coefficient of expansion and resistance to thermal shock. With the infusion of five percent cerium oxide, the glass is able to withstand the darkening effects of radiation and ultraviolet light. Dichroic filters sandwiched between the glass block out ultraviolet and infrared light.
Transparent Boron Nitride Nanotube Composite Film	This film is transparent to visible light through; however, it blocks or absorbs various types of radiation to allow for safe planetary viewing.

2.3.2: Artificial Gravity:

Artificial gravity is only supplied once two opposing tori are completed. Each pair of tori are spun in opposing directions at the same speed to counter the effects of torque on the colony.

3.1: Location and Materials Sources

3.1.1: Orbital Altitude

3.1.2: Construction Materials

3.2: Community Infrastructure

3.2.1: Atmosphere, Climate, and Weather Control

Aynah's atmosphere consists of 41% oxygen, 40% nitrogen, and less than 1% carbon dioxide. The overall temperature of the colony (with the exception of residential and agricultural areas) will be set at approximately 72 to 77 degrees F, with an average humidity level of 40%. Atmospheric pressure will be kept at one-half times that of the Earth. Temperatures and humidity levels of our agricultural farms will vary depending on the crops/animals. This varying temperature and humidity will be regulated through the use of dehumidifiers, which will also be used to reclaim water. In storage areas for crops, humidity will also be regulated. Furthermore, our food production facilities will each have a different temperature and light composition, simulating seasons and keeping food production constant. For example, far red and red light would stimulate the photoperiod that a plant required to flower. In order to simulate Earth-like changes in weather due to seasons, different areas of the residential district will be kept at different temperatures.

Section of the Colony	Average Temperature	Humidity (Mid-day)
Residential (Winter)	62 degrees F	50%
Residential (Spring)	72 degrees F	45%
Residential (Summer)	76 degrees F	40%
Residential (Autumn)	68 degrees F	45%
Industrial/Commercial Rings	75 degrees F	40%
Food Production (Winter)	50 degrees F	40%
Food Production (Spring)	65 degrees F	55%
Food Production (Summer)	77 degrees F	65%
Food Production (Fall)	60 degrees F	60%

Water

The process of reclaiming water on Aynah will be achieved through two independent methods. The first involves extracting water from the air with a dehumidifier. The moisture from Aynah's agricultural districts mainly comes from plants through a process known as transpiration. This moisture will be captured using dehumidifiers and then distributed throughout the colony. This water will be pure and stripped of chemicals or any dissolved salts.

The second method of reclaiming water is somewhat more self-sufficient. Water will also be reclaimed from wastes through a process known as the Zimmerman method. In this method, wastes are heated with oxygen at 500 degrees at 100 times normal atmospheric pressure for 1.5 hours. This produces a very high-quality water containing ammonia and fine phosphate ash; these minerals are then filtered out of the water and mixed into animal feed or given to plants. This process also produces a gas rich in carbon dioxide, but without nitrogen, sulfur and phosphorus; this gas can be used to maintain carbon dioxide levels in the farm areas. Both the water and gas from this process are sterile.

After water is reclaimed, it will be used as irrigation water for crops, water for food and waste processing, and drinking water for both animals and residents. Water will always flow continuously throughout the colony in a cycle, allowing for a closed ecosystem.

3.2.2: Food Production

3.2.2.1: Agricultural Torus

The farms on the agriculture torus are divided into terraced levels: fish ponds reside at the highest level, from which the effluent flows to the lower levels, where crops and animals are grown. This method of using the effluent of fish is known as Aquaponics (see section 3.2.4). Sunlight will also be distributed through each of these levels through the use of mirrors reflecting upon each other. Aynah's agricultural farms will require a total of 115 acres of land to support the 14,000 residents continuously.

3.2.2.2: Plant Growth

Plant growth on Aynah will involve the use of raft hydroponics. In this method, our crops will be suspended on a pool of water and nutrient solutions and kept afloat using Styrofoam. Through this method, short stature plants such as lettuces and salad crops can be grown easily. Aynah will also particularly grow tomatoes, cucumbers, cabbage, radishes, broccoli, melons, and potatoes, which can be grown in controlled greenhouse environments. Interplanting will also be utilized to optimize crop production per acre. Docile bees will also be introduced for the purpose of pollinating these plants and producing honey. Grain production will include wheat (as it is a dietary staple), which will provide much of the carbohydrate requirement for our residents.

3.2.2.3: Animal Growth

Animals grown on Aynah will include rabbits, chickens, goats, and fish. Rabbits are the most desirable source of meat for Aynah because they reproduce quickly, require little space and forage, and are versatile. A rabbit and its litter require only 0.85 sq meters of living space and about 10 square meters of alfalfa (rabbit feed). Rabbit meat is also a healthy source of protein. Chickens, though they produce more waste, will be fed kitchen waste and leftovers from meals, which will give each resident 3 to 4 eggs per week. Aynah will also utilize ruminants, particularly goats, to produce milk from plant-based waste materials; goats are used for this purpose as they produce more milk than cows do. These goats must not be fed onions and must be kept clean. Goats require grain as feed, which can be used from the excess grain produced for human products.

Fish also provide us with an excellent source of food. The fish from the top levels of the agricultural system help recreate the food chain by eating the diatoms and algae that grown on the minerals, sunlight and CO2 (See Aquaponics).

Animal	Feed	Benefits/Uses
Tilapia	Diatoms/Algae	Nitrite/Nitrate for nutrient-rich water
Rabbits	Alfalfa (10 sq. meters per rabbit and its litter)	Good source of healthy, protein-rich meat
Goats	Excess grain from food production	Milk
Chickens	Kitchen waste/Leftovers	Eggs (good source of protein)

	from meals	
Meliponine Bees	Nectar	Honey and pollination of plants. They are docile and cannot use their stingers for defense.

3.2.2.5: Aquaponics

The integration of aquaculture systems with hydroponics forms a recirculating system that maximizes food production by converting fish effluents to nutrients essential to plant growth. The aquaponics module to be utilized on Aynah will start with four rearing tanks in which fish will be raised. Water, as it accumulates toxic levels of effluents for the fish, will be pumped out and prepared for a hydroponics subsystem, first passing through solids removal then through biofilters of bacteria *Nitrosomonas* and *Nitrobacter* to be converted to nitrite and then nitrate respectively. The nutrient-rich water will be pumped into eight hydroponic tanks and later to a sump to be treated then reintroduced to the rearing tanks completing the cycle. Although the technique requires greater initial water needs than hydroponics and aeroponics, it eliminates most nutrient replacement and results in less than 2% daily water exchange, resulting in a more efficient system over time.

3.2.3: Generation of Electrical Power

3.2.4: Waste Management

Because Aynah is a closed ecosystem, it will provide two methods of waste disposal. In the first, the harmful gases released from cooking and wastes will be absorbed on activated charcoal, which is then sent to waste treatment. Another method of disposal is to pass atmospheric air through a catalytic burner to dispose of certain substances. For pollution regulation, mass spectrometers and gas chromatographs can be used to detect even the lowest concentrations of a gas. Waste disposal can also be in the form recycling and compost piles. Animal waste can be converted into fertilizer that will be used for agricultural purposes. Waste from the industrial districts will be recycled and reprocessed for further use.

3.2.5: Communication Systems

The Nyx tablet provides all necessary communication between residents on Aynah. It is able to support video calling or advanced holographic calling. Desktop and wall interfaces will supplement communication by projecting full body holograms of a user.

3.2.6: Internal Transportation Systems

The spokes connecting the tori are very important for transportation between the different rings of the colony. The MetroRail System (see 5.2.1) will assist residents in traveling from different rings, particularly those who travel from the residential to the commercial districts for work. This system will feature a maglev train system, which uses electromagnetic suspension to keep the subway train suspended. An electrical power source will then allow for rapid transportation.

3.2.7: Day/Night Cycle Provisions

The day-night cycles inside the colony will emulate the twenty-four hour day-night cycles on Earth to make the citizens feel natural and enable an easier transition from life on Earth to life inside the space colony. Natural views will be projected on the ceiling of the colony, transitioning from day to night. Fiber optic cables will relay light from the sun to the colony. Optical filters adjust with each hour ensuring that light emitted during the day portion of the cycle is mainly comprised of bluer higher temperature light and gradually redder and lower temperature light as the day cycles into night. More blue light inhibits the production of melatonin allowing for alertness during the day while red light nearing the night cycle encourages sleep. Such cycle encourages the maintenance of natural circadian rhythms of colonists. The use of LED lights compensates for the lack of natural light when Aynah is behind Mercury in its orbit.

3.2.8: Hypothetical Crop Failures

Aynah's farming system is very stable and can withstand a major crop failure or infestation. Fumigation of shipments from Earth will be mandatory to keep out undesirable insects, weeds, bacterial and viral diseases. The wide variety of plants and animals grown and the physical separation of farms along several vertical farm will prevent any major infestation occurring. There can also be several seedbanks, which are gene banks that store seeds of food crops and rare species. Seedbanks will serve as a precaution for major crop failure if seed reserves are somehow destroyed, perhaps by natural disaster.

Generally, however, 1/4th of all agricultural production is kept frozen in a pulse tube cooling system after flash freezing to provide for freshness before being cycled out by new produce. This ensures that if there were to be a catastrophic outbreak of crop failure or infestation, there would be enough to sustain residents of Aynah before assistance arrived.

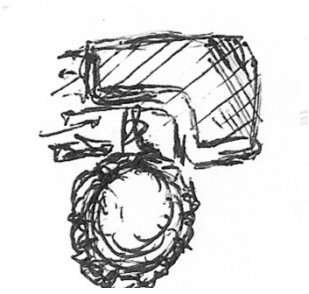
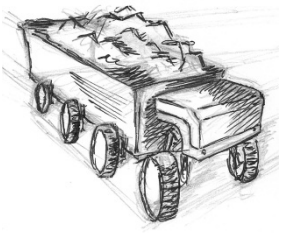
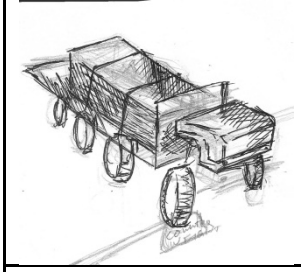
3.3: Construction Machinery

3.3.1: Use of Materials and Components
3.3.2: Process of Construction

3.4: Use of Solar Panel

3.5: Mercury Surface Operations

Surface vehicles generally work autonomously, however, by entering a special cockpit and having it attach to a surface vehicle, a user may either assume command of the vehicle or ride the vehicle for monitoring by allowing it to continue functioning autonomously.

Demeter (The Front Unit) 	Several proximity sensors, and cameras coupled with computers allow each Demeter unit to engage in independent and intelligent operation and work cooperatively with all other machinery on the surface of Mercury and, more importantly, maintain safety in the presence of humans. Each unit equipped with three hydraulically suspended wheels is able to detach from either bed when it is to be reloaded or refueled and attach to a loaded carrier or hauling bed allowing for little down time while reloading. Solar panels on the Demeter unit supplement energy from the recharging station.
Carrier Bed (with Demeter) 	Six wheels each powered by independent motors and each independently hydraulically suspended facilitate movement on the planet's undeveloped surface while keeping the load of Reardonium free from damage by stabilizing the carrier bed with a gyroscope.
Hauling Bed (with Demeter) 	Hauling beds move with six wheels similarly to carrier beds for the purpose of transporting loose ores of various minerals and regolith on the surface of Mercury to bases to be shipped or simply away from excavation sites.
Recharging Station	Recharging stations draw energy from portable solar panel arrays when the sun is in view and store energy in a flywheel suspended by superconducting magnets allowing for minimal loss of energy from friction. Recharging stations are constantly mobile to follow the position of the sun and available to any units operating on Mercury when needed.

4.1: Community Design

City layout is based off a hexagonal grid.

4.1.1: Community Layout

Services	Number	Location(s)
Hospitals	2	Located in two of the residential rings, with one in each ring.
Gyms	5 (for 2800 people per day)	Located within 1g part of residential ring
Hotels	2 (100 rooms per hotel)	Located in two of the residential rings, with one in each ring.
Parks	8 (small parks)	2 in each ring; will have playgrounds and walkways.
Schools	2 (for 350 children each)	Located within 1g area of residential rings
General Supply/Local Markets	10 gen. supply, 10 local markets	5 of each in each ring.
Post-Secondary Education	4 (for both higher education and research)	1 in each ring
Restaurants	10	5 in each ring; provides food of many different cultures.
Movie Theaters/Arcades	3 of each	has movies of many genres/languages, and video games

Hospitals

Aynah will have two hospitals for its 14,000 residents, one in each of its residential districts. These hospitals will also be located within the 1g ring of the colony. In order to provide each resident with quality health-care, we will allot 56 hospital beds per hospital such that there are 8 hospital beds per 1000 people.

Gyms

To prevent common ailments that arise from prolonged exposure to low-g environments without sufficient exercise, such as nausea, muscular atrophy, and skeletal deterioration, Aynah will have five fitness centers located within each 1g ring. Each gym will provide services for 2800 people, with 300 people using it at any given hour. These gyms will be equipped with cardio equipment such as treadmills, elliptical machines, stationary bicycles, and stair climbers, strength training equipment such as presses, leg curl machines and free weights, and areas designated to specific sports, including tennis, basketball, and track and field.

General Supply/Local Markets

Aynah will also have 10 smaller general supply stores distributed within the residential district so that residents are able to get necessary supplies for survival or research without having to travel to the commercial district. Residents will also be able to buy groceries and food supplies at the 10 local markets in the residential district without having to go to the commercial district.

Education

For the up to 700 children residing on Aynah, two schools are provided in the 1-g rings of residential districts that specialize in kindergarten to 12th grade education. The University in the business district will serve as a research hub for scientists and professors that spend part of their time filming digital lectures to provide post-secondary education to residents of Aynah.

Entertainment/Other Services

For entertainment, Aynah will provide three movie theaters that offer many movies in a variety of languages and genres. For our younger residents, three arcades with many different video games will also be provided. Parks will allow residents to relax and enjoy nature as they would on Earth; on Aynah, there will be six parks throughout the district. Finally, Aynah will provide two hotels (with 100 rooms each) in each of the residential rings for the 200 possible visitors to the colony.

Virtual reality chambers within Aynah rely on an omnidirectional treadmill and multipoint ultrasonic haptic feedback technology and a virtual immersion helmet to fully immerse users in a virtual world.

4.1.2: Consumables

4.2: Residential (Housing) Design

All residents on Aynah will be provided housing while visitors will be given temporary townhouses. Housing for single residents is 1250 sq. feet (116 sq. meters), housing for married residents without children will be 1800 sq. feet (167 sq. meters), and housing for married adults with children will be 2500 sq. feet (232 sq. meters) in order to allow people adequate comfort and safety. Single residents will live in apartment style houses, while married residents and married residents with children will live in townhouse style houses. Five different housing styles will be provided for the different types of residents we must accommodate. If we estimate that about 1 in every 3 couples will have a child, then we can determine the number of houses necessary for married adults with children.

Number of People	Type of House	Number of Houses
1 (single men/women)	Apartment	4900
2	Townhouse	2700
2-4	Townhouse	1400

4.2.1: Housing Designs

Housing for Single Men/Women

For single men and women, we will provide two different housing plans to choose from, both of which are 1250 square feet. This apartment style housing includes a kitchen, dining room, bedroom, and bathroom.

4.3: Safe Access

4.3.1: Safety Precautions

4.3.1: Transportation along the main bar:

Transportation along the main rod is a necessity for residents of Aynah who make daily trips through its zero G environment. Traffic along the rod is conducted through a constantly running, automated monorail which transports users to the elevator of a selected torus.

4.3.2.1: Spacesuits

Space suits are composed of a layer of Orthofabric followed by several layers of boron nitride nanotube composites for effective radiation protection and structural strength. Following these initial layers, several layers of kapton multilayer insulation and a layer of tubes to allow cooling water to flow providing for efficient thermal insulation and cooling of a user.

Space suits are created to facilitate suit up as well as actual use. A large back opening allows for the suit to be docked and put on as one piece eliminating joint injury that occurs from traditional suit up. Having the suit docked allows for easy transition of a user from the airlock to pressurized volumes. Reardonium bearings on the suit in the waist area and joints allow for easier extravehicular use as well as enormously improved terrestrial use.

4.3.2.2: Spacesuit Docking Sequence

Phase I - Primary dust off: A stream of air blows large particles of dust off the user.
Phase II - Secondary dust off: Robots assist in detailed dust removal.
Phase III - Docking: Arms of the space suit dock lock onto the back panel of a space suit and pull it in.
Phase IV - Suit Off: A user may now safely exit the suit through the back.

5.0: Decentralized Mainframe

Operations on Aynah will be directed by a mainframe divided into three branches of control. Using design elements from a spider's web, creating a control mainframe that is entangled and both physically and virtually separate, any possible failure is isolated within one branch which is possibly sacrificed to halt the propagation of malfunctioning sectors. These branches, HAL, DAV, ERI, ensure that two branches have control of certain aspects of a sector ensuring that one, there is both a check on all branches and two, that if any serious malfunction were to occur to any part of the system, it would immediately relinquish responsibilities, possibly shut down depending on the severity of the problem, and allow the other branches assume responsibilities of that part. Responsibilities are routinely cycled throughout the day to increase randomness of the system and shield from cyber attacks.

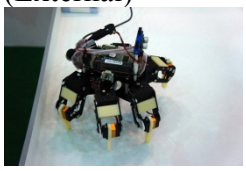
5.0.1: Personalized Automation Devices

Device Name/Function	Data Storage Capacity	Number	Function/Capabilities
Nyx Tablet 	Ranges from 250 to 500 GB	14,000 (for each resident)	The Nyx touchscreen tablet is provided to each citizen on Aynah. Utilizing silver or copper nanowire electrodes, graphene transistors, and transparent and flexible batteries created from redox-active organic polymer film, the tablet, both flexible and transparent, is able to be folded and worn as a watch, held like a book, or manipulated into any form to fit the needs of a user and charged by light or even by heat emitted by the user's body. The Nyx will be able to handle all personal records and finances of a user and serve as their identification, payment assistant, and communication. Nyx is equipped with both holographic and haptic technology allowing myriad uses and streamlining of all its applications as students and professionals alike are able to utilize tablets to gain a hands on experience with their specified field, create tangible and manipulable 3D objects for presentations, or integrate them into their lives however they wish or however their occupation specifies. These are able to connect to desktop and wall interfaces or several ports.
Desktop and Wall	250 GB	2000	Nyx is able to interface with desktop and

Interfaces	storage for storing information from Nyx tablets		wall interfaces to extend its capabilities. Attached to wall or desktop interfaces, Nyx is able to both project its presence into any interface, allowing for specialized use as interfaces vary, and download information, allowing for portability. Common interfaces allow the sharing of presentations and creation of more complex virtual and tangible 3D objects via ultrasonic haptic feedback using ultrasonic waves to stimulate touch receptors on the skin, and the retrieval of maps in a certain area. Specialized interfaces allow for the access of certain systems by authorities.

5.1: Automation of Construction Processes

Name	Function(s)	Description	Dimensions
Decobot 	Interior Decoration/Construction	Decobot is a humanoid robot that assist residents in interior decoration. It has 37 degrees of freedom, and an actuator known as the backdrivable mechanism to move its limbs smoothly. For decoration, it can help move and arrange furniture. It can also help construct smaller furnishings like chairs and beds.	0.5m x 0.2 m x 1.4m
Contour Crafter 	Interior Finishing	Contour Crafters extrude layer by layer cement created from regolith and sulfur extracted from the surface of mercury. Alternatively, a heating element is used at the nozzle of the device to fuse regolith. A robotic arm adds reardonium supports to the structure for added strength. The automation acts as a large 3D printer, facilitating and automating construction of buildings on Aynah as well as landing pads and blast walls for use on the surface of Mercury for in situ resource utilization.	

Spiders (External) 	Exterior Construction/ Repair	Construction robots will be reardonium-plated and made modular and modified accordingly for the operation that they will perform. Each is equipped with claws and an electron beam welder for assembly. Main responsibilities of these robots will be the securing of the inflatable bladder during phase, and the assembly of prefabricated triangular plate modules in several phases of the construction process. These robots are capable of working cooperatively, attaching to one another in several arrangements to accomplish a multitude of tasks. EVA structures on the outside of the colony allow for easy support and mobility of the robots throughout the construction process.	1m x 1m x 1m
MiniSpiders (External) 	Exterior Construction/ Repair	Small spider robots will crawl within the physical shielding, each equipped to repair one of the several layers. These robots exhibit swarm behavior; that is, if one were to witness any damage, robots within proximity join in the repair effort. The radius of an alert will be proportionate to the amount of damage present.	0.08m x 0.08m x 0.08m

5.2: Facility Automation

5.2.1: Maintenance Automation

Automation to maintain a level of security is a large priority, as it is necessary to keep our residents safe at all times.

5.2.2: Emergency Automation

Codes	**Meaning**	**Contingency Plan**
Blue	Colony is running smoothly without any hazardous	Continue current maintenance plan

	situations or breaches in security	
Yellow	Colony has minor problems in safety, but these can be fixed easily	Send MiniSpiders out to survey the area and make repairs if necessary.
Red	Serious breach or security threat that can potentially destroy the entire colony.	MiniSpiders will report threat to our decentralized mainframe and residents will be given emergency precautions to follow. Other automation devices will be sent to the area to try and fix the problem.

5.2.3: Limited Access to Automation Systems

5.3: Habitability and Community Automation

5.3.1: Automation for Livability in the Community

The Tube Delivery System on Aynah will allow for rapid and efficient transfer and delivery of materials to our residents. Items such as groceries or medical supplies can now be delivered directly into their homes, thereby enhancing the quality of life on Aynah.

The Voice Recognition House System on Aynah will allow residents to give vocal commands in their houses to activate certain routine household tasks such as dusting and vacuuming. These tasks will be performed through the use of robots that reside within the walls of the home. After giving the command, robotic arms will dust and vacuum the surrounding area; other machinery will be stored within the appliances of the house so that it too, can clean the surrounding area. In addition to this system, one Housebot will be provided to each household in order to assist in these routine tasks.

Our Super Bathrooms take advantage of periods when genetic materials and excretions are shed. Toilets scan actively for blood composition and abnormal protein excretion as signs of diseases such as cancer early in their development before physical effects are examined allowing for the initiation of treatment leading to the early eradication of maladies. Health information is then sent to a user's Nyx Tablet with a customized health plan and daily schedule. A daily visit to the bathroom will be equivalent to a daily visit to the doctor's office without the hassle.

The MetroRail system on Aynah will assist residents in moving from one district to another; there will be two transportation stations within each district, one on each end of the district. These stations will provide residents with rapid and efficient transportation to each of the other districts. Tickets can be obtained from automated counters in which residents can pay for their individual tickets, or buy a yearly/monthly pass for those who frequently travel to other districts.

5.3.2: Increased Productivity in Work Environments

The SmartOffice System can effectively assist residents in their work areas in routine/maintenance tasks. This system is mostly run by Officebot (?), one of the series of small worker robots; three Officebot will be allocated to each office environment. In a lab research environment, for example, SmartOffice will provide safe and sanitary tools for our scientists to use and help analyze data (ex. finding correlations or trends) from experiments. In a purely

enclosed office environment, this system works best as it can free workers from worrying about routine tasks, such as vacuuming, dusting, or

5.3.3: Maintenance and Routine Tasks

Throughout the colony, many automated tasks will need to be performed in order to maintain a clean and secure state. Atmospheric regulations will be performed by our Workerbots: they will check for any hazardous gases in the air and report them to our central computer system in order to maintain equilibrium. They will particularly look for any increased levels of Carbon Dioxide. These Workerbots will also keep the streets and pathways of the city clean for the comfort of our residents. Within the houses, routine tasks will be performed by our Housebots. They, will, for example, assist in vacuuming the areas of the house that the Voice Recognition House System does not reach. For completing routine tasks in work environments, see section 5.3.3.

5.3.4: Privacy

The Nyx Tablet

An active biometrics system provides needed security for tablets. Nyx is capable of learning the physiological and behavioral signs of one sole user during a critical stage of two weeks. The use of sensors and behavioral analyzing technology allow Nyx to verify identities and be used uniquely by its user. Any abnormalities are reported to authorities automatically for additional authentication or to health care if they are indicative of health problems. Nyx is capable of running iris scans for further identification. All information of a user is uniquely encrypted to protect against security compromise. Nyx is additionally able to request appropriate safety measures in signs of user distress. Information is sent through contact with desktop or wall interfaces whenever possible to better preserve security of information.

Desktop/Wall Interfaces

Common interfaces commonly require little authentication for use as Nyx actively verifies the identity of its user. Specialized interfaces allowing for the access of more secure information or control systems require iris and fingerprint scanning conducted as soon as Nyx is contacted with an interface. If verification fails, a user is denied access and authorities are notified.

Bathrooms

Health Scanning will be accomplished through noninvasive means. Genetic material is scanned for abnormalities from already sequenced genomes of all residents each stored encrypted in a unique bank which no person shall have authority to access for the purpose of preserving genetic security. Nanobots sterilize all contact surfaces upon completion of daily routines.

5.5: Robotic Planetary Surface Procedures

Jacques	Flipping Reardonium Parts	Jacques forces itself underneath the part and clamps onto a side. Using a pneumatic jack, it lifts the part and uses it as a fulcrum for a lever. With an active counterweight and mechanical advantage, Jacques is able to effectively flip reardonium parts for curing. Several Jacques working cooperatively are able to lever large pieces onto the back of hauling beds for transport.
Plat	Excavation of Minerals and Forming of Dig Sites	Plat is an automated bucket-wheel excavator. Its primary use is moving massive amounts of regolith to clear away large areas to prepare for mining procedures. Plat moves regolith to a scanner to seperate useable ore from unuseable minerals.

5.5.1: Safety Configuration

Solar flare cycles cause an increase in radiation dispensed by solar activity causing electrical and communication malfunctions. During such cycles, all automation operating on Mercury shall assume a common “safe” configuration outlined in the table.

Phase 1 Positioning	Surface robots position themselves near a Demeter unit or recharging station. The unit lowers itself to the ground for stability.
Phase 2 Deployment	A telescoping rod extends 5 meters from a compartment on the anterior of a Demeter unit or Recharging Station. Balloons composed of a thin layer of kapton coated with a layer several nanometers thick of gold extend via rods from the top of the main trunk laterally.
Phase 3 Charging	Negative charges applied on exterior balloons and larger positive charges applied on interior balloons both inflate the balloons and create a barrier to reflect charged particles.

Sources

http://www-ssc.igpp.ucla.edu/personnel/russell/papers/merc_mag/

http://burro.cwru.edu/stu/advanced/mercury.html

http://esamultimedia.esa.int/docs/hsf_research/ISS_User_Guide/FS052_10_IBDM.pdf

http://ston.jsc.nasa.gov/collections/TRS/_techrep/CR-2004-208941.pdf

http://www.ca.uky.edu/wkrec/454fs.PDF

https://sites.google.com/site/coriolislife/

https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxjb3Jpb2xpc2xpZmV8Z3g6MTU3MjA1NWI4MmM1NzQ1NA

settlement.arc.nasa.gov/Contest/Results/96/winner/tres.htmltoc

Spacecraft Shielding

Colonnies in Space: Chapter 10 - Ventura Highway Revisited

Materials

deflector shield

Can Whipple shields be scaled up? [Archive] - Bad Astronomy and Universe Today Forum

thayer.dartmouth.edu/~simon_g_shepherd/research/Shielding/docs/vonBraun_69.pdf

Measuring Mercury's Surface Composition

Why Build Orbital Space Colonies?

Basic Concepts

Cal Poly Partners with California Energy Commission to Launch Algae-Based Wastewater Treatment Plant - Cal Poly

http://www.3m.com/market/industrial/ceramics/pdfs/CeramicFabric.pdf

http://dheise.andrews.edu/leadership/comps/1c/2biblio/10708702.pdf

http://stereopsis.com/flux/research.html

http://almashriq.hiof.no/lebanon/600/610/614/solar-water/idrc/01-09.html

http://www.jdsu.com/ProductLiterature/sccrrg_ds_co_ae.pdf

http://www.appliedcoatingsgroup.com/optivex-ultraviolet-blocking-filters.html

http://web.mit.edu/newsoffice/2012/spider-web-strength-0202.html

http://en.wikipedia.org/wiki/Atmosphere_of_Earth

http://www.ccohs.ca/oshanswers/prevention/cryogens.html#_1_6

http://science.nasa.gov/science-news/science-at-nasa/2000/ast13nov_1/

http://www.nasa.gov/centers/marshall/pdf/104840main_eclss.pdf

http://en.wikipedia.org/wiki/Biosphere_2

http://www.biometrics.gov/documents/biointro.pdf

http://thayer.dartmouth.edu/~simon_g_shepherd/research/Shielding/docs/Buhler_I-final.pdf

http://www.lpi.usra.edu/lunar/documents/NTRS/collection3/NASA_TP_2869.pdf

http://1bog.org/blog/charging-an-electric-car-at-home-how-many-more-solar-panels-do-i-need/

http://www.engineeringtoolbox.com/us-outdoor-design-temperature-humidity-d_296.html

http://www.robots.com/blog/viewing/construction-robots-of-the-future/61

http://www.pcmag.com/slideshow_viewer/0,3253,l%253D265118%2526a%253D265118%2526po%253D8,00.asp?p=n

http://spectrum.ieee.org/automaton/robotics/humanoids/france-developing-advanced-humanoid-robot-romeo