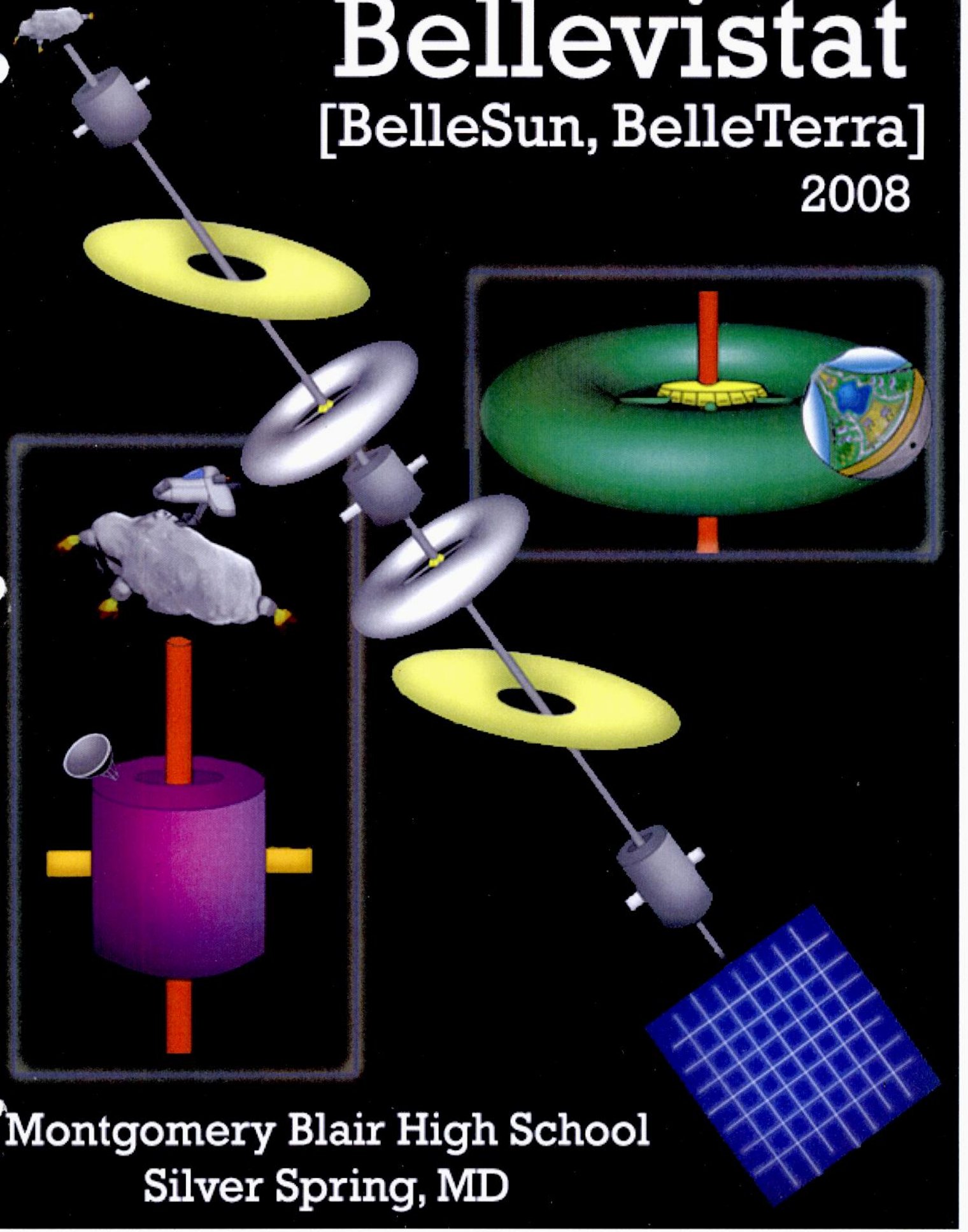
Bellevistat

[BelleSun, BelleTerra]

2008



Montgomery Blair High School

Silver Spring, MD

=1.0 Executive Summary=

Bellevistat is a sun-synchronous settlement composed of three cylindrical compartments and two Stanford tori, all "strung" onto a central shaft. The central shaft will contain columns for "elevators" between the compartments, as well as a core for the power lines. Construction will be completed in space; with many compartments being built after asteroid mining has begun. Any surface that may be reached by radiation and particles will be shielded as soon as it is built. Bellevistat will rely on solar power for energy, which is assisted by the sun-synchronous orbit. However, the Stanford tori will have simulated day and night, controlled by the mirror reflecting visual light into the residential area.

Bellevistat can support a maximum of 20,000 residents, and is geared towards resident happiness. The Stanford tori are dedicated for residential purposes, with agriculture in the forms of fields, ponds, and gardens scattered within communities. Automated services perform dangerous and tedious tasks, providing the residents with a stable food supply and clean homes.

The three cylindrical compartments are for mining, tourism, and manufacturing. The mining sector will be dedicated to processing ores that are collected from the asteroid. The asteroid will have automated propellers to keep it in orbit at the same pace as the settlement, but will not be connected to the shaft so that the settlement will not be affected by the addition or removal of the large object.

The tourism sector will not be rotating with the shaft, to maintain zero gravity. There will be recreational rooms for games and amusement in this sector, as well as access to the shaft to go on tours to the other areas. Hotels will be in the torus cities, except for a hotel specialized for zero gravity living.

The manufacturing sector will remain stationary to maintain zero gravity necessary for zero gravity manufacturing. Infrastructure will remain at the disclosure of companies who seek to lease space from Bellevistat. However, they will be reassured that no radiation or harm will come to their business ventures, as there will be shielding and automated services monitoring the sector.

Bellevistat aims to have a fluid but interesting daily life, providing the amenities for amusement, food, and psychological factors. Residents are trained and educated from youth to perform tasks necessary on the settlement. Bellevistat will be a settlement for enjoyment of life while still promoting the future of space research.

=Structural Design=

2.1 Structure

The overall structure is shown in figure 2.1.1. It will have 5 volumes, each with a specific purpose.

To shield the settlement, all surfaces where particles or radiation can hit are covered with 18+ feet of insulation, as shown in figure 2.1.2

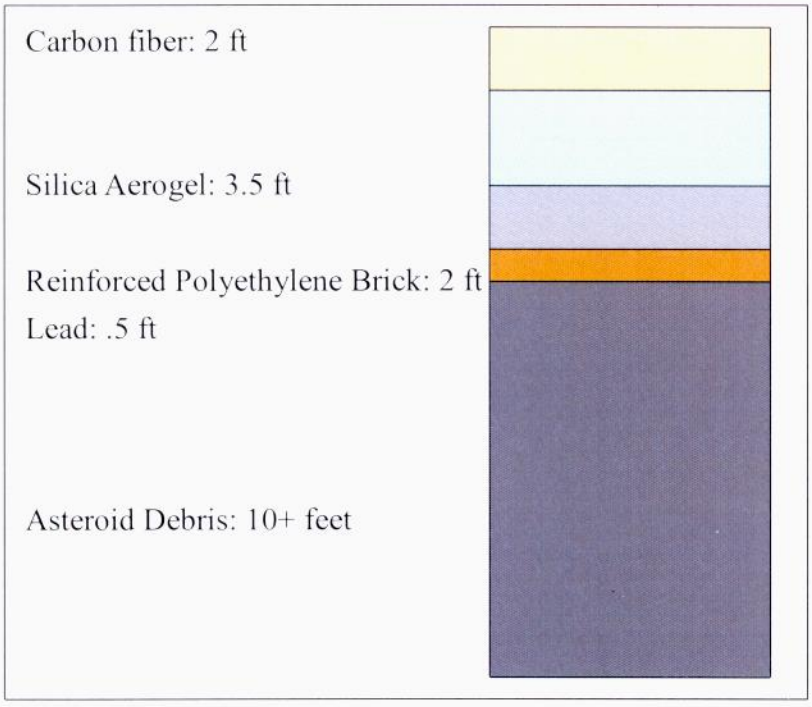


Figure 2.1.2: Shielding from innermost to outermost layers

Asteroid Debris: protects settlement from most particle impacts, while being the perfect place to deposit asteroid debris

Lead: Protects settlement from most alpha, gamma, x-ray radiation

Reinforced Polyethylene Brick: Protects from remaining radiation and all particles that get through

Silica Aerogel: Thermal protection

Carbon Fiber: Protects shield from internal projectiles (monorail crashing into wall, etc)

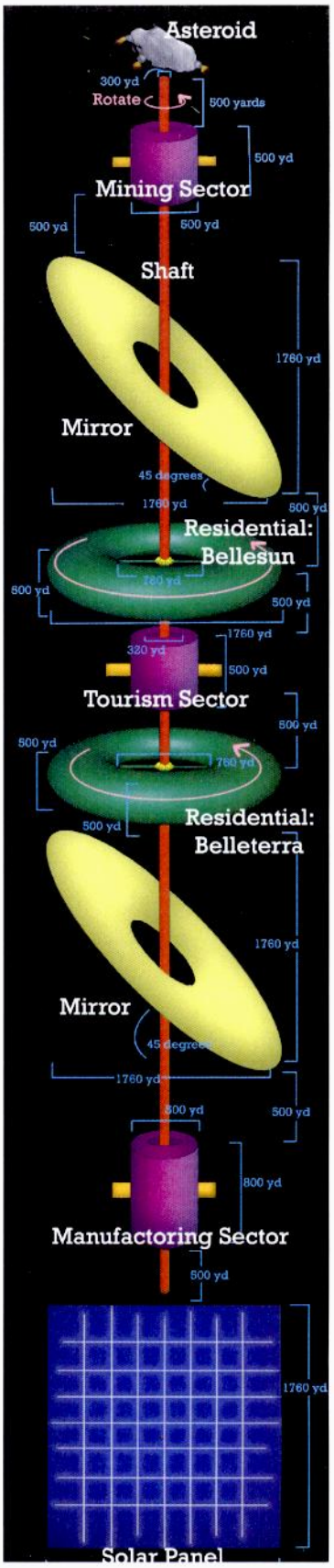


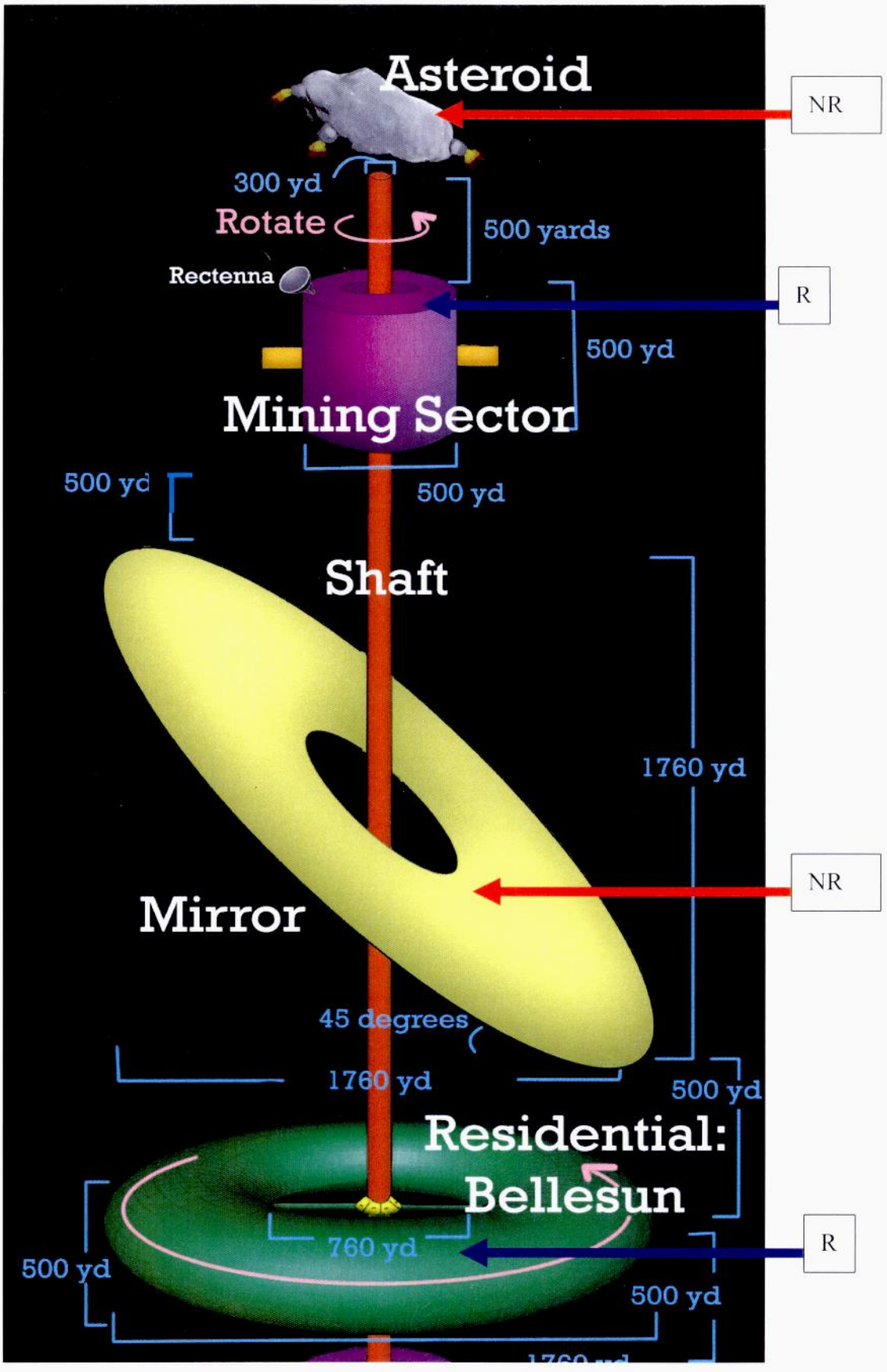
Figure 2.1.1: Overall Exterior Structure

Asteroid

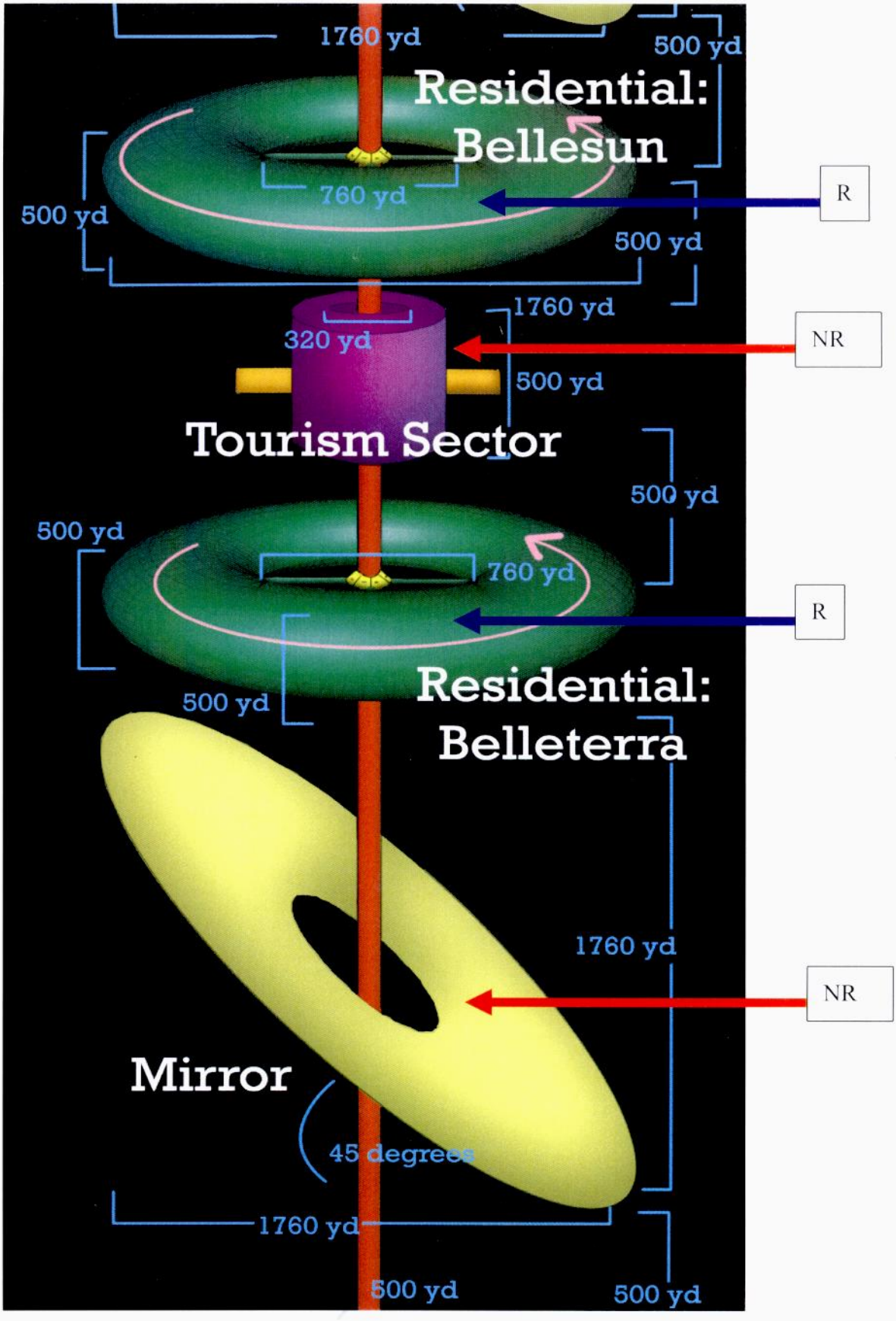
Mining Sector

BelleSun Mirror

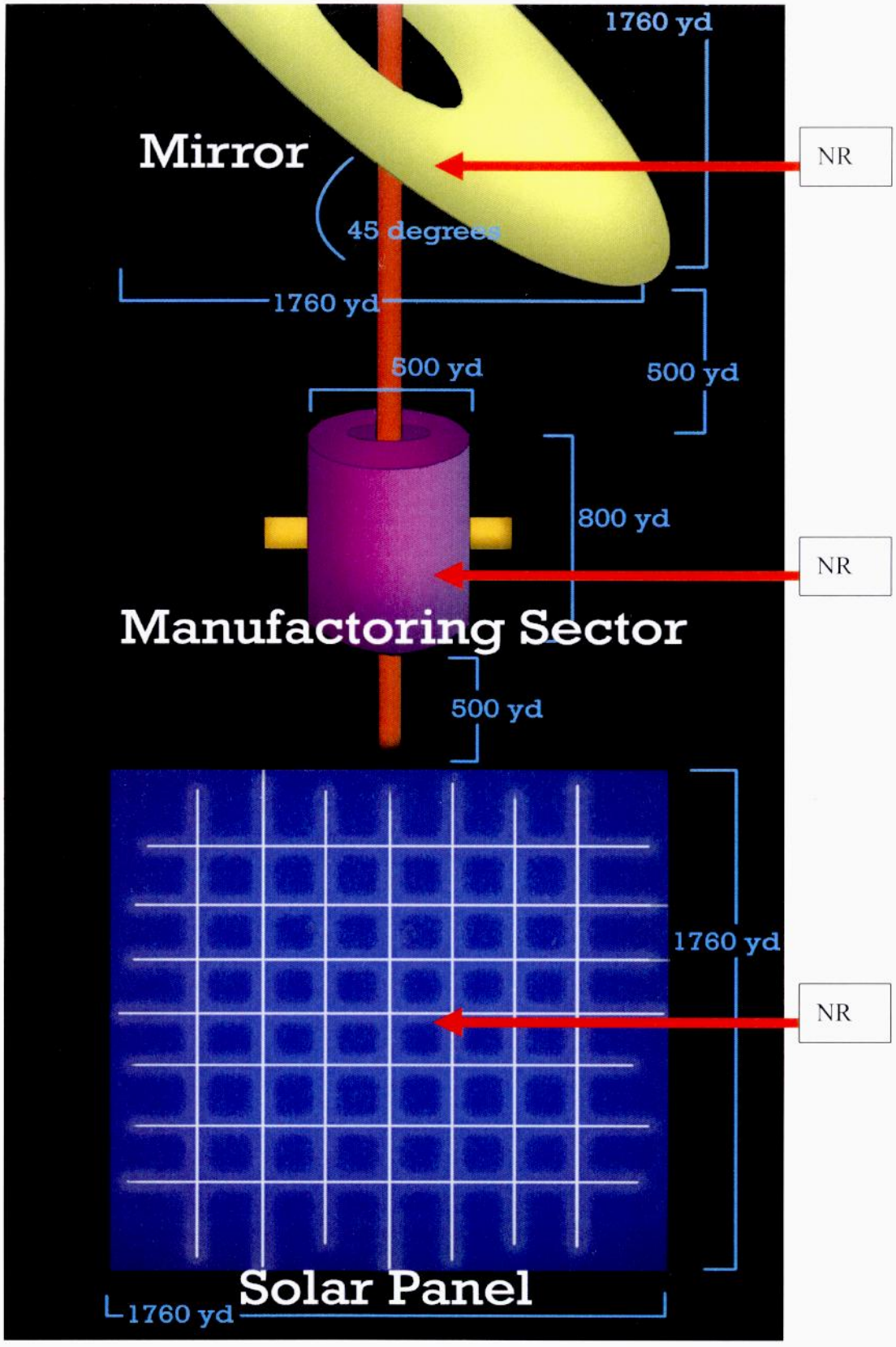
BelleSun



Bellesun Tourism Sector BelleTerra BelleTerra Mirror



BelleTerra Mirror Manufacturing Sector Solar Panel



2.2 Allocation of Space

The mining sector will contain different levels for asteroid processing and refinement. All space in the sector will be used, with the low gravity at the center used for manufacturing new shaft components, while outer areas with more gravity are used for ore processing to minimize on dust floating around.

BelleSun will be more for suburban residents and important crops. Children are more likely to have psychological issues with not being able to see the sun while growing up, or having less sunlight than humans are used to. Important crops would also be more likely to need full sunlight. There will be commercial and some industrial areas scattered throughout the torus, as mentioned in the human section. Agriculture will take place in the center of the circumference of the torus, where sunlight is strongest.

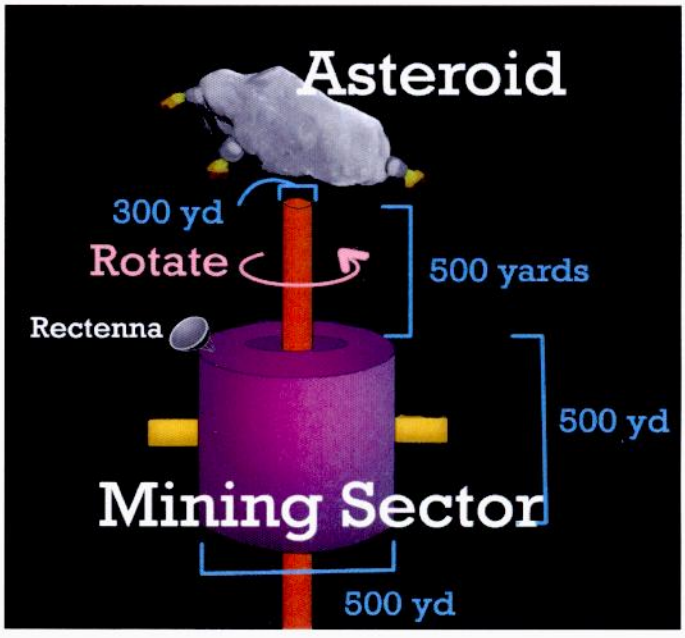
The tourism sector will have half of it dedicated to recreation, and the other half for optional zero g living for tourists.

BelleTerra will be for adult residents and visiting members, because the view of earth is mainly for enjoyment, and the lack of direct sunlight may affect children. Crops will still be able to grow, but they may grow at a lower rate.

The manufacturing sector will be empty until leased by Earth companies. It will be separated by layers parallel to the cylinder so that maximum space can be used.

2.3 Construction

Initially, only the mining sector, solar power satellites, and Constructoman, Commandoman, and Repairoman will be sent out to space and navigated into orbit. After the droids put together the mining sector and build the automation on the asteroid, the Commandomen will change constructoman programming to begin shaft and BelleSun construction. Construction will then proceed inside Bellesun- Constructoman will also create specialized automation for house construction with alloys from the asteroid and additional materials from Earth. After Bellesun is complete, and sufficient asteroid debris has



been created to shield the settlement, humans can begin populating Bellesun and direct construction of the remainder of the settlement at a faster speed.

=Operations and Infrastructure=

3.1.1 Orbit Data

Orbit type: Sun-synchronous
Height above equator: 22,236 miles
Orbit radius: 26,194 miles
Orbit circumference: 164,582 miles
Arc length per degree: 457 miles
Orbital velocity: 6876 miles

Bellevistat will orbit in a sun synchronous orbit because of its size requires maximal solar power production, while still remaining close to the earth so manufacturing and mining can be the most profitable.

3.1.2 Sources of Materials

Materials	**Source**
Metals for construction	Earth, Moon
Agriculture and crops (initial shipment)	Earth
Liquid Hydrogen	Earth, Asteroids
Oxygen	Earth
Water	Earth, Asteroids
Nitrogen and other atmospheric gases	Earth
Plastic	Earth, some from Asteroids
Electrical Units (power generators, lights, etc.)	Earth, later from Asteroids
Shielding (reinforced polyethylene bricks, silica aerogel, lead, and debris)	Earth, Asteroids
Solar Panels (silica)	Earth, Asteroids
Organic matter and nutrients (phosphorous, bacteria)	Earth
Equipment	**Source**
Construction Facilities	Moon and Earth

Materials can be initially shipped from the Earth and later mined from asteroids. Periodic shipments from Earth will supply Bellevistat with raw material.

3.2.1 Food Production

Most people need nine to eleven pounds of food, water, and oxygen per day. In order to grow the food, high-intensity agriculture will be necessary. The space farm will use simulated climate to make the growing season year round. Adjustments can be made to the temperature for better growing conditions. Genetic engineering can result in crops with higher yield and shorter growing time. Interplanting is can also be used. Plants grow slowly in the first few weeks as seedlings, but by planting the next crop in between the first before it is harvested, time spent waiting will be reduced. At all times there will be crops being planted, newly growing, ripening, and being harvested.

The crops will be planted out in open air in a medium of soil with supplemented nutrients and sprinklers to provide water. Given good conditions of light, temperature, humidity, and nutrients, a minimum of 200 acres is enough for the agricultural section to grow enough nutritious, varied food for 20,000 colonists.

Rabbits, unlike hogs and chickens, are not in competition with humans for food. Alfalfa is easily grown, has a high yield, and can be complete feed for rabbits. Rabbits also reproduce quickly, a litter every two months. Another good source of protein is fish. Several ponds with algae and clean, fresh water can support half a million fish; enough to give people as much fish as they want. Fish eggs are also viable as a source of food, since a single fish lays millions of eggs at once. Ruminants can graze in waste materials from vegetable production. For instance, they can eat stems, leaves and roots that are inedible to humans.

Goats can produce more than twice as much milk as a cow can for the same amount of feed. Chickens can also be raised on surplus grains and leftovers for eggs and meat. Just the wastes will support enough hens to give everyone three or four eggs a week.

Food is produced, packaged and distributed on a daily basis. Raw foods will be stored in the food preparation sector. Prepared food will be packaged in thick, reusable, plastic containers at the processing center. The packages will then be shipped for distribution. Surplus meats can be freeze-dried and stored in case of a surge in demand. Food variety, other than meat, grain, and protein, will be provided by residents themselves. Desired vegetables and fruit can be planted within the residential areas, on rooftops and between homes. Care for the plants is done by automation.

All agricultural processing will be done by automation, supervised by human workers for quality and disease of products.

Food group	Sources	How much needed a day
Protein	Rabbit/goat meat, fish, chicken eggs	10,000 pounds
Dairy	Goat milk	2500 gallons
Grain	Main sources are rice and wheat	12,500 pounds
Fruits	May vary, but include berries, apples, oranges, bananas, peaches	Planted by residents near their homes depending on which products they desire
Vegetables	May vary, but include broccoli, potatoes, carrots, lettuce, kale, tomatoes, peas	Planted by residents near their homes depending on which products they desire

3.2.2 Electrical Power Generation

The mining sector will be mainly powered by a solar power satellite, while the remainder of Bellevistat will be powered by the solar panel at the other end of the settlement. The entire space station will be powered by photovoltaic solar panels facing the sun and adjusted for maximal reception by small automated thrusters. The solar power satellite collects sunlight in the form of photons and converts this into direct current and sends it to the rectenna on the mining sector, collected in a superconducting power line or high frequency AC system. Extra power is sent via the central power lines in the shaft.

Extra power is sent to supercapacitators along the central shaft, so when the power is needed, the batteries are tapped and the electricity flows to the power grid where it is distributed to the different sectors.

Approximately 2,500,000 squared yards of solar panels at 50% efficiency will provide 4,200,000 kilowatt-hours per day. 21% of this power will be used for residential areas, 18% for commercial interests, 33% for industrial purposes, and 28% for transportation.

3.2.3 Internal and External Communication

Buildings are all wired underground, providing access to the web. For security, all activity will be monitored. Bellevistat will get service from various commercial companies via other satellites in orbit.

Satellite antennae on the station provide communication with transports, space vehicles, etc. Signals will be encrypted for security.

3.2.4 Internal Transportation

Internal Transportation will be provided in two forms. Each adult resident with be provided with an electric scooter that has an attachable small seat for a child. Scooters can travel up to 15 mph and are used to travel short distances (i.e. to school, nearby hospital, etc.). Long distance travel (to other sectors) will be provided through a monorail system. The monorail system consists of two trains, one going one way and the other going the opposite way, and 4 stations. Each train has 4 cars. Each car can hold up to 50 people. The train travels at a maximum speed of 60 mph.

Transportation throughout the settlement will be done through the shaft. There are four shafts, with different purposes to minimize transportation dangers. Travel will be done in special vehicles. Humans will travel through the connection from the torus to the shaft in vehicles, which will run by automation to avoid traffic issues. Mining and manufacturing transportation will occur in shafts different from the human vehicle shafts. They have seats for humans for those who need to supervise the transportation. Vehicles are powered by hydrogen rocket fuel provided by carbonaceous asteroids.

3.2.5 Atmosphere/Climate/Weather Control

The atmospheric composition and pressure of Bellevistat will be based off current atmospheric composition and pressure on Earth at sea level. The pressure will be 101325 Pa, and the composition of the air will be:

Gas	Percent by Volume
Nitrogen	78.084 %
Oxygen	20.9476 %
Argon	0.934 %
Carbon Dioxide	0.0314 %
Neon	0.001818 %
Methane	0.0002 %
Helium	0.000524 %
Krypton	0.000114 %
Hydrogen	0.00005 %
Xenon	0.0000087 %

Water vapor will be adjusted specifically in each section, with more humidity in the central agricultural portions and less in suburban and commercial sections.

The pressure and the temperature will both be held constant at 101,325 Pa and 18°C. Nighttime temperature will decrease to 15°C. Small sensors will be placed around the establishment, monitoring temperature, pressure, and the various atmospheric gasses. All three will be adjusted accordingly based on these measurements through a gas release, heating and cooling, and pressure system. It will also simulate wind as it releases the gas.

3.2.6 Day/Night Cycle Provisions

Day and night cycles are each 12 hours long with a transition period between the two cycles. Because Bellevistat will be in a sun-synchronous orbit, the space settlement will always be facing the sun.

The mirrors above the residential area will be control day and night by increasing or decreasing the tint on the mirrors, thereby changing amount of reflection of sun. The mirror will have electrochromic gel between two pieces of glass, one with a reflector and one with a transparent, electrically conductive coating. To simulate changes in day, a

control on the back of the mirror will automatically send voltage to the electrochromic gel, which will tint the mirror to the necessary degree.

3.2.7 Waste Management

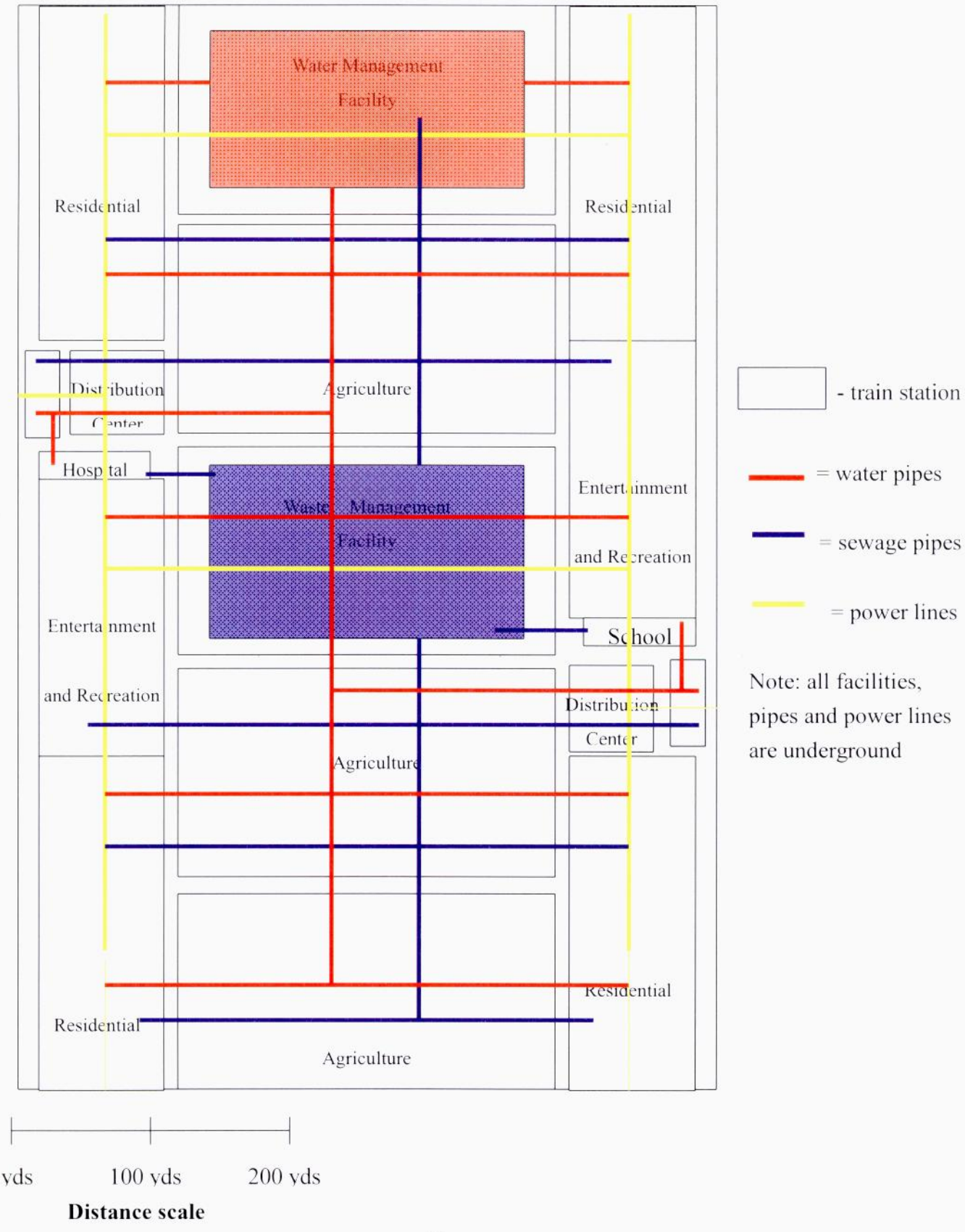
Human excretory waste will be flushed through underground pipes to a storage tank, where a collection of bacteria, including Saprobic, lactic acid, acetogen, and methanogen bacteria will break it down into methane, carbon dioxide, and water. Some of these products will proceed to the atmosphere control to be converted and released into the atmosphere. Automation in the storage tank will control the amount of bacteria.

Household waste will be collected on a weekly basis and moved to a waste processing facility. Here the organic matter will be separated from the recyclables. The organic matter will be processed into fertilizer by various types of bacteria. The recyclables will be renewed and reused in a separate building.

Mining debris will be placed on the sides of the settlement, along any surface open to radiation, by cold welding. To maximize the welding strength, similar metals will be placed in locations near each other. This will stop the majority of small particles from hitting the actual settlement, while disposing of dust and larger unnecessary chunks. Industrial waste can be disposed of in this fashion if it is metallic, but the majority

3.2.8 Water Management

The settlement needs at least 112 million gallons of water in storage at any given time with weekly shipments and refills. 45% goes to industries, 42% goes to agriculture and 13% goes to the residential areas. For distribution purposes, each torus will be divided into 4 sections, and each section will have its own water storage/management facility storing at least 7.7 million gallons of water. Industry and manufacturing will have a separate water management facility, getting the additional water from carbonaceous asteroid mining.


Water Management Facility
Residential
Residential
Distribution Center
Agriculture
Hospital
Waste Management Facility
Entertainment and Recreation
Entertainment and Recreation
School
Distribution Center
Agriculture
Residential
Residential
Agriculture
- train station
= water pipes
= sewage pipes
= power lines
Note: all facilities, pipes and power lines are underground
0 yds
100 yds
200 yds
Distance scale

3.3 Vehicles

Equipment	Description	Source
Passenger ship	Seats 1,000 people. Bimonthly journeys	Commercially Funded
Cargo ship	Carries raw materials from Earth to settlement for building and commercial goods- Monthly journeys	Commercially Funded
Tractor	Transports equipment and infrastructure already constructed	Part of Contract
Sector transportation	Transports passengers through shaft elevators to specific areas (pressurized and oxygenated)	Part of Contract

3.4 Land Use

Approximately 200 acres are needed to provide enough agriculture for people, and feed for animals. This can be increased to 300 acres; surplus can be sent back to earth or stored for future use. Animals for feed will only require 20 acres of land (this includes the lakes with fish).

Animal and animal feed facilities (except for fish) will be conducted in a strip of land separated from the rest of the land. It will be separated by fiberglass walls, with a separate atmosphere filtration and control.

Animal	Facility	Feed
Angora Goats	10 pens, each containing 30 goats	Agricultural waste
Chickens	60 large hen houses containing 300 hens each	Leftover foods
Fish	Various lakes near food production center	Tilapia: Algae Trout: rabbit offal
Giant Angora Rabbit	3000 small pens each with a doe and litter	Alfalfa

3.5 Materials for Homes

Section	Material	Explanation
House frame	Light steel alloys, silica glass windows	Due to little wind and no weather disasters, heavy, expensive metals are unnecessary.
Interior	Light aluminum alloy	Sturdy enough, but not too expensive
Siding	Recycled cardboard	Cheap and adequately sturdy
Plumbing	Stainless steel pipes	Less susceptible to rust, can be produced from asteroid
Kitchenware	Stainless steel	
Furniture (chairs, etc.)	Light metals; covered in rabbit fur	Rabbit fur insulates well, and will be abundant as rabbits are a primary source of food
Cloth	Spun angora goat hair or angora rabbit wool	Angora goat hair is long (11 inches) Angora rabbit wool

Insulation and protective surfaces are not necessary, as temperature is monitored. Stores will provide residents with decoration and miscellaneous items.

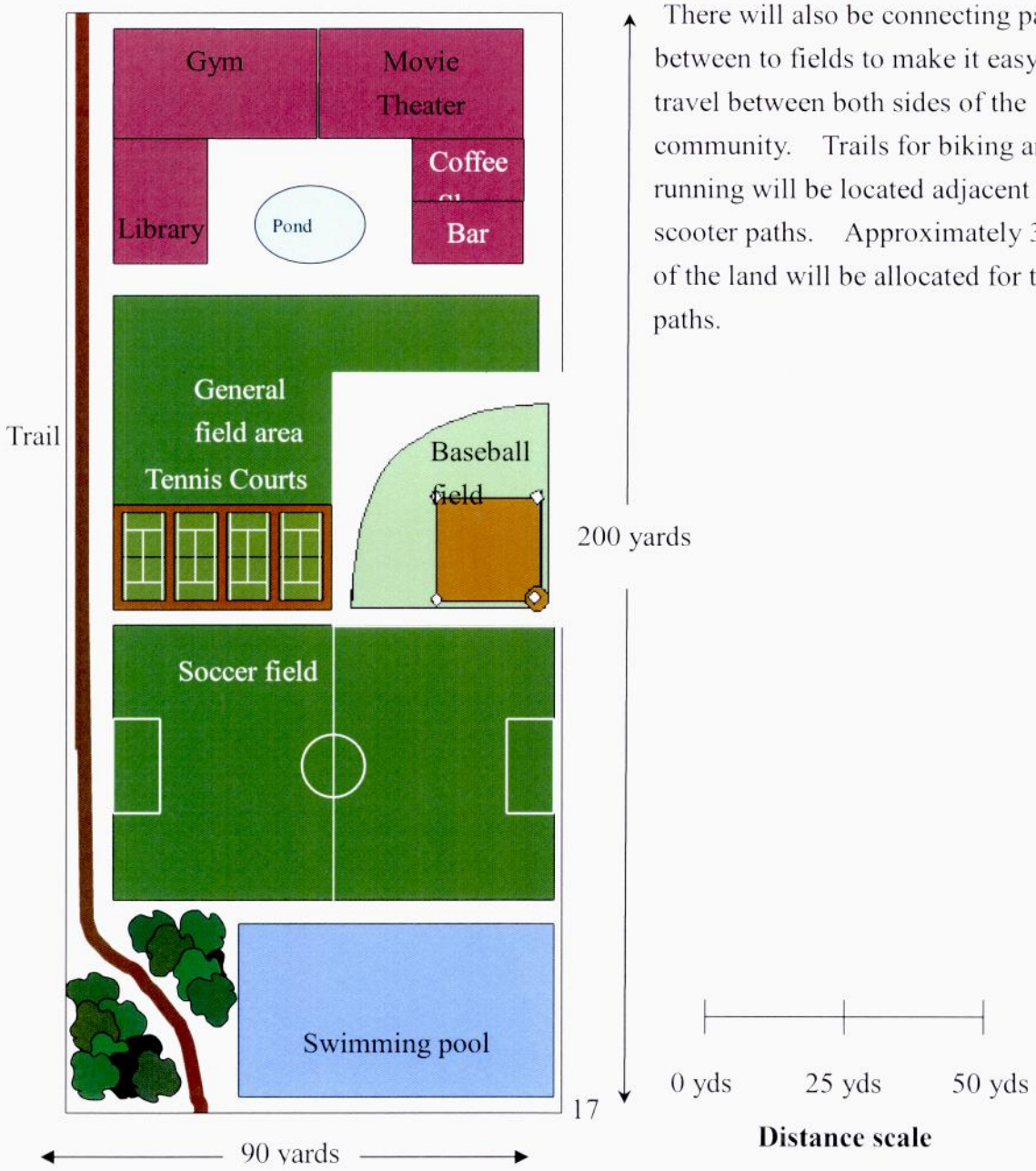
Cloth will be formed from Angora goats and rabbits because they are necessary for food production already. The fur on both animals will be combed daily and cut as soon as possible to minimize diseases and tangles in the fur.

=Human Factors

4.1 Community Layout

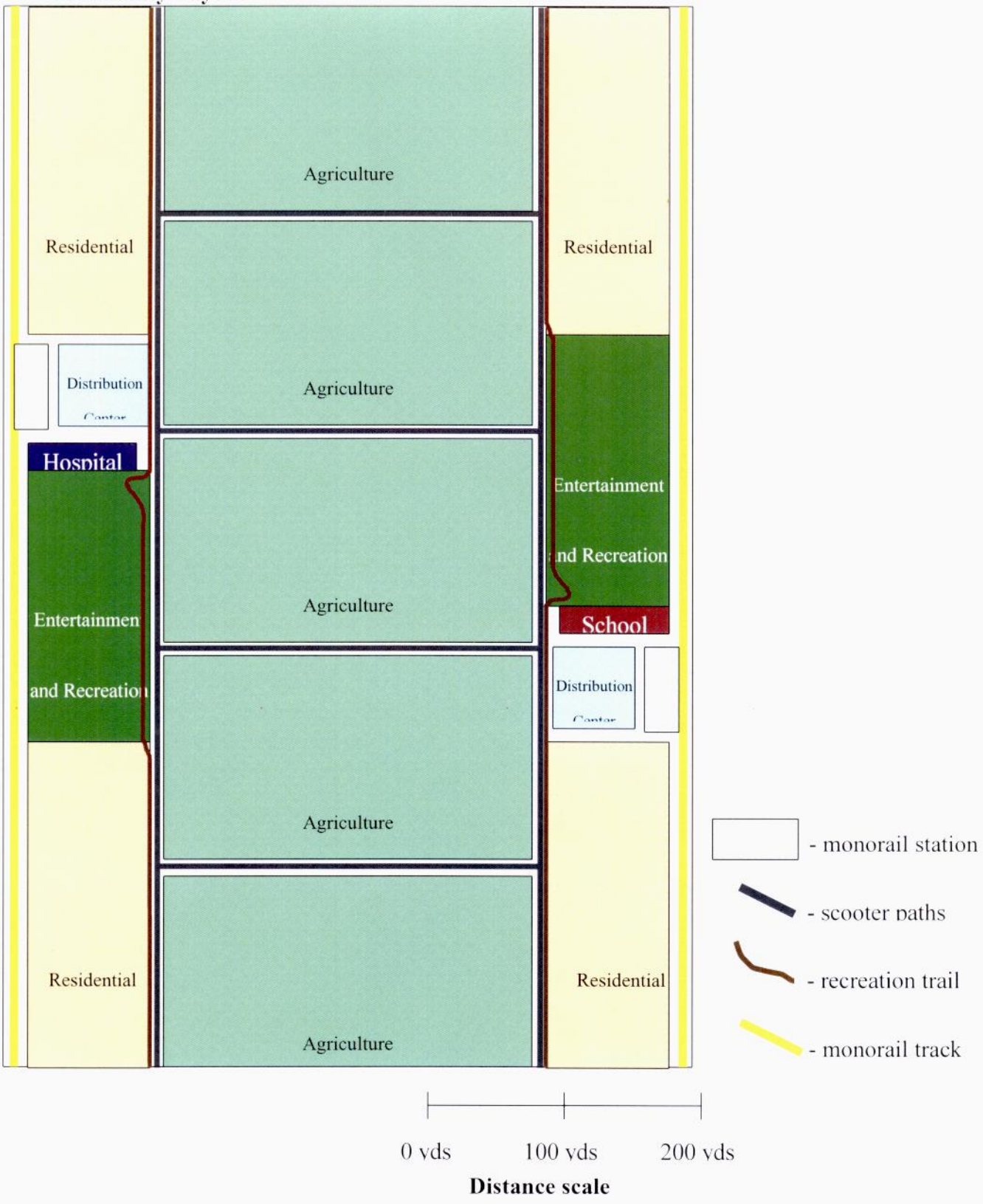
Each torus of Bellevistat will be split into four communities, each comprising one fourth of the torus. Each community will have two monorail stations, a school, a hospital, distribution centers, recreation areas, and residential areas. The sizes of the residential and recreation areas will differ slightly depending on the neighborhood style. The middle areas of the communities will be agricultural land. There will be scooter paths running along both sides of the field which go around the entire torus.

Entertainment and Recreation Area



There will also be connecting paths between to fields to make it easy to travel between both sides of the community. Trails for biking and running will be located adjacent to the scooter paths. Approximately 3.2% of the land will be allocated for these paths.

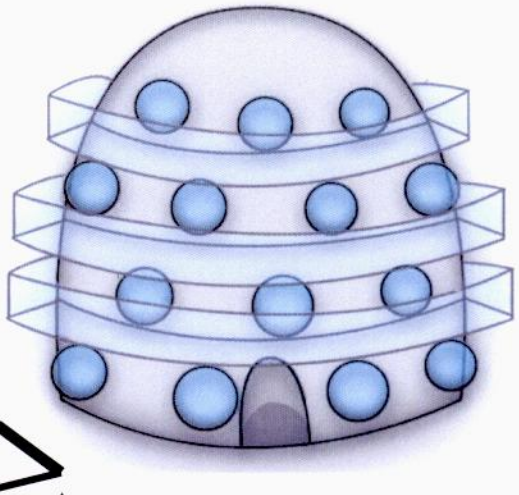
Community Layout



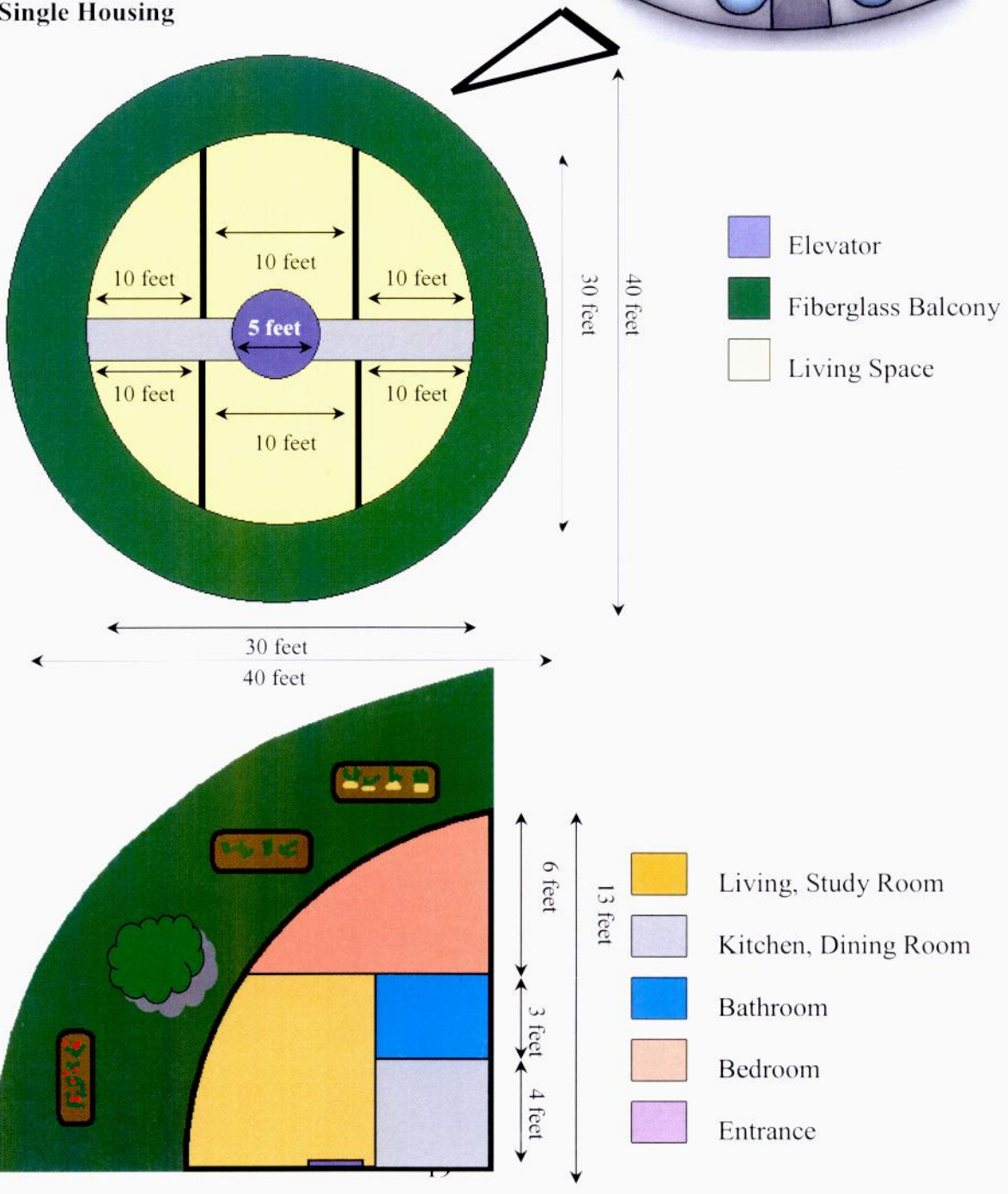
Distance scale

4.2 Residential Designs

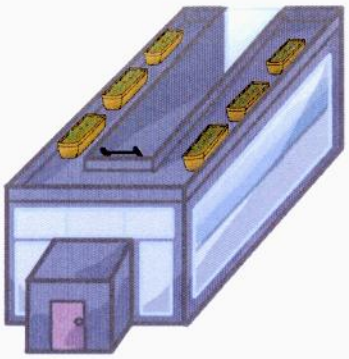
In the residential areas, there will be two different kinds of homes, family homes and singles homes. The family homes will be reserved for the married adults, and will have extra rooms for possible children. All single adults will live in single person homes. Adults who marry while living on Bellevistat will be able to request a family home

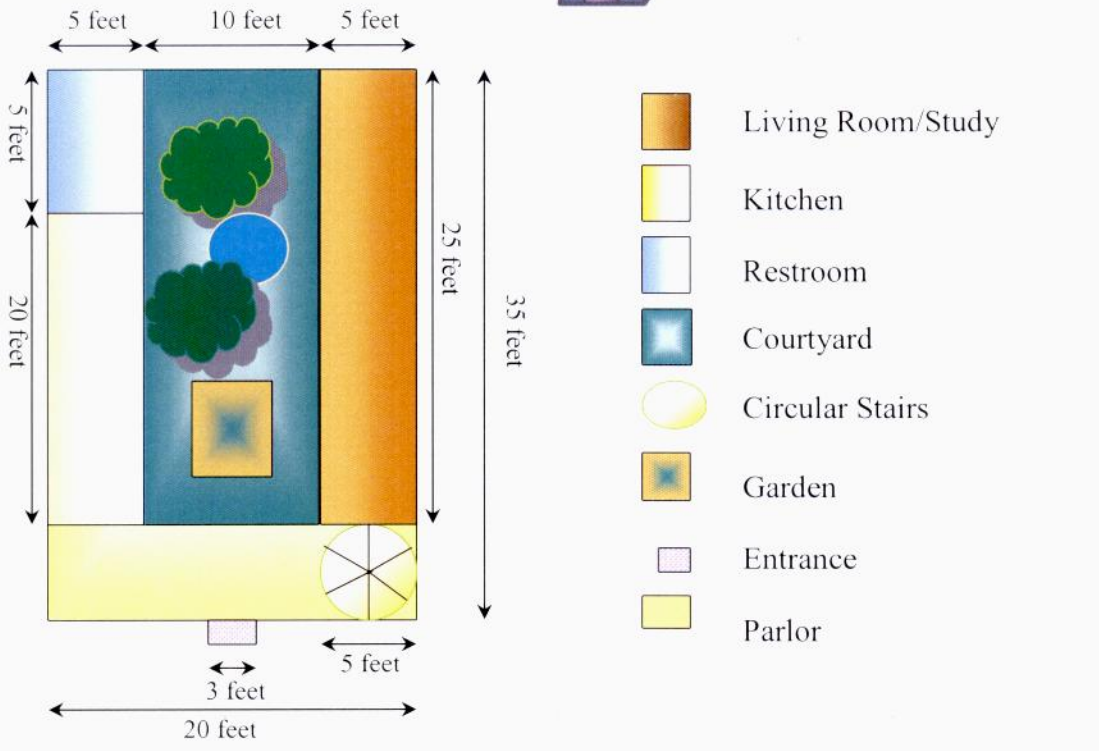


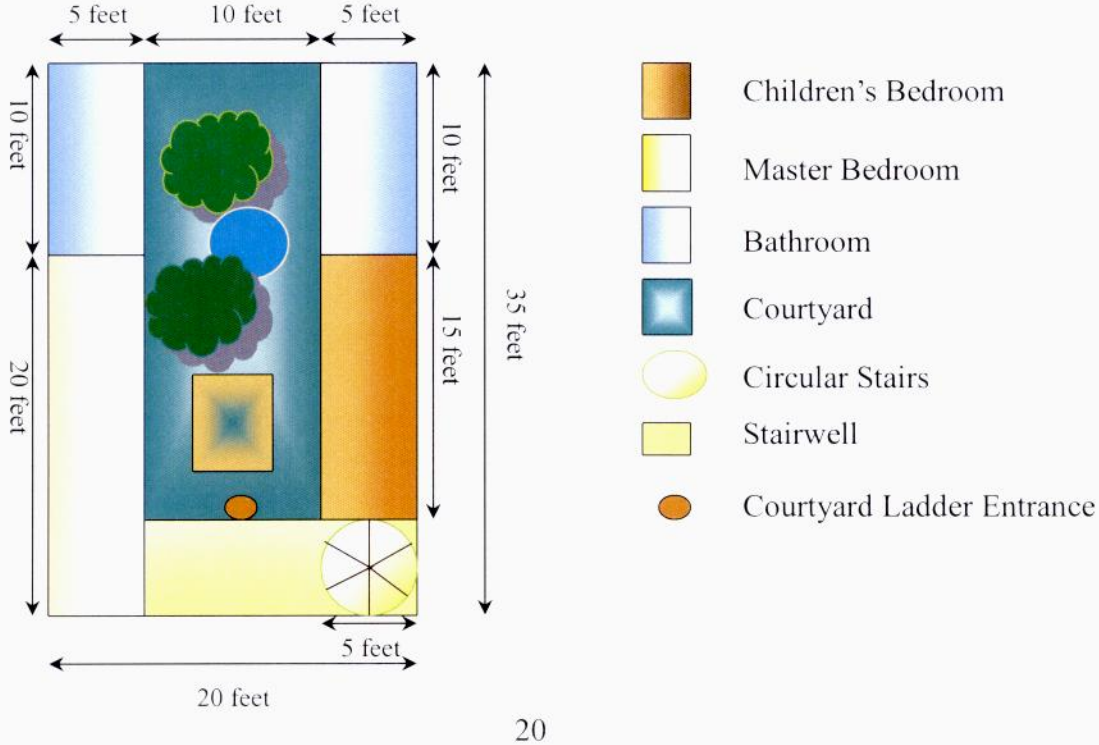
Single Housing



Family housing



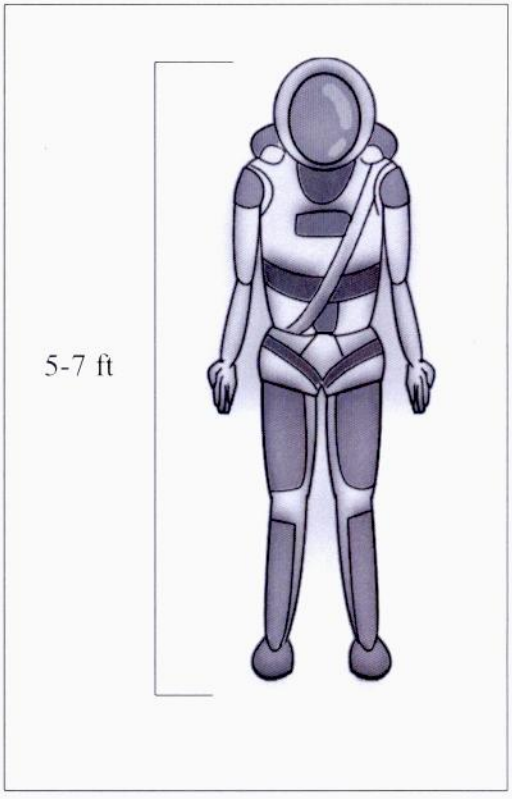




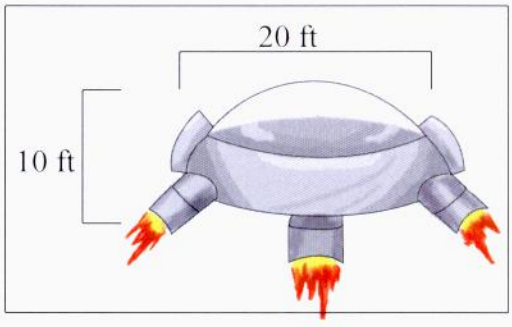
4.3 Vocational Technology

The work done on Bellevistat will require many specialized tools. All robots are programmable by humans.

Categories of Work	Tools
Mining	Asteroid mining ship – contains a shovel, drill, canopy, and numerous arms to mine asteroids and transport the ore into the settlement
Lead	Commandoman – commands the other robots
Agriculture	Agriculturobo – plants and harvests crops
Construction	Constructoman – robot that aids in the construction of buildings
Cleaning	Roboman – robot that keeps houses and buildings clean in the residential communities
Maintenance	Repairoman – robot that fixes small maintenance problems. Can work in residential and industrial areas.
Exterior work	Space suits – provides air that is 100% oxygen, shields wearer from extreme temperatures. Sizes range depending on the size of the user. Spaceship Junior – mini spaceship for aid in exterior maintenance

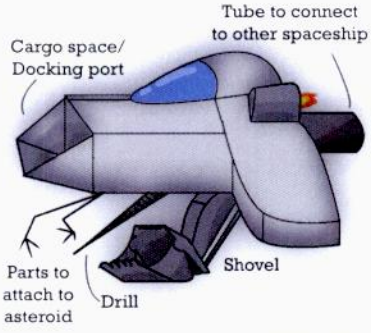


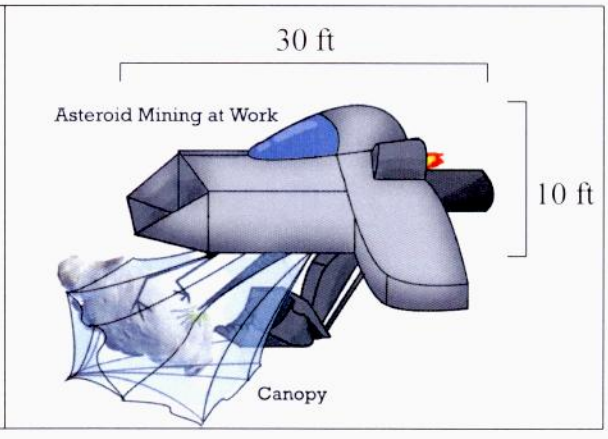
Space suits



Spaceship Junior

Asteroid mining ship





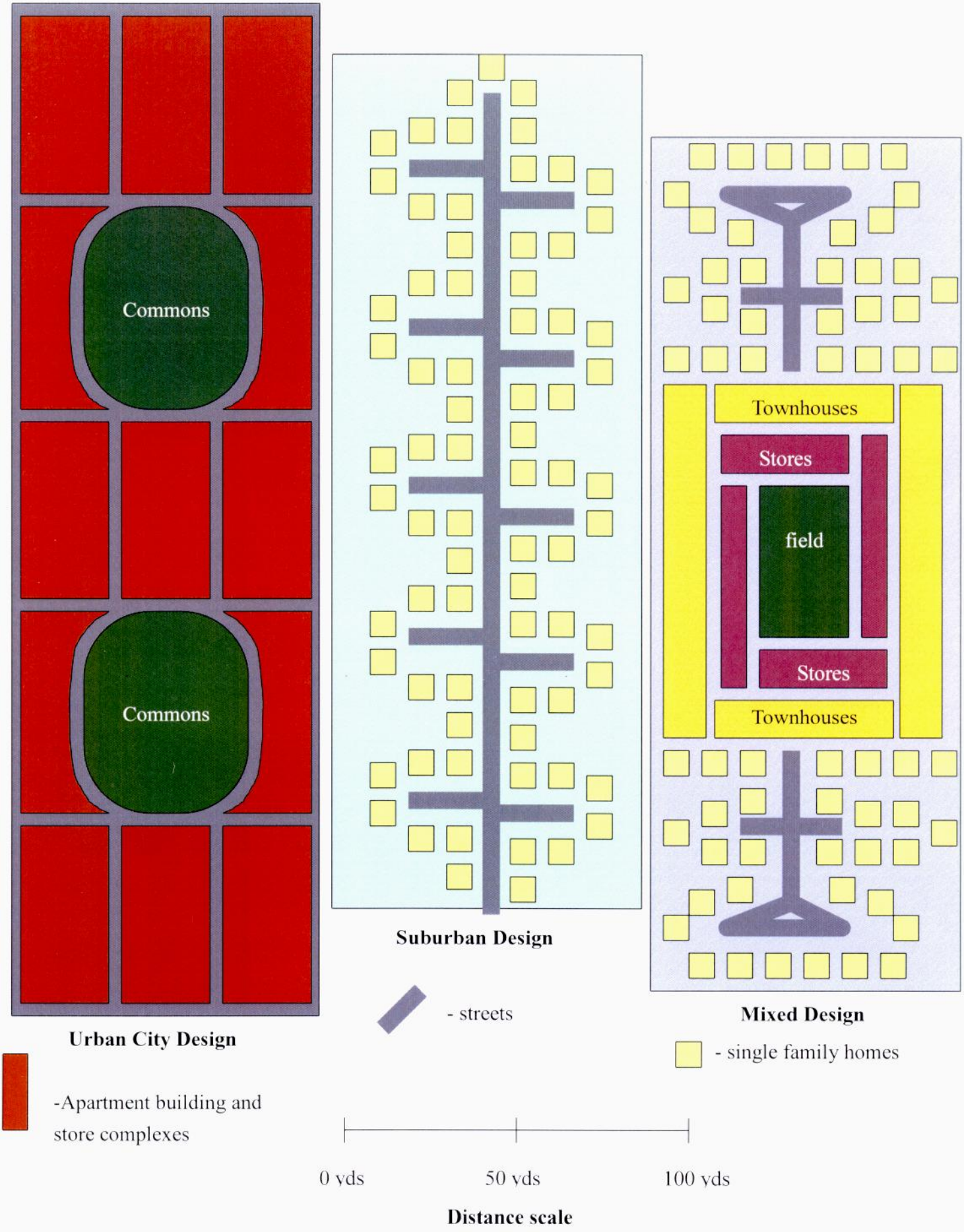
4.4 Neighborhood Designs

There will be three distinct neighborhood designs on Bellevistat, an urban neighborhood, a suburban neighborhood, and a mixed neighborhood with both townhouses and single family homes.

The urban neighborhood will be a set of spacious apartment buildings organized on city blocks. Stores and amenities will be within short walking distances, with stores and entertainment making up the first floor of many of the apartment buildings. Unlike in the suburban area, the recreation area will be combined with the residential area, as there will be grassy commons between the city blocks and libraries, theaters, and shops will be located beneath the apartments.

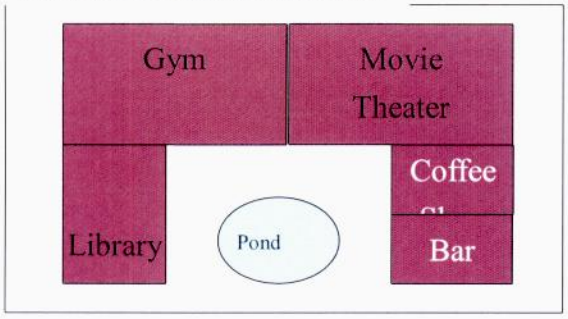
The suburban neighborhood is filled with comfortable single family homes, complete with small green lawns, and will be located next to an urban area. The suburban area will hold fewer homes than the urban area, but the homes will be slightly more spacious. There are no stores inside the neighborhood, but these amenities will be nearby slightly outside the neighborhood.

The mixed neighborhood will be centered on a town square, which consists of a field for special events and a few stores. Outside of the square will be a row of townhouses, and slightly farther still will be single family homes. This neighborhood combines the conveniences of an urban neighborhood and the open areas of a suburban neighborhood. The mixed neighborhood can be located next to either a suburban or rural neighborhood.


Commons
Commons
Urban City Design
-Apartment building and store complexes
Suburban Design
- streets
Townhouses
Stores
field
Stores
Townhouses
Mixed Design
- single family homes
0 yds
50 yds
100 yds
Distance scale

4.5 Entertainment and Recreation

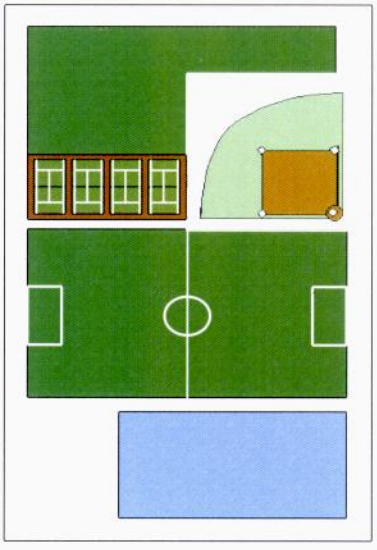
Stores and Entertainment



Bellevistat residents will be able to enjoy many of the same past times as on Earth. In the communities on Bellevistat, there will be a recreation center which contains gyms, movie theaters, coffee shops, and bars. The gyms, like those on Earth, will be fully stocked with a variety of fitness equipment, including stationary bikes, treadmills, and elliptical machines. The movie theater will receive the latest movies from Earth every week via satellite, and will play the movies on a high definition screen. Coffee shops and bars will serve as social area for the community, in addition to providing beverages and snacks.

For the residents who prefer outdoor recreation, there will also be hiking trails and paths for joggers, runners, and bikers. The path will be six feet wide, with a dotted line dividing the path into two parallel five feet wide sections, one for each direction. There will be some common courtesy rules on the path, such as passing a slower moving person on the left side. There will also be fields in the recreation area. Fields can be used for playing sports. Some fields will be for public use while others can be reserved for a fee. There will also be an outdoor swimming pool.

Recreation Fields



Individual recreational activities shall include home entertainment systems, personal workout machines and karaoke. Home entertainment systems can vary from HD plasma televisions, DVD and BluRay disc players to videogame consoles. People who wish to workout at home can have a treadmill or other type of equipment installed into their residence. Karaoke and other similar activities are designed not only for personal use but also for use when guests are over during a party or gathering. Since going to the recreational center would be cumbersome when hosting a party, these home activities provide nearby entertainment and enjoyment.

=Automation=

5.1-Construction Automation

A spaceship will be used to ferry materials to and from the settlement and Earth for supplies. In order to the heat of reentry into the atmosphere, the spacecraft needs to be constructed of temperature resistant materials. The chassis of the spacecraft will be constructed Ludlum 430 Ferritic Stainless Steel which is resistant to oxidization at elevated temperatures and has the comfortable melting point of 1460°C, which is well above the maximum temperature of reentry into the Earth's atmosphere of around 1200°C. In addition, an anodized layer of alumina may be used to coat the craft, which retains properties of non-flammability and a melting point of 2054 °C.

The spacecraft would be equipped with two types of engines for travel inside and outside the atmosphere. For traveling inside the Earth's atmosphere, the use of a combination of turbojet and ramjet propulsion systems will allow the spacecraft to save fuel at low speeds and travel at high speeds up to Mach 5 within the Earth's atmosphere if necessary. For interplanetary travel, the spacecraft's turbines will contract and hydrogen will be flash-burned to create a propulsion system. Since the engines are powered by hydrogen, large polyethylene tanks of liquid hydrogen must be stored at extremely low temperatures, and enough must be stored for a round trip.

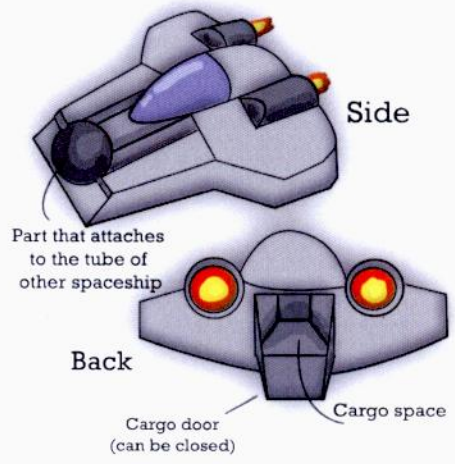


Diagram of Cargo Ship

Diagram of Construction Droid

The mining sector is sent out first, in a few trips, along with the construction droids. Along with large cargo spacecraft, small platforms will attach to electric cables that connect from the space docks where cargo spacecraft land to the structure. These small platforms will use electric energy to move from end of the cable to other, allowing for efficient and quick transport of building materials.

Construction droids will be deployed throughout the

structure to separately manufacture each of the 35 parts of the settlement's structure. Construction droids will be deployed in units of 10 with one command droid with entire blueprints uploaded into the command droid's internal memory. Damaged construction and command droids are repaired by Repairoman, with others capable of being ferried from factories on Earth.

After the base structure's various parts have been constructed, 90% of the units of command droids reassigned to create interiors structures such as power lines and plumbing. The units will still remain a 10:1 ratio for construction droids to command droids, but the command droids will be updated with blueprints of the interior. After basic plumbing and power has been established, droids will begin construction of buildings, facilities, roads, landscaping, and lights. The remaining 10% of the units will be assigned to welding together the 35 separate parts of the structure into one working piece.

Name	Quantity	Purpose
Constructoman (Construction droid)	1,000 units/ 10,000 droids	All-purpose construction (welding, assembly, etc.)
Commandoman (Command Droid)	1,000 droids	Carry blueprint, evaluate/ ensure quality of construction
Repairoman (Repair Droid)	500 droids	Repair broken/ malfunctioning droids

5.2-Emergency Repair and Safety

5.2.1-Safety

The onboard computer system will perform a series of checks to ensure the safety of the settlement. A chief function of the system will be to monitor the oxygen levels and pressure levels, essential for human life. The computer system will control the constituents of the air level, maintaining around 78.1% nitrogen, 20.1% oxygen, .9% argon, and other trace elements in the air with a threshold of plus or minus .1% of each component. The excess gasses will be derived from liquid forms of oxygen, nitrogen, argon, and trace elements stored onboard the settlement that is cooled in storage tanks. The computer system manages how much is let out, and excess gasses are extracted and

cooled to replenish the supply. The water supply will also be regulated by computers to ensure there is no contamination. Additionally, the regulatory computers will monitor any breaches on the outer skin of the settlement along with moderating a livable temperature. Upon detecting a breach in the skin/shielding of the settlement, the computer will release space suits to aid any citizens trapped nearby as well as closing gate doors so that the breached zone will be separated from the other sections of the settlement. The computer system will also notify maintenance droids to help fix breaches as quickly as possible. The system will also regulate power, life-support and the gravity generator to ensure functionality and safety.

The computer system regulating safety consists of three supercomputers each working at 66% capacity so that if one computer malfunctions, the other two computers may successfully take over duties until the malfunctioning system is repaired. In addition, two supercomputers will share regulatory duties to make sure the safety regulating computers function correctly.

5.2.2-Emergency

In case of emergency, the safety regulatory computer system detects and assesses the severity of the problem, taking in information relayed from the sensors distributed throughout the walls of the entire settlement, including peripheral areas. From the data relayed back to the central safety computer system, central computer decides a course of action depending on the severity of the problem.

Certain sections of the torus may be closed off/isolated using retractable and air-tight gate doors distributed throughout the settlement. Problems may then be addressed according to individual sections based on a distress beacon that will be sent out.

As a last resort, the settlement will be equipped with escape pods that are distributed and store in compartments throughout the facility. Each escape pod may comfortably house 15 adults and are stocked with a year's worth of instant noodles. The pods number 750 in total to ensure that in case some pods malfunction; all residents will still be able to escape.

It should be noted that in the event of a solar flare, electrical systems may be damaged in the process. In that case, backup generators will startup immediately following the detection of a solar flare's impact to minimize effect on functionality of essential systems. In addition, all safety measures (escape pods, space suit deployment, etc.) will have a manual override so they will still function in the event of a power outage,

caused by a solar flare or otherwise.

5.2.3-Repair and Maintenance Automation

Repair droids will be housed in centers distributed throughout the system. Hooked up to the main computer system (insert name), repair data as detected by the system guides droids that automatically repair any structural damage.

Evaluation/detection droids also perform weekly evaluations of damage and assesses the risk of failure for each system (power, life-support, water, air quality) and structure. The reports generated will allow the repair droids to key-in on high priority repairs that are done during its biweekly repair sessions.

5.2.4-Computer Security

Security access to the computer system will consist of a multi-step process that differs depending on the amount of security desired for the used computer. All computers aboard the settlement will have retinal and fingerprint scans to ensure a basic sort of protection. For those that require, old-fashioned password and pass phrases will be available as an add-on. For important computer systems that are required for overall system functionality and also regulatory systems, an additional DNA test will be required that will take about 30 milliseconds to perform. The user will be granted access upon matching of 99.995% of the DNA with the sequence stored in the database.

5.3 Daily Automation

Monorail trains on either side of the "down side" in the tori will allow people in Bellevistat to travel quickly within the outer rings of the tori.

Also, people will have motorized scooters (figure 5.3.1) that will help them travel faster over shorter distances with little physical effort which will have an approximate maximum speed of 15 mph. There will be an elevator system in the center shaft of the tori that will facilitate travel between the tori and the tourist, industrial, and mining sections of the facility.

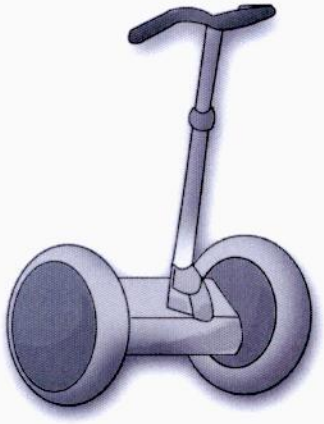


Figure 5.3.1

Agriculture machines (Agriculturobo) (figure 5.3.2) will plant and harvest the plants and deal with agriculture while tubes on the ground will irrigate the fields on a programmed schedule. The agriculture machines will have four wheels and will travel down the rows where the crops are to be planted, placing the seeds in the soil with the center tube. This tube will act as a harvesting device in addition by pulling the useful parts of the plants off during the harvesting, so there will be no need of people in the agriculture process.

Figure 5.3.2

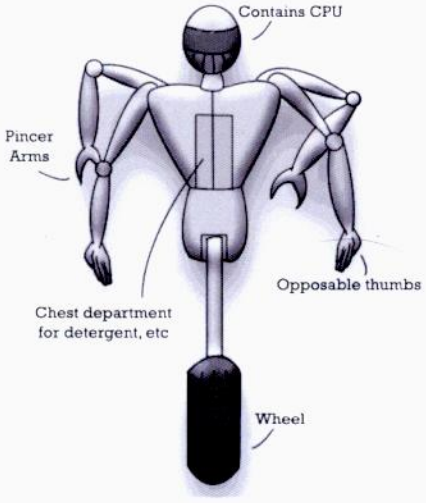


Figure 5.3.3

There will also be Robomans (figure 5.3.3) that will go down the sidewalks and clean trash in the environment and clean inside individual buildings when needed. A thermostat system connected to an HVAC system throughout Bellevistat will monitor the temperature and humidity within the environment as well as each building, maintaining both as specified by the people within the buildings.

All residents will be supplied with a laptop that will be able to connect to the network of Bellevistat that can be used for work as well as personal matters. People will be able to store information on a hard drive built into the laptops or on an account which they will have on the network. Each computer will be able to connect with a 1 megabyte per second transfer rate to the network via a wireless network antenna that runs along each of the monorail lines and the central elevator shaft.

5.4 Automation for Residential Buildings

For construction of the interior of the settlement, the same robots used to build the exterior of the facility (section 5.1) will be sent new information after completion of

the exterior to build the inside. 90% of the Command Droids will be sent the blueprints for the inside of the settlement and they will take their units of 10 construction droids to begin work on plumbing and electricity within facility. After finishing the power and plumbing, the droids will begin construction of the buildings, with each unit working on each building. Most houses and buildings should be finished with basic construction in 12 hours as they are all made of aluminum, so it will not take long to weld the buildings in place. Once finished with the buildings, the droids will proceed to furnish the buildings, installing lighting and electricity within them and installing the interior plumbing, which should take about 2-3 hours per building depending on size. Finally the buildings will all be painted and furnished, with painting taking approximately an hour per building. The furnishing should take about 2 hours for a standard home, and more for different buildings depending on what they need. When the buildings are finished, the Construction Droids will fill in soil generated from the automatic compost-synthesizer where it is needed and will pave the roads using a synthetic rubber polymer that will maximize traction.

5.5- Asteroid Mining

Mining will be done by spaceships (figure 5.5.1 and 5.5.2) approximately 10 yards square with a drill, shovel arm, and arms for grasping the surface of the asteroid with on the bottom side. Despite their large size, these mining vehicles will have little trouble maneuvering as a result of the lack of gravity and the attached rocket thrusters.

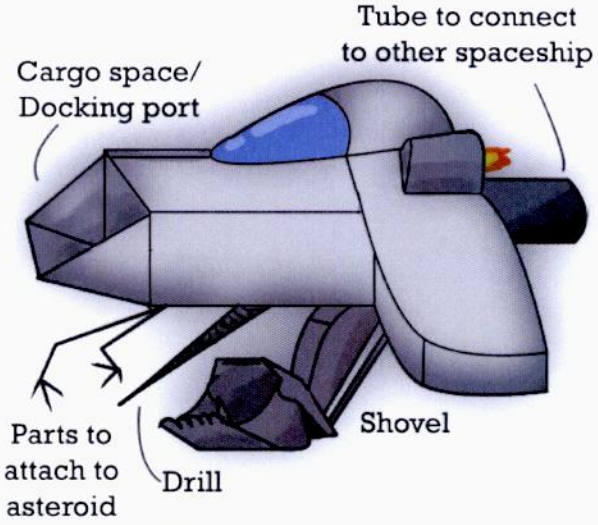


Figure 5.5.1

When the vehicle begins mining, it will first attach to the surface with the arms and drop a canopy over the space to prevent kicking up dust that may damage other vehicles or the settlement. After the canopy is in place, the mining ship will dig up a large piece of the asteroid using the shovel and drill and after the piece has been removed from the surface, it will be broken up into a number of blocks approximately 3 cubic yards.

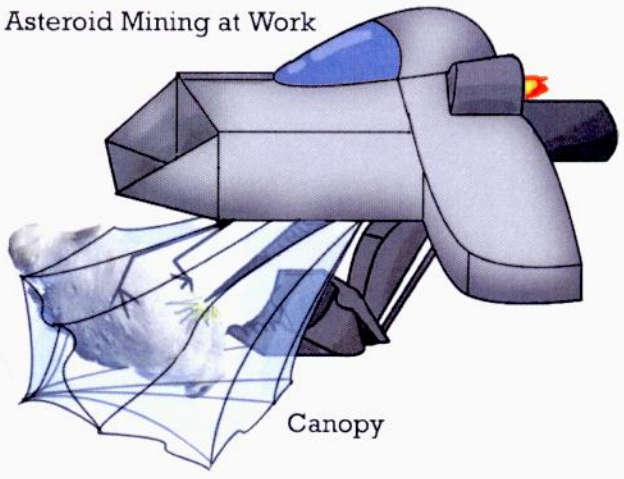


Figure 5.5.2

Once these blocks have been created, they will be sent up through the tube in the rear of the vehicle to a waiting transport vehicle (5.5.3). These vehicles which will be about 10 yards square will have an attaching port in the front to connect to the tube and will then fly back to the mining sector of the settlement, where the materials will be removed from the rear cargo door.

The transport vehicles will also be loaded there with fuel which they will then carry back to the mining vehicles. There will be two transport vehicles for each of the 100 mining vehicles so that the mining vehicles will not need to stop and can always transfers the materials to a waiting transport vehicle. The mining vehicles will be completely automated at the start of mining, with two assigned transport vehicles, however, once people begin living in the settlement, there will be ten operators (1 per 10 vehicles) that will remotely control the mining vehicles as needed to increase efficiency, and may change which transport vehicles go to which mining vehicle.

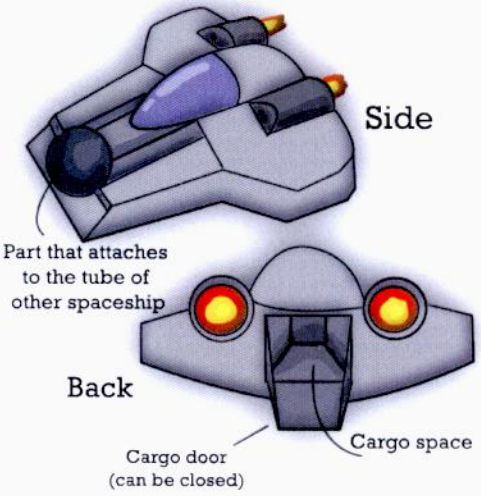


Figure 5.5.3

=Scheduling and Cost=

Schedule

10 May 2028: Begin construction of initial mining sector, construction, mining automation, solar satellite

2035: Launch sector portions, automation, satellite

2036: Have sector portions, satellite in orbit, automation ready for work

2037: Finish assembling mining sector, accept asteroid delivery

2040: Finish construction automation creation, begin shaft construction

2041: Finish shaft construction; begin solar panel, mirror, and BelleSun construction

2045: Finish solar panel, BelleSun mirror

2047: Finish BelleSun construction, begin importing first humans- begin settling Bellesun, faster mining and construction

2050: Finish Bellesun settlement, finish tourism sector, finish BelleTerra mirror

2055: Finish manufacturing sector, BelleTerra, begin construction in manufacturing sector, begin BelleTerra settlement, and begin tourism

2060: Complete Settlement

Cost

Materials from Earth (Mining sector, automation, solar satellite, shielding): 400 B

Takeoff from Earth: 20 B

Maintenance costs per year: 20 B

Imports per year after 2060: 20 B

Employee Salary per year after 2047: 10 B

Revenue

Asteroid ore (platinum, iron, nickel) @ 40 B per year (2047-2060): 520 B

Manufacturing lease: 60 B per year

Tourism ($5,000 per tourist * 1000 monthly) = 60 B per year

Total at 2060: 27 B

Annual Revenue after 2060: 110 B (more when imports lessen)

=Business Development=

7.1 Extraterrestrial materials harvesting and refining

A major portion of the commercial ventures that Bellevistat will pursue is harvesting and refining extraterrestrial materials, specifically asteroids. Bellevistat will be mainly mining carbonaceous asteroids and a few silicaceous asteroids. All asteroids will be harvested by automation and then refined in the mining sector. The refined and/or raw materials will be sent to earth encased in low quality superalloy, to prevent them from burning up during reentry. This superalloy encasing can be reused and will be directed by an attached rudimentary thruster powered by liquid hydrogen, also harvested from the asteroids. The asteroids will be shot towards Death Valley, where other transport will take it to be further refined, stored and sold.

7.2 Space manufacturing

Another portion of the commercial interests will be space manufacturing. Space manufacturing consists of three parts: facility rental, space construction supplier, and spacecraft rental. Bellevistat will provide facilities for private company manufacturing of spacecrafts. To ensure that the private companies' products are safe, these facilities will be protected from outside impact through asteroid debris serving as particle impact deflection as well as from radiation through thermal radiation protection layered walls. Furthermore, a separate portion of the manufacturing facility will be dedicated to Bellevistat's own commercial production. Bellevistat will produce components for solar power satellites, future space settlements, as well as any other orders from customers.

Manufacturing space will be leased to companies desiring to manufacture in zero gravity, but all costs beyond shielding and sector maintenance will be at the cost of the company. The company must agree to follow the laws of the settlement, and a review panel will decide whether the manufacturing is possible and safe. The settlement will provide Constructomen and Commandomen for rental.

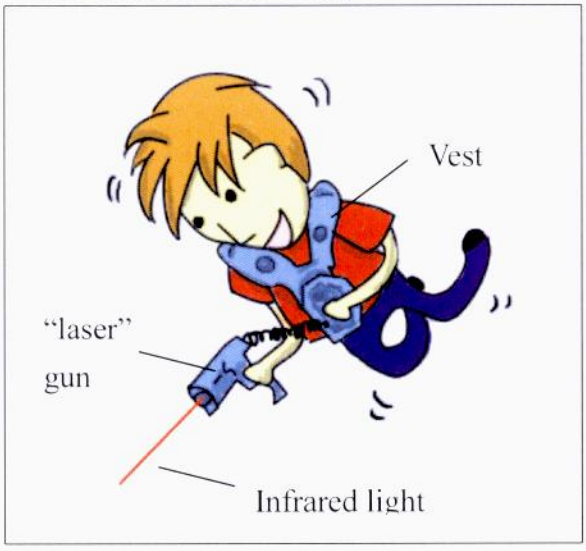
7.3 Tourism

There will be many zero gravity activities which will attract tourists to Bellevistat, including swimming and laser tag.

The main recreational highlight of Bellevistat will be zero gravity laser tag, held in zero gravity tourism area. The rules in zero gravity laser tag are similar to those of traditional laser tag. A group of 10 or more players are divided into two teams, and each team member receives a gun and a sensor vest. The gun will emit a beam of infrared light

when the trigger is pulled. If a sensor on a vest receives light from an opposing team member's gun, the wearer of the vest is temporarily unable to use his or her gun, and the opposing team receives points while the wearer's team loses points. The winning team in each match is the team which can score the most points. The game will be played in a dark arena lit only by black lights. The lack of gravity will make this game both challenging and fun. Variations of the game will also be available, such as a free-for-all mode, power up version (rapid fire, points bonus), and elimination (players who have been hit are immediately eliminated until only one person is left).

Zero Gravity Laser Tag



Another zero gravity recreational activity will be swimming. The swimming pool will be cylindrical shaped and possess numerous diving boards. Thanks to the lower-gravity, the speed and motion of the water will be slowed. For example, if an individual were to jump into the pool, a hole will be seen in the water for a few seconds. Such a unique property will surely be entertaining to whoever goes to the pool. Furthermore, water fights will be more enjoyable than those on Earth due to the increased cohesion property of water – small "blobs" of water will be able to hold together for people to throw at one another.

Other zero gravity recreational activities include soccer, baseball, football and other sports commonly played on Earth. The added aspect of reduced gravity will place a new spin on conventional games. In addition to these organized activities and games, there will also be an area for free activity, where an individual can play a sport that does not have a designated area, sports like Ultimate Frisbee or the classic game of Catch. This area will also be used for people who simply want to enjoy zero gravity in and of itself, floating around or "air swimming".

The allure of zero gravity activities that are only available on Bellevistat will greatly contribute to tourism.

Compliance Matrix

1.0	Executive Summary
Structural Design	
2.1	Dimensions of major components, design, and their uses. Materials for construction of major hull components. Volumes with artificial gravity and how it will be supplied, maintained, and the reasons for gravity magnitudes. Volumes with zero or low gravity, pressurized and nonpressurized environment. Means for protection from radiation and debris penetration.
2.2	Dimensions and orientation for residential, industrial, commercial, agricultural and other areas. Volumes and uses of micro-gravity and nonpressurized areas.
2.3	Process required to construct settlement. Drawing of assembly of major structural components.
2.4	Construction or attachment of a capture asteroid. System to minimize transfer of asteroid materials into settlement. and it's location in the settlement.
2.5	Locations for docking port facilities for vehicles.
Operations and Infrastructure	
3.1	orbital location, sources of materials and equipment for construction and operation, method of transporting these materials and equipments
3.2	basic infrastructure (i.e. food production, power generation, etc.), means of access throughout and between facilities
3.3	existence of orbit infrastructure required to develop or to sustain settlement operations (i.e. power plants, satellites, vehicles)
3.4	residential and commercial area agriculture (i.e. farming and herding)
3.5	design and materials of furniture, interior finishing of residences, plumbing and kitchen equipment
Human Factors	
4.1	Community Layout (areas for residents, recreation and entertainment, storage, machines, etc)
4.2	Residential Areas (details on housing, living conditions, rooms

	depending on number of people, etc.)
4.3	Recreation (movie theaters, gyms, game rooms/ arcades, pools, playing around in zero gravity)
4.4	Goods and Supplies (food and water rations, other necessities)
4.5	Environments and spacesuits (adapting to areas with different gravity)
Automation Design and Services	
5.1	Automation for construction of facility, including transportation of materials and interior finishing
5.2	Safety, emergency, repair, and maintenance automation, security for access to computer system
5.3	Automation for everyday life to increase convenience and decrease manual labor
5.4	Automation for internal construction i.e. plumbing, electricity, furniture
5.5	Automated mining and transportation of asteroid ores (it is dangerous)
Schedule and Cost	
6.1	completion date and duration of major designs, people can move in, etc.; starts May 10, 2028
6.2	costs for construction
Business Development	
7.1	Method for harvesting and refining asteroids, transporting raw materials back to Earth
7.2	Facilities for manufacturing necessary machines for construction projects and spacecrafts
7.3	Tourist - games, observatories, housing/accommodation Include restricted and unauthorized access locations