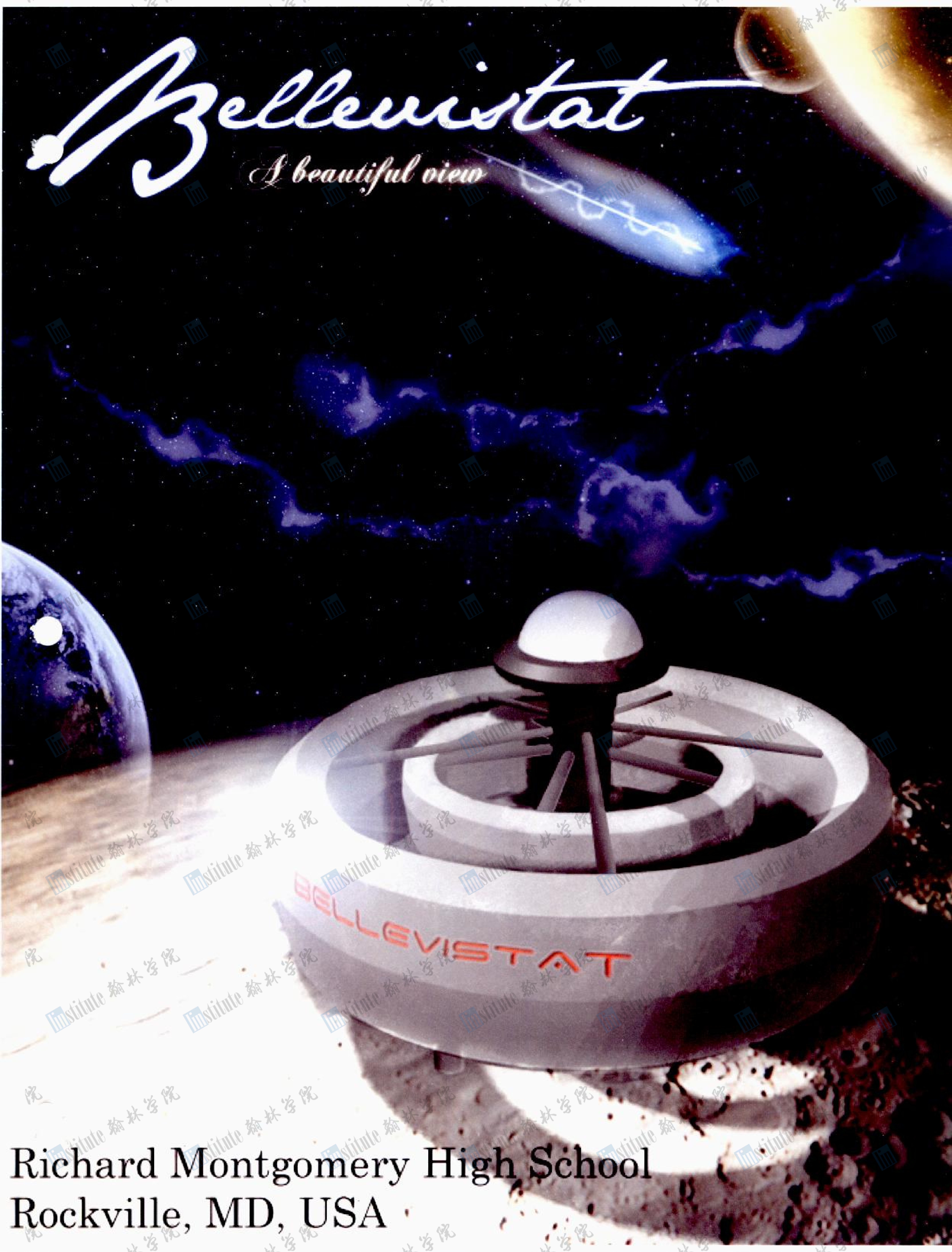

Bellevistat
A beautiful view
BELLEVISTAT
Richard Montgomery High School
Rockville, MD, USA

- Table of Contents –

- 1. Executive Summary -

Bellevistat is a fully operational ore refining settlement orbiting at L1 and is not only a useful industrial tool for the Foundation Society but also a very feasible response to the growing interest in space colonization.
Bellevistat consists of two main regions: the two rings, which are two independent hollow cylinders that hold the residential areas, support structures and related basic industry, and the central shaft, which contains heavy industry, industrial docks, and the means to capture an asteroid and hold it to the station, allowing mining of its ores. The two rings are calculated to spin so that they create the feeling of gravity and are to mimic that of Earth's very closely, whereas the central shaft acts in little to no gravity to help maximize the efficiency of the hard industrial tasks.
Construction of Bellevistat will take approximately 20 years, as run by a schedule. Materials for construction will be gathered from many sources, such as the captured asteroid, Alexandriat, the Moon and Earth itself. Food production will be done through the use of vertical farming and aeroponics, and a combination of micro-produced animals and safer, healthier lab produced meats. Energy is provided via solar power transferred through microwaves and many steps have been taken to ensure that the energy needs are addressed. Walking on foot will be encouraged, though there will be many automated vehicles that can provide a faster means of transportation.
Built to accommodate 18000 permanent residents along with 1000 in transient, Bellevistat is very specialized towards its inhabitants. It allows for multiple different living environments, from a suburban neighborhood to an urban one, and also provides 3 different types of housing structures of different sizes for different kinds of occupants. Human development and care is focused on heavily in Bellevistat, with nearly all possible concerns with residency in space addressed thoroughly and effectively. Resources are well taken care of, making the station nearly self-sufficient.
New technology allows Bellevistat to reach a higher level of efficiency. Automated systems for many regular processes allow ease and safety as well as a more thorough control over the operations to be done. Droids help in law enforcement, providing a fool-proof system for stopping crime. Mining, a very dangerous but still necessary activity, is also controlled through automation for increased productivity and far less casualties. All Automated systems can be quickly restored if malfunctioning, and are controlled through a larger system which processes all the drones' actions and is easily accessible.
Bellevistat is very capable of refining ores and encouraging aeronautical commercial expansion. Using advanced automotive systems, asteroids can be harvested for their minerals to help sustain Bellevistat and provide it with crucial materials. Using a safe system of spears, the asteroid will be safely secure and also able to be released in the event of an emergency. Commercial exploits are also a very important goal for Bellevistat, as there will be a large area devoted to industrial ventures. Ports specifically designed towards business help ensure that the marketing companies of Bellevistat are free to grow. This can also be seen in the large rotating rings of Bellevistat, which are covered in LCDs, allowing for allocation of time towards advertisements. Bellevistat thus can succeed at achieving its goals and providing a safe and comfortable option for those looking into aeronautical expansion.

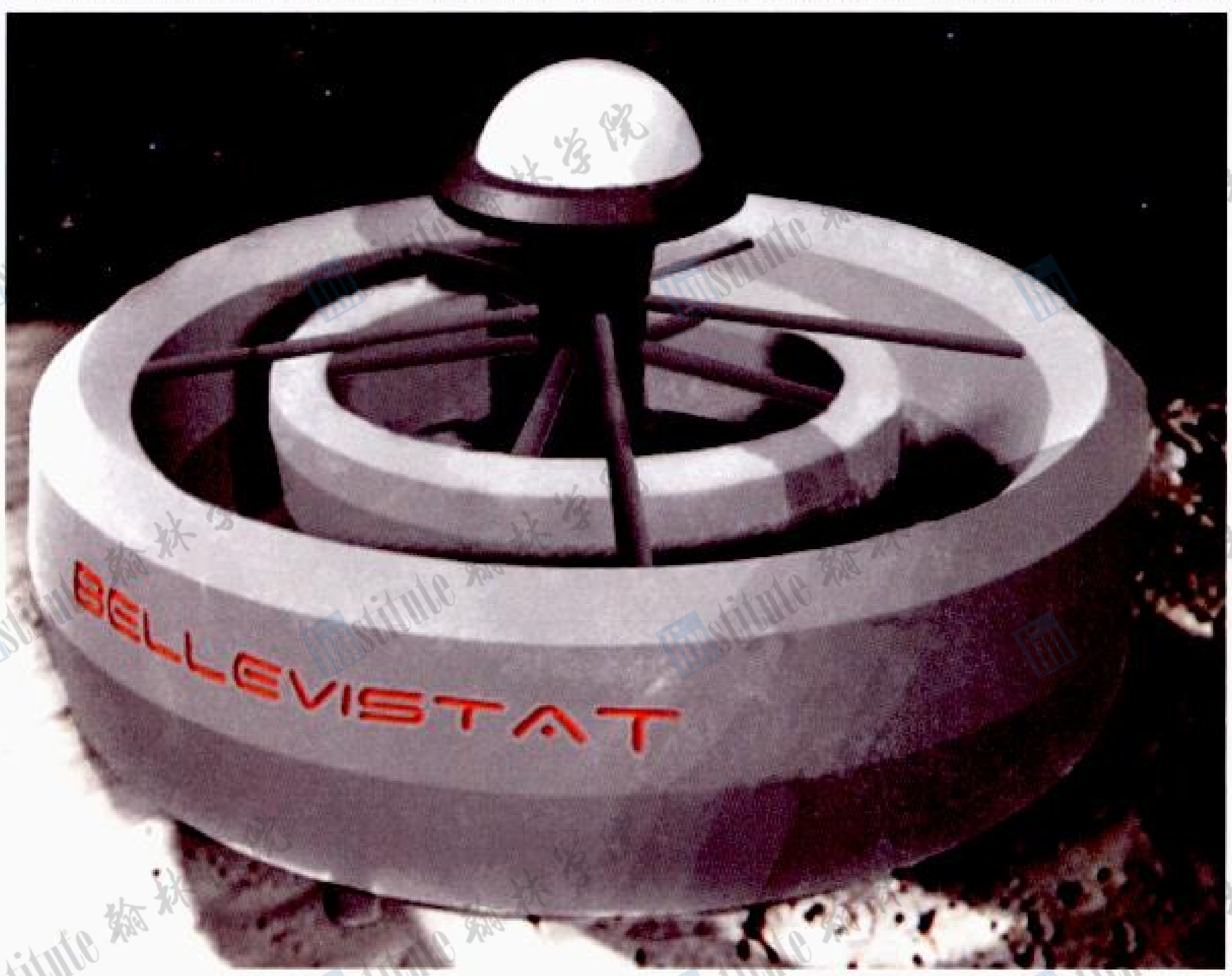
- 2. Structural -

2.1 Overall Station Design: Bellevistat consists of two rings, one inside the other, rotating in opposite directions around a central shaft. The central shaft itself expands at the ends, containing communications centers, tourist facilities, and science facilities on one end and commercial ports, some industry, and mining sectors on the other.

Explanation: The division of the primary living environments into two independent rings allows for efficient use of space as it creates a large surface area under artificial gravity while keeping the overall size of the station small – in other words, in contrast to a one-ring design, the two-ring design makes use of the space between the ring and the central axis. A reduction in station size is very important as it significantly reduces the chances of the ring or its "spokes" colliding with meteorites, saves construction materials, and makes the station more durable. Additionally, such an arrangement allows for better compartmentalization of the station into separate communities, which can still easily communicate with each other.

The separation of the commercial-industrial sectors from the scientific and tourist sectors in the central shaft creates task-specific environments and avoids excessive redundancy of residential or industrial accommodations. Also, the separation of commercial ports from each other and from the tourist-oriented port avoids excessive clutter of incoming ships, decreasing the chances of collisions and minimizing the impact of emergencies on the overall flow of traffic.

2.1.1 Station Dimensions: The dimensions of Bellevistat are as follows:



Dimensions:

Outer Ring: Radius: 650m
Width*: 75m
Height**: 350m

Inner Ring: Radius: 500m
Width*: 75m
Height**: 250m

Central Shaft:

Center: Radius: 50m
Height: 450m

Top (Observatory): Radius: 150m
Height**: 100m

Bottom (Commercial): Radius: 250m
Height**: 100m

* Width refers to the distance (thickness of the ring) along the radius
** Height refers to the distance perpendicular to the radius and circumference

2.1.2 Artificial Gravity: Artificial gravity in the two rings will be maintained by the centripetal force created due to the rotation of the rings at a constant velocity. The magnitude of the artificial gravity is proportional to the speed at which the rings are rotating: $g=v^2/r$. Thus, assuming an earth-like gravity of $g = 9.8\ m/s^2$, the following rotation speeds were derived

Rotation Speeds: Outer Ring: 79.8 m/s (clockwise) = 1.17 rpm
Inner Ring: 70 m/s (counterclockwise) = 1.34 rpm

Additionally, all areas under artificial gravity are pressurized and kept at pleasant living conditions.
Explanation: Considering that the purpose of this station is to provide comfortable, near-Earth conditions, the artificial gravity created in the rings of the station should be as close to that on Earth as possible. The choice of the speed of rotation is only limited by the disorienting impacts of the Coriolis Effect and the wear on the connections between the rings and the central shaft. Yet as can be seen, the rotation speeds at Earth gravity are only 1.17-1.34 rpm: speeds at which the Coriolis Effect is not noticeably harmful and the wear on the stations joins can be accommodated for. The rings rotate in opposite directions so that the friction of the ring spokes with the central shaft cancels out.

2.1.3 Zero-Gravity Areas: The central shaft and its extensions are at zero gravity (disregarding the small amounts of gravity provided by the asteroid that the station is attached to). These zero-gravity sectors are reserved for exclusively zero-gravity industry (refining of ore, heavy industry mostly for export), zero-gravity scientific research, mining operations, and transient tourist populations that remain on the station for less than 24 hours. Of the zero-gravity areas, the following areas are not pressurized: mining areas, all port facilities (excluding the reception areas for humans),

Explanation: The central shaft is stationary and thus allows for zero-gravity areas, such as those required by some industries, scientific facilities, and mining operations. Keeping mining operations under zero-gravity avoids energy expenditures needed when transporting mining materials against the force of gravity. Additionally, keeping the mining sections not pressurized avoids the extreme energy loses since mining areas are very weakly isolated from the outside environment. At the same time, mining machinery is completely automated and thus does not require pressurization to function.

2.1.4 Wall Structure: The wall consists of several layers, all of which serve multiple functions. Radiation shielding layers provide thermal isolation, and also block infrared radiation which is responsible for most of the heating in outer space, helping maintain a stable temperature in the settlement. (see figure 2).

Material (from outer layer in)	Structural Value	Thermal Isolation	Radiation Shielding
Carbon Fiber/Kevlar	Flexible, but durable material. Capable of sustaining minor impacts without damage. It is low density and easily repaired. Kevlar strands woven in add strength.	Low energy transfer across the layer of carbon fiber.	Kevlar has moderate radiation shielding capabilities.
X-Aerogel and Hydrogen	Capable of withstanding massive pressure with very little deformation, protecting inner layers in the event of a massive impact and reducing the likelihood of damage. In the event of damage to the layer, more X-aerogel can be manufactured on site.	Aerogels have very low thermal energy transfer rates.	Certain types of X-aerogel may provide slight radiation protection. Also, large amounts of hydrogen gas can be stored in aerogels, providing additional shielding.
Polyethylene	Can be compressed into bricks or layered as a cloth. Low-density and moderately strong.	Moderately low energy transfer.	Very high potential for shielding against radiation.
Steel	Provides a strong central framework on which the other layers can be anchored.	N/A	N/A

In addition, excess heat is removed from the station via a water-and-liquid-ammonia based cooling circulation system (water pipes absorb excess heat on the insides of the station, and transfer then transfer the heat to liquid ammonia flowing in pipes in the exterior layers of the wall)

Explanation: Carbon fiber and Kevlar on the outside of the wall are flexible to allow for sustaining small impacts without suffering any serious damage and could be repaired very easily in the event of any serious damage either by replacing them or by covering the damage with a polymeric fastener. Also carbon fiber does allow much thermal energy transfer, helping maintaining thermal isolation. Kevlar weave mixed with the carbon fiber improves the structural integrity and also provides some radiation shielding. The next layer, X-aerogel, can endure massive pressures with only minimal deformation, decreasing the need for repairs and shielding the inner layers of the structure. Typical aerogels have less structural potential, and so will be placed behind the X-aerogel layer, but both variations have minimal thermal exchange rates. Also, specific types of X-aerogel have radiation shielding properties and the large amounts of hydrogen gas (about thirty moles per kilogram of aerogel/metal hydride) stored in an aerogel/metal hydride mixture provide further radiation shielding, without the danger of the nucleus destabilizing and becoming radioactive itself. This is especially important as the inner layers contain more metallic elements, whose nuclei may shatter when bombarded by radiation. The remainder of the outer structure is composed of a steel framework filled with polyethylene. The framework provides a stable structure on which to anchor the other layers while the polyethylene provides the final layer of both radiation shielding and thermal isolation. Achieving this practically perfectly insulated environment, the temperature of the station can be regulated by either heating the station using the heat generated by energy plants and industry, or cooling the station by using the water-liquid ammonia coolant system. The water absorbs extra heat from the stations environment and gives it off to the liquid ammonia, which cycles outside the station for enough time to give off its heat but in short enough periods to not freeze.

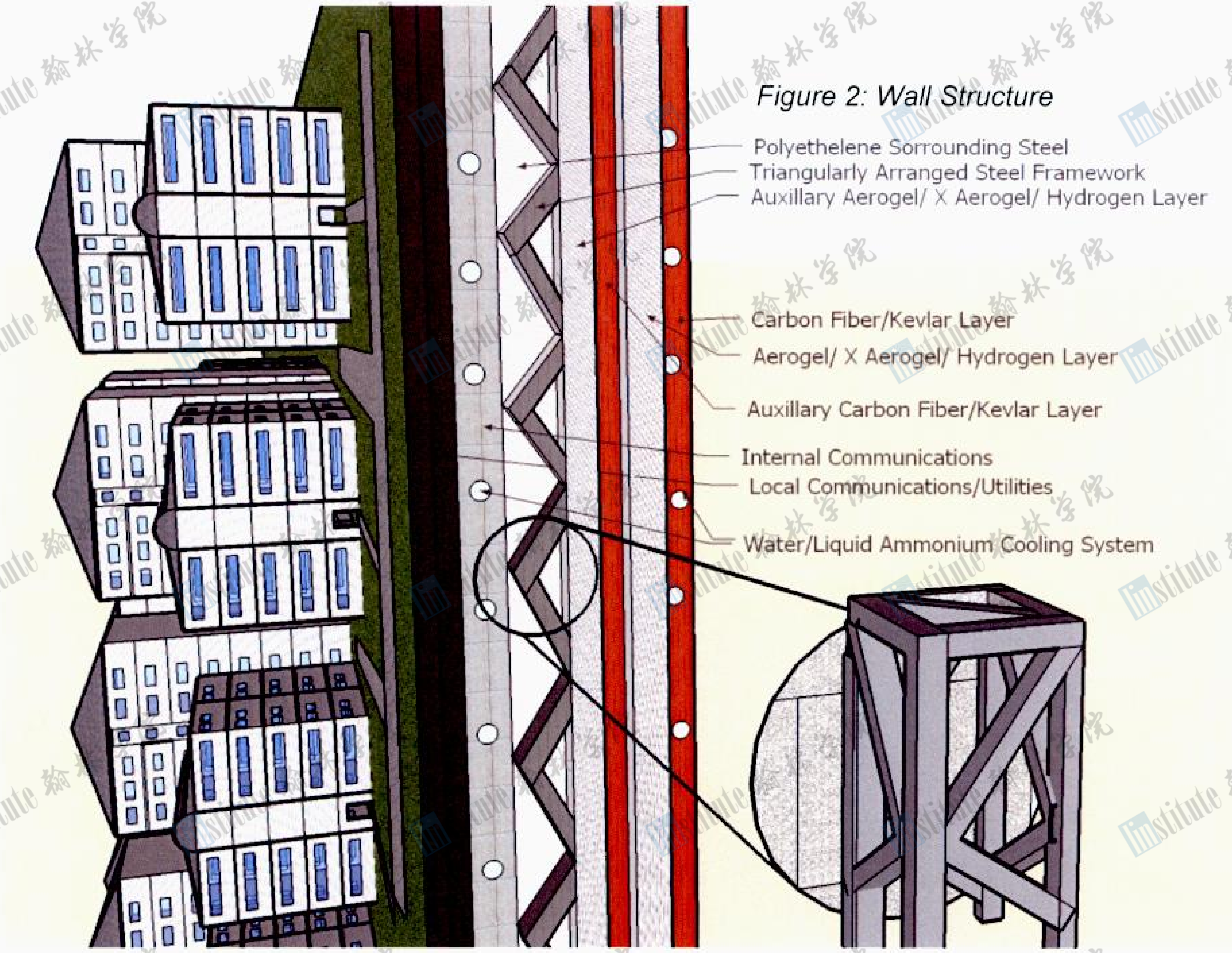


Figure 2: Wall Structure

2.1.5 Major External Construction Materials: The station is held up by a steel framework (steel can be made from the iron and carbon abundant on the home asteroid). All the exterior walls consist of materials outlined in section 2.1.4. In addition, section dividers consist of 1m thick elastic rubber layers, intended to absorb the shockwave from any major impact. The axels connecting the rings to the central shaft consist of a steel framework and a similar, although thinner version of the outer wall, and thus relies on the same materials as the outer wall. Thus the major materials of used in the station are: Carbon Fiber, Silicon (aerogel), Hydrogen, Steel, and Aluminum.

2.2 Interior Station Design: The station is divided into three major components: two independent rings and the central shaft as described in section 2.1. Each ring is subdivided into six sectors, half of which are residential and half of which are supportive. (See figures 3, 5). The central shaft is divided into three major areas: the Observatory end of the station, which also includes tourist accommodation, the Center, which includes energy generators, ring rotation regulation mechanisms, and transition chambers connecting the rings to the central shaft and allowing transit. Finally, there is the Commercial sector of the central shaft, located at the asteroid end of the shaft. This end includes mining operations, commercial ports, industry, and storage.

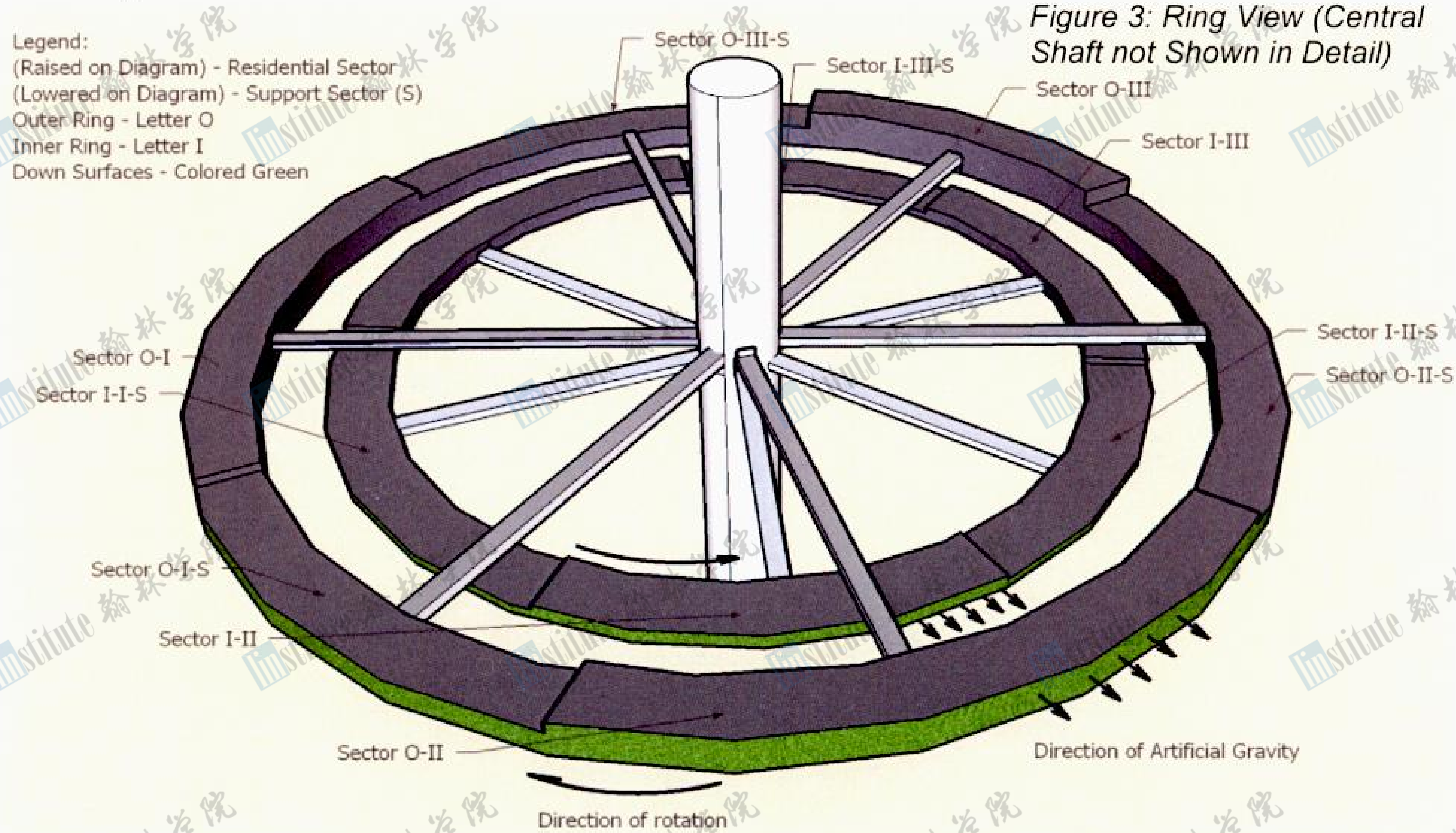


Figure 3: Ring View (Central Shaft not Shown in Detail)

Explanation: The rationale behind the subdivision of the station into the rings and the central shaft into sections is explained in section 2.1. The subdivision of each ring into sectors allows for compartmentalization of tasks and the division of living and production environments, allowing for a more Earth-like environment. Also, three residential sectors allow: 1. more contact with support sectors, reducing transportation needs; 2. variation in environments and architecture, modeling different cities and areas, much like on Earth; and finally 3. decentralization of living environments so that in case of emergency, one could be evacuated and quarantined for repair without significantly impairing the functioning of the station as a whole.

2.2.1 Ring Sectors: Each ring is subdivided into 6 sectors, three of which are residential and the other three are support. (See figure 4) The dimensions of the sectors are as follows (given in length x width x height, where length is the distance along the circumference of the ring, width is the distance perpendicular to the radius and circumference and height is the distance along the radius):

Outer Ring: Residential Sectors: 612m x 350m x 75m = 214200 m^2 floor area x 75 m
Support Sectors: 749m x 350m x 75m = 262150 m^2 floor area x 75 m
Inner Ring: Residential Sectors: 471m x 250m x 75m = 11775 m^2 floor area x 75 m
Support Sectors: 576m x 250m x 75m = 144000 m^2 floor area x 75 m

Functionally, a support and a residential sector form a group, with the support sector providing food, energy, and processing power to the residential sector. Additionally, the support sectors contain some industry, producing everyday necessities for the inhabitants of the station, but in this case, the support sectors produce is distributed to all the sectors in the ring, not just its designated residential sector. Thus the sector tasks are divided as follows:

Residential Sector:

- Earth-like living environment (varying in density and architecture – see Humans)
- Commerce and government administration
- Scientific Research
- Entertainment, Parks
- High-tech industry

Support Sector:

- Food manufacturing (agriculture)
- Energy generators
- Life support and storage
- Basic industries

Nevertheless, the divisions between these areas are not absolute. Residential sector parks contain small agricultural plots and zoos, and the support sectors have specially reserved "garden" regions where station residents are able to visit at any time.

Explanation: Dividing the "support" and "residential" areas of the station mimics modern cities on Earth where industry is typically kept in certain regions away from "sleeping regions". This division separates residents from noise and psychologically damaging impacts of automated industry and creates comfortable residencies. Also, this division greatly increases the efficiency of the station's operation as energy production is closest to the greatest energy drain – industry, life support, and agriculture. On the other hand, to avoid complete isolation of residencies from the internal workings of the station and psychologically damaging monotony, visits to special "demonstrative" parts of the support sectors are allowed. For the same reason, people are allowed to choose and move between residencies of various densities and architectural styles, creating a sense of diversity.

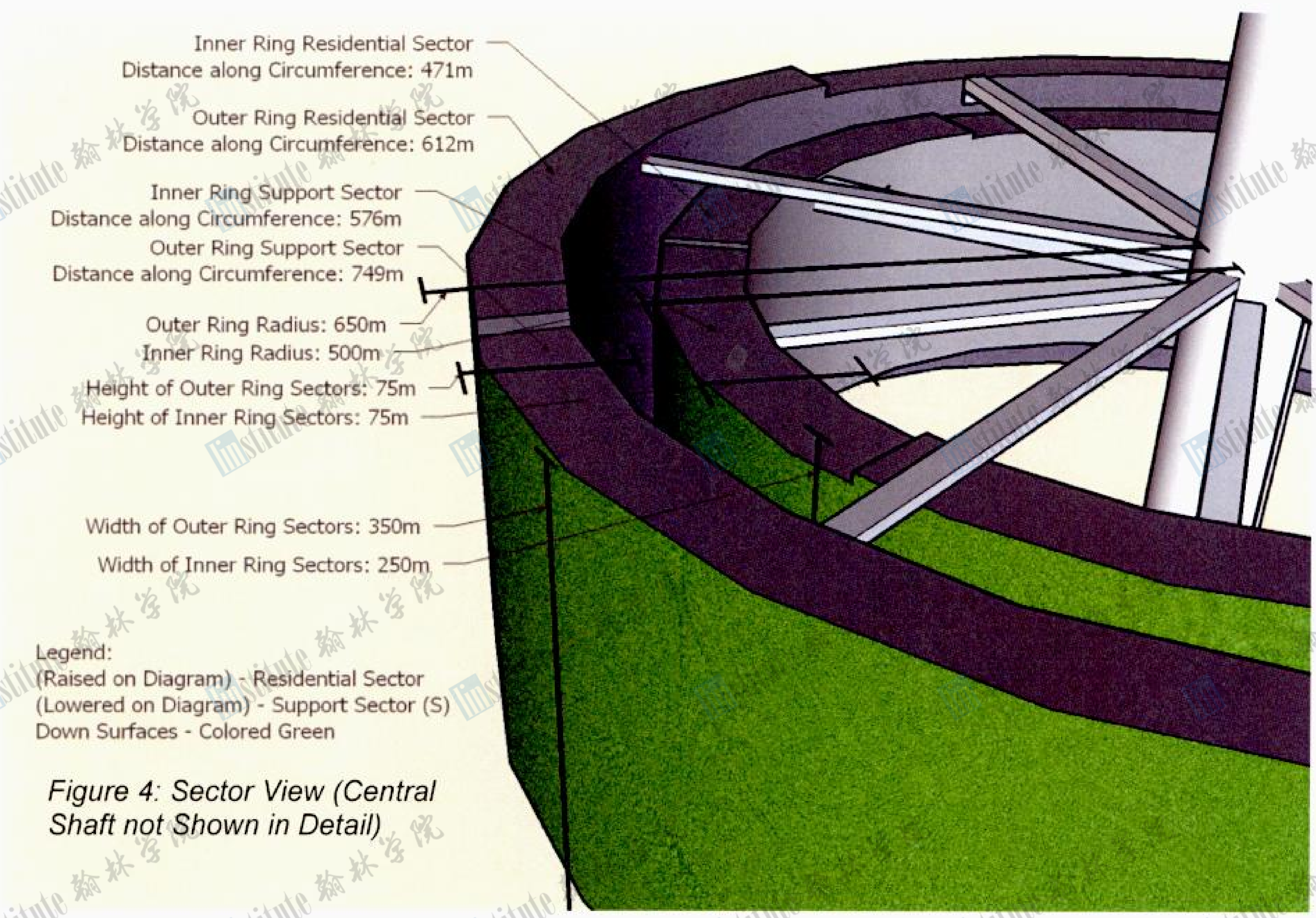


Figure 4: Sector View (Central Shaft not Shown in Detail)

2.2.2 Central Shaft Sections: The central shaft is divided into three major sections: the top section, the central section, and the bottom commercial section. (see figure 5). All of these sections are pressurized, with the exception of the very bottom of the commercial sector that contains the mining operations, and all are at zero-gravity.

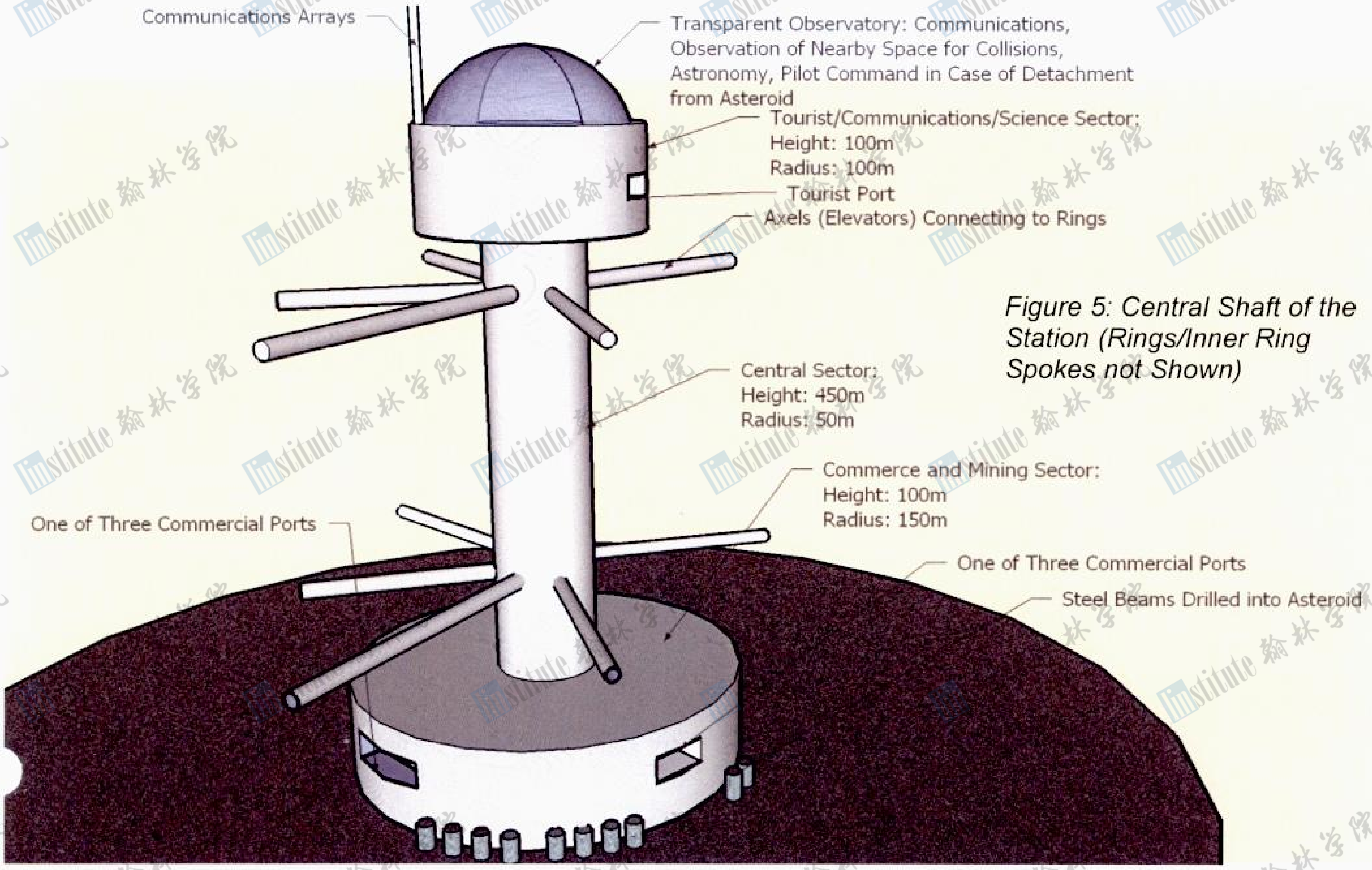


Figure 5: Central Shaft of the Station (Rings/Inner Ring Spokes not Shown)

2.2.2.1 Observatory and Tourist (Top) Sector: This sector contains the tourist port and reception facilities, as well as a transparent dome observatory serving as an astronomical station, communications center, and pilot command center in case of station detachment from the asteroid. The dimensions of this section are:

Height (along central axis): 100m
Radius: 100m
Total Volume: 3141593 m^3 (sector volume) +2759 m^3 (observatory)

Explanation: By putting tourist, scientific, and communications facilities together, a type of friendly residential environment is created in this section of the central shaft, which accommodates for both the tourists and station residents working in this section (since most of the manpower in the central shaft is concentrated in this area).

2.2.2.2 Center Sector: The second section is the central sector. This sector contains transition chambers to the two rings of the station through axels connecting to the rings (axles connecting to outer ring show on the diagram. A second identical set is present for the second ring). In the center of this section is also the central station power plant that powers the central shaft and provides reserve power to the rings to supplement their individual power supplies. The dimensions of this sector are as follows:

Height (along central axis): 450m
Radius: 50m
Total volume: 3534291 m^3

2.2.2.3 Bottom Commercial Sector: This sector contains the major mining facilities on the very bottom, drilling into the asteroid under the station, processing plants right above the mining facilities, and zero-g industries (heavy industries, mostly for export) in the top part of this sector. Also, this section contains three commercial ports, spaced 120 degrees around the central shaft. The dimensions of this station are as follows:

Height (along the central axis): 100m
Radius: 150m
Total volume: 7068583 m^3

Explanation: By putting the mining, processing, and heavy industries next to each other and to the station's commercial ports in zero-gravity conditions, clutter and transportation energy expenditures are minimized. Also, spreading the three ports evenly around the station minimizes clutter and "traffic" around the station, protecting the ports from becoming unnecessarily overcrowded if a ship breaks down or an emergency happens at one of the ports. Finally, separating the commercial sector from the "residential" top of the shaft serves the same purpose as the support sector in the ring: to avoid destroying the friendly residential atmosphere of the densely inhabited sections of the station with industry and machines.

2.3 Construction Order: The station construction includes four major phases:

1. Construction of the bottom commercial sector of the central shaft, where ore can be extracted and refined to make materials for the rest of the station.
2. Construction of the rest of the central shaft
3. Construction of the inner ring
4. Construction of the outer ring

2.3.1. Commercial Sector Construction: The first step in the construction is the establishment of a temporary base of operations on the asteroid, around which numerous mining and refining facilities are built (these are imported from Earth rather than constructed on site). Then the walls of the sector are built, establishing the areas for industry, and finally, the docking facilities are built to allow large ships to dock to the settlement before the start of the next major phases of construction. (See figure 6). During this time, the station runs on life support and energy provided by temporary generators imported from Earth.

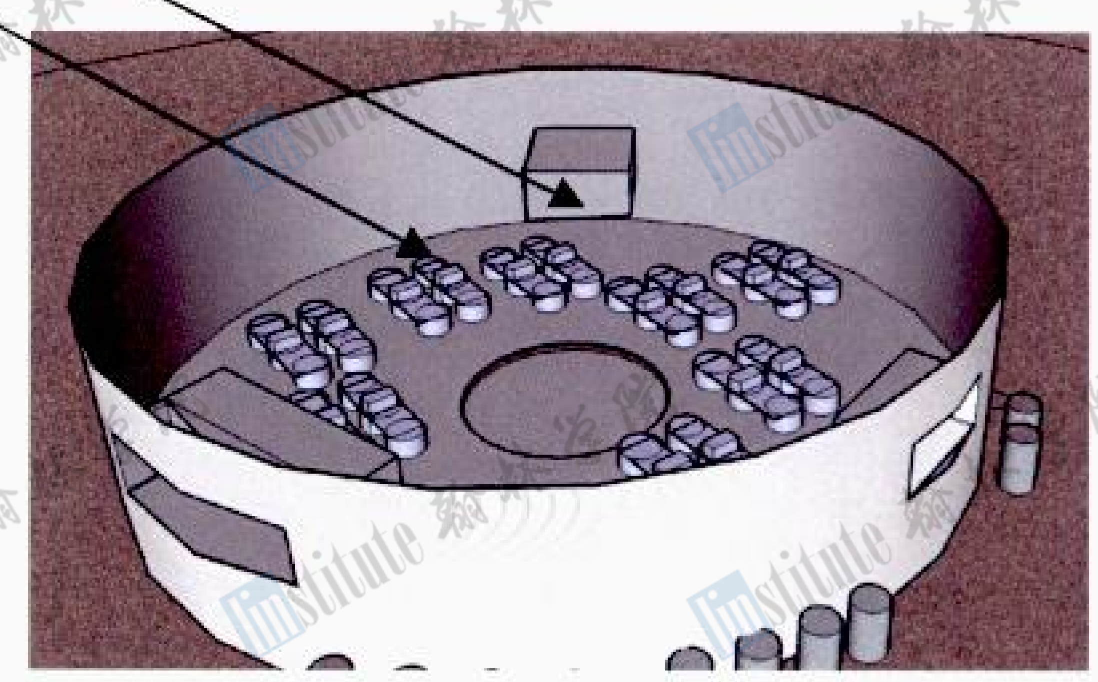


Figure 6: Construction of the Primary Commercial Sector

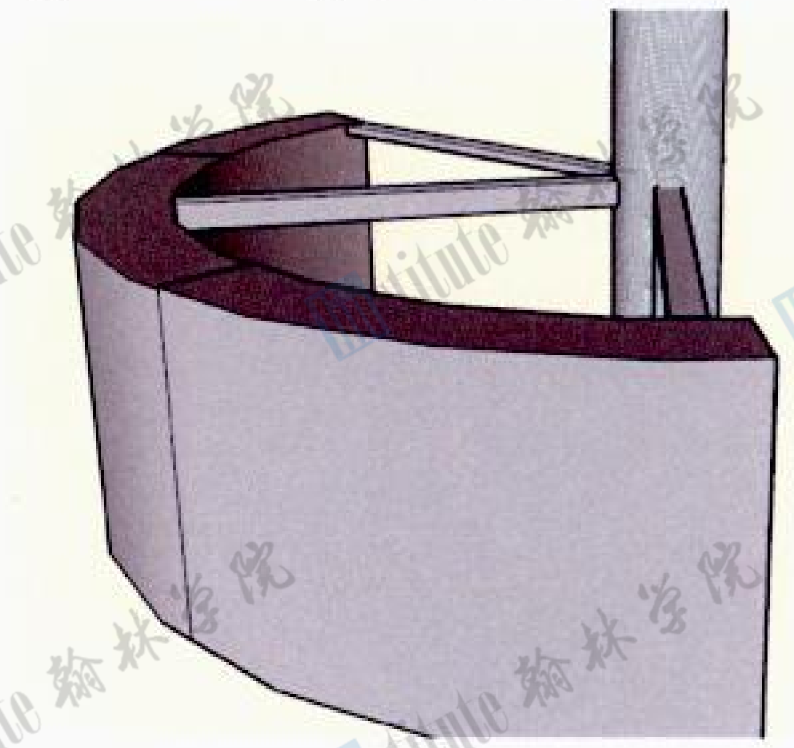
Explanation: The initial commercial sector serves several functions. It provides a strong base for the station, firmly attached to the asteroid. Also, the docking facilities on this section allow for incoming ships with construction materials and workers to dock easily and safely. Finally, the mining and refining apparatus within this sector provides ore and synthesized materials such as steel, carbon fiber, silicon, and precious metals for further construction of the station.

Figure 7: Center Shaft Construction

2.3.2 Central Shaft Construction: The central shaft construction begins with the construction of the center section of the shaft (see figure 7), including the main station generator which replaces the temporary generator mentioned earlier. The influx of power allows many more construction robots and machines to operate. Finally, the top section is built, first building the communications arrays and the observatory, and in the end, the tourist facilities and port.
Explanation: The central shaft generator provides the power needed to construct and support the station in place of the temporary imported power generator. As the central shaft is completed, the station gains its first "residential" sector in the top of the central shaft, as well as its communication arrays, completely replacing the temporary settlement established on the asteroid initially.

2.3.3 Ring Construction: The last two phases of construction involve the construction of the rings. The rings are constructed sector by sector on the asteroid, and then lifted into position and connected to each other through semi-

Figure 8: Ring Construction



elastic bands. (See figure 8). When the sectors are lifted into position, they are practically completed, and include all the internal construction. Finally, as the station nears completion, pivot-able boosters are placed on the bottom (asteroid side) of the rings and the rings are accelerated to a speed providing for first one tenth of earth gravity (using the pivot-able boosters), at which point all the stations systems are started up for testing, and the construction crews are given time to adjust to the stations artificial gravity. Gradually, the ring rotation is accelerated to their normal speeds.

Explanation: Constructing fully functional sectors in zero-gravity saves energy and time since once the rings are rotating, transporting mass amounts of material into them is tedious and slow (since axel elevators have to be used and their volume and speed is not very high).

2.4 Station Attachment to the Home Asteroid: The commercial sector of the stations central shaft is attached to 24 steel poles drilled into the asteroid. These poles can be blasted off the station, detaching it and sending it into free flotation near the asteroid should the asteroid ever need to be abandoned. Peripheral structures, such as the temporary settlement placed on the asteroid before the stations construction, are held in place by coiled steel cables hooked onto drilled holes in the asteroid.
Explanation: Poles provide rigid support to the station by virtue of their very low elasticity as compared to, for example, cables, making them well suited for long term support of the station. They can be stuck into mine shafts drilled with the stations mining apparatuses before the stations construction, and held in place by expandable "rose-ends" (ends of poles that can be pushed into a hole and then expanded into petals, holding the pole in place).
Cables on the other hand are elastic and much more vulnerable to bombardments by meteorites and small sharp rocks, making them ill suited for long term support, but they are also cheap and easy to put in place or replace, making them well suited for temporary operations.

2.4.1 Isolation from Space Dust and Asteroid Debris: To ensure that space dust and asteroid debris does not harm the insides of the station or bother its inhabitants, care is taken to keep this dirt out of the station. All entrances to the station, including those at ports for both cargoes and people, contain a transition chamber. Objects and people entering the station enter this chamber, which is then sealed off and filled with the standard air used in the rest of the station. Then, this air is sucked back out of the chamber, carrying much of the dust out of the chamber like a vacuum cleaner. The air is then filtered, and pumped in again. Only then are the contents of the chamber are allowed into the station. Meanwhile, the air filtration systems throughout the station are tuned to filter out harmful dust from the air.
In the specific case of mining and ore refining, where asteroid debris may be a problem, all mining machinery is enclosed in protective carbon fiber cases, and all entrances have transition chambers similar to those used for external exits.

2.5 Docking Facility Overview: Three major commercial docks, as discussed before are located on the bottom sector of the central shaft, next to the mining operations. The noncommercial dock on the top of the station takes all other incoming traffic and serves as the main transportation hub of the station. The placement of all these docks helps with docking by providing a wide range of approach angles so that ships can always move either left or right to avoid the station.

2.5.1 Docking Accident Prevention System: A space travel control center for each dock coordinates space dock traffic. This control center utilizes computer systems to help guide docking approach courses and clear traffic. A space emergency response team for each dock is available to react to contingencies.

- 3. Operations –

3.1 Construction

3.1.1 Location: The Lagrange point between Earth and Moon, dubbed L1, is the location for the space station because it is gravity neutral, minimizing fuel expenditure. The location of our station minimizes transportation between source and destination points (often Moon and asteroid). The solar power satellites are located at the other Lagrange points, L4 and L5.

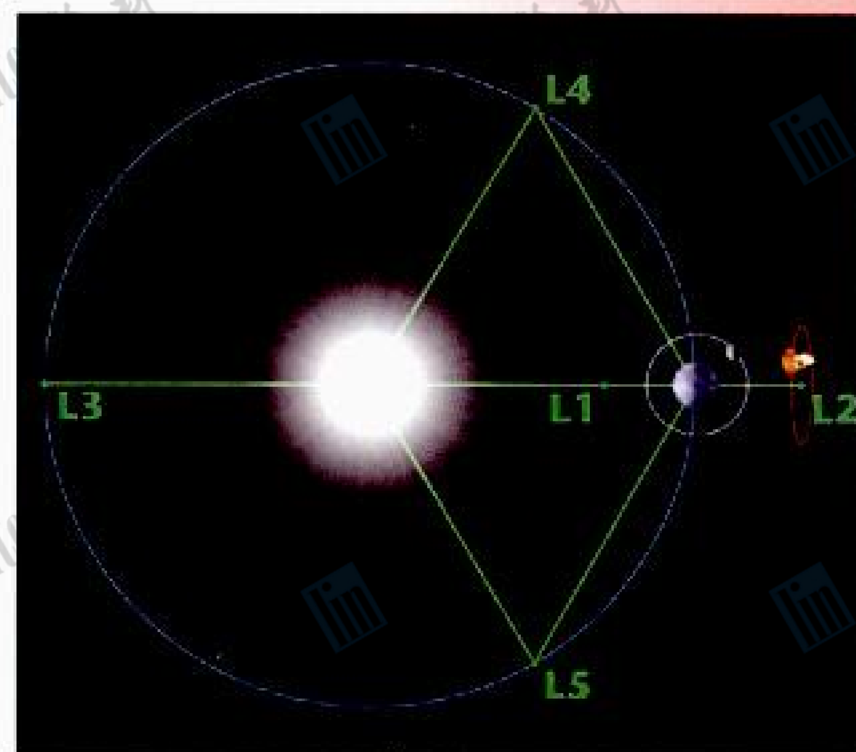


Figure 9 (Credit to NASA's website)

3.1.2 Materials/Equipment Required:

Materials	Source
Silicon	Moon
Hydrogen	
Oxygen	
Water	
Iron	Asteroid
Aluminum	
Carbon/Carbon fiber	
Nickel	
Platinum	
Gold	
Other minerals required for agriculture	
Beryllium	
Gallium	
Uranium/Plutonium	
Cement	
Permanent magnets	
Plastics	Earth
Nitrogen	
Inert gases (helium, argon, neon)	
Ammonia	
Rubber	Alexandriat
Polyethylene	
Kevlar	
Initial bio-matter (e.g. seeds)	

Equipment	Source	Transport
Electronics	Moon	STV
Ventilation System		
Spaceship parts		
Pipes		
Microwave Beam Reflection Satellites (MBRS)	Earth	Space shuttle
Construction Robots		
Fiber optic cables		
Water filtration system		
Fuel cells		
Air filters		
Space Transport Vehicles (STV)	Alexandriat	Pre-existing space cargoes

3.1.3: Construction Process:

Phase	Objective	Logistics Details	Time Frame
1	Construct collector array on asteroid, place first set of solar satellites, and deploy reflector satellites around Earth.	Satellites delivered to asteroid via space shuttle from which the STV's transfer them to their proper location.	5 months for placement and alignment
2	Move Zero-Gravity Mining and Processing Facility to the asteroid.	Space shuttles transport this.	1-4 months depending on weather at launch site
3	Begin mining asteroid and manufacturing space ship components.	STV's and space shuttles serve as transports.	N/A
4	Finish core of space station and deploy more solar satellites.	See above.	3 years
5	Build first ring. Build second ring (sector by sector)	See above.	1 year. 2 years
6	Initiate rotation/populate.	See above.	1.5 years. 2 years

The chronology of the construction process should minimize the need for storage on-site.

3.2 Internal Infrastructure

Figure 10: General Layout of a Support Sector
(Dimensions are given for the Outer Ring Sectors; Inner Ring sectors are proportionally smaller)
(For Residential Sector Layouts, see section 4.1 Community Design)

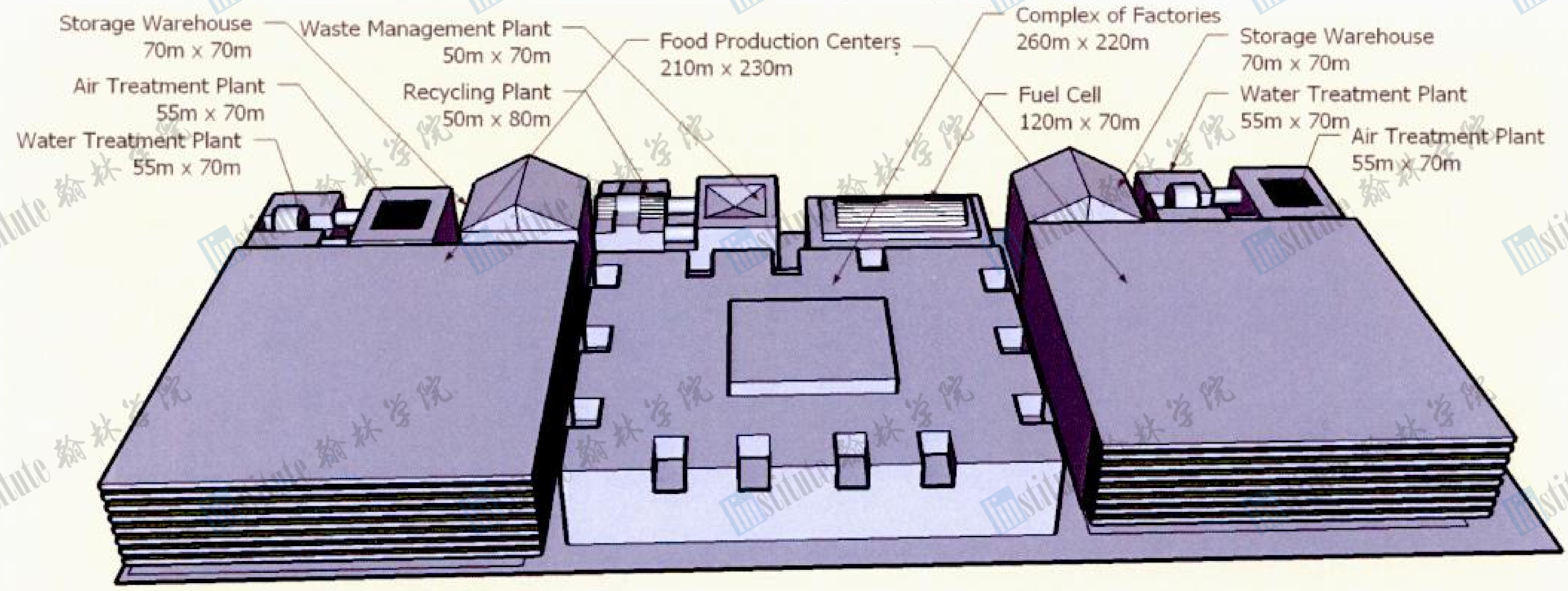


Figure 11: The movement of goods between the Residential and Support Sectors
(Labeled layouts for each sector are available in sections 3.2 and 4.1)

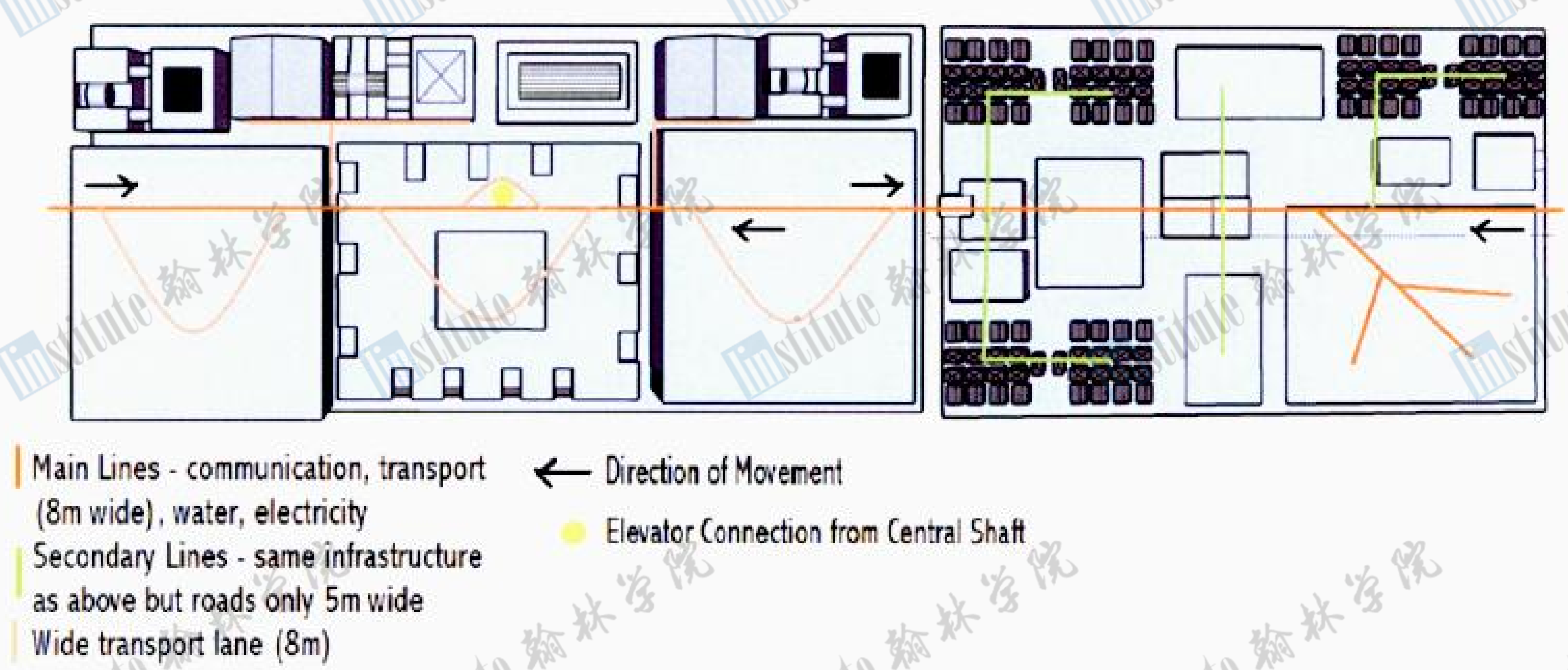
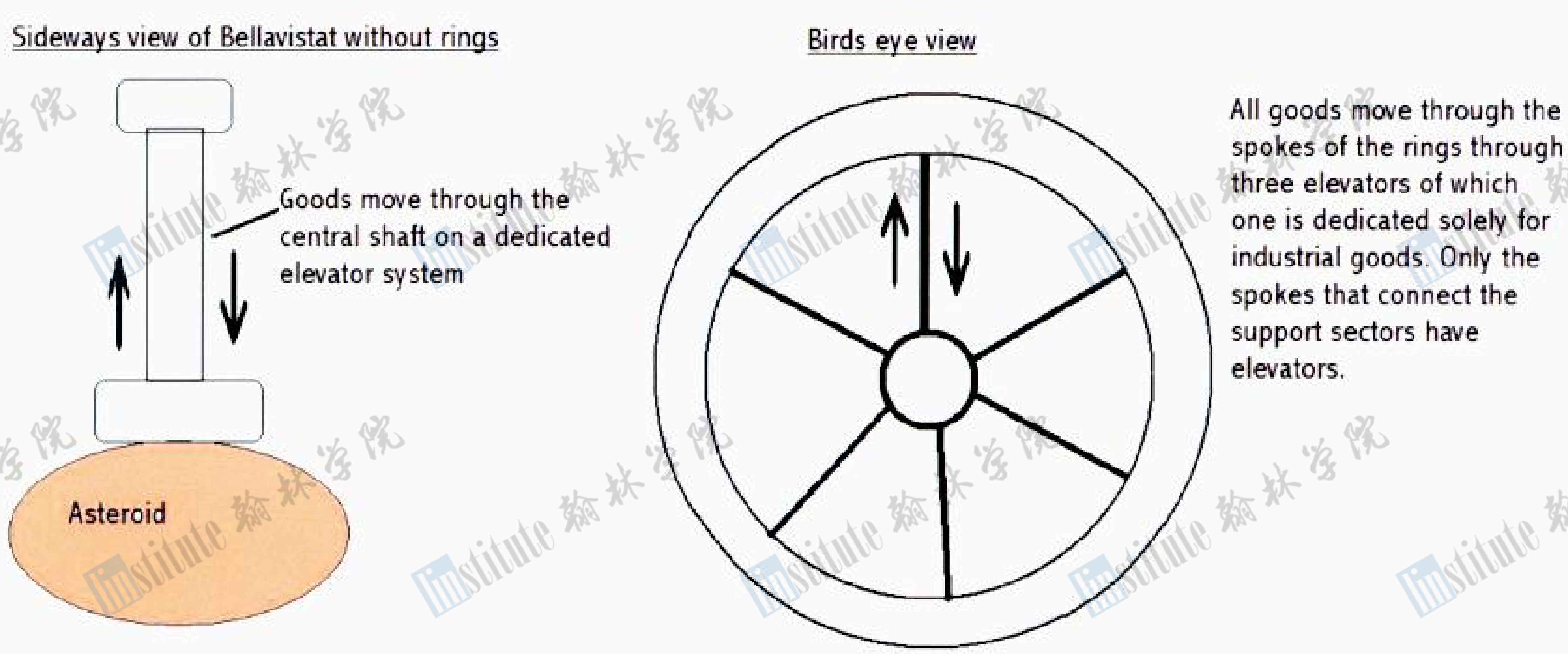


Figure 12: The movement of goods between the Major Areas of the Settlement



3.2.1 Food Production: For feeding the population, we use the vertical farming concept that consists of a tall structure with stacked layers, each home to a different set of crops. The farm serves to filter black water, produce oxygen, and provide high-yield crops. Before entering the farm, the wastewater undergoes a filtration process. Since the artificial gravity propels the water down the different layers, minimal powered irrigation is necessary. Most crops grow in an aeroponic environment that abrogates any need for pesticides, reduces water and nutrient consumption, speeds the growth process, and is highly productive. The general design is one in which the topmost layer harbors plants that can be grown in a pure aeroponic environment, the middle layers harbor a hydroponic environment and the bottom crops that need some kind of soil or foundation and filters black water. The concept design in Figure 13 is another kind of farm that integrates these three methods is designed for holding more hydroponically-grown crops. The concept of integration reduces waste and transportation. Animals grow in the same kind of building except that they replace some agricultural floors. Micro-farming—genetically altered mini-animals that consume less feed, have higher meat density, and grow faster—contributes 25% of meat supply to satisfy the population's desire for high quality, all-natural meat. The other 75% laboratory-grown, which uses less space and healthier (in addition the nutrient composition is adjustable). Since producing medicine through artificial chemical processes requires complex machinery and a dedicated pharmaceutical industry, we harvest medicine from genetically altered crops approved for such production.

Figure 13 Vertical Farm Concept Design

The proximity of the crops to the consumer simplifies transportation logistics. Most residents purchase their food products through the spaceship's web at the residence, allowing production to closely follow demand. The producer puts the individualized order together and delivers it to the residence everyday. This distribution method harnesses the efficiencies of mass packaging and distribution. The items are transported in a reusable box in which residents also return their waste. The staggered time in time zones allows the same crew of vehicles serves an entire ring.

The short time frame between production and consumption for both meat and plant products abrogates the need for a temporary preservation medium. There may be, however, cooling processes at the commercial to preserve products. There are trucks dedicated to moving these goods to the community markets.

Commercial organizations design packaging for their products, but they must all use the standard plastic to encourage recycling.

3.2.2 Electrical Power Generation: Free floating solar panels outside of the space station beam solar energy via microwave beams (safer and more efficient than other frequencies) from locations with uninterrupted sunlight exposure to an array on the asteroid (see Figure 14). If Earth-based power sources are cheaper, however, it would be possible to beam energy from a terrestrial source to the asteroid by adding several more satellites between Earth and ship.

In residential areas, power-hungry devices connect to the power grid through contact pads in place of traditional electrical outlets (similar to the technology developed under the trademark WildCharge). In residence and public areas, electricity is transmitted wirelessly for small devices and lights, simplifying electrical infrastructure. At gyms, exercise machines return power to power the site's facilities. Nanowires woven into clothes convert kinetic energy into current that powers residents' portable devices.

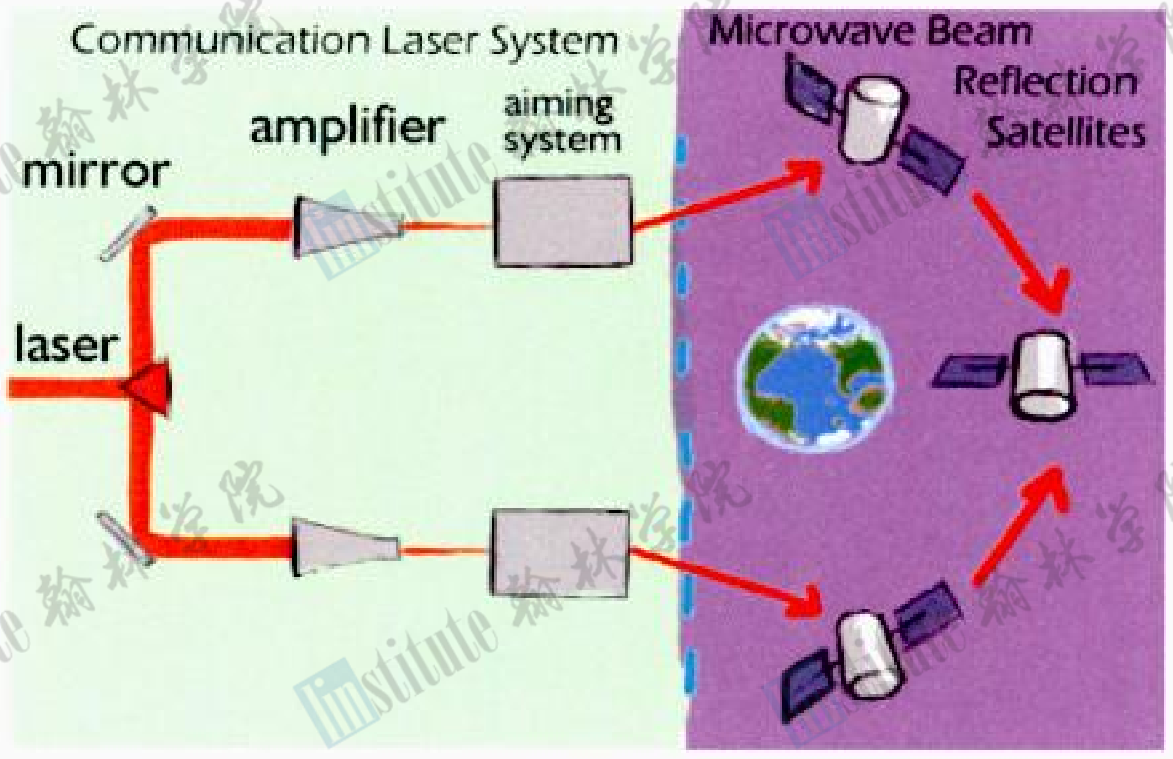
Each sector contains its own backup generator (dependent on a fuel cell because of the fuel's high energy density and efficiency) and a distinct power grid from the other sectors. If, however, one sector loses its generator, separate sectors can be connected to ensure that basic systems continue to function in multiple areas. Excess power collected goes to convert biomaterials or water into oxygen and hydrogen gas that is compressed and cooled for storage for the fuel cells. The liquid hydrogen, however, also goes to the main superconductor power lines, cooling the superconductor core lines and also serving as fuel for vehicles

(Grant, Paul M., Starr, Chauncey, & Overbye, Thomas J. "A Power Grid for the Hydrogen Economy" in *Scientific American*, July 2006).

The waste treatment plant has its own contained supply of power and may even contribute excess electricity when the mix of waste is appropriate. Effluent appropriate for agricultural use undergoes decomposition in a bioreactor located in the greenhouses, a process that also provides the temperatures necessary for soil-based crops.

3.2.3 Internal/External Communication: We use a combination of wireless and wired communication. Wireless access to the station network is for general use. A general communication protocol exists for all devices, allowing universal contact between them. To prevent unauthorized access to sensitive equipment, any connection between two devices is automatically recorded in a central database and cross-checked. Despite the high capital investment for optical fibers (especially since they come from Earth), interconnectivity in the future is so prevalent that their high capacity but also security for the government channels (also leased to private organizations) is crucial. Realizing that solar flares would seriously disrupt any external communication that relies on wireless signals, we communicate with earth via a laser based system (Figure 11). Several mirror satellites serve as relays between Earth and station and the station seamlessly switches between satellites with the method detailed in the diagram that only requires one laser. We superimpose several frequencies in the beam, transmitting a signal by rapid switching the laser on and off.

Figure 14 External Communication System



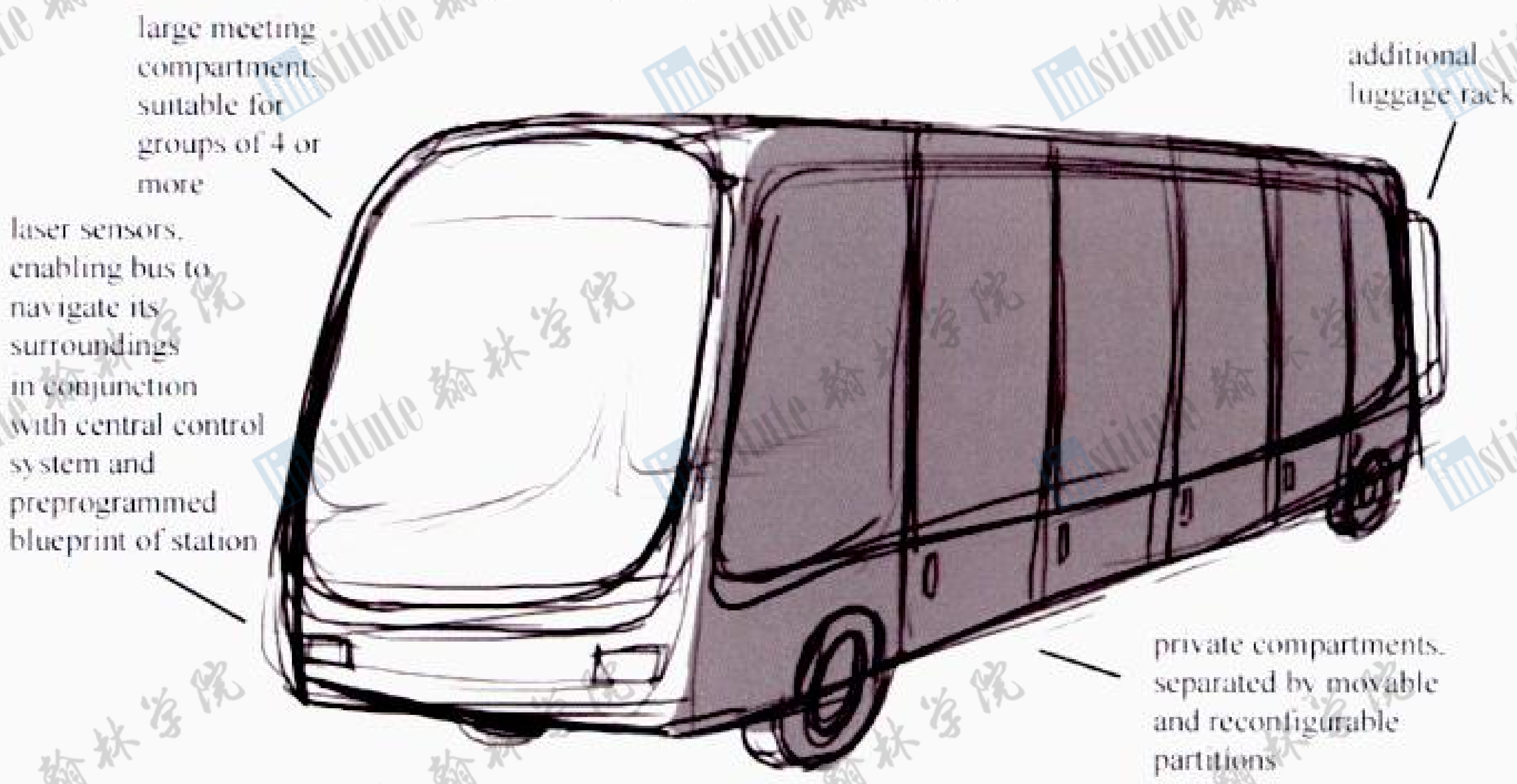


Figure 15: "The Agito" public transportation vehicle seats 30 people.
Dimensions: 8m x 3m x 2.5m (l x w x h).
24 in total with 4 for each residential sector.

3.2.4 Internal Transportation: The small dimensions of the sectors encourage walking. Public transportation is available and supplants all individual cars (but not small motorized transportation). The Agito (see Figure 15) and its smaller version provide regularly scheduled trips according to the known transportation patterns. It has reconfigurable private compartments which can join together for group meeting spaces.

3.2.5 Atmosphere/Climate/Weather Control: The air composition mimics that of Earth with nitrogen (78%), oxygen (21%), carbon dioxide (1%), and relative humidity to vary between 25% and 60%. Air pressure is slightly lower than sea level at 14.0 PSI to limit air needed, reduce structural stress, and minimize atmospheric leakage. Assuming a temperature of 70 F, we need 1.4287×10^{11} kg of nitrogen, 4.3938×10^{10} kg of oxygen and 2.8776×10^{9} kg of carbon dioxide.

Large fans encourage the natural convection of air rely on ionizing the air and accelerating the charged particles through a magnetic field because this method is energy-efficient, silent, and removes fine particles from the air. By routing this air through the greenhouses, much of the CO_2 is removed. For safety, however, CO_2 scrubbers are located in every building. The air treatment plant also treats the air for odor-causing volatile organic compounds, removes unwanted gases, and maintains the gases ratio.

We allow temperature to fall during the night cycle to imitate the terrestrial and to save energy. Temperatures vary according to the corresponding Earth season from between 63° and 78° Fahrenheit to break the monotony of the enclosed environment. The entire spaceship is filled with microsensors that regularly sample the environment for abnormalities in these conditions and send data back to a central server by wireless hopping through nearby sensors. Floor panels that generate electricity from the kinetic energy of a passing person or vehicle power these devices.

3.2.6 Water Management: After filtering black water through the hydroponic farms, the water undergoes an energy-efficient filtration process that includes flowing through multi-filtration beds that remove organic and inorganic impurities and neutralizes organic compounds with catalysts. The final stage is an ultrafine filter that removes any remaining material. Water used in the industrial process must go through a chalcogel (based on sulfur) filtration process that removes heavy metals. Water is rationed but adjusted individually for size and physical activity. To improve water efficiency, Using the United Nations Development Program's estimates of US water usage (575 liters per person daily and because this country has a large industrial base) and assuming 85%, 60%, and 70% efficiency in agricultural, industrial, and residential water use, respectively; assuming that a constant filtering cycle requires only 60% of that water be available at a time; and realizing that Bellevistat's agricultural base is smaller in proportion to the population, Bellevistat needs 1,835,400 liters of water. Moisture captured from the air undergoes filtration and goes to the water supply.

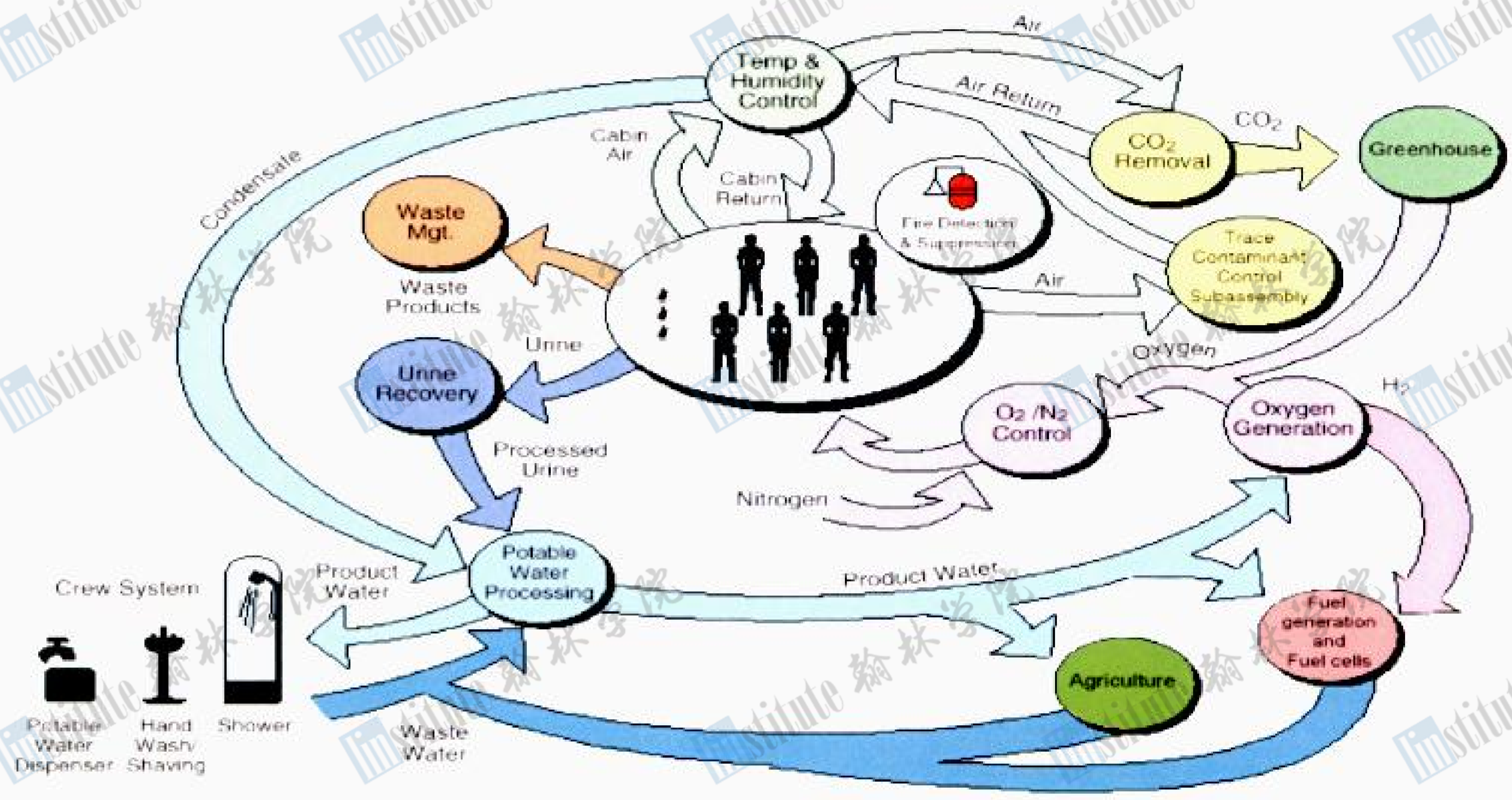


Figure.16 Air and Water Cycle, credit to NASA.
This diagram is copied from NASA's website with some changes.

3.2.7 Household and Solid Waste Management: We encourage the consumer to sort all recyclable waste materials at the residence for efficient processing, but also, we have a brief sorting process at the waste plant. For efficiency at the production and recycle stage, we use a standardized plastic for construction of goods (containers, furniture, etc) that are recycled simultaneously. Unusable waste goes through a plasma gasification process that powers itself and returns extra energy to the grid via burned syngas. Some of the slag is converted to rockwool by cooling by compressed air which is then used in hydroponics. Slag can be mined for extra metals or converted to a cement-like substance for reinforcing the asteroid during mining.

3.2.8 Day/Night Cycle Provisions: The day and night cycles follow those of actual ones on Earth so communication is easy. There are six different time zones on the station, each four hours apart to ensure that a human crew is always available to maintain operations and to reduce strain on infrastructure. Pairs of connected residential and industrial sectors share time zones.

3.2.9 Propulsion: For moving the station, chemical reaction engines are used for their high immediate thrust. The engines are Oxygen/Hydrogen engines, since both materials should be easily acquired from the asteroid, and they are some of the simplest yet most powerful engines available.

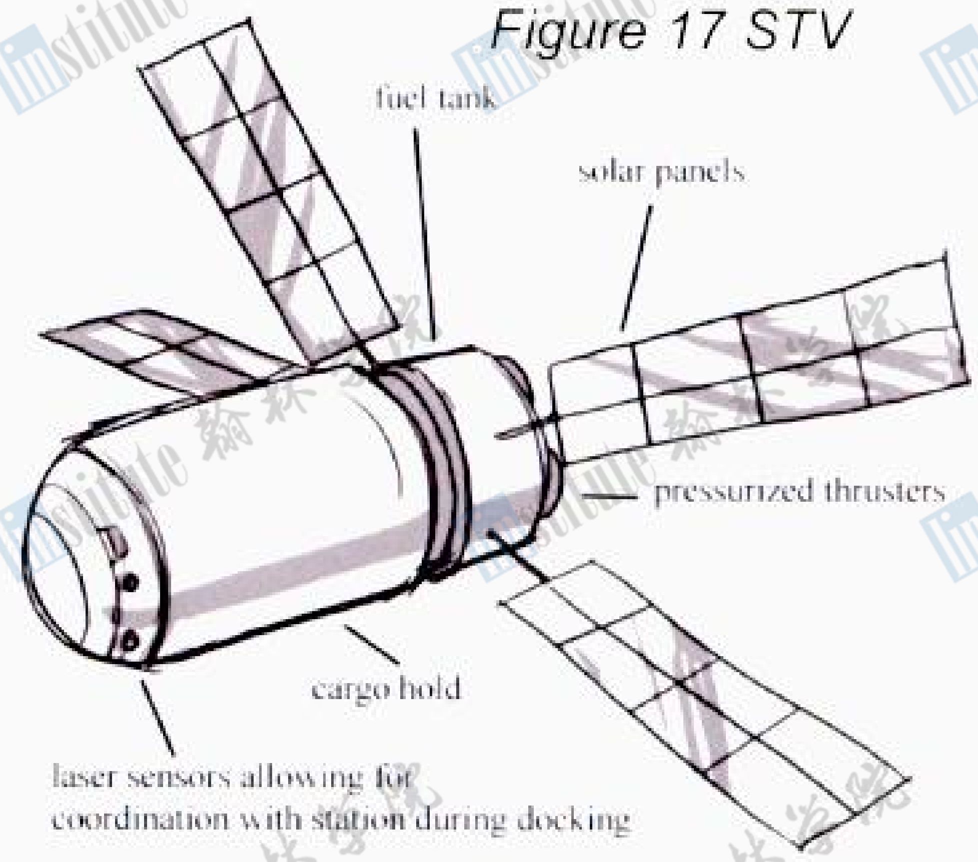
3.3 Space Infrastructure:

Required Infrastructure	Location	Information
Microwaves Collector Array	Asteroid	This is an array of metal rods connected with wiring over a large surface area receive the energy collected by the solar satellites.
Zero-Gravity Mining and Processing Facility	Asteroid	This is the first mining facility and must be constructed on the moon. Once on the asteroid, it can provide the materials for the Moon-based facilities to begin spaceship construction.
Compartmentalized Warehouse	Asteroid	Large building for protecting materials from damage from space (temperature changes, debris) It is simply a number of large rooms with shielding and some with insulation for equipment.
Manufacturing Plant	Moon	Constructs the components needed to assemble Bellevistat.
Solar Power Satellite Plant	Moon	This constructs the solar satellites for powering the station.
Space Vehicles Hangar	Moon	Holds the STV's.

Ship (#) (P-part of contract)	Location	Function	Mission Time	Payload
Space Shuttles (10)	Earth to space and back	These convey from Earth to the asteroid. They are essentially with a large compartment that can be adapted to hold a mechanical arm or be fitted with a cabin for transporting people.	8 days total travel to asteroid, 2 days unloading cargo, 1 week inspection/repairs before re-launch	50,000 kg, 400 persons
Space Transport Vehicle (STV) (8)	Moon to space and back	These ferry the raw materials from and manufactured goods to the asteroid. They also transport solar satellites.	1 day total travel to asteroid, 2 days unloading, 1 week inspection/repairs	250,000 kg, 4 solar satellites
Microwave Beam Reflection Satellites (6)(P)	Orbit around Earth	Explained in power generation section.	Indefinite	N/A
Construction Robots (P)	Asteroid	Small vehicles that can build and put pieces together. A plant on the moon manufactures them. They are highly versatile because their limbs are exchangeable. They are powered by radioisotope thermoelectric generators with fuel from the asteroid.	Duration of construction	

3.4 Interior Design Materials: Mass manufacturing has brought efficiency and interchangeability to many parts of the modern world with economies of scale. Realizing that such a process, if applied to interior design, would greatly increase the rate of construction and decrease labor expenditure, we use the LEGO® concept. All the rooms in the station are mass manufactured with interior design and connections (plumbing, wires, etc.) already installed. Once on site, they only need to be stacked and cemented together like LEGOs®. The only labor intensive process is constructing the façade. Moreover, the rooms are built collapsible to minimize "dead space" during transport. To individualize the rooms, a computer at the factory randomly, but tastefully, assorts various variables (room color, location wall fixtures, etc.), but the resident may at any time rearrange the inside of the room to his own preference because he can easily remove and replace parts of the rooms.

Figure 17 STV



3.4.1 General Furniture Innovations: Multi-functionality in furniture is crucial for conserving resources so that a single piece of furniture can serve multiple functions. For example, an invention by a man in Pennsylvania can be a table, chair, bed and chaise. Not all examples have to be this versatile, some can be as simple as placing the drawers underneath the bed. By condensing several functions into a single piece of furniture, residents will use less space and materials.

3.4.2 Specific Furniture Innovations:

- All lights are LED for efficiency.
- In the kitchen, there will be no conventional sink but instead a drinking water spout and a fine mist spray nozzle. There is no use for the sink because dishwashing is all done by the dishwasher. The spray nozzle wets cloth that the resident uses to clean.
- Refrigerators use most of their energy removing the heat that entered when their doors were opened or closed. To reduce the time spent searching for a specific item in the refrigerator, each refrigerator has a screen on the door that shows the location of each container by reading the RFID signals emitted. Furthermore, the refrigerator is compartmentalized so that only the needed amount of space is cooled and less cold air escapes when opened.
- The oven measures the temperature of food and automatically shuts off when the latent heat in the oven is enough to finish heating the food to a preset temperature.
- Circular stovetops have adjustable diameters because the outer rings of the heating element are connected to a separate circuit. This minimizes heat radiated into the room.
- White water from sinks goes to a filtration tank located underneath the sink so that is can be reused for the toilets.
- Washing machines use steam cleaning technology that uses little water and run on reduced cleaning cycle because clothes lined with nanoparticles deflect grime and odor.
- Human beings tend to use less electricity when there is a visible meter ticking off the amount that they use. Each household has a digital meter that displays water and electricity usage as well as the community average.
- Zombie appliances waste electricity when continue use electricity even turned off. On Bellevistat, all appliances sever the connection to the grid after a designated period of time.

3.4.3 Materials Chart:

Material	**Source**
Wood	Alexandria, Farms, and imports
Nylon	
Polyester	
Steel	Asteroid
Plastics	
Glue	
Glass	

- Humans Development –

4.1 Community Design

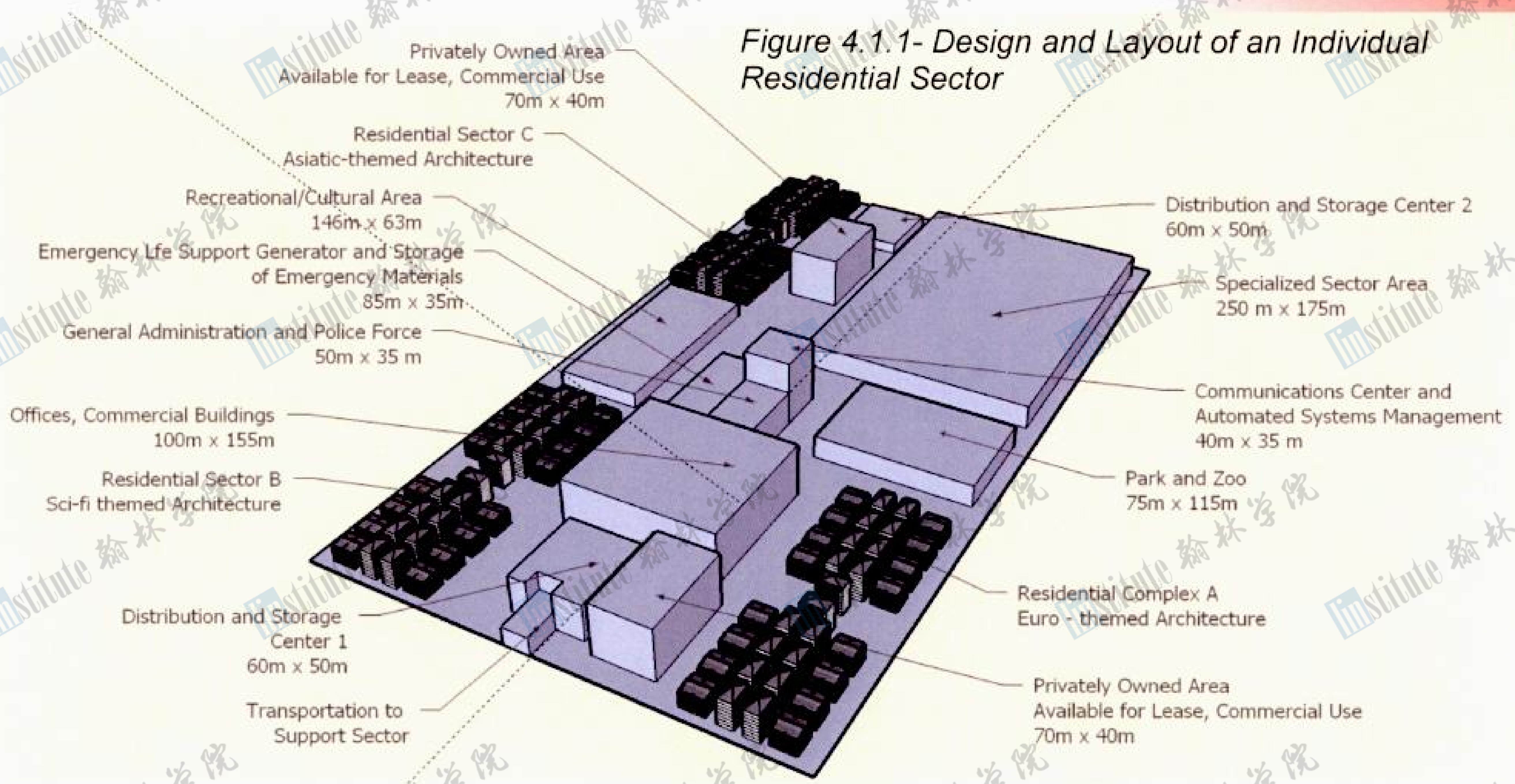


Figure 4.1.1- Design and Layout of an Individual Residential Sector

4.1.1 Facilities and Service: The various forms of facilities and service will be expanded upon in the later parts of proposal. The environment of this station is set up for the comfort of the residents and to allow them to lead an enjoyable and productive life. There are research and medical facilities to address health issues as they arise. A postal system, newspaper, and central news channel allow swift distribution of announcements and news from outside the station. There are physical training facilities such as a pool and gym, as well as a cultural center to nurture the mind. The police and investigation departments take care of any extralegal activity and maintain security. A sanitation team of automated bots monitored by human government officials handles disposal of waste, including regularly scheduled pickups. There are amusement parks as well as nature parks for relief from the drone of every day life.

Explanation: Maintaining health is an important and difficult under the conditions of space settlements. There is the possibility of bone decays and muscle atrophy due to the stressing confinement of residents in settlements and some zero-gravity conditions: thus gyms and physical activities are abundant. Furthermore, another major cause of every day stress is lack of security and order in every day life. To avoid potential stress associated with space, each Bellevistat resident is handed a chip that contacts emergency teams.

4.1.2 Community Environment for Psychology: To provide a psychologically healthy environment, it is necessary that interior buildings have plenty of light, which will come through the exterior structure into the general settlement. Interior buildings will have sufficient windows as well as interior lighting. For the "outdoor" style sectors, the ceiling is a projected display that simulates clouds and the blue sky. These areas are spacious and a ventilation system emulates a gentle breeze, while filtering harmful particulates. There is also a strong communication system between Bellevistat and Earth, allowing for the residents to feel close to home.

4.1.3 Quantity of Consumables: A variety of fruits, vegetables, grains, and meats are available to inhabitants, with an emphasis on providing as many essential nutrients as possible at the lowest cost. They are produced in the hydroponic or aeroponic farms built in the support sector. The staple crop is rice, not mentioned in the table below, due to less demanding space requirements when compared to acreage for the growing of wheat.

Table 4.1.1: Fruits grown in Bellevistat and associated health benefits*

Fruit Type	Nutrient Benefits
apples	Cardio-protective fiber, flavonoids, fructose
raspberries*	antioxidants, oxalates
pumpkins	Seeds promote prostate health, anti-inflammatory, minerals, protein, monounsaturated fat, lower cholesterol
pineapples	anti-inflammatory, helps with digestion, vitamin C, immune support, manganese, thiamin,
bananas	potassium, fiber, laxative, protection from ulcers
papaya	carotenoids, flavonoids, vitamin C, B vitamins, folate and pantothenic acid, and the minerals, potassium and magnesium, and fiber
strawberries*	phenols, phytonutrients
oranges	phytonutrients, vitamin C, antioxidants, immune support, liminoids, fiber, lowers cholesterol, prevent kidney stones, ulcers, protect respiratory health
blueberries*	antioxidants, improves vision, brainpower, heart, gastrointestinal system, laxative
apricots	heart, eyes, fiber

Table 4.1.2: Vegetables and Other Grown Plants in Bellevistat and associated health benefits*

Vegetable/Grown Plant Type	Nutrient Benefits
Oats	manganese, antioxidants, protects heart, against childhood asthma, lowers cholesterol, enhance immune response to infections, stabilize blood sugar, protect against breast cancer
tomatoes*	vitamin C, lycopene, helps colon and prostate health, pancreatic health, antioxidants, helps reduce heart disease, lower cholesterol, reduce blood-clotting, eases stress, many other benefits
Tea	protect against heart disease, inhibit atherosclerosis, minimize brain damage after stroke, lower blood pressure, protect against cancer, protect against kidney disease, builds bone, protects liver from harmful substances, promotes fat loss, increases exercise endurance, protects against cognitive diseases, help fight flu
Garlic	protect heart, anti-inflammatory/antibacterial/antiviral, protect against cancers, promote general good health, promote weight control
Beans	good source of fiber, lower risk of heart attack, energy boost and sugar stabilizer, iron, thiamin helps maintain memory, manganese for energy production and antioxidant defense, protein
swiss chard, collard greens, kale, spinach	vitamin K boosts bones, vitamin A, lung health, vitamin C, potassium, iron, anti-inflammatory, heart health from vitamin E, fiber, manganese energy boost, riboflavin and B6, slow loss of mental function
carrots, sweet potatoes, potatoes	carotenoids, better heart health, better vision, better general health, helps blood sugar regulation, lung health, antioxidants/anti-inflammatory, Vitamin B6
bell peppers	protection against free radicals, heart disease, promote general health, promote lung health, better eyesight, protect against rheumatoid arthritis, vitamin C and A
green beans and peas*	bone growth, heart protection, vitamin A and C, fiber,

* Includes plants grown in personal gardens, marked with an asterisk (*)

	potassium, folate, promote colon health, anti-inflammatory, iron, minerals and antioxidant protection, zinc, immune function improvement, 8 vitamins, 7 minerals, dietary fiber and protein
Mushrooms (assorted)*	phytonutrients, selenium, copper, manganese, iron, riboflavin, pantothenic acid, niacin, vitamin B6, optimal immune function, protect against age-related cognitive decline, top source of L-ergothioneine, heart health
Onions	chromium, vitamin C, flavonoids, quercitin, blood sugar-lowering, heart health, gastrointestinal health, protection against many cancers, boost bone health, anti-inflammatory/antibacterial
herbs (including rosemary, basil, assorted peppers, cinnamon, peppermint, cloves, mustard seeds, oregano, sage, thyme, cumin, cilantro/coleander seeds)	numerous benefits, including anti-inflammatory effects, abundant nutrients, stomach problem relief, soothing properties, anti-congestion properties, and many more
Sugarcane	safe alternative to refined sugar, does not cause many of the health problems associated with refined sugar, vitamin B2
nuts, assorted	many nutrients and vitamins, offering a vast array of protective measures against many diseases, lots of protein without all the fat
flaxseed*[1]	anti-inflammatory, bone health, Omega-3 fats, manganese, dietary fiber, protect against cancer, heart disease, and diabetes, prevent and control high blood pressure, lowers cholesterol, good for women's health
olives and olive oil (extra virgin)	iron, vitamin E, cellular protection against free radicals, heart disease, gastrointestinal health, anti-inflammatory, prevent chronic degenerative disease, oil highly protective against heart disease, polyphenols, control blood sugar, prevent bone loss, protect DNA

Table 4.1.3: Livestock Raised in Bellevistat and associated benefits of meat and other animal products

Livestock Type	Nutrient Benefits
Cow	tryptophan, protein, vitamin B12, cardiovascular protection, cancer protection, milk/cheese/dairy production: calcium, protection against gout, burn fat, protect against metabolic syndrome, prevent childhood obesity, vitamin D, B vitamins for energy, alternative source of omega-3 fat, promote thyroid function, vitamin A, potassium, iodine, boost immune response, lowers bad cholesterol and raises "good" cholesterol, protect against arthritis, ulcers, breath freshener
goats/sheep	tryptophan, protein, zinc for good immune system, B vitamins for energy, protection against cognitive decline, milk production: people who can't tolerate cow's milk can tolerate goat's milk, riboflavin, potassium
Chicken	tryptophan, vitamin B3, protein, protect against bone loss in older people, cancer protection, protect against age-related cognitive decline, B vitamins for energy, vitamin B6 for cardiovascular

[1] Also an ornamental plant, especially suitable for garden plots

health, egg production: brain health, choline, promote weight loss, heart health, protect against macular degeneration and cataracts

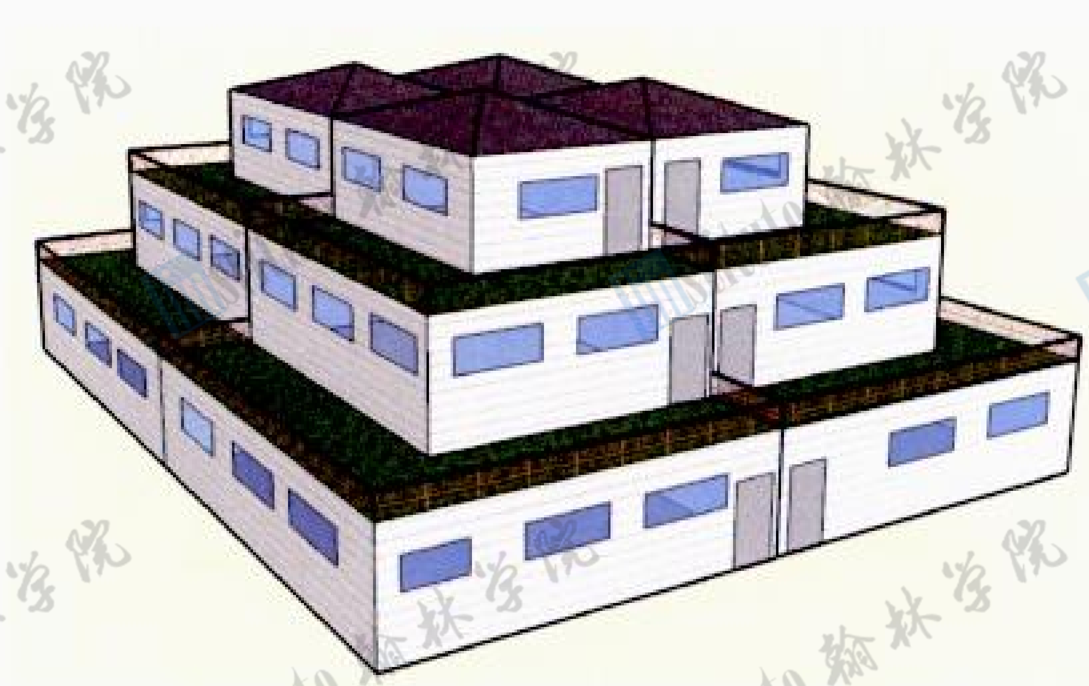
Explanation: The fruits, vegetables, and livestock varieties shown here are those which are among the healthiest foods in the world. By choosing healthy foods to grow, the inhabitants of the settlement are given only the most beneficial types of consumables. With a daily dose of vitamins and minerals, as well as the guarantee for healthy long-term effects of their diet, residents can be assured to live an optimal nutritional lifestyle. Many of the residents specified that they wished to grow their own plants, and those marked as available for growth on personal plots will satisfy their need to exercise a green thumb. Additionally, due to the high number of people in the Asian population who are lactose intolerant and the high percentage of the world that drinks goat milk rather than cow milk, as in the United States, goat's milk will be offered to ease the inconveniences of multi-cultural living. Various spices also add variety, allowing residents to create meals according to their cultural tastes and likes.

4.1.4 Means of Distribution: Distribution of food and other essential living materials is handled by a central government agency with distribution centers spread throughout the sectors, with a higher concentration in residential areas. The residents are to go to these distribution centers and purchase goods using a biweekly provided stipend, at their leisure. The distribution centers are placed in the corners of the sectors used for the residents; however, they are large and can serve a great number of people at once. The supplies are shipped from the support sector directly to the distribution center, which allows for the purchase of such supplies. These supplies include daily groceries, medicines, clothes, hygienic materials and other necessary items.

Explanation: It is most efficient to distribute the supplies to the residents if they were able to acquire them on their own through the distribution locations. These allow for distribution of supplies through orderly fashion, as well as keeping index of the stocks of supplies to quickly find out what to replenish, which the data is used in the support sector quickly to adjust for the need of residents.

4.2 Housing Designs: There are three different types of neighborhoods to provide variety to the choice of living space. The first is a stacked suburban housing complex. The second is an urban, apartment-style high-rise. The third is an enclosed condominium complex. Each borough has a different architectural and cultural theme, such as "English village" or "Danish hamlet". The rooms and houses are built with same size specification to allow for mass production using the factories. However, the wall-designs and internal arrangements of each house can be altered and customized to the residents' needs.

Figure 4.2.1- Basic Exterior Design of Suburban House



Explanation: Different people have different needs. To accommodate these differences, the internal layout of rooms of houses may be altered by each family. To manufacture and make the buildings quickly, we are using a factory to produce houses with same floor area with same layout of general features as windows, and have it modified later by residents. The houses are all square or rectangular so they may be stacked easily for faster construction. The houses' roofs may be altered to the community's design, as "English Village" roof or "Chinatown" roof. This variety allows more diversity in housing choice.

Figure 4.2.2- Basic Exterior Design of Urban Housing Complex A

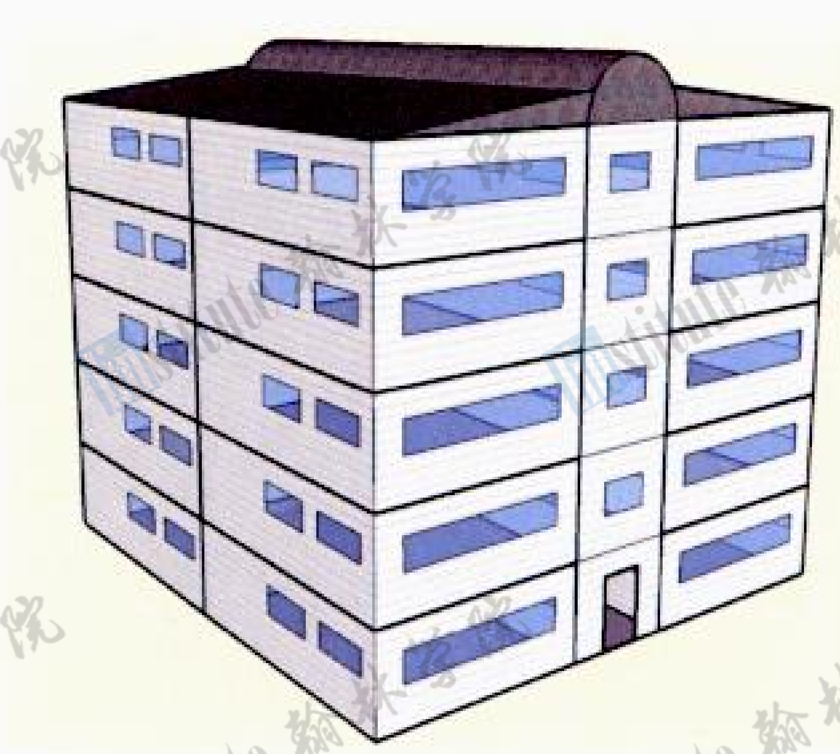
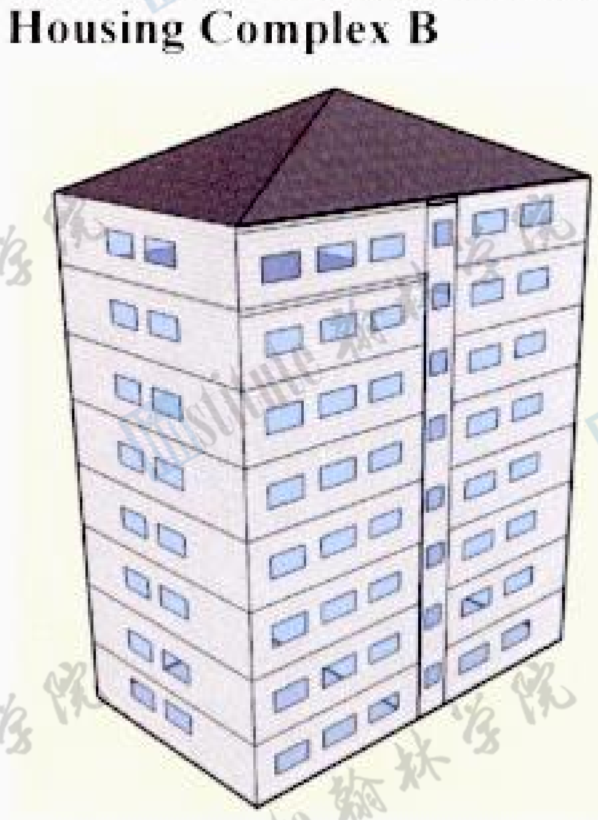


Figure 4.2.3- Basic Exterior Design of Urban Housing Complex B



4.2.1 Features of houses: All houses and apartments have certain features in common, outside of the standard kitchen, bedrooms, and living area. First and foremost is a terraced balcony, providing ample space for the occupants to grow their own fruit and vegetables, a practice that is allowed and encouraged. Despite small dimensions, each house has ample room while still maintaining space efficiency. The designs are simple so the residents can modify the houses on their own.

4.2.2 Apartment Floorplans: The residential houses have slightly different sizes depending on the style of the neighborhood: in the urban areas, there is a condo suited for a single person that is 5m x 6m, a bigger apartment room for 2-3 people that is 6m x 8m, and family-size houses that are 8m x 10m. In the suburban areas, the houses at the bottom are 8m x 10m, 6m x 8m in the middle, and 4m x 6m at the top.

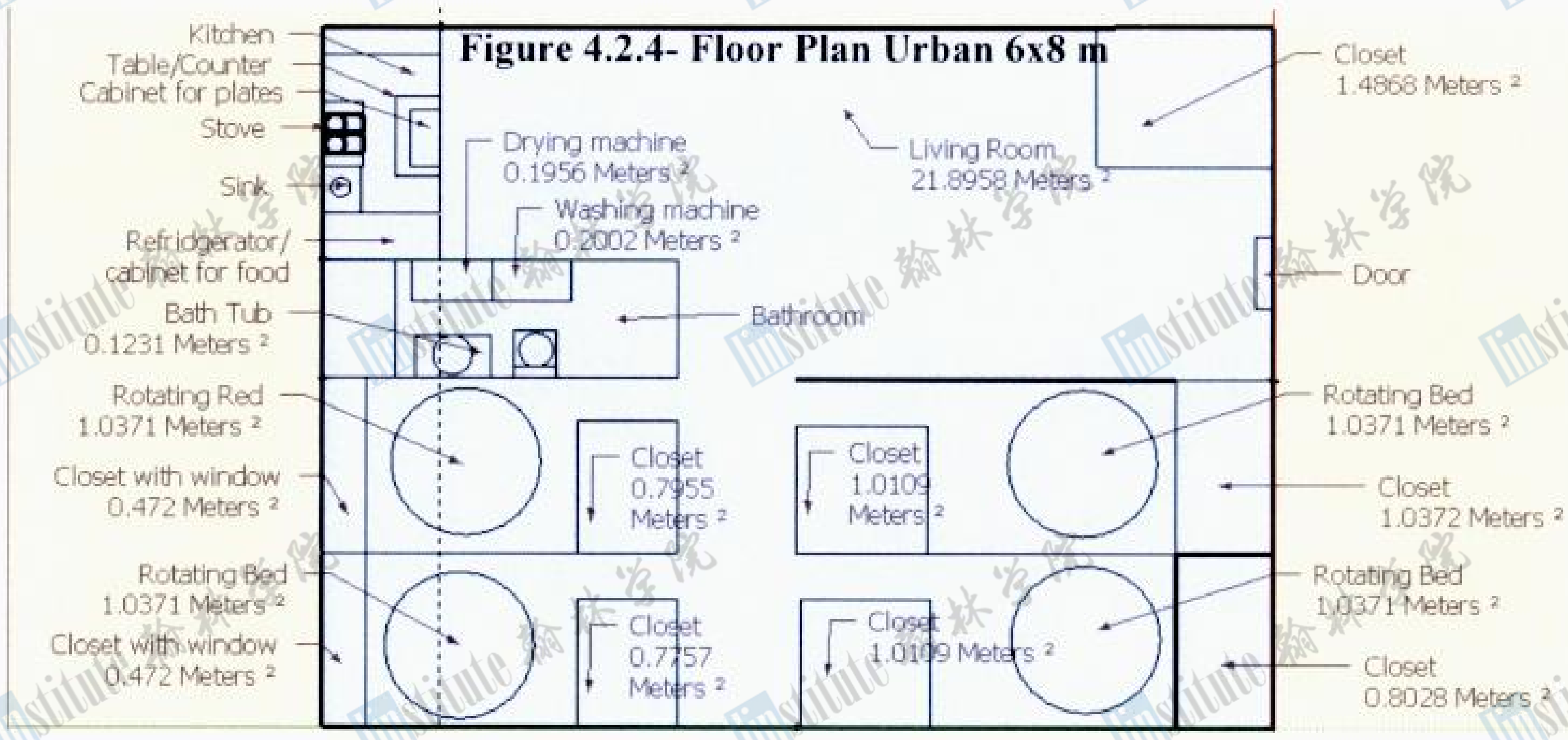


Figure 4.2.4- Floor Plan Urban 6x8 m

The house styles are different in urban and suburban areas. Urban residence consists mainly of 7 story high-rise buildings with apartments for singles and multiple tenants. In the suburban areas, houses are stacked into a pyramid shape.

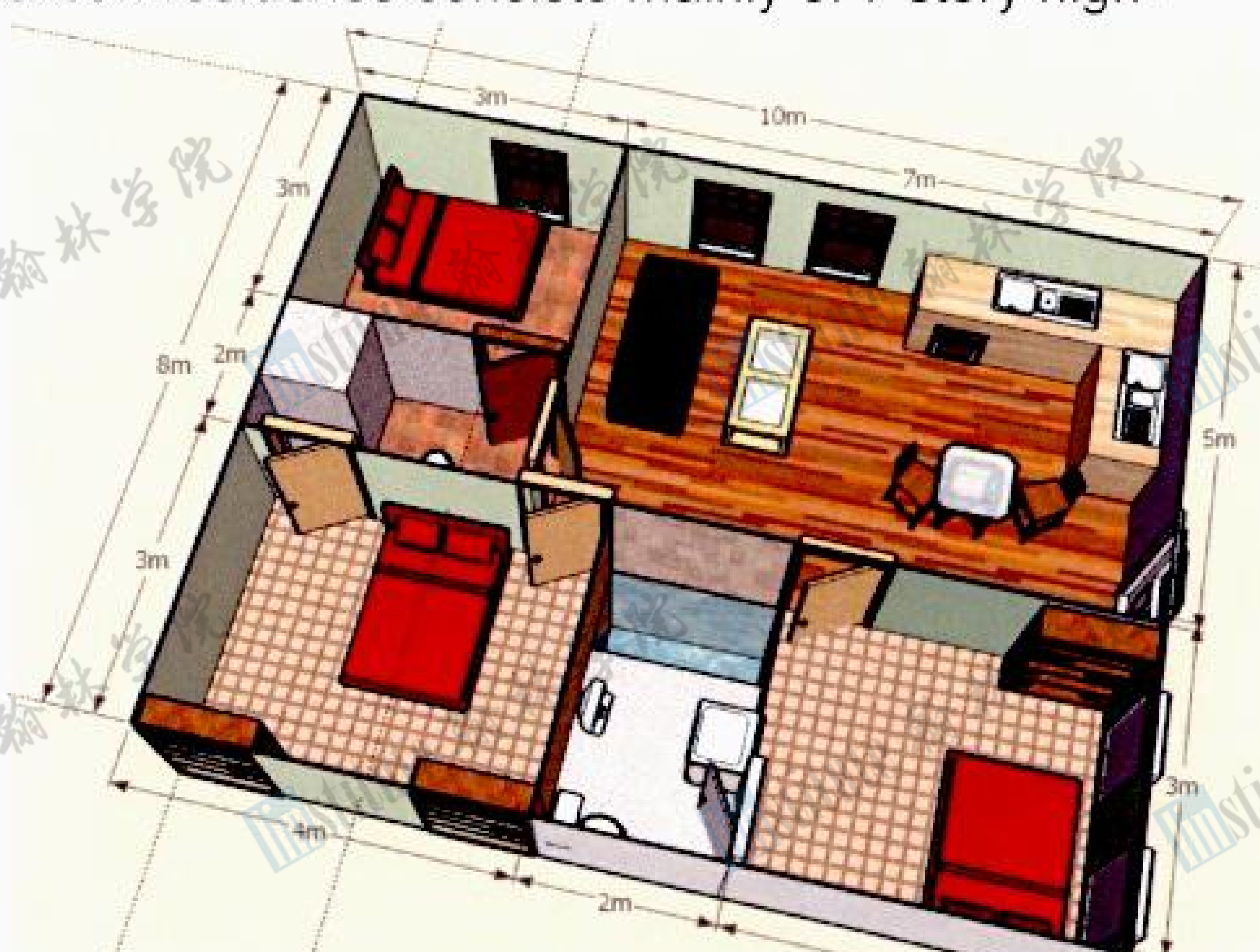
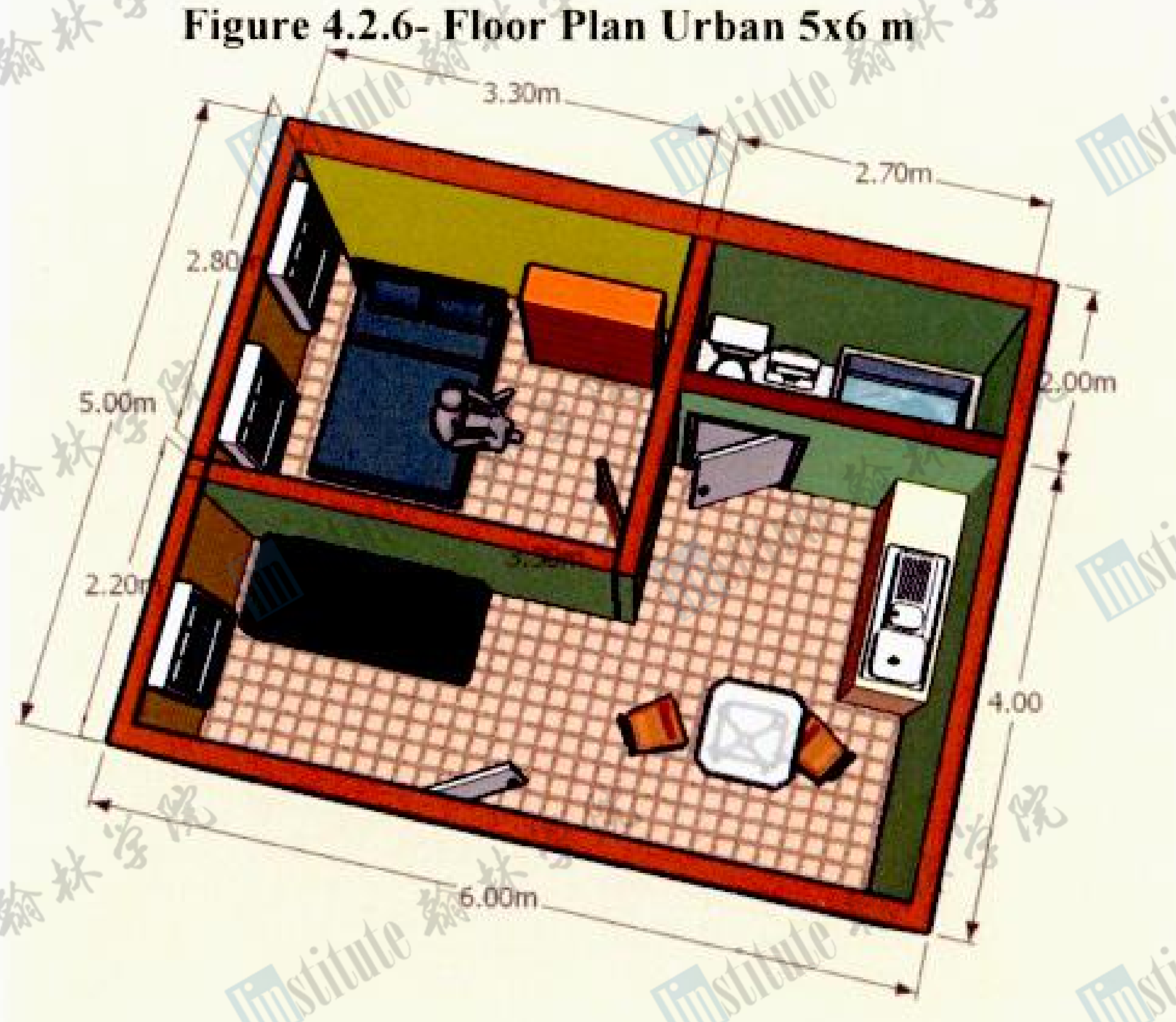


Figure 4.2.5- Floor Plan Suburban 8x10 m

Explanation: This system allows for differentiation of the houses, fitting the needs of the families better. This also allows residents to choose what kind of environment in which to live; people who are used to urban areas may feel uncomfortable in hamlets, and people who are used to suburban areas may not adjust well to the urban life. Distinct communities will form, resulting in newfound relationships and a fresh new lifestyle which retains the comfortable elements of earthly living.

4.2.3 Furniture: The provided furniture is intentionally austere to save money, though each resident may acquire unique pieces that appear periodically at the distribution centers. However, the standard furniture does include a rotating bed that would aid in adjusting heart rate. The rotating bed would regulate the minute difference in gravity that still affects people in the long run, allowing for longer lifespan and a decrease in health issues. There would be cabinets, clothes drawers, and tables, among others. The civic entertainment center has art classes in which the inhabitants can create whatever art they want, ranging from pottery to painting to sketch, which are then sold as aesthetic furniture for the homes.

Figure 4.2.6- Floor Plan Urban 5x6 m



4.3 Work Environment

4.3.1 Design of Systems: There are security systems such as series filters that monitor of the atmosphere within Bellevistat. There are sensors for both water reservoirs and in the artificial dome roofs as well as throughout the ducting systems to monitor the particles in both water and air. The air also uses Trace Contaminant Control System, to keep the contaminants below the critical level.

4.3.2 Design of Vehicles: There are mopeds and a train system available for the residents to travel throughout Bellevistat. Additionally, some cars will be used. These cars are semi-automated. For public transportation systems, see the Operations section.

Explanation: Trains are used for the transporting the massive load of supplies throughout the settlement. Mopeds are efficient, as they are single-driven and they do not go as fast so major accidents are avoided.

4.3.3 Design of Devices: The filters for atmosphere control are autoclavable for full reuse. There are systems of cleaning for water, as UV radiation to sterilize, as well as filter systems. They are of 0.2micron pore size, and are replaceable. Trace Contaminant Control System uses carbon beds to filter out the contaminants. Because certain contaminants may bleed off the sorbent bed or breakthrough early, a portion of the effluent is routed through a catalytic toxin burner. The acid gases which result from the decomposition of halogen, nitrogen, and sulfur containing organics in the toxin burner are then removed by sorption using an expendable LiOH bed.

Figure 4.3.1- Filter System Design

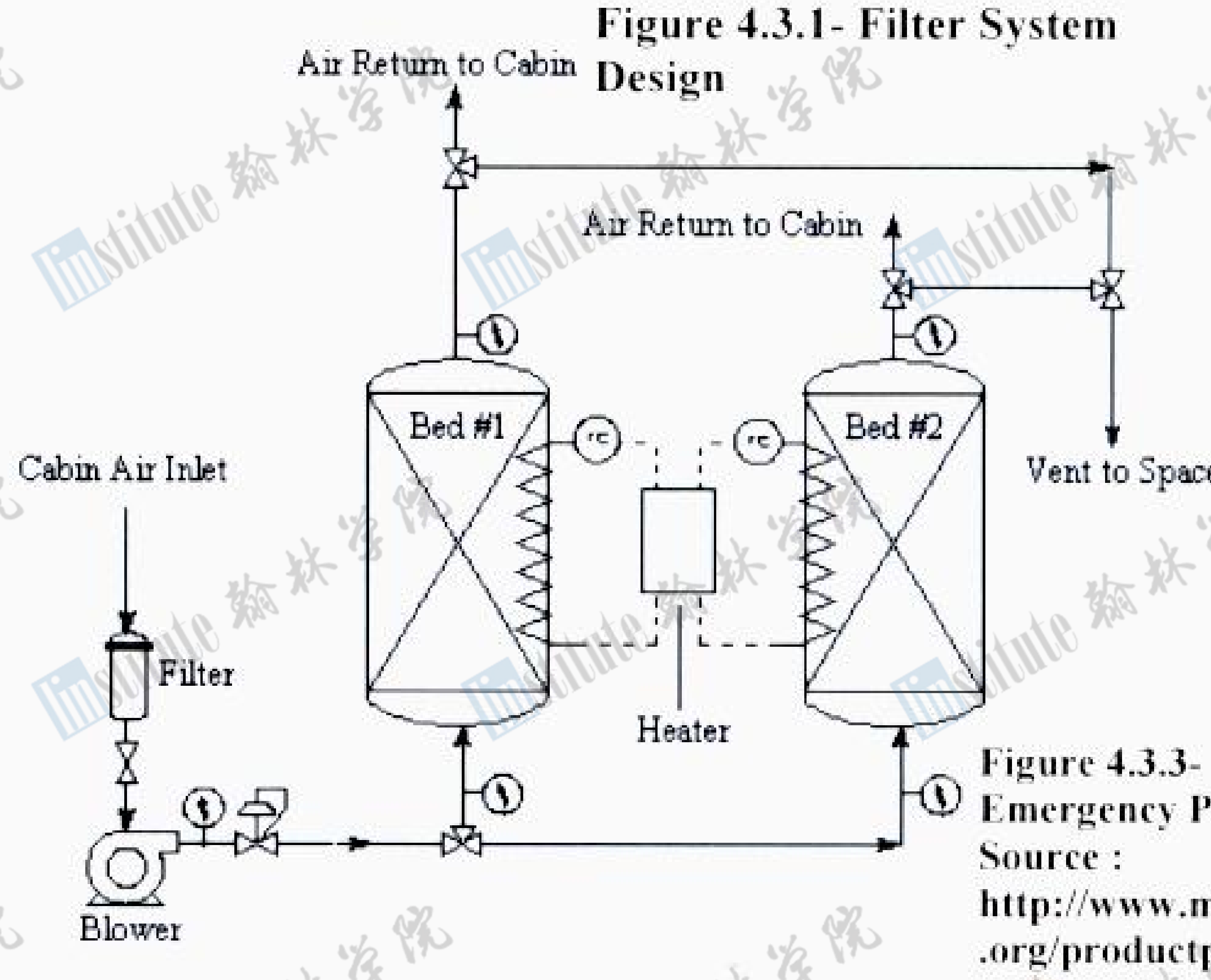


Figure 4.3.2- Emergency Wristband, Source: http://www.medscope.org/productpics.htm

There is a button handed to all of the residents, PB (Panic Button) to be kept on them the entire time. This chip allows for the contact of emergency teams through the push of the button. This button uses the network setup by beacons throughout the settlement, immediately activating GPS positioning for the nearest emergency team to come help at a moment's notice.

Figure 4.3.3- Emergency Pendant, Source : http://www.medscope.org/productpics.htm

There is also a communication system between the earth and Bellevistat, allowing for communication with earth whenever for the residents. The residents all have to do to call the earth through their communication device given by the government.

The police force uses a set of Segways® to facilitate quick movement throughout the community in an environmentally friendly way. Less intrusive than cars, the Segways® will allow easy movement in the neighborhoods as well as faster speed than the typical car available to residents (although most cars are not available for private use by residents).

Figure 4.3.4- Segway®, Source: www.segway.com

Explanation: These devices aid the residents live a more secure and easier life on the settlement, by padding for more security and padding for better environment. The cleaner water allows for better containment of diseases. The PB allows for better security and livable condition for all residents in dire need of help, allowing for less stress upon the residents living on the settlements. The communication system allows for residents to feel less distant to earth the homeland, allowing for more comfort and better upkeeping with the current news. This allows for the residents to be aware of the reality, not be disconnected from earth.

4.3.4 Spacesuit: Space suits are necessary for maintenance of the station. This suit allows for communication and maneuverability in outer space. It is made of a polymer matrix composite that has high strength and low density, totaling 14 kg. It includes a 2.0 L oxygen tank with a 0.5 L backup and a similar tank and backup for water. A Valsalva stick is for ear pressure and the suit itself maintains 29.6 kPa internal air pressure as well. It controls temperature, shields from radiation, and is streamlined for maximum flexibility. It has communication equipment, biosensors, computers and climbing gear for extra-vehicular activity. It relies on fabrication and application of open cell foam, smart materials like muscle wire technology and electrospinlacing. The suits have electronic checklists for additional security.

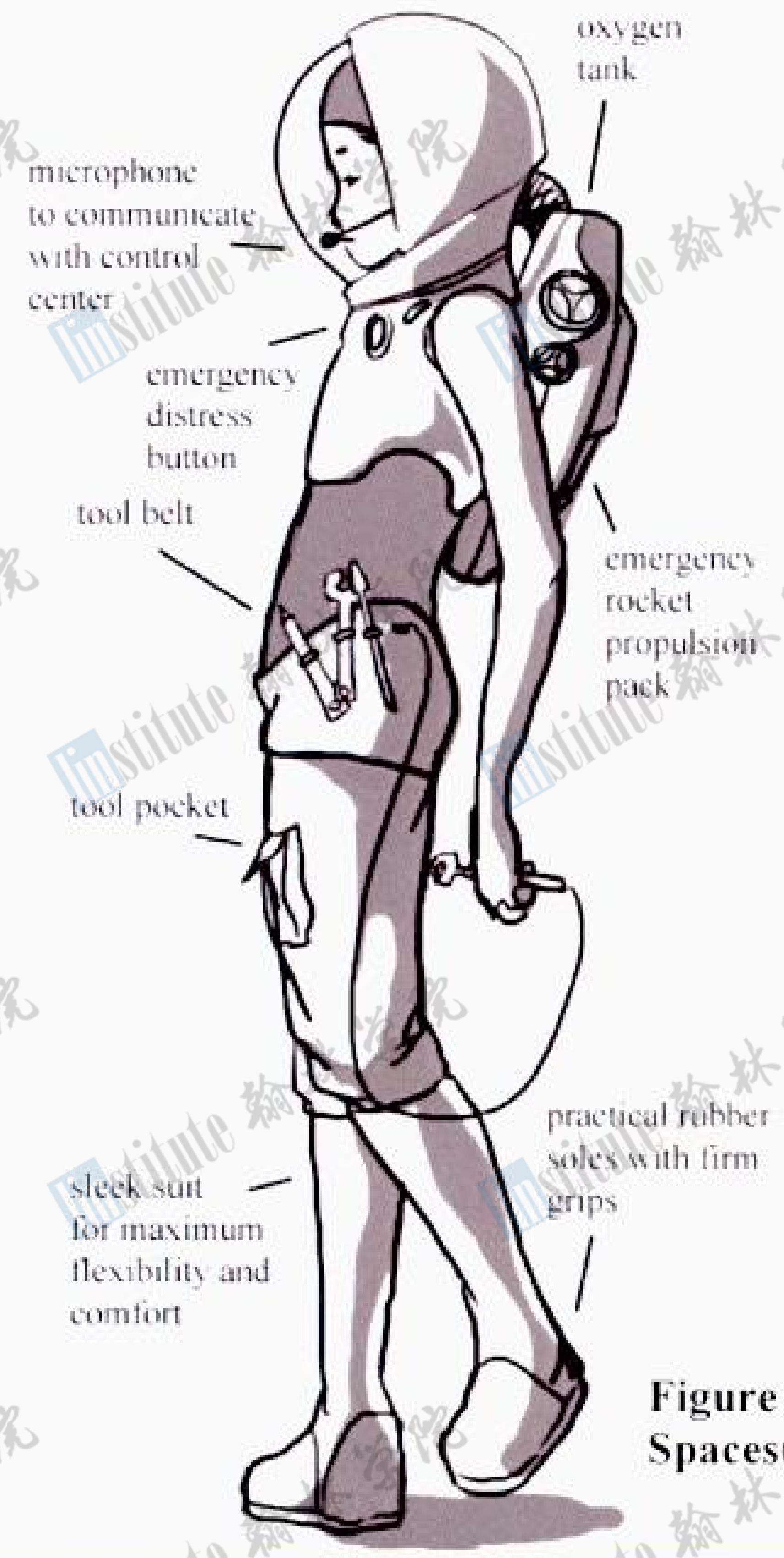


Figure 4.3.5- Spacesuit Design

4.3.5 Jobs and Tools: The selection of jobs is based upon an IQ test given at the age of ten. The comprehensive IQ test gives a guideline for the future; this guideline create adequate training for when they grow up, and allow plenty of time in school to give training for the jobs needed.

Table 4.3.1: Description of Major Job Categories and Tools Needed

Job Category	Emergency support (police, all medical support)	Education	Science Research
Frequency Descriptions/ Details	5% Physicians- should be human because people enjoy the compassionate nature of another fellow human being, especially when they are feeling miserable Surgical technologist and other nurses- aid in surgery, will make mistakes, but can also react in accordance to mood in the OR Police- show some understanding when human, enforce laws	5% Teachers- will teach to their best abilities all subjects and should be extremely skilled/knowledgeable Upper management in each job type will train teenagers in each of the jobs following their basic school education during the day. Teens will experience both on-site job experience and classroom learning in their assigned specialty, which will be determined by their early years of schooling and a personality test. An IQ test will be administered to all students at the age of 10 for job placement in intellectual	15% Medical research is primary. Possibly secretive bioengineering projects on the side, but remain unannounced. They are also to investigate any risks associated with outside materials and non-biological researchers will create more efficient methods of growing agriculture, mining, etc. Tools: laboratory equipment, prototypes of innovative engineering projects

		sectors.	
	Tools: much reliance on technology in medical field and in risky tasks, standard equipment, life support, emergency vehicles (described in Automated)	Tools: borrowed ebooks, books which store many pages of books, prevents the necessity for pounds of books to be shipped from the Earth	

Entertainment	Automated/Semi-Automated Jobs	Government (executive, judicial, security)
10% Entertainers will be expected to work as such only after normal work hours and on weekends. It is unpractical to ask them to work during work hours since it is expected that most people will be working during the day. They will perform music, drama, dance, and help with the presentation of movies. The rest of their time will be spent planning new ideas and rehearsing for shows, since their job is not seasonal but rather daily**.	45% Cars- all semi-automated, speed of occupational emergency vehicles much faster than that of other cars	10% Robot Control- this department specializes in controlling robots and regulating their movements. They are also in charge of repair and construction of new bots
Other types of entertainment will not need employment. Most places for individual recreation will be maintained through robots and open to everyone.	Firefighting- under ultimate control of humans, with mostly automated bots fighting the actual fire. The bots should focus on efficiency and eradicating the fire, especially when creating an escape route for humans saving the people in the building	Executive- oligarchy, most competent leaders will be selected prior to arrival in settlement, still externally moderated by other governments, leaders appointed, not elected, but can be replaced by higher powers
Tools: artistic needs, stage, sound and light equipment, raw materials for clothes	Sewage control/Cleaning- unpleasant and undesirable jobs should be automated, especially those which pose unnecessary health hazards Hard Labor (general)- difficult jobs which would otherwise require either vast amounts of manpower or undue power from a person should be automated	Judicial- arbitrators for those who commit crimes, must be trained in law and be familiar with laws of local and global governments (those in charge of settlement) Department of Planning and Growth- in charge of any further construction projects or expansions within the settlement Department of External Affairs- in charge of regulating those who dock at Bellevistat and any other interactions with non-regular visitors to the settlement Department of Internal Affairs- regulates security*, safety of residents, notifies upper ranks of government of emergencies, suggests further improvements

** day-night cycles vary by sector

* Security is controlled and regulated by humans using non-invasive techniques because humans will be less harsh on each other and again, there is a human consideration in this decision. Human-to-human interaction is better than constant confrontations with robots

		within Bellevistat. They will conduct regular observations of the conditions within the community and make appropriate suggestions to the people's benefit.
		Tools: Segway® i2 Police, standard laptops, repair tools, security precautions for visitors, possible visitor ID with tracking device

4.4 Design of Neighborhoods

4.4.1 Architectural Differences: Each residential district has a different theme and thus, a different architectural style. For example, the Gothic district is characterized by imposing arches and faux stone façades.

Table 4.4.1: Themes and General Characteristic of Neighborhoods

District theme	Notable design features
Modern European	Squarish, glass, more crowded and dense population
Asiatic	Curved roofs, with town houses and homes suited for 3-4 people.
Space	sci-fi architecture

Explanation: The architectural differences allow for different aesthetics and communities. The aesthetic part represents variety in culture and upbringing of the people, which shows that Bellevistat respects different cultures. These different styles create unique communities in which people may lead illustrious lives.

4.4.2 Neighborhood types: There are three types of neighborhood. Most will be urban in two styles. The first is a rectangular-shaped unit with condos. The second is an elegant apartment complex. The remaining residential areas are stacked houses for larger families. This suburban style with open areas and clear sky allow for more public comfort, both physical and psychological.

Explanation: The differences in neighborhood allows for a healthy sense of community to grow. By creating neighborhoods, natural communities are formed, which allows for common experience as well as common lifestyle aspects. This allows for a stronger bond among the members of the community, thus allows for better support in every day life to live on the settlement, decreasing stress as well as fulfilling the social aspect of residents' lives.

4.4.3 Demographics: Since most residents of the station are middle-aged professionals past prime reproductive age, there is not a large anticipation for population growth in the near future. Married adults make up 30% of the population with single men at 37% and single women at 30%. Only 3% of the population consists of children.

Table 4.4.2: Population Distribution of Permanent Residents

Group	Average age (mean)	Median age	Percent of population
Married adults	38	35	30
Single men	35	36	37
Single women	40	35	30
Children	11	9	3

Explanation: Most residents are adults, as they must be on the mission for the research and mining businesses. Therefore there are fewer children, as they must come as a part of an established family, and single residents are preferred. There are facilities such as universities and schools for the children, to allow for education that is necessary to live on the settlement. The men and women are mainly working for research, to further the knowledge of how space environment affects the residents, as well as how space materials may be used for further industrial uses.

4.5 Entertainment and recreation: A variety of entertainment services are available on the station for the residents. Since sufficient leisure time is necessary for optimal productivity, these services are provided free of charge. Each resident is allotted a certain amount of time to spend on recreation, per biweekly cycle, and more time is accumulated as hours of work are logged into the computer system. This setup is controlled by a universal ID card that serves as a time card for both work and leisure. These services include but are not limited to: concert hall/all-purpose performance area, arcade, parks, computer-based games, a movie theater, and art centers. The art centers help the residents to release their yearning for creation and decorating their own homes, by allowing then to create pottery, artistic drawings, paintings and other forms of art.

Explanation: It is vital that residents do not express stress in negative fashions since within this contained environment, it is easier for such behavior to affect others. To release the stress through work and human interactions in general, there are many accommodating institutions as art civic centers to physical centers to nature parks and amusement parks.

4.5.1 Physical Fitness: Institutions: A pool, a gym with weight training equipment, a multipurpose gymnasium, and a multipurpose field are all available to promote physical fitness. As an added incentive, leisure time accumulated on the ID card is worth 1.5 times (value is variable) as much when used for physical activities.

Explanation: Physical health is very important, especially for those residents whose field of work takes them into changing gravity conditions, which may lead to muscle degeneration or strain. In addition, researchers and scientists may not be able to get the exercise required due to their strenuous lifestyle. However, it is vital that they do; to accommodate for this the governments are endorsing health institutions, as well as using any time to move as much as possible. These gymnasiums also hold games for everyone to compete and play in, so that they may enjoy competitive sports, as well as making bonds with residents for the community. Sports often act as a gateway for many to make new bonds between people; the institution serves not only as a gym and other physical workout but rather a community center for people with similar interest.

4.5.1.1 Physical Fitness: Activities: The pool services include regular exercise programs for the elderly. The weight training gym is primarily used to fight muscle fatigue and weakening due to artificial gravity. It would be accompanied with sound systems to relax while training, so that workout feels less tiring. The multipurpose gymnasium is capable of accommodating table tennis, martial arts, and indoor sports such as volleyball. It houses the weight gym, sports fields for various sports such as baseball and soccer as well as football, etc. Also, competitions between different residential districts are organized by a central recreational committee.

4.5.2 Mental Stimulation: Institutions and Activities: Mental health is equally important for the highly educated residents of the station. As such, a wide variety of intellectually oriented facilities are spread across the station, including: Art Museum, Historical Museums, Science Museum, Concert Halls, Gaming room, Theatre, Media House, Public Library, Public Art Studios, Public Dance Studios, Cinema. Activities related to available facilities will bring peace, outlets for self-expression, and relaxing places of recreation. To keep intellectual minds sharp, libraries will provide countless amounts of information.

Explanation: Within an enclosed environment, people may feel that their resource for mental stimulation is limited. However, this would cause people to be in a detrimental cycle, losing focus on life in general. To avoid this, every resident of Bellevistat is a member of the overall community.

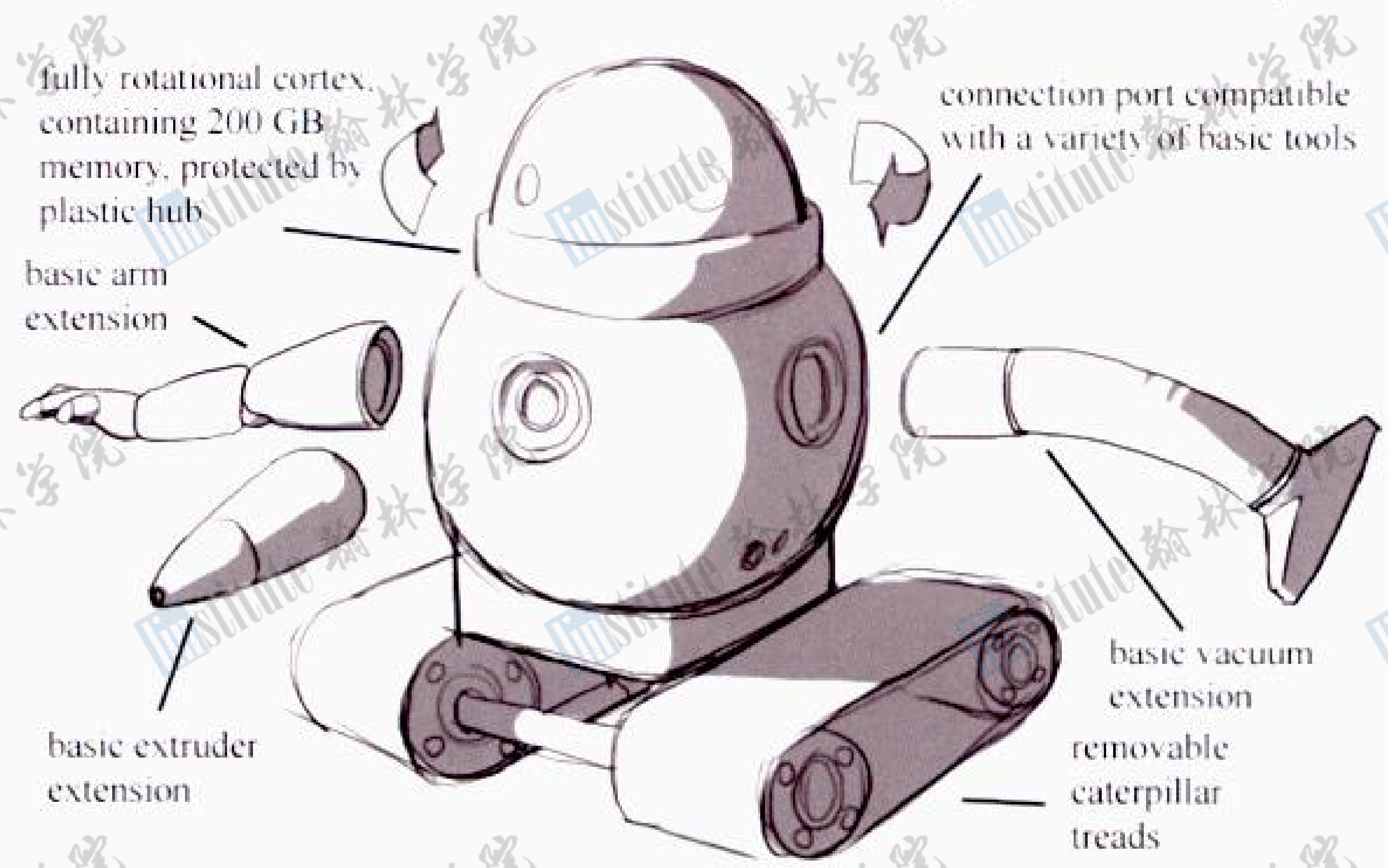
4.5.3 Psychological Health: Institutions and Activities: Religious observances will be fostered throughout the settlement to maintain spiritual awareness for those pious citizens. Additionally, the wide array of natural scenes should serve to calm the mind and raise more calm inner reflection. Places of community gathering such as amusement parks, nature parks, and coffeehouses help to create a social and joyous community. Importantly, a lot of natural light will be available since scientific studies support the benefits of seeing sunlight for at least a short period of time in a day. Bellevistat aims to provide a comfortable living area in which residents may cherish their new lives and maintain a good standard of both physical and mental health.

- 5.0: Automation Design and Services -

- 5.1 Settlement Construction

5.1.1 Assembly Process: Robots will assemble the station in parts, beginning with human overseer quarters, storage, power, and solar panels, and progressively adding new sections. The outer shell of the settlement will be constructed first, to allow for simultaneous construction of interior structures and spindle. Construction will occur using robots (Omnis) working in groups of 12, capable of a wide array of tasks (Fig. A), such as welding, sealing, bolting, and maneuvering in space. Omnis will be equipped with automatically interchangeable parts to decrease costs and hasten repairs. They will also be shielded from radiation by a thin layer of Kevlar, and will be capable of being magnetically and/or physically (via rail, over electronically sensitive areas) bound to the frame of the settlement. Mobility will be altered as required for each task, but each robot will be capable of physically accessing any part of the construction site in order to provide minimal assistance for all possible tasks.

The Omnis will be responsible for almost the entire construction of the settlement: the only tasks that they will not cover are the creation of the initial frame and large-scale movement of materials. As the robots handling interior finishing (Decoro) are simply modified Omnis, some Omnis will be moved inside and modified into Decoro for simultaneous construction and reduction of construction time as sections of the exterior construction are completed. Humans will be housed in a set of living quarters on the asteroid, used for a temporary home. They will be present only to as a failsafe for emergency situations, or other complications that cannot be done with Omnis. The robots will be controlled from Earth.



5.1.2 Diagram Describing Automated Construction Devices and the Purpose for Each: Specific tasks for each type of robot include oversight, protection, and exterior construction. Each robot will be preprogrammed with the overall blueprint for the entire station, and each individual robot will send requests to a central server periodically, specific to their jobs. To facilitate this process, each robot will be equipped with wireless transceivers.

Name	Purpose	Number of Units	Responsibilities	Features	Dimensions (LxWxH)
Mollis	Heavy Object Moving	2	Moving heavy beams and other unwieldy objects. While weightless, objects in space retain inertia; hence, a powerful moving arm is required.	Shape of a human arm (follows proportions of one), with "hand" at one end capable of moving by grasping, magnetism, or both. Will be anchored to the asteroid.	7m x 3m x 2m - "radius/ulna" 10m x 3m x 3m- "humerus" 4.3m x 2m x .5m - "hand"
Villicus	Oversight / Safety	30	Detects incoming debris, houses plans for construction, transmits commands to Omnis.	Anchored robot with a scanner based on reflected light that will scan space for incoming debris. It will serve as a hub for every 3 groups of Omnis, and will transmit orders according to preprogrammed instructions.	1m x 1m x 1m

				They will be reused after construction to provide control points during the life of the settlement.	
Omnis	Exterior Construction (Multifunctional Robot)	80/sector + 40 for general use	Handles all manual labor involved in creating the settlement: welding, bolting, etc.	Omnis are the crux of the settlement: They are, collectively, the robotic drive behind all productive activity. They are constantly refitted to do different tasks: for exterior construction, they will be in groups of 12, with different attachments (automatically equippable) depending upon the nature of their work (outlined by Villicus).	1m x 1m x 2m
Decoro	Interior Finishing	400	Handles interior work, such as laying floors, electrical wiring, setting up hardware.	Decoro will run along the temporary interior rails installed within Bellevistat after the Omnis install the basic framework. Decoro will be a type of Omnis, specialized towards interior needs. They will be modified into robots for the reduction of manual labor.	1m x 1m x 2m

5.1.3 Interior Finishing and an Approximate Timetable: Each house is composed of a number of rooms, each of which is pre-fabricated and shipped to the settlement in collapsed form. At the station, Decoro bots will restore the rooms to normal, and will weld at specified points in order to remove its collapsibility and stabilize the room. They will then finish connecting all wires and fixtures, and connect rooms to each other at interlocking points. A programmed arrangement of connections between the rooms results in a few different configurations for homes, and different models of each room correspond to the three types of housing provided. Each Decoro will keep a copy of the (simplistic) blueprints for use when it is re-outfitted for maintenance. Only a few Decoro are required for each house, so they will work in groups of 6, along with a Gravis for heavy lifting needs. Each squad can complete a house in less than a day.

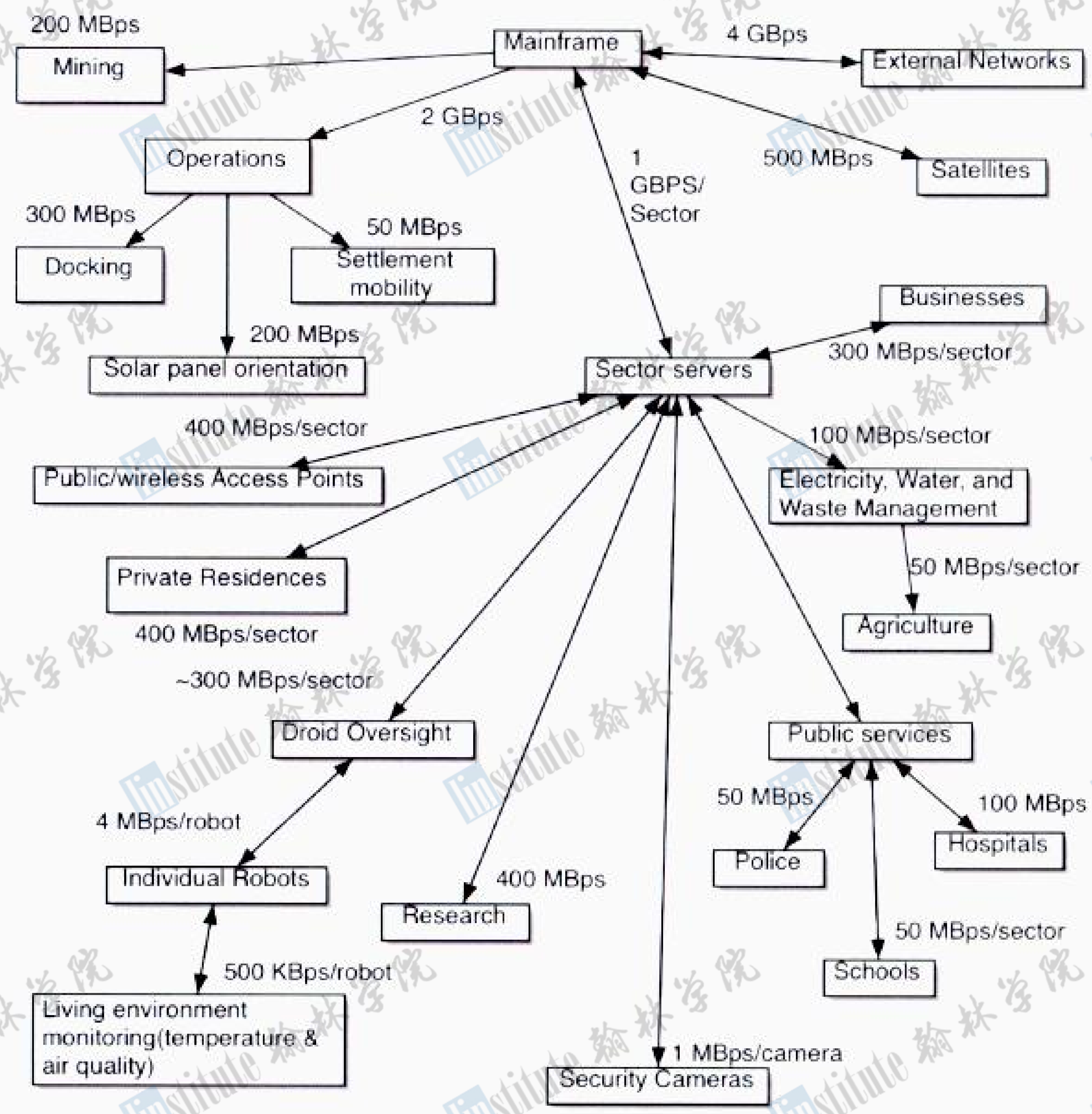
5.1.4 Human Oversight: On-Site human oversight will be kept as minimal as possible in order to reduce risk and costs. All controllers will be on Earth or the Moon, and will be assigning the Villicus its orders and programs to deliver to the Omnis. In the case of an emergency that requires human intervention, a small group of astronauts will be stationed in a small set of living quarters on the asteroid

5.2 Networking

5.2.1 Physical Locations of Computers, Servers, and Wireless Access Points: All storage will be in the central computer system, a set of computers which collectively handle all data transfer in the settlement. Private citizens will be able to access their personal data via wireless access points located at 50 meter intervals or at certain public landmarks such as parks and businesses. Wireless access points will also serve as nodes in the station's Triangulation System used to locate robots and residents. The servers themselves will be located at the center of each sector in the Communications Center, along with the storage for the robots. The sector servers will be connected to one another and the mainframe via optic fibers. There will be two mainframes in each ring, located on opposite sides of one another. The primary mainframe and secondary mainframe will alternate roles every 15 days, and the secondary mainframe will serve as a backup. There will be a 1 hour transition interval when both mainframes will be fully operating.

5.2.2 Network Connections and Anticipated Bandwidth Requirements to Enable Computer Connectivity: The mainframes will have a 2 GBps connection to each of the three other mainframes.

Network Connection and Anticipated Bandwidths



Note: Each bandwidth label represents the cumulative bandwidth of each category unless otherwise specified. Not all categories will be present in a given sector (e.g. no private residences in a business sector)

5.2.3 Privacy of Personal Data & Method of Storage: The station will use a centralized hub to store all private data in 100 TB solid state drives partitioned to about 2 TB per person. A citizen will be able to access his account wirelessly or through an authorized computer. Each citizen will protect their data with a personal username/password, the former of which is assigned in a method similar to social security numbers, the latter of which shall be changed periodically. Data will be backed up by having each computer create a copy of all files in a second hard drive (trimmed periodically), in addition to a "marking" system, by which highly sensitive or critical files will be flagged and then transmitted to and stored on a dedicated hub as a third copy.

5.2.4 Network Authorization: Authorized personnel will be issued a magnetic strip card, an ID, and an encrypted password (which will be government issued and be changed at 1 month intervals). Specific computers with administrative access will require all three of these along with a retina scan to give access to administrator privileges. Once the system detects an administrator logging in, it will monitor and record all administrator's activities to ensure that there will be no abuses of the granted privileges.

5.2.5 Station Security: Bellevistat's automated security will come in the form of security robots and drones, though in very small numbers. Tracking miscreants will be done using a combination of implanted position0monitoring(via the Triangulation system) chips and alarm systems in secure/sensitive areas, which will be triggered when someone with an unauthorized chip comes too close or attempts to access the area in question.

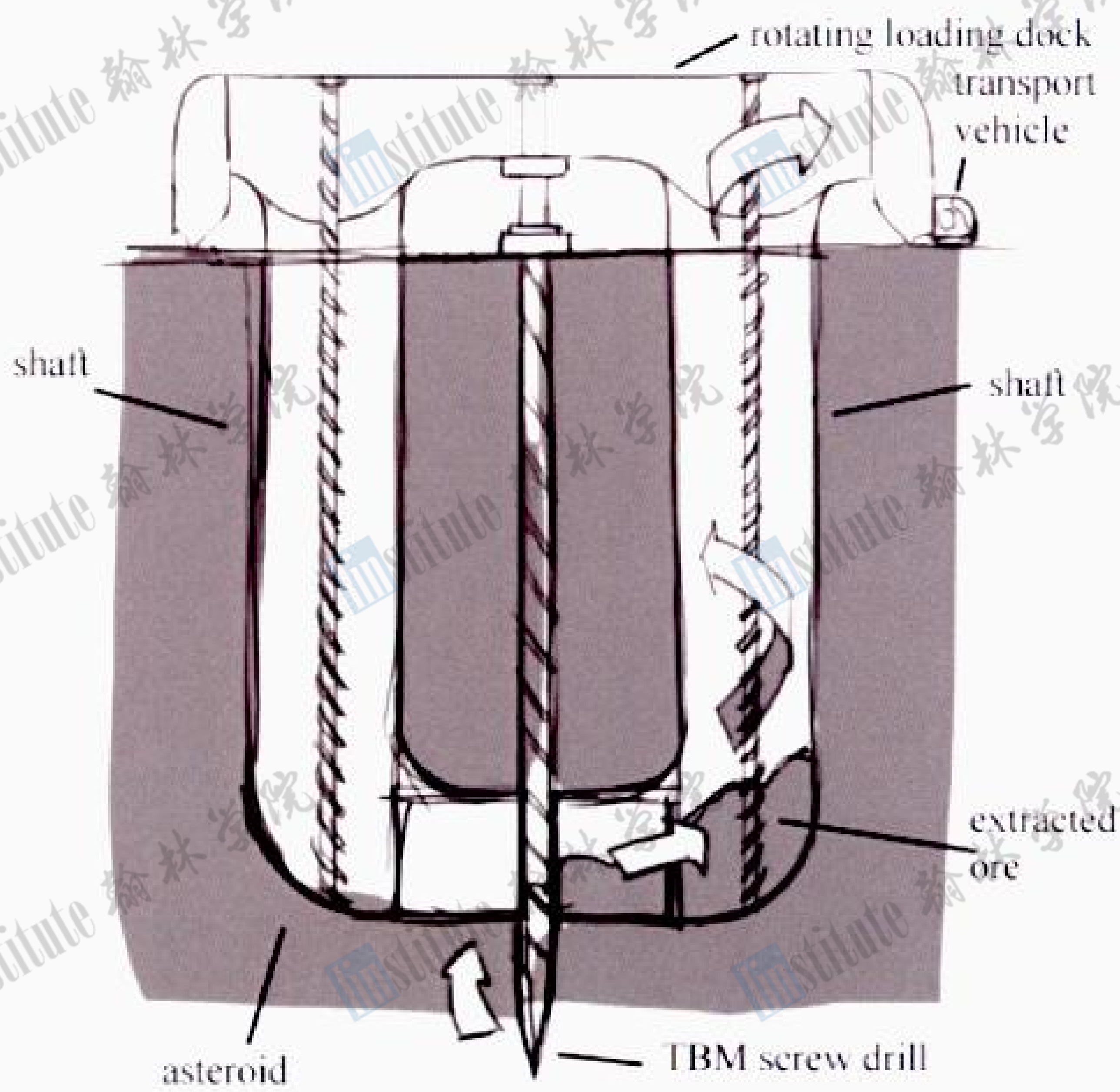
Additionally, each sector will be dotted with security cameras (save for in private areas, such as homes and businesses), and the task of watching for suspicious activity will be assigned to a force of security workers. In addition, each beacon will transmit the relative location of each member of the settlement at 30 second intervals, to be used to calculate robot and resident's locations. Should a crime be discovered in the area, all people who had been in the area at the time would have been recorded. Additionally, should a crime-in-progress be noticed, the officer on duty may "flag" an individual for tracking.

Tracking will be carried out by small Chaser-model versions of the original construction bots: they will be highly mobile, equipped with a taser, and synchronized with the Triangulating Beacons in order to receive the position, at all times, of its target. The taser is operated completely by the officer on duty to avoid potential issues with arming robots.

5.2.6 Privacy in Private Homes*:* Private computers will only be accessible to members of the family or authorized friends. Their privacy will be ensured by a firewall and personalized passwords. The residence will also be periodically scanned for cameras or other bugs to eliminate spyware or hacking. Also, when any photos or videos are uploaded, the network will alert the person featured within the photos or videos and ask permission to post it before allowing public access to the materials.

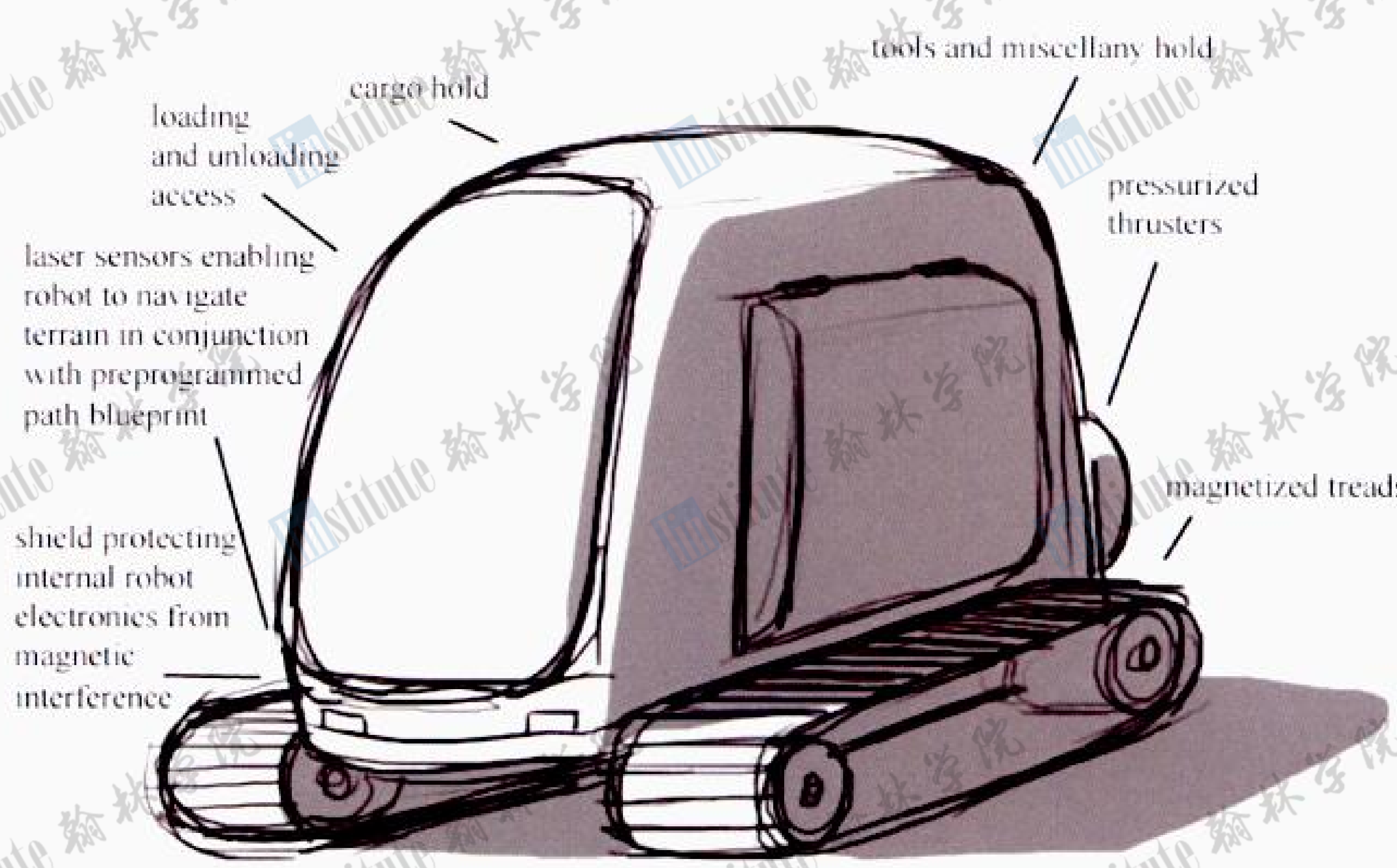
5.2.7 Connecting to an Exterior Network: Bellevistat's central servers will download certain commonly accessed web domains continuously and store the data in the 5 petabyte cache until next updated. The cache, located in the station's mainframe, will be a decentralized network of solid state drives in order to maximize read speed. Each storage drive will be dedicated to particular domain names in order to recycle specific content and minimize bandwidth consumption. Anybody from the public may request more obscure domain names, which will be assigned a higher priority in the download sequence.

5.3 Mining



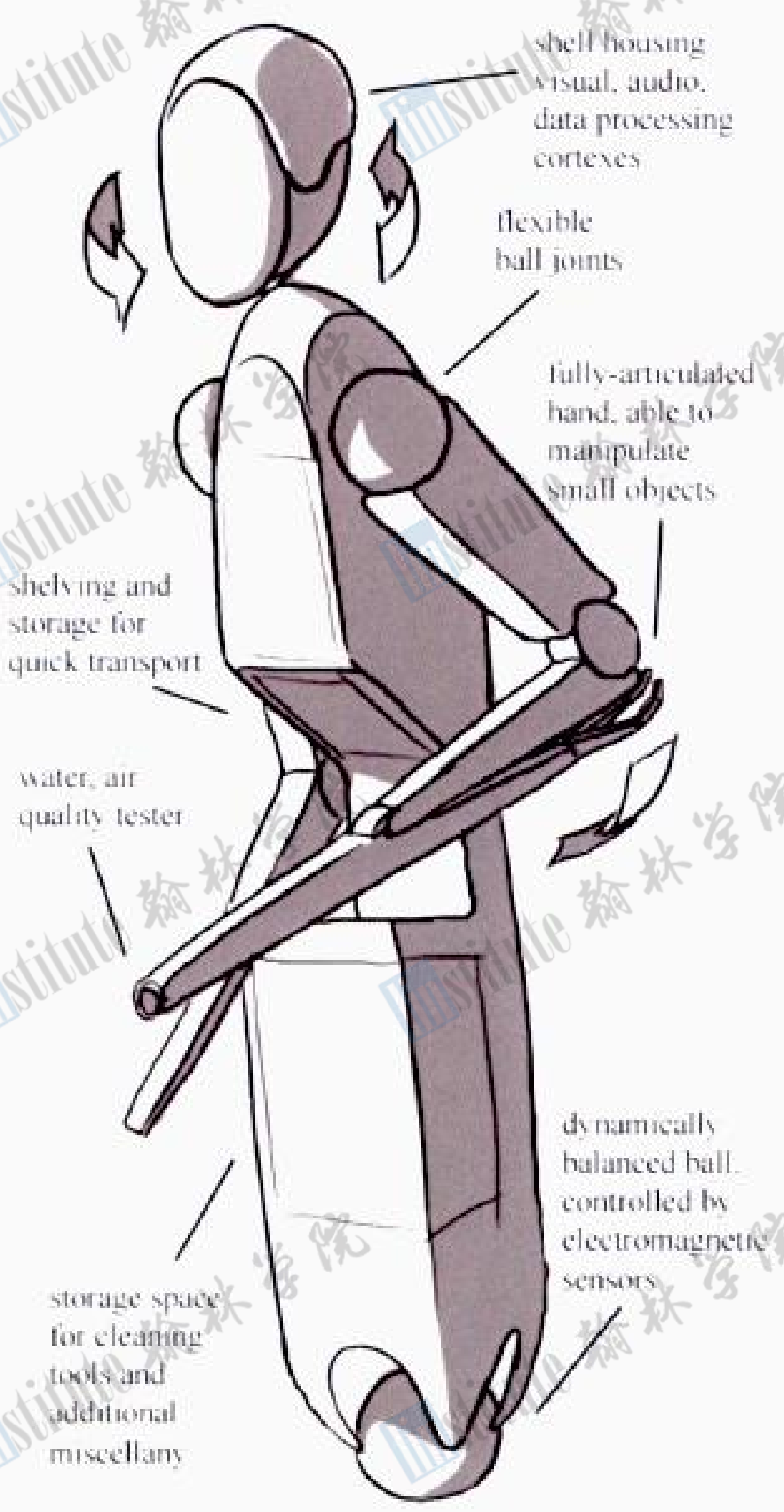
5.3.1 Heavy Mining Equipment: Approximately 110 mining stations are positioned in roughly 50mx50m squares on the asteroid surface. The area around the drill will be overlaid with a steel floor anchored to the asteroid to provide a concrete base. A 750 meter drill extends into the surface of the asteroid, with automatic sensors controlling the motion of the drill and measuring depth. Separate sensors also analyze rock content. The automatic sensor controlling movements will cut-off when the sensors reading depth and rock sample content indicate that there is rock that the drill is not capable of drilling through. Positioned along both sides of the drill are two elevator shafts that transport materials into the mining station. The drill will load rock samples onto a rolling loading dock, which will lead into the elevator shaft. Weight sensors are present in each elevator shaft with a maximum capacity of 2.5 tons. Once the maximum capacity is reached in one shaft, operations will stop momentarily, the loading dock will rotate to the other elevator shaft, and transport of materials will continue.

5.3.2 Robotic Presence: Heavy transport vehicles, named Inferus Fimus, will be the primary automated presence on the asteroid's surface. There will be approximately 1 vehicle per drill and the vehicle's dimensions will be 4x2.5x2.5 (m). Each vehicle will be fully automated and come equipped a loading dock, thruster system, magnetized treads, magnetic shields and a laser sensor for maneuvering. The vehicle's loading dock will attach to the elevator where the pressurized air used to move the elevator is used to push a piston that pushes the ore into the vehicle. As for any dust or debris on the asteroid's surface, the Inferus Fimus vehicles will be enclosed in protective carbon fiber cases to prevent entry of dust or debris.



5.3.3 Human Presence: There will be about 3-5 properly outfitted people per drill total to monitor the different sensors and at least 3-4 people to observe the drilling process to ensure that no errors should arise. A manual cut-off switch should be made available to stop the drills if necessary.

5.4 Facility Automation



5.4.1 Enhancing Livability in the Bellevistat Community: For each block of 25 houses (30 robots per sector, assuming 4 members per family), there will be one housekeeping robot (Domus) that will do routine maintenance, including trash collection and recycling, for each house once a week. These robots will maintain cleanliness at night, when they are not working in individual houses. Safety concerns about air quality will be addressed by Omnis and Domus robots, which periodically test for unhealthy levels of carbon dioxide, carbon monoxide, and ozone. These test results are then reported back to the sector servers. In addition, there will be robots available to the public for their various needs. In case they are in need of services such as plumbing or electricity repairs and heavy lifting, all houses will also be equipped with a call function to request robots. Community robots will be stored in the designated storage area in each sector. In order to maximize the robot per volume ratio, robot storage will involve stacking with the heavier robots stored on the bottom levels. The higher levels will be accessed by lifts.

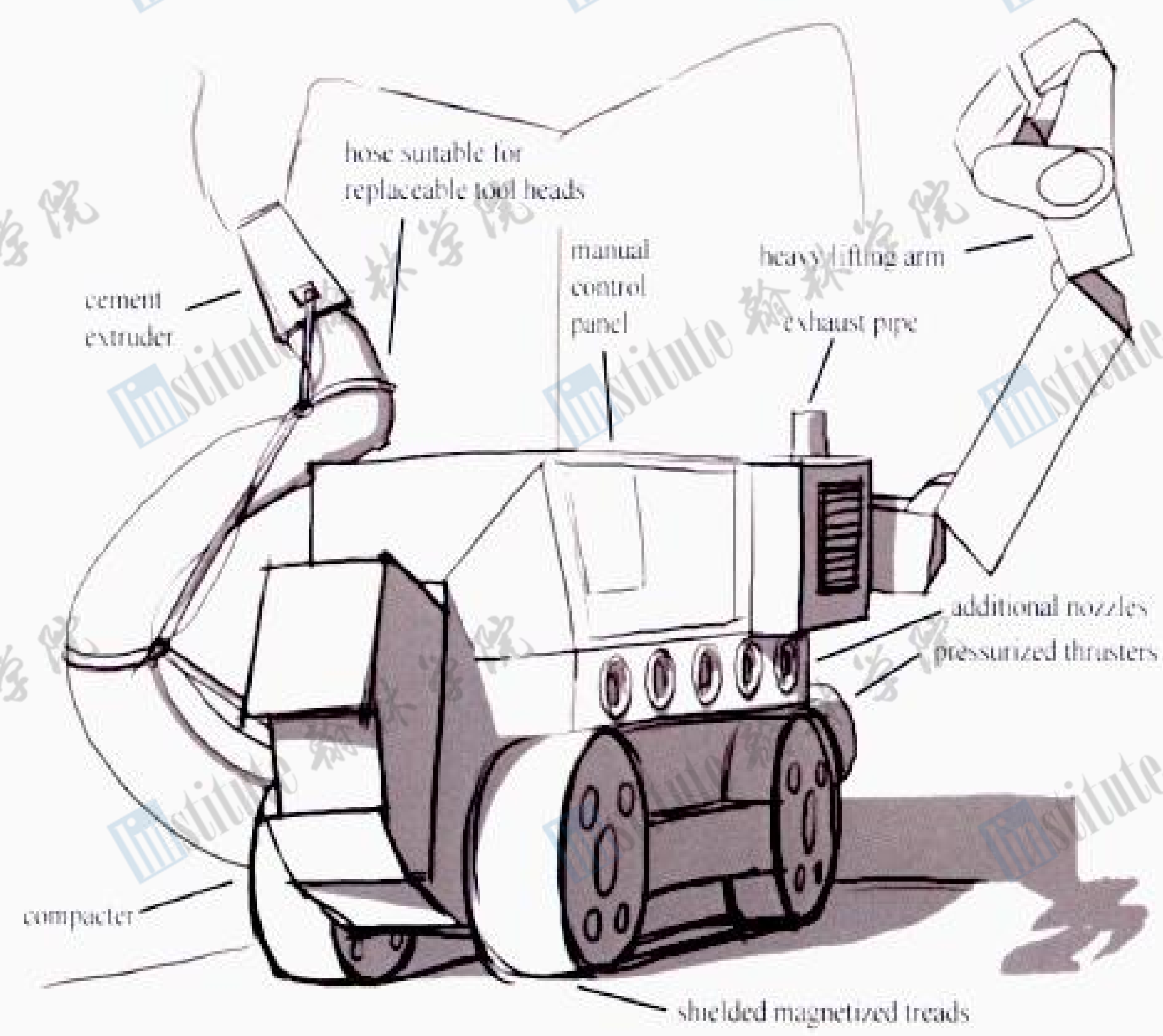
Housecleaning Robot Specifications:
Dimensions: .4x.4x1.5 (m)
Features: Vacuum, storage area, air quality monitor (pressure, temperature, CO_2, O_3, & CO concentration), fully articulate hand.

5.4.2 Productivity in Work Environments: In the office, employees will be equipped with a PDA-esque device (BPAC - Bellevistat Personal Assistant Computer) that comes with a calendar, address book, and dedicated messaging system to communicate with fellow coworkers. The calendar can be updated and changed easily, but may be preset and show pop-up reminders. Each of the individual computers will be monitored according to manager specified guidelines to ensure daily productivity (i.e. manager-flagged documents will be saved at the beginning and the end of the workday, and compared for progress). Certain websites will be prohibited at the workspace; the overseer is capable of viewing any computer output at will, and Solitaire and other games will not be installed on any computer.

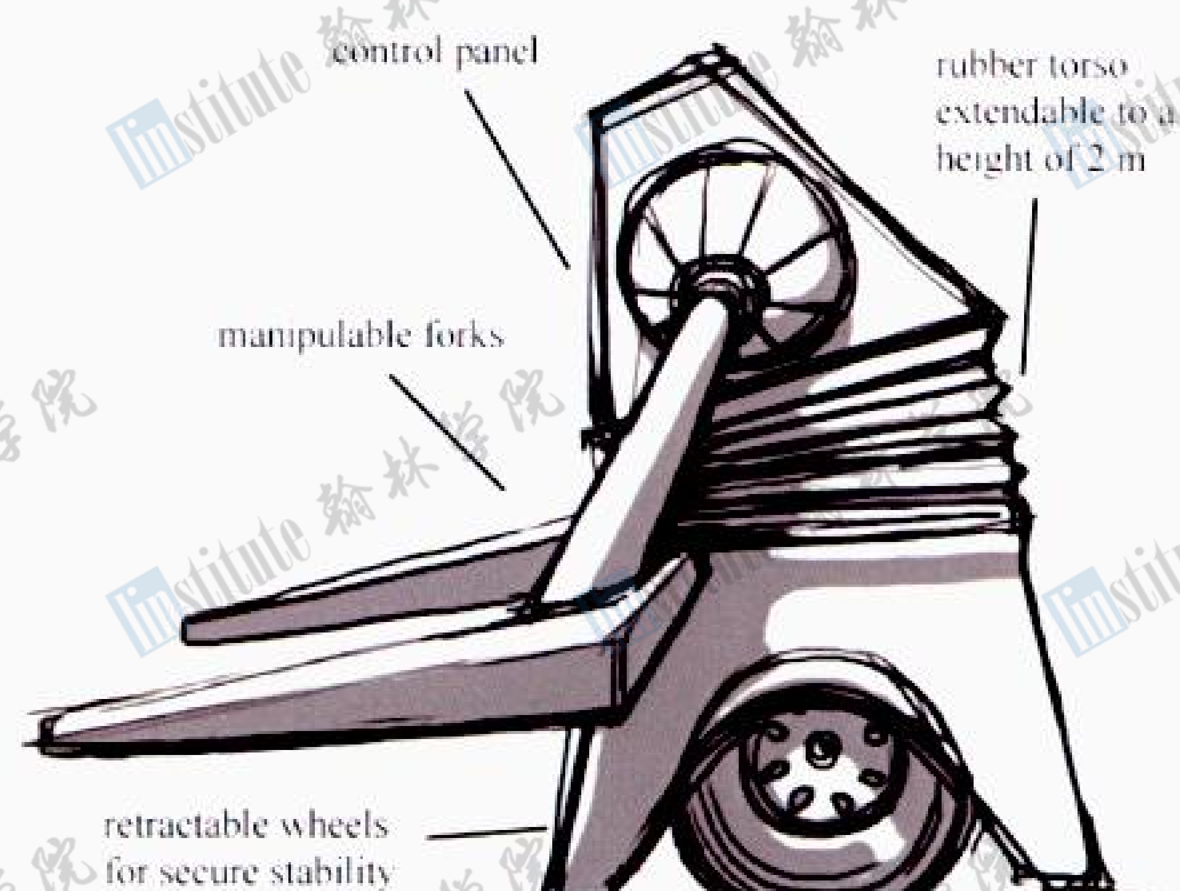
5.4.3 Reducing Requirements for Manual Labor (Automation in Maintenance and Routine Tasks): Robots will be created that will address various human needs. Each robot will come equipped standard with a wireless transmitter to communicate with the main servers, rechargeable battery pack connection port, preprogrammed blueprint of the station, triangulation beacon, visual and audio recognition software, and at least 300 GB of solid state memory.

Purpose	Model Name	Dimensions (m) (LxWxH)	Number of Units on Board	Responsibilities	Features
Basic Robot	Omnis	.8x.8x1.5	80 units per sector, 40 for general use, 1000 total.	These robots will do the simplistic tasks that the specialized robots are not needed for. Also, they will help the specialized robots when they are overwhelmed by demand	Connection ports for various arms and legs to adapt to a variety of situations. Comes standard with a 400 GB drive for programmable instructions, audio/visual cortexes, and removable caterpillar treads, CO2 + CO + O3 detector. Certain attachments come with magnetic capabilities.

Firefighting	Aestus Estus	.8x.4x.4	15 per sector, 180 total.	Extinguishing fires.	Tripod adjustable to a height of 2.5 m, oxygen-suppressing foam, able to collapse or stretch self, infrared sensors
Construction and Repair	Foris Renovo (FR)	3x2.5x3	20 per sector, 240 total.	Interior construction and repair.	Welding, bolting, and sealing capabilities. Blueprints will be preprogrammed into each construction robot. Heavy lifting arm. Cement extruder.



Heavy Lifting	Gravis	.5x.6x.6	10 per sector, 120 total.	Lifting weighty objects. These robots will be utilized to clean up after disasters (for example, they will take care of any debris left over from fires).	Ability to bear approximately 900 pounds of force. Manipulable forks. Retractable wheels to increase stability.



Electricity Repair	Levis	.3x.3x.8	8 per sector, 96 total.	Repairing minor and major damages to the electrical system, such as short circuits or misconnections, after being alerted by the centralized robot hub in the appropriate sector.	Ability to manipulate wires (fine control), rubber insulation. Welding and soldering capabilities. Able to use drills for opening compartments. Flexible accordion torso.
Plumbing Repair	Eluvies	.4x.3x.5	5 per sector, 60 total.	Repairing minor and major damages to the plumbing system, after being alerted by the centralized robot hub in the appropriate sector.	Welding, sealing, water-resistant coating on tools and the robot body.
Sanitation	Balaena	2x1x1	1 per 2 sectors	Sewage disposal, oxidation, and recycling; water denitrification and recycling.	Polyphosphate-accumulating organisms to aerate the scum and most of the sludge with oxygen as the byproduct, ovoid tank with two pipes for efficient distribution of the waste to agriculture and the recycled water, filtering.

In the event that the individual robots lose power, each robot will be able to recharge by a back-up single use battery. The robots will also be able to be individually repaired at their designated storage area. Robots that are acting erratically or destructively will have their power supply shut down manually. Each robot will have an independent system that will monitor its behavior and whenever a malfunction occurs it will alert Edoceo and disable the robot's functions.

5.4.4 Facility Automation Systems

Purpose	Model Name	Units	Responsibilities	Features
Monitor Space Station Orientation	Glados	1 (1 backup)	Ensures that Bellevistat will maintain its preprogrammed orbit and accounts for any fluctuations. Orients solar panels to maximize direct reception of solar rays. Tracks satellite and space debris positions and prevents any collisions.	Contacts the thrusters on the outer ring and adjusts the station's trajectory accordingly.
Droid Oversight	Edoceo	2/sector (2 backups/ring)	Monitors each robot's location. Coordinates robot actions when an emergency is detected and requests assistance from other sectors if it anticipates a shortage of response resources. Responds to individual requests from each robot.	Refitted from original construction commanders. Considered part of each sector's server. Requires high bandwidth and processing power to coordinate robot actions & requests, and to communicate with each. Calculates each robots' location based on a triangulation system using each robot's signal and at least four wireless nodes as reference.

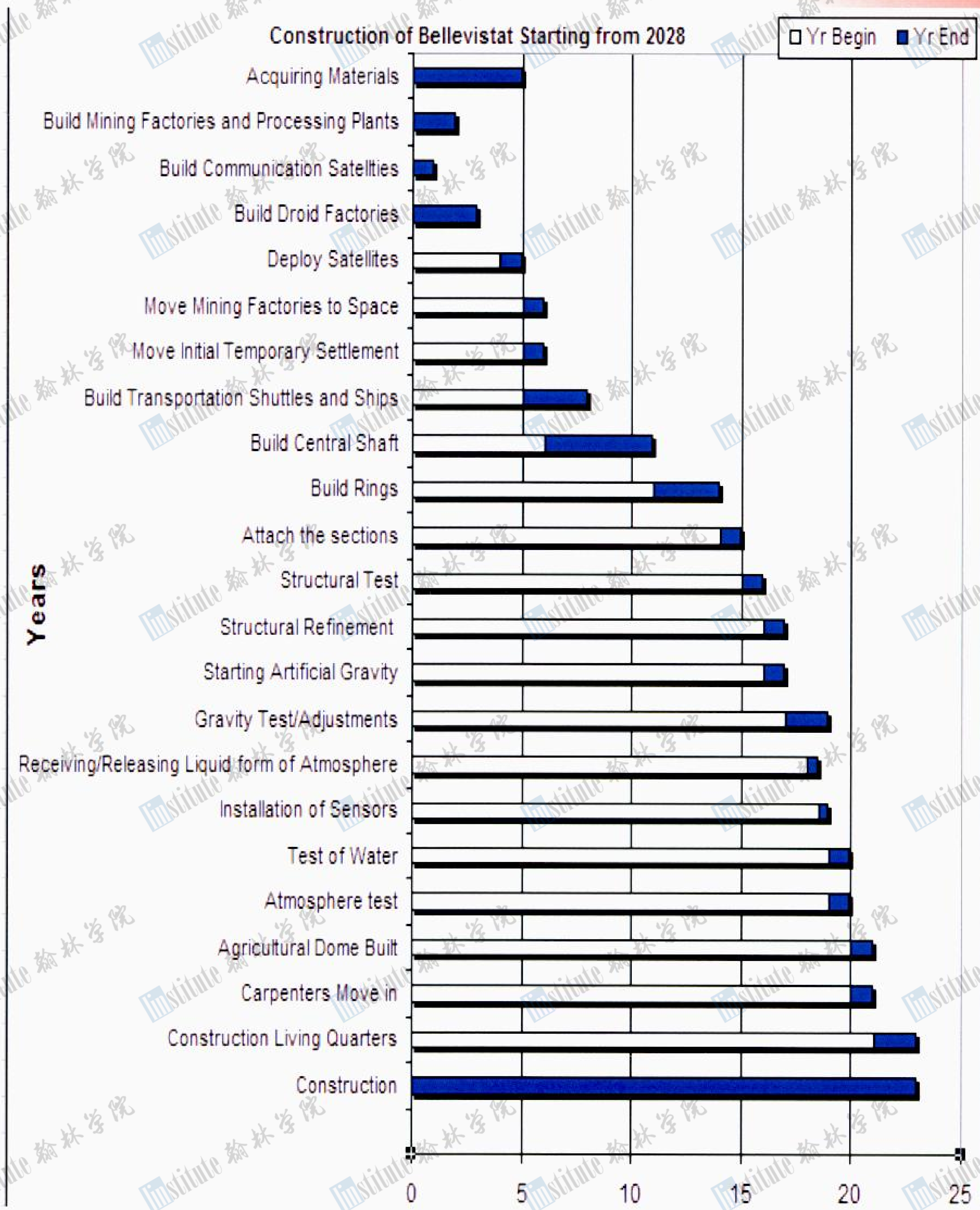
Monitor Living Conditions	Mater Matris	2/sector (2 backups/ring)	Receives and compiles incoming information from robots concerning temperature and air quality.	Sends out an alert if a threat is detected. Superimposes compiled data onto a map of the station and creates a visual to help personnel diagnose problem.

Backup systems remain dormant but receive updates from the main system at regular intervals, which depend on the system in question. Backups also come into use when the main system is shut down for repairs or updates.

5.4.5 Contingency Response and Emergency Repairs

Anticipated Emergencies	Response Systems
Maintenance and Repairs	Teams of repair-mode Omnis (see chart 5.4.3) will be available upon request to deal with malfunctions or damages to the interior of the space settlement. The robots will have interchangeable parts to help facilitate repair processes that require large amounts of specialized labor. Most of the work, however, is carried out by Omnis. If more specialized and/or extensive repairs are required then a robot specific to the problem type will be sent (i.e.- a Levis or an Eluvie, see chart 5.4.3)
Emergency External Repairs	The external repairs will also be done by Omnis. In case the station is hit by space debris, there will always be team of Omnis on standby that will be ready to repair any damage. While the station is being repaired, doors will be sealed off to prevent entry and for protection against oxygen loss. These will be located in the central robot hub as well, but in a ring around its outer edges for greater ease in entering and leaving the hub. To protect against solar flares, each construction robot will have a device selectively sensitive to radiation of 1.8 Angstroms. The device is connected to an alarm which will give sufficient warning to the robots. All the robots will have primary reinforced Whipple shield- layers of Kevlar, aluminum mesh, assorted ceramics, and multilayer insulation between the aluminum shield and pressurized wall-in order to offer both debris protection and increase the shield's longevity as well as a secondary layer of gold foil to help repel radiation.
Emergency Escape	There will be a total of 800 Pooka (Escape) Pods, each capable of holding 35 people, located in the outer edge of each ring. As excess of Pooka Pods is required because some will eject before they reach their maximum capacity. Pods are preprogrammed to go into orbit around earth. They will have communication devices, enough liquid oxygen for 6 days, and food and water for 4 days. Each pod will also emit an emergency signal to try and gain earthly attention.

6.1 Construction Schedule



6.2 Projected Costs and Revenues

Costs Before Becoming Operational		
	Construction for Droid Factories (200 plants)	1000 M
	Construction of Foundation	400,000 M
	Construction for Rings	550,000 M
	Construction of Shaft	200,000 M
	Materials and Shipping	29,835 M
	Testing Cost of Building	500 M
Costs After Basic Construction		
	Gravity Test	100 M
	Roads	2,070 M
	Agricultural Dome	300 M
	Droid Operation	1000 M
	Satellite Operation Cost	20 M
	Beacon	3.2 M
	Infrastructure (Water, Electricity, Plumbing)	14,140 M
	Sensors with Monitoring System	200 M
	Monitoring Atmosphere	100 M
	Monitoring Water	100 M
Costs After Populating		
	Construction Workers	3.2 M
	Station maintenance/ upgrades	250,000 M
	Fuel	9,000 M
	Solar satellites replacement	10,000 M
	Atmosphere maintenance	10,000 M
	Utility maintenance and operation	25,000 M
	Crew salary	5,000 M
	Manufacture of Droids	1,000 M
	Manufacture of Food Supply	4,700 M
	Manufacture of Clothing Supply	17 M
	Manufacture of House	84,2011 M
	Operating the factories	5.12 M
	Communication Satellites	150 M
Total Construction Fee:		**2,356,155 M**
Revenues from Taxes		
	Manufacturing leases	20000 M
	Business tax	7500 M
	Sales tax	600 M
	Income tax	200 M
	Foreign tug and docking tax	900 M
Revenues from Vacation/Recreation/Commercial/Industrial Facility Use		
	Recreation	4000 M
	International research rights	1000 M
	Surplus food exports	40 M
	Advertising rights	10000 M
	Restaurants	400 M
	Office and Retail leasing	1000 M
	Tourism, hotels	300 M
	Manufactured goods sales (economy)	5000 M
Revenues from Mining		
	Asteroid Mining	287,000 M
	Refining services	400000 M
	Manufactured goods sales (industrial)	600000 M
Revenue Total:		1,328,940 M

- 7. Business Development -

7.1.1 Asteroid Mining: Materials and equipment needed to mine asteroids are initially imported, but then manufactured through the factories using droids. The excess mined minerals are sold for business ventures on Earth to make profit for the settlement; platinum, silicon, aluminum and carbon are highly valued minerals on Earth. By mining excess materials and transporting them to Earth, Bellevistat generates great profit. Efficiency of mining is achieved by scanning through the asteroids using X-ray and probing for the mineral. Once mined, the components are separated using electromagnets and industrial-size centrifuge. Separating the impurities from the high-value minerals improves the quality of the raw product, thereby increasing the selling price.

7.1.2 Space Transport Vehicle: Cargo ships ferry materials, products, matter, and energy from one place to another, regardless of distance between the two. Cargo ship design will be similar to the current Mack truck, in that the front end, which provides actual movement, is detachable and applicable to any other container, while the end that contains the cargo is adjustable to any other form/shape. The front end has 3 different sizes and powers; specifications depend on the type of cargo, taking into consideration weight, volume and density. The cargo ship may be customized to carry radioactive materials: the storage area will have a 2 cm thick lead coating. The cargo ships use LOX and LH2 as fuels. Ships are built using the minerals mined at the settlement, and parts from obsolete Space Shuttles and droids. The factory is built near a droid factory and recycling plants for quicker access to the materials.

7.2.1 Manufacture of Space Transport Vehicle: As more settlements are built, Bellevistat has the capability to mass-produce the Space Transport Vehicle for sale to those settlements. Construction of the cargo ship itself will be done in the settlement with prong-interchangeable assembly line: one assembly line puts together the engines, which can be used for all models with power of small, medium and large, with modification in booster to change its power output, another makes the outer shells for cargo ships, which houses the driver/engine/boosters, and yet another is used to construct the casings of the cargos to ship. After this, piecing together the different parts is all that is left in the construction phase. Maximizing the efficiency of construction in turn helps to maximize the output.

7.2.2 Manufacturing of Miniature in Space: By its flexibility and ability to produce, Bellevistat has a great ability to generate profits through custom-ordered projects aiding other settlements; building settlements becomes easier as droid and miscellaneous factories are established on Bellevistat, as there is a shorter traveling distance and time, as well as less damage accumulated during the transport from location to location. Bellevistat, by its strong capability to manufacture through the extensive use of droids, can generate great profit by selling such items.
Through extensive use of droids, Bellevistat automation has wide array of ability and flexibility in pursuing the customer satisfaction as well as products to be sold for profits. The plants use automation line to mass-produce satellites and antennae, which are key components in the efficient construction of settlements. Bellevistat also takes on customer-specific orders such as extensions to the settlement, production of droid factories, and manufacture lines. The parts used to construct these components are interchangeable, allowing for smooth transition in case of contingency, as well as smooth transition from working on a section to a different section of the manufacture line.

7.2.3 Large Scale Tools: Large-scale tools are also constructed based on the same principle of manufacturing and automation through the use of droids. The droids used have different physical parts allowing for taking on different tasks. Also, tools use interchangeable parts, which allow for smooth transition between facilities to produce the products. This ensures Bellevistat to be a great distributor of tools as well as other key components of the settlement; having the ability to generate tools efficiently is useful in its own production as well as producing other products ordered by the customers. Some examples of large-scale tools would be Mining Drills, Space Craft Hangars, Cranes for construction of internal settlements.

7.3.1 Plans to visit/explore Bellevistat: Conventional Spacecrafts carry the tourists to the Bellevistat. There are 2 travel packages for the tourists to consider: the one week tour package and two week tour package; one is $20000, while the latter costs $35000. Both options take tourists through a thorough tour of the settlement and the factories under strict supervision using uniforms and monitoring. They also include one day of space walk in the space park, the option of going through the automation support sectors. Bellevistat is a harmony of science, art and culture: there are new-age technology and amenities as well as research. By observing Bellevistat, scientific curiosity will be satisfied along with cultural needs. To allow for the tourists to come with better ease, there are loan programs for people who are unable to pay for themselves: down payments, and the tourist cost may be paid back with interest over 5 years.

7.3.2 Amenities: There are numerous places for the tourists to visit, including amusement parks, space parks located outside but connected to the settlement, physical gyms, spas, and culture art centers. There are museums, library and databases of electronic databases to research and look up information for free and at any time. Tourists are encouraged to take photos, enjoy their time spent, and talk to as many scientists and residents as they desire to find out about life in space. The Bellevistat tourists are there as a part of the learning experience of life. By encouraging these activities from both the researchers and the tourists greater scientific minds are made. The tourists are never to interfere with the lives of the workers, to prevent the possibility of breaking droids. If an incident occurs, the tourist is deported off of the settlement. They are to stay in local hotels that are located in the urban sectors, which are designated for the transients, during the remainder of stay.

7.3.3 Mining, Refining, Manufacturing: Factories are specifically made with observation rooms from which 100 tourists can reside simultaneously looking over the manufacturing in the automation line. The tourists are handed goggles, aprons, gloves and masks for which they must wear at all times when they are in plants, along with their uniforms. The mining process may be observed by taking a Space Bus, which is a conventional space shuttle, to the work area, observing strictly from inside the bus, on their seats; tourists will not have the option of standing, even when the Space Bus is stationary. Space suits, with full space protection, will be provided to the tourists in case of emergencies. There are always trained professionals around to keep the tourists safe. The refining process is observed again through an overseer room, but still with masks, goggles, and aprons. The mask is of 15micron pore size, attached to face mask. This allows only for essential gas components to go through. The mask uses 2 filter systems; the filters are autoclavable, treated and may be reused up to 20 times. Gloves handed out are of surgery-grade gloves, which are nitrile. They are to be recycled through the recycling plant, treated extensively with the filtering and cleaning process. Goggles are of hard-coated Polycarbonate lenses.

7.3.4 Zero-G Entertainment: There are chances in which the tourists may go visit the physical training gym facilities. Gyms offer zero-g moon bounce, zero-g experience. The tour includes time allowing for space walks at space parks, overlooking space experience. The space walks are done in the space parks, of clear carbon fiber top dorm of metallic floor, but filled with asteroid soils and microgravity. There are 'space games' in arcade system, for instance a simulation of defending a space battleship against asteroids. There are space virtual tours of scientists, virtual tours of the miners.

7.3.5 Visitor's access to Communication, Droids: Each hotel room is equipped with same communication device to communicate with Earth using satellite communication. Each tourist is handed a portable panic button for emergencies. Robot resources are limited to public robots that perform domestic tasks, including cleaning and doing the laundry. All travelers are handed uniforms that are implanted with special chips that locks them from going into unauthorized areas. They include the worker's areas for factories, research facilities, and factory areas outside the area designed for tourists and observers. These chips monitor the heart rate, pulse, and temperature of the tourists to ensure a healthy stay. In addition, it is equipped with a tracking GPS for emergency or security breach. They are reset with every new tourist.

- **8.0 Compliance Matrix** –

Section	Requirement	Subsections	Pages
1.0 Executive Summary	Describe the overall settlement design and its merits	N/A	2
2.0 Structural	2.1 Overall exterior design of the settlement	2.1 Overall Station Design 2.1.1 Station Dimensions 2.1.5 Major External Construction Materials	3 3 5
	2.1 Specify where gravity is supplied, pressurized and nonpressurized sections, means for radiation and debris protection	2.1.2 Artificial Gravity 2.1.3 Zero-Gravity Areas 2.1.4 Wall Structure	3 4 4
	2.2 Specify interior volumes and down surfaces	2.2 Interior Station Design	6
	2.2 Show residential, agricultural, industrial areas of the settlement	2.2.1 Ring Sectors 2.2.2 Central Shaft Sections 2.2.2.1 Observatory and Tourist (Top) Sector 2.2.2.2 Center Sector 2.2.2.3 Bottom Commercial Sector	6 7 7 8 8
	2.3 Describe construction order	2.3 Construction Order 2.3.1. Commercial Sector Construction 2.3.2 Central Shaft Construction	9 9 9
	2.4 Show structural attachment to/construction on asteroid and systems to minimize transfer of asteroid dust in the settlement	2.1 Overall Station Design 2.2.2.3 Bottom Commercial Sector 2.3.1. Commercial Sector Construction 2.4 Station Attachment to the Home Asteroid 2.4.1 Isolation from Space Dust and Asteroid Debris	3 8 9 10 10
	2.5 Situate docking facilities to minimize traffic and the impact of emergencies and breakdowns.	2.5 Docking Facility Overview 2.5.1 Docking Accident Prevention System	10 10
3.0 Operations	3.1 Identify orbital location	3.1.1 Location	11
	3.1 Identify materials and equipment used in construction	3.1.2 Materials/Equipment Required 3.1.3: Construction Process	11 12
	3.2 Show basic infrastructure for internal activities: food, energy, communications, transportation, climate control	3.2 Internal Infrastructure 3.2.1 Food Production 3.2.2 Electrical Power Generation 3.2.3 Internal/External Communication 3.2.4 Internal Transportation 3.2.5 Atmosphere/Climate/Weather Control 3.2.6 Water Management 3.2.7 Household and Solid Waste Management 3.2.8 Day/Night Cycle Provisions 3.2.9 Propulsion	13 14 15 15 15 16 16 17 17 17
	3.3 Identify on-orbit infrastructure for sustaining the settlement.	3.3 Space Infrastructure	17
	3.5 Develop resource saving	3.4 Interior Design Materials	18

	materials for furniture and interior finishing	3.4.1 General Furniture Innovations 3.4.2 Specific Furniture Innovations	18 18
4.0 Human Factors	4.1 Identify means to distribute consumables to residents	4.1.1 Facilities and Service 4.1.2 Community Environment for Psychology 4.1.3 Quantity of Consumables 4.1.4 Means of Distribution	19 19 19 22
	4.2 Provide designs for typical residential homes	4.2 Housing Designs 4.2.1 Features of houses 4.2.2 Apartment Floorplans 4.2.3 Furniture	22 23 23 23
	4.3 Identify tools used to enhance productivity	4.3.1 Design of Systems 4.3.2 Design of Vehicles 4.3.3 Design of Devices 4.3.5 Jobs and Tools	23 24 24 25
	4.3 Identify means of moving safely in low gravity and design a spacesuit	4.3.4 Spacesuit	25
	4.4 Design differentiated neighborhoods for the residents to choose from.	4.4.1 Architectural Differences 4.4.2 Neighborhood types 4.4.3 Demographics 4.5 Entertainment and recreation 4.5.1 Physical Fitness: Institutions 4.5.1.1 Physical Fitness: Activities 4.5.2 Mental Stimulation: Institutions and Activities	27 27 27 28 28 28 28
5.0 Automations	5.1 Describe the use of automation for construction of Bellevistat	5.1.1 Assembly Process 5.1.2 Diagram Describing Automated Construction Devices and the Purpose for Each 5.1.3 Interior Finishing and an Approximate Timetable 5.1.4 Human Oversight	29 29 30 30
	5.2 Specify automations used for settlement maintenance and repair	5.4.5 Contingency Response and Emergency Repairs	36
	5.2 Define locations and security measured in relation to computers and networks	5.2.1 Physical Locations of Computers, Servers, and Wireless Access Points 5.2.2 Network Connections and Anticipated Bandwidth Requirements to Enable Computer Connectivity 5.2.3 Privacy of Personal Data & Method of Storage 5.2.4 Network Authorization 5.2.5 Station Security 5.2.6 Privacy in Residencies 5.2.7 Connecting to Exterior Network	30 31 31 31 31 31 32
	5.3 Specify automations in residencies to ease daily tasks	5.4.1 Enhancing Livability in the Bellevistat Community 5.4.2 Productivity in Work Environments 5.4.3 Reducing Requirements for Manual Labor (Automation in Maintenance and Routine Tasks 5.4.4 Facility Automation Systems	33 33 33 35
	5.3 Specify privacy measures in residencies	5.2.6 Privacy in Residencies	31