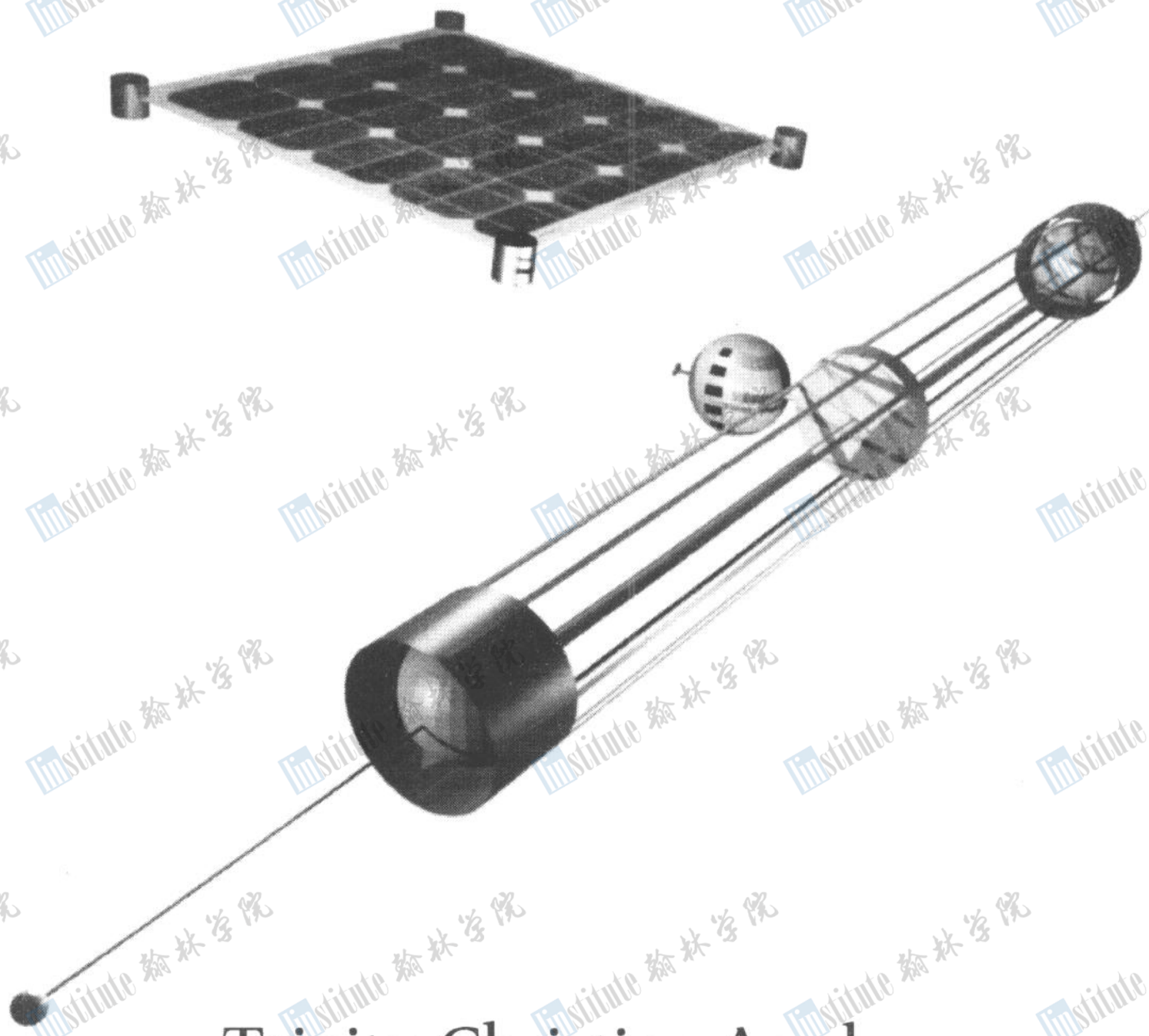
Columbiat

2009



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1.0 Executive Summary

A space colony of the size proposed for the "Columbiat" project will require engineering on a massive scale. Providing food, water, recycling, air and gravity to that many people will surely be a feat that will stress our resources and ingenuity. Our team has set itself to designing this project, and designing it to the best of our ability.

Our space station design is not based around the traditional Stanford torus that most space stations use to create artificial gravity. We have decided on a new design, which we will term as a "baton"- the main design concept being that instead of a solid, orbiting ring, we have two individual habituated spheres, rotating on the end of carbon nanotube cables. Another, non rotating sphere will be connected to the baton at the axis of rotation, providing zero gravity work areas, storage, and shuttle docking. At the "top" of each sphere, a large open area with soil, grass, and views of space will be created, to give colonists a more comfortable stay.

This system allows for a long enough radius for the habitat modules to have a little less than 1 g, but with a relatively slow rotation rate. One of the most important factors of this design is the simple system to adjust mass shifts between different parts of the space station. The weight trim system is a weight on the end of a cable that can be winched up or down in accordance with the mass difference between the two modules. This prevents rotational wobbles from occurring, as opposed to the Stanford Torus and Bernal Sphere models. This system also attempts to use spheres to enclose the main pressurized areas to reduce space proof surface area.

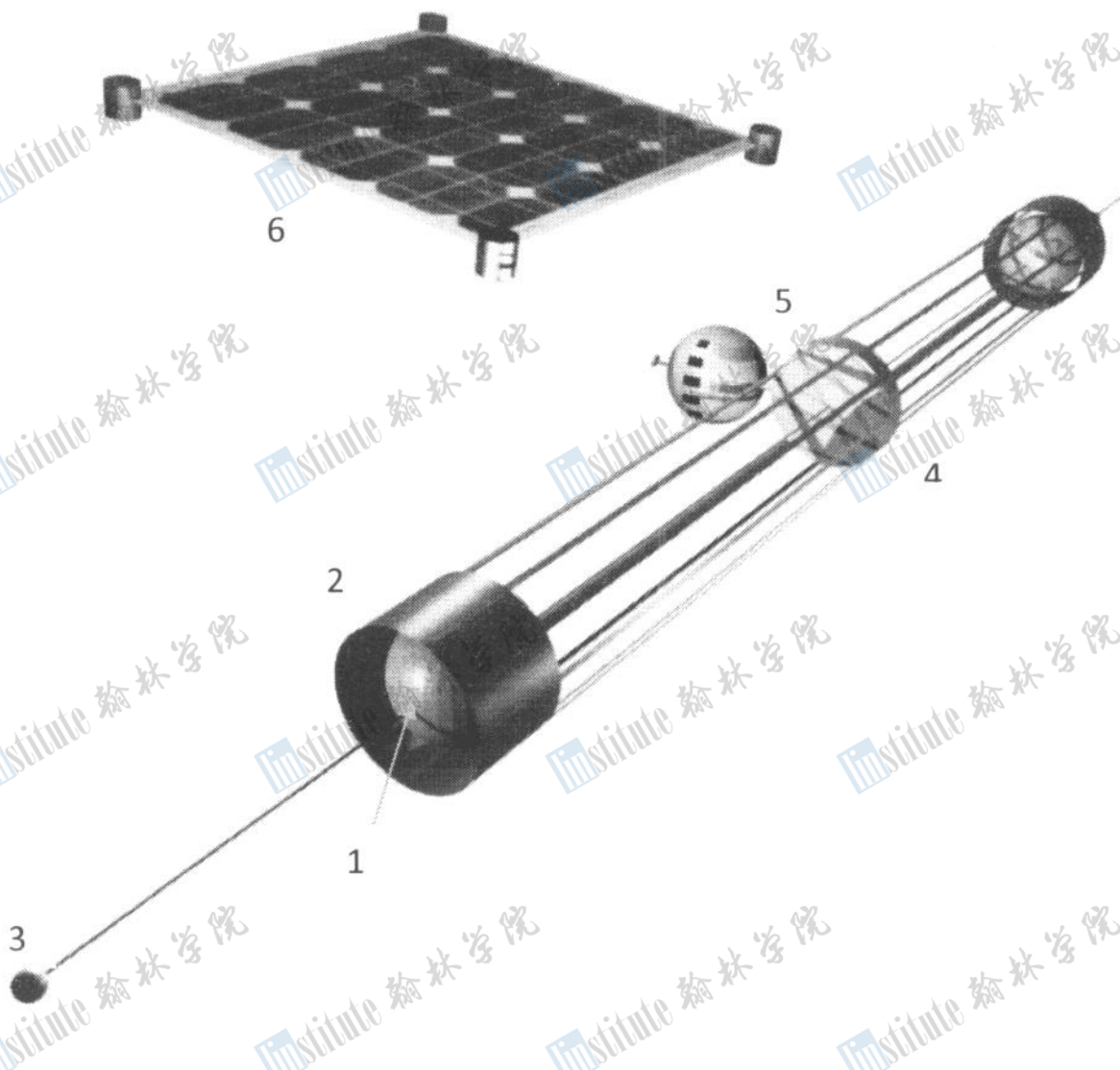
Our team has attempted to use as much current technology as possible. Though Alexandriat, Bellevistat, and Alaskol were mentioned in the summary, we are operating under the assumption that they can supply little to no heavy industrial support in the form of girder, surface protection, or other heavy industrial production. We are assuming that manpower from one of the two stations may be utilized, as it would be many times more cost effective than bringing rockets of construction workers from earth. We are also assuming that Bellivistat or Alexandriat may supply us with light manufactured goods, such as basic electronics, wiring, pipes, fuel tanks, dehumidifiers, and similar products. Products that require laboratory equipment for construction, such as carbon nanotube cables, we will be importing from earth.

The internal structure of the Columbiat will be organized around a three dimensional grid contained in each sphere. Each grid cube will be 10 meters by 10 meters by 10 meters. Initially after construction, it will be an essentially empty structure. But each grid pane may be fitted with a "wall piece," allowing the easy creation of areas of 1000 cubic meters. For residential homes, this may be separated into three floors of 100 square meters, with apartments taking up one floor, and homes growing by floor. Commercial and industrial centers may create larger enclosed areas with this system. A factory might enclose eight cubes, creating one large room with 800 square meters of floor space, and 10 meter high ceilings. This system will optimize the space inside each sphere, and allow for maximum flexibility. As well, the habitat modules are designed with more area than is immediately needed, allowing for long views of the interior of the habitat.

2. Structural Design

2.1 External Configuration

The Columbiat is designed as a baton, and the two spheres rotate around the central node. The radius of the baton is five kilometers long, allowing a leisurely .40 rotations per minute. This creates an average gravity in each or the spheres of .948 gravities, which is barely any difference between earth. This allowe colonists not to suffer any ill effects from their stay. Almost the entire structure is made out of steel, except for the cables, made of carbon nanotubes, and the solar panels.



In reference to the picture above, the following descriptions correspond to their matching numbers.

1. The Habitation Sphere

Each habitation sphere is a large three dimensional grid, enclosed by a steel surface. The Spheres enclose a volume with full atmospheric pressure, and enough room to allow 15000 citizens to live with ease. The waste of the colony is recycled, and provided for agriculture. Each sphere is self sustainable except for the electricity required, as the food is grown under artificial lighting.

2. Radiation Sheild

The large cylinder enclosing the habitation spheres are the radiation shield. The radiation shield is made up of slag from the mining operation, and is enclosed between steel. The radiation shield's sole purpose is to give the colonists as much protection from radiation as possible.

3. Weight Trim System

The weight trim system is a way to keep the station from wobbling as the center of gravity changes in reaction to the shifting of masses between the two habitation spheres. As the mass increases in one sphere, without the other having an increase, the weight is retracted, to keep the overall center of gravity the same. This is a simple, yet effective way to control wobbling in the Columbiat's rotation. The weight trim system will also act as a radiator for each sphere, to take away excess heat.

4. Central Node

The central node is a large disc shaped structure that is at the center of rotation of the Columbiat. It acts as a crossroads between the 3 spheres, the two habitation modules and the gravitational sphere. The Central Node has little purpose besides being an elevator terminal. It is a large disc, with a slightly larger radius than the spheres that contains full atmospheric pressure.

5. Zero Gravity Sphere

The Zero Gravity Sphere is the central part of the colony. It is built exactly like the habitation sphere, with full atmospheric pressure inside. The main difference is that it has no gravity, and does not rotate. The Zero Gravity Sphere is the center for zero gravity industry, storage, commercial needs, and the port. The Sphere has a series of large openings around its surface, which facilitate the entry of space craft. The Zero Gravity Sphere is connected to the main body of the space station via a short elevator that twists as it travels to compensate for the differences in alignment of the two bodies.

6. Solar Panel(s)

The solar panels are the primary means of electricity production for the colony. These large structures are free floating, and have their own engines to move them. They collect solar energy, and beam it in microwave form to a large microwave receiver located on the Zero Gravity Sphere. This in turn is transformed into electrical power for the rest of Columbiat.

Dimensions

Cables stretching from central node to habitation sphere: 5000 meters

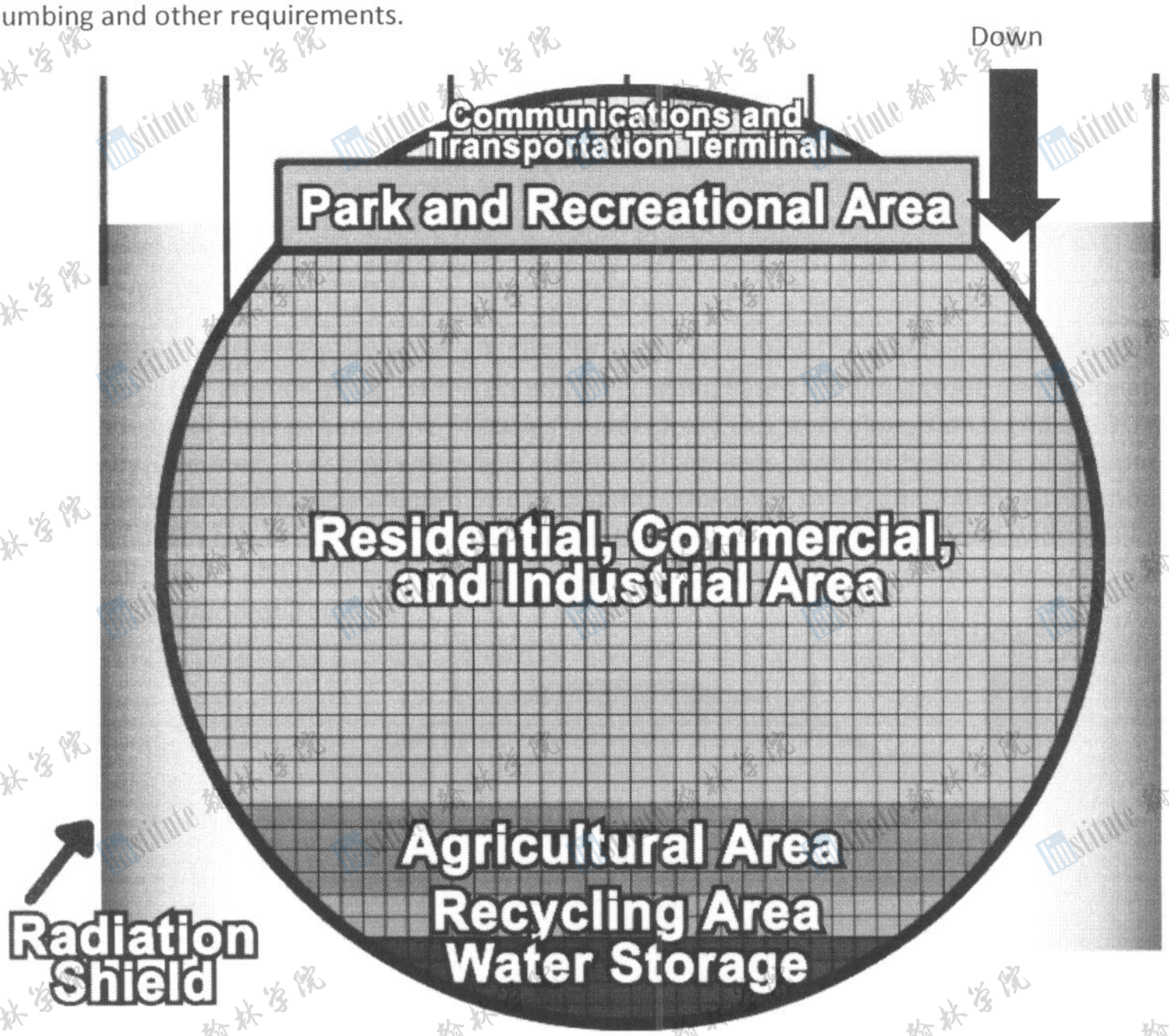
Radius of Each Sphere: 300 meters

Radius of central node: 310 meters

Solar Panel dimensions: 500 meters by 500 meters

2.2 Internal Arrangement

The Habitation Sphere is the center of colonist life, and is referenced as number one on the overall design layout. The interior design of the Columbiat is again, based around a three dimensional grid system made up of steel girders. The "cubicles" made up by this steel dimensional grid are 10 meters by 10 meters by 10 meters. Each sphere is 600 meters in diameters, with the total cubicle amount over 100,000. Because each cubicle created by this system is the exact same, and the massive amount of them, the cubicles can be easily changed between uses. Each cubicle may be fitted with "wall pieces," creating walls, floors and ceilings. Holes will be cut in these pieces to create doorways and holes for plumbing and other requirements.



Water Storage

The Water Storage area is located at the bottom of the habitat facility. This allows easy drainage from all other parts of the habitat. More importantly, the Water storage area creates a thick layer of water at the bottom of the habitat, forming a thick radiation shield. This aids the radiation shield in protecting colonists from radiation.

Recycling Area

The Recycling Area is the part of the habitat facility that processes biological and commercial waste. Human waste is converted into fertilizer and nutrients for plants, and inorganic waste is converted into a standard shipping form and shipped to the zero gravitation facility. This is almost completely autonomous.

Agricultural Area

The Agricultural Area grows food for the rest of the sphere. This is also almost completely automated. With hydroponics, it is estimated that only 5000 cubicles are needed to grow enough food for the colonists in the sphere. 10000 cubicles is taken up by agriculture, including corn, rice, wheat, beans, sugar beets, goats, rabbits, chickens, and a few cows, allowing for shortfall. Another 5000 cubicles are taken up by automated food processing facilities. The Agricultural area is sealed off from the above section, with few doors, as to keep the smell from interfering with the colonists lives.

Residential, Commercial, and Industrial Area

This is the bulk of the sphere. Inside this area, colonists may form the landscape however they choose by building in the designated cubicles. Cubicles will be sold to the colonists, and effectively act as real estate. Afterwards construction, this area is essentially given over to capitalism, allowing colonists to form it over time. It will contain the homes, 1 g industries, and commercial businesses of the colony.

Park and Recreational Area

This is a large open space, in which the 3d grid is reduced to a few pillars. Inside, it is 40 meters high, and contains a layer of soil on the ground. This area is supposed to simulate earth as much as possible, with growth, streets and buildings. At the edge, the colonists will be able to view the stars through large glass windows into space. The land in this area will mostly be made up of parks, but some land will be sold to businesses or as homes, on the basis that they must make the building they build as similar to one on earth as possible.

Communications and Transportation Terminal

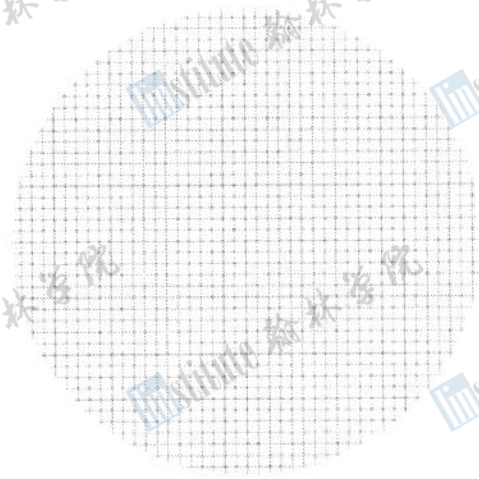
The Communications and Transportation Terminal is the area in which the colonists move to other parts of the station. Large elevators travel up and down the cables connecting the central node to each habitation sphere. Elevators descend to the sphere, lock to the door on the sphere, and accept colonists. Information is also routed in this area, and it contains the central control computer for each sphere.

2.3 Construction Sequence

Step 1

STEP I:

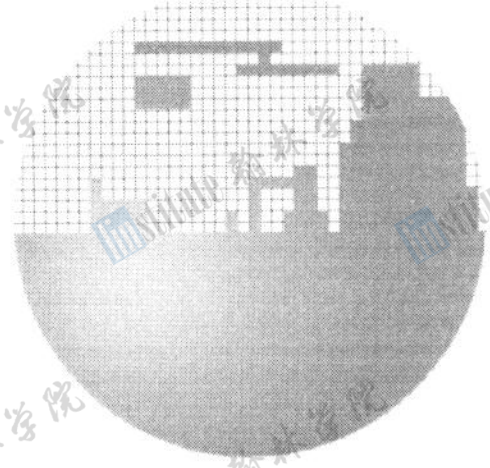
Step 1 is to assemble a large 3D grid made out of steel girders, in the shape of a sphere. The grid will have units of 10 meters by 10 meters by 10 meters, with a radius of 300 meters. Three of these are made



Step 2

STEP II:

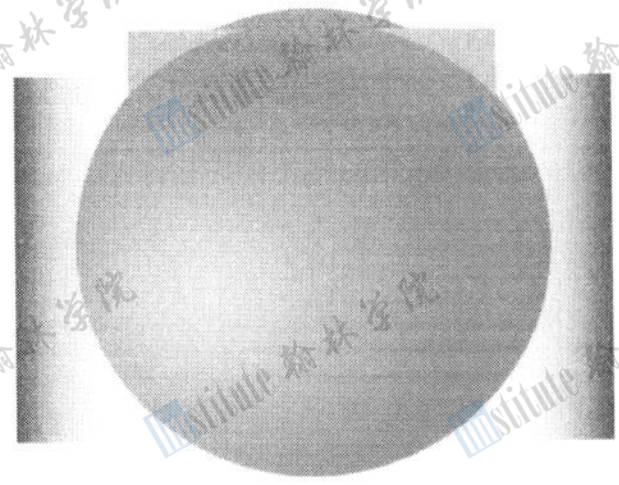
Step 2 is to cover the grid with a surface of steel. The grid will be completely covered by this, which must be airtight. Three of these are made.



Step 3

STEP III:

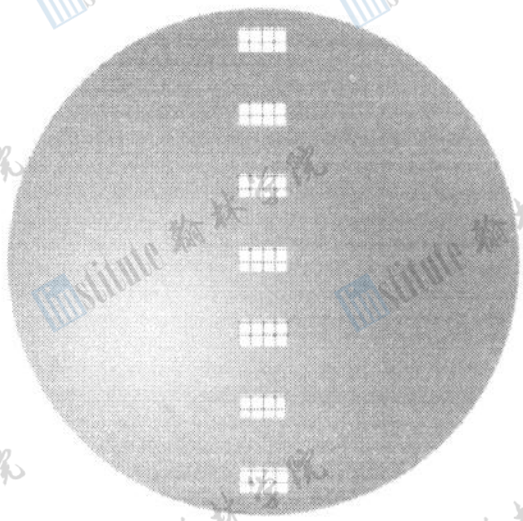
Step 3 is to create the radiation shield around the sphere, and add the glass for the park and recreation area. Two of these are made.



STEP IV:

Step 4

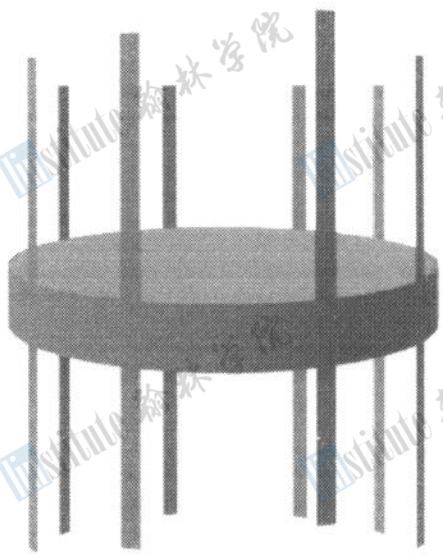
Step 4 is to create the docking bays on the Zero Gravity Sphere. One is made.



STEP V:

Step 5

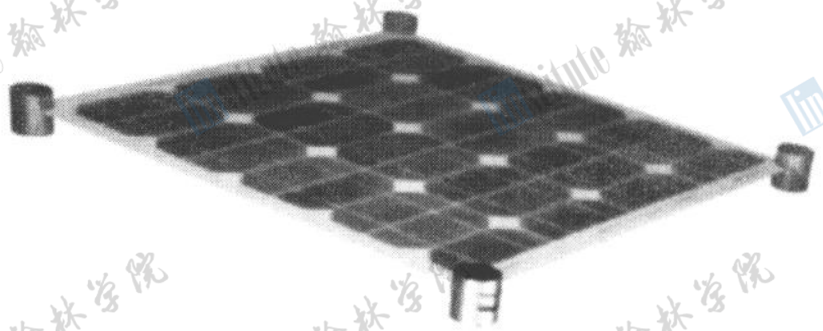
Step 5 is to create the central node by using the procedure above, but to create a disc instead of sphere shape. As well, the carbon nanotube cables are to be shipped up and attached to the disc.



STEP VI:

Step 6

Step 6 is to create multiple solar panels with engines, and suspend them in space.

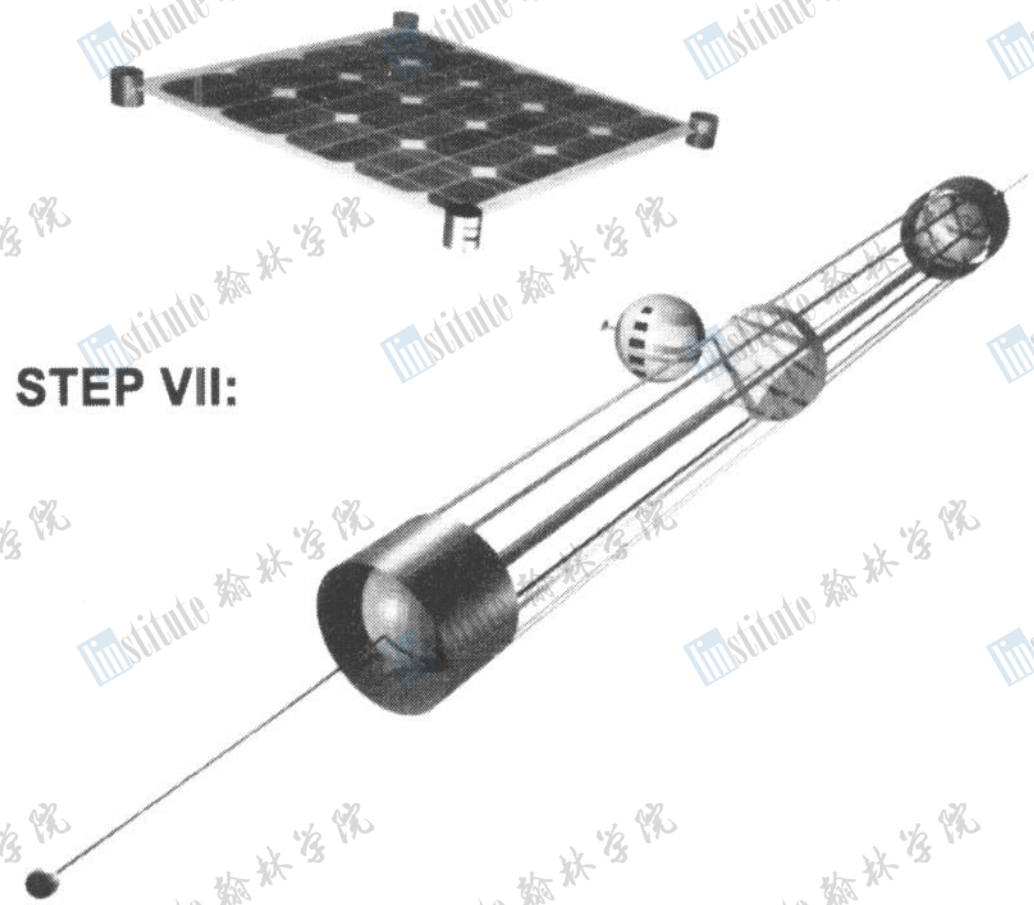


Step 7

Step 7 is to attach all these parts,

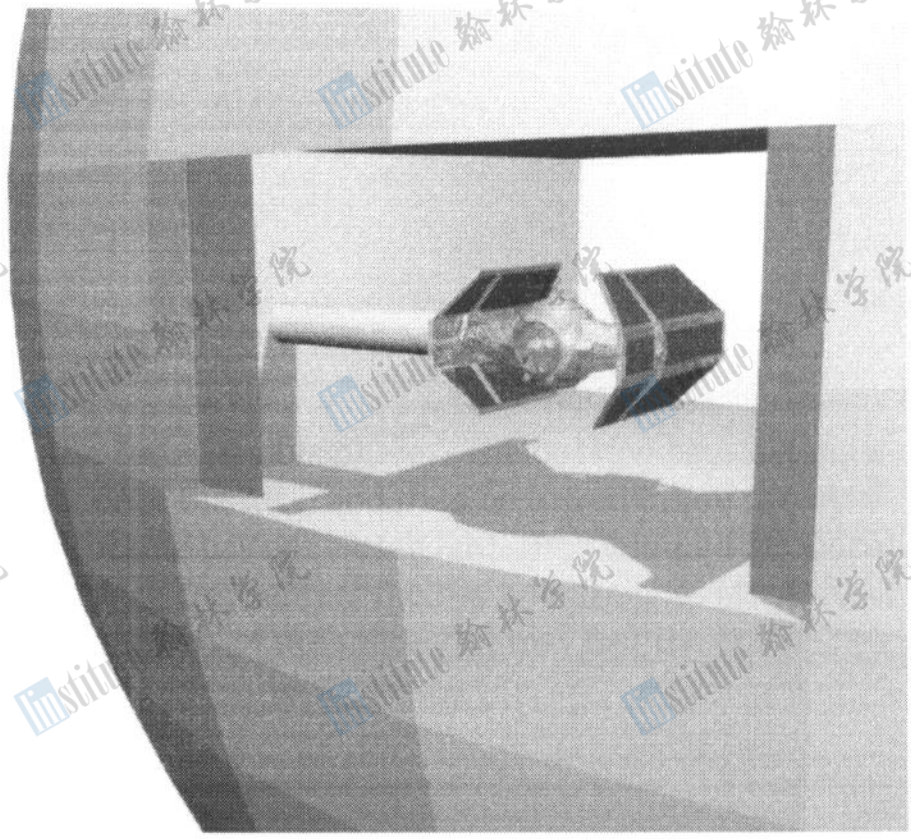
and begin to add the smaller parts, such

as interiors, the weight trim system, etc.



The docking bays of the Columbiat are located in the Zero Gravity Sphere. The docking bays extend a cable with a lock on the end. A spacecraft may lock onto this lock, and then be towed inside the zero gravity module. Once inside, the bay doors of the docking bay are closed, and air is pumped in. Once the docking bay is under full pressure, the maintenance crew enters the bay and attaches refueling and waste disposal hoses. During this time crew and passengers of the spacecraft may exit the craft.

The docking bay will look something like this:



Visitors to the station emerging from zero gravity may board a gravity elevator. This is essentially a giant elevator with enough supplies to last its passengers for weeks. It starts at the central node, and gradually descends to the habitat module over a period of 6 days. During this time, the gravity gradually increases, slowly accommodating the visitors to full gravity. The elevator is entirely self sufficient, but does have two smaller elevators, one on top and one on the bottom, which may detach and act as normal transport elevators, in case of emergency. The gravity elevator is located with the other elevators on various cables suspending the habitation sphere.

3.0 Operations and Infrastructure

3.1 Construction Material Sources

The main construction material required for the space station is maraging steel, which is composed of iron (67.3%), nickel (18%), cobalt (10%), molybdenum (4%), and titanium (0.7%). The iron and nickel (and possibly the other metals) can be retrieved by transporting a 1 km diameter M-type asteroid to the construction site via a swarm of ion thrusters with electromagnets. Other metals can be mined and sent from the Moon via a mass driver or from Earth. The creation of the steel will take place on Bellevistat. 1.5 billion kg of steel is required.

3.2 Community Infrastructure

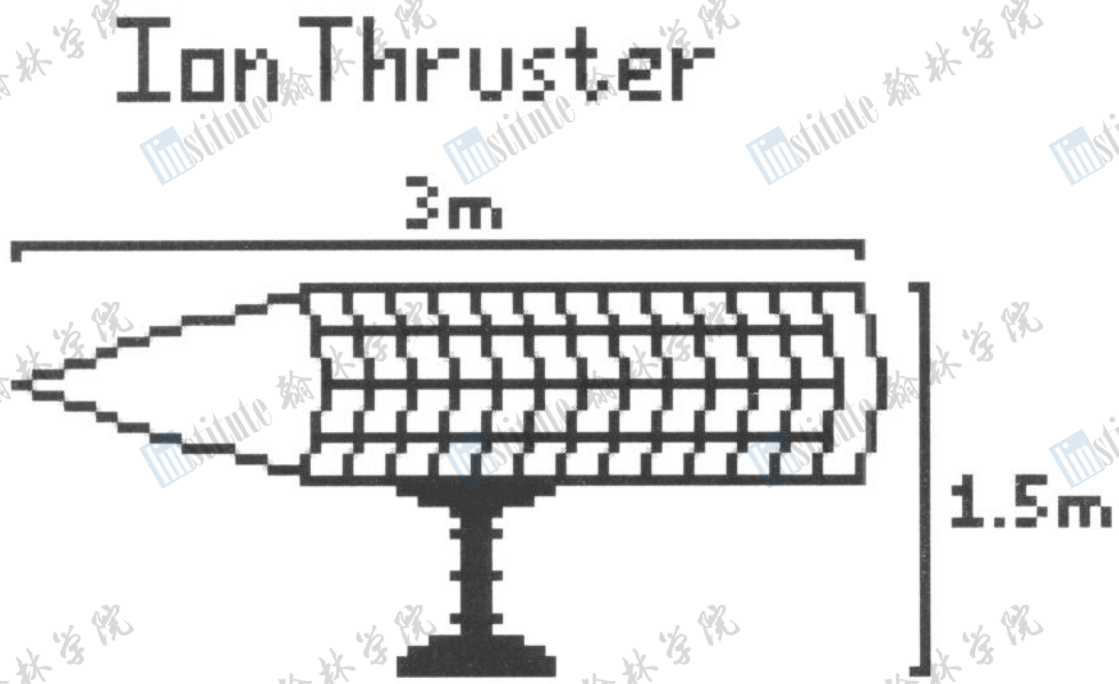
The composition and pressure of the atmosphere will be similar to Earth's: 78% nitrogen and 22% oxygen at 101.3 kilopascals. The total volume of air needed with be about 450 million m^3. The climate and ecosystem in the area designated for parks will mimic a temperate deciduous forest on Earth. Temperatures will vary between -7ºC and 27ºC and rainfall will be around 75-150 cm per year. Seasons will change in synchronization with the Temperate Zone of the Northern Hemisphere, with the rain turning to snow during winter, increased humidity in the summer, etc. Between the recycling and residential areas is the farming section, where the crops are grown and processed, and livestock is bred. All crops will be grown hydroponically, with nutrients in the water and artificial sunlight provided. The food will be stored in either the residential, commercial, and industrial area or in the cargo area of the nonrotating sphere. Most to all food processing, packaging, and delivering will be done using robots. Several large solar panels will exist alongside the space station, beaming the energy to the nonrotating sphere in the form of microwaves. The actual amount of kilowatts required will change as the number of residents and businesses increases. To solve this, the solar panels can be rotated to face the Sun more directly, or more solar panels can be built. When the station has reached full capacity about 1 million kWh need to be produced per day. There will be one large storage facility in each sphere, covering the bottom to block out radiation. The total amount of water required to fully protect the bottom surfaces

of the spheres and meet the usage needs of the space station is 15 million m^3. Just above the water supply, a recycling plant will handle anything from easily recycled materials, such as metal, glass, and plastic, to human waste, which can be turned into water, ash, and gases. All communications equipment will be located at the top of each sphere. Radio towers, antennae, dishes, etc. will be located on the outside, with the computer systems and servers running them on the inside. Internal WiFi internet modems and routers will be located at various nodes in the residential and business section, relaying back up to the communications terminal. Cellphone service will also be broadcast throughout the spheres. Main, predesigned utility hallway and shaft systems will exist for robots, elevators, trams, cargo, plumbing, and electrical wiring. After initial construction, residential and commercial hallways will be built and tap into these services for use by the adjoining homes and businesses. Spider-like vehicles will be used to navigate the yet undeveloped girder network to transport construction materials to desired locations. The two spheres will be on opposite time schedules, so one of them is always "awake". During the "day" hours, artificial lighting, complete with UV rays, will be supplied for the Earth-like "outdoors" sections (i.e. the parks). At "night", the overall temperature will be slightly lowered, and artificial lighting will darken. Inside the business and residential areas, the lighting and thermostat controls can be adjusted by the users.

3.3 Space Infrastructure

In orbit with the space station will be several large solar panels built specifically for use by this space station. Energy in the form of microwaves will be beamed back to the space station, and any ships nearby that need to recharge. The space station will have the appropriate equipment to act as its own satellite, and to communicate with other satellites, Moon bases, and Earth.

The space station will have swarms of small ion thrusters with a movable electromagnetic arm and solar panels. Specifically, they are magnetoplasmadynamic thrusters that use a hot lithium propellant. They will be able to attach to the outside of the station when necessary via the electromagnets and guide the station into its position and Earth-Moon L2 or start the station rotating. After use, they will be stored on the non-rotating sphere where the fuel will be stored until they are required again.

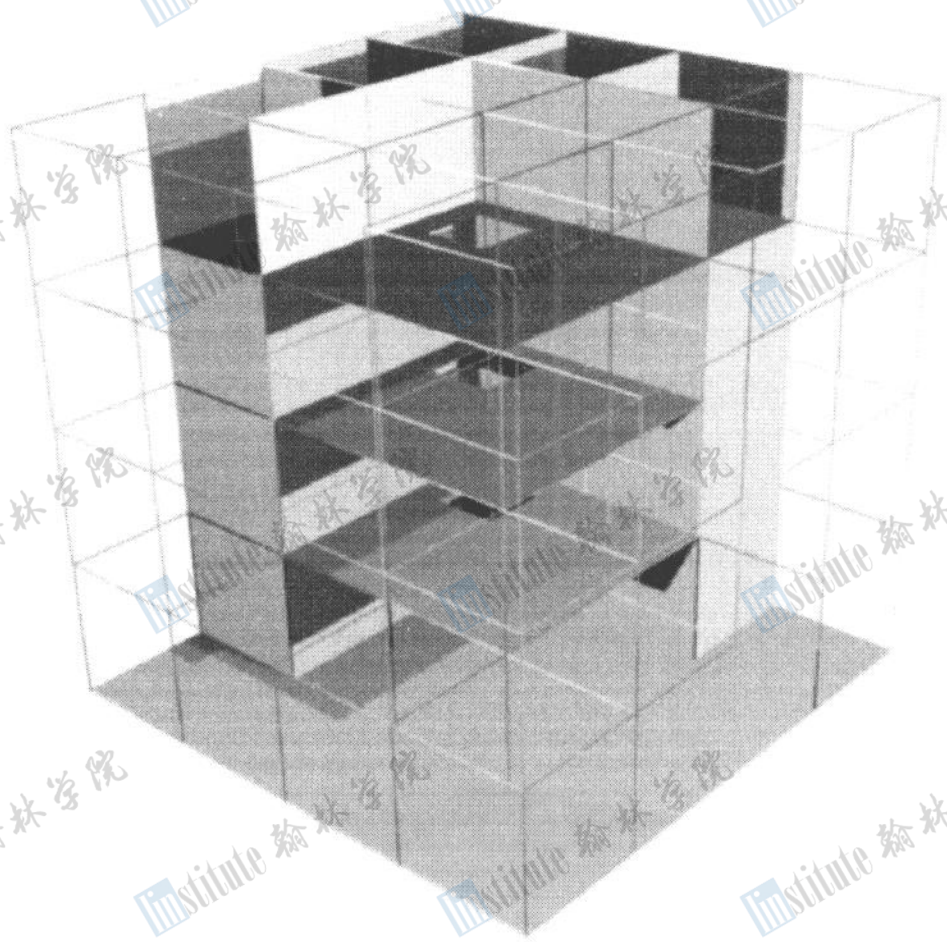


All interactions with visiting ship will take place on the nonrotating sphere. Food will be shipped over from the other sphere's agriculture sections via cargo elevators that connect to the central node and the third sphere. Most of the third sphere will be used as cargo storage, and the food will have already been shipped there prior to the ships' arrival. All fuel will be located here ready to be pumped onto the ships. Veterinary services will also be based here. Along with the cargo, extra water will be stored to replenish the ships' supply when necessary. Liquid and solid wastes will be transported to the other spheres' recycling areas to be processed. Also stored in the third sphere will be luxuries, furniture, supplies, etc. that may need to be restocked onto the visiting ships.

4. Human Factors

4.1 Community Design

the Columbiat is based around a three dimensional grid, in which structures are created via attaching the "wall pieces." The buildings will end up being arranged however the colonists decide is the best course. For example, a convenience store inside each large structure might work, or a central mall area where most or all of the convenience stores are located. The idea is that location of conveniences will operate the same as on earth, completely by supply and demand. We have designed an example structure, which might be the result of the colonist's experiments in community layout.



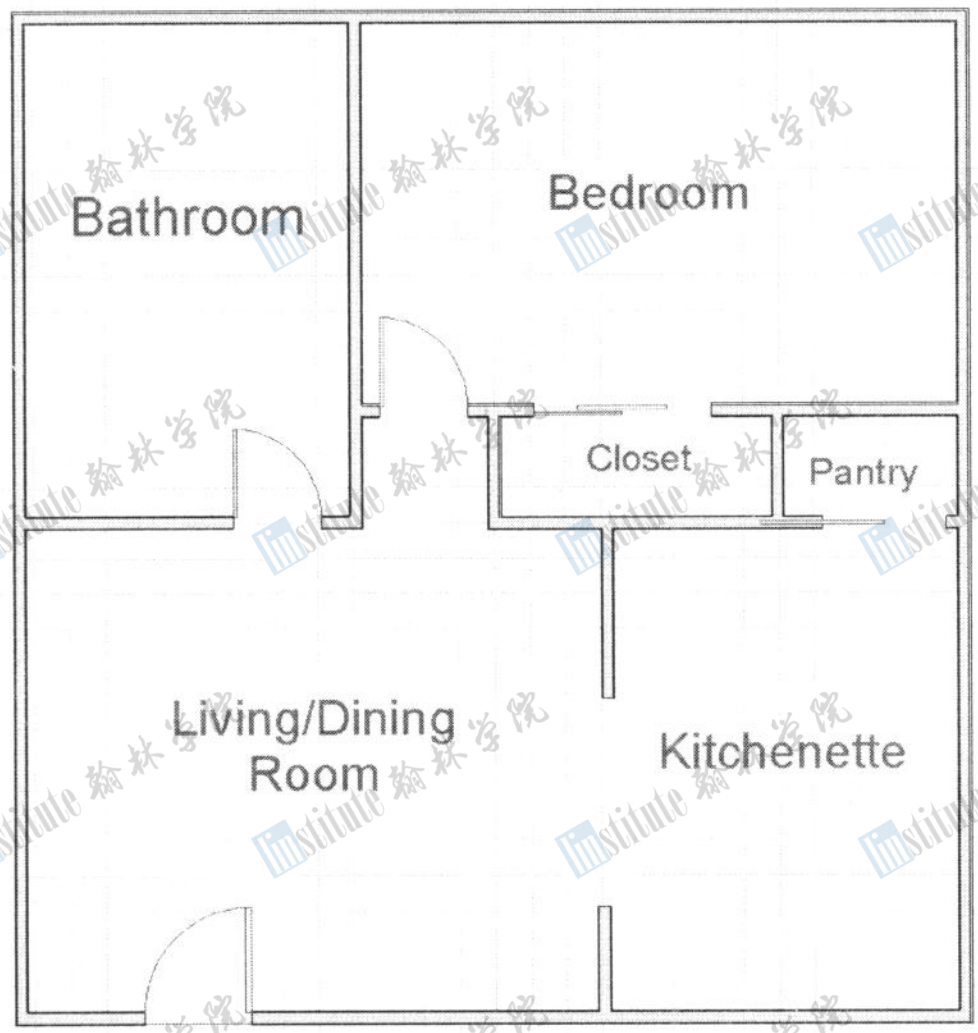
The building will be made up with single cube homes arranged around a central courtyard. Each level has its own courtyard, which acts as a central congregation area, as well as the location of the elevator for the building.

4.2 Residential Design

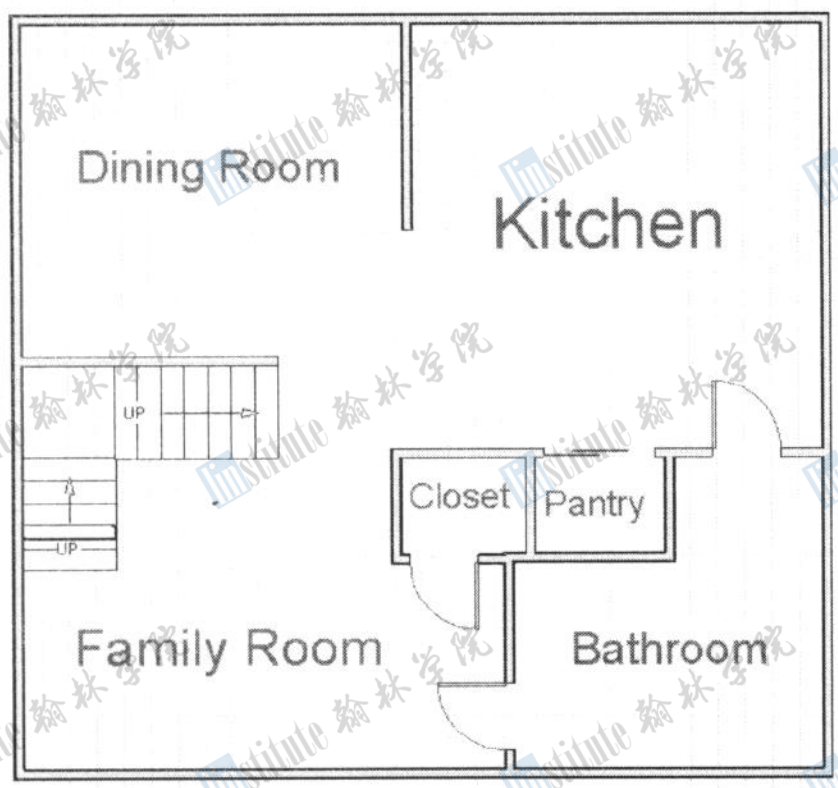
Housing on the columbiat will all be based around the cubicle format. All buildings are built inside these cubes, and subdivided into three levels. Each level is 10 meters by 10 meters, giving 100 square meters, or approximately 900 square feet. This allow for interchangeable pieces, but does limit aesthetic factors. Essentially the exterior of each house or apartment is a solid steal cube. The insides may differ widely, as the owners may customize the interior as they want. We are designing two apartments, one two level home, and one three level home. The apartments have room for two people, or a small family. The two level house is the standard 5 person house of the suburbs. Finally, the three level house is essentially a mansion.

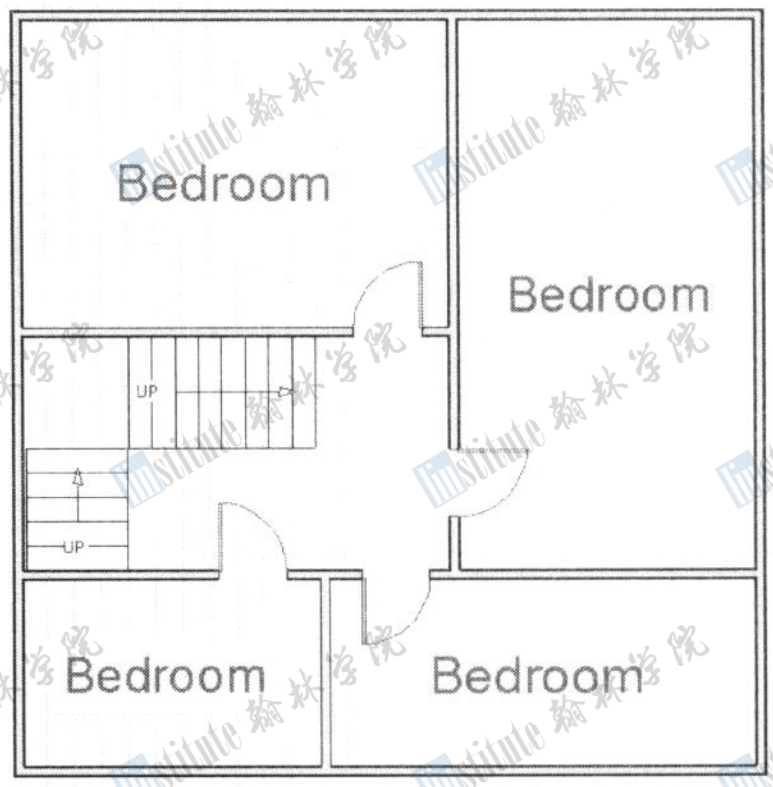
Apartment example. We will probably need around 10000 of these.

Another apartment layout example. We will probably need around 10000 of these.

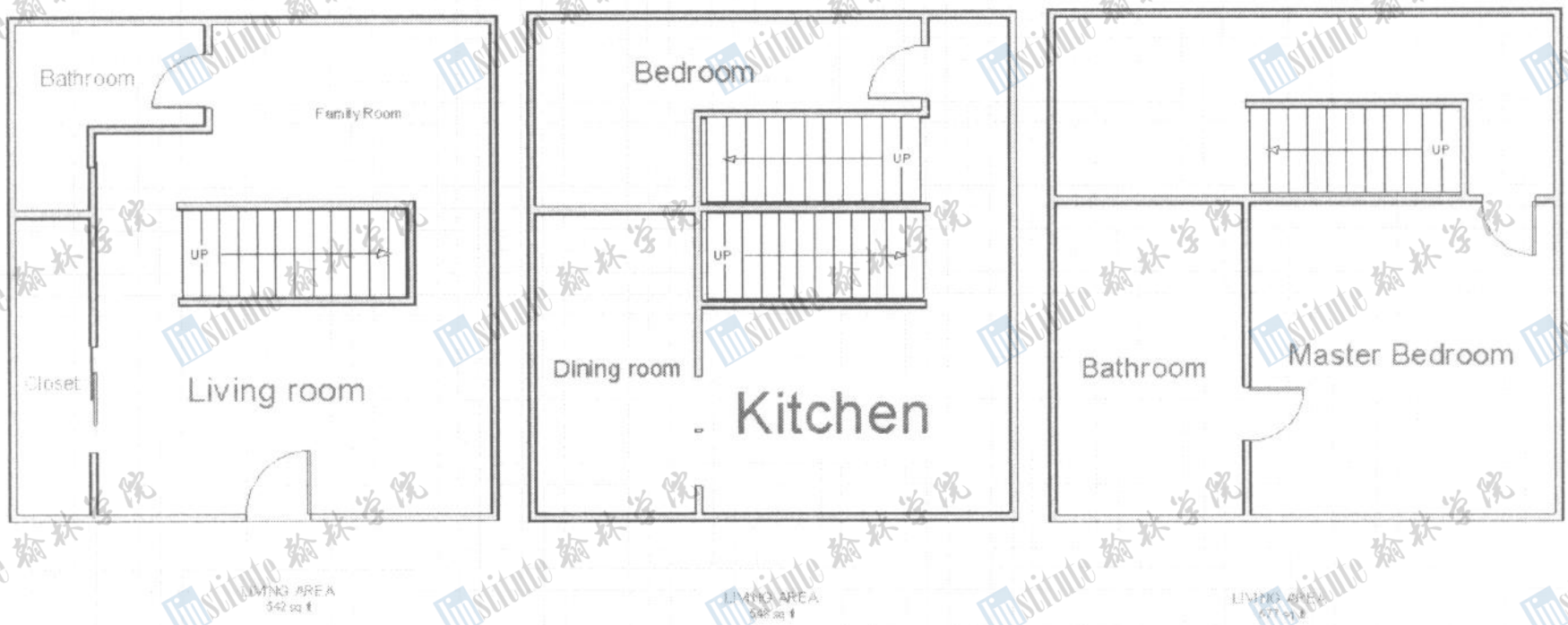


A two story layout example. We will probably need 7500 of these.



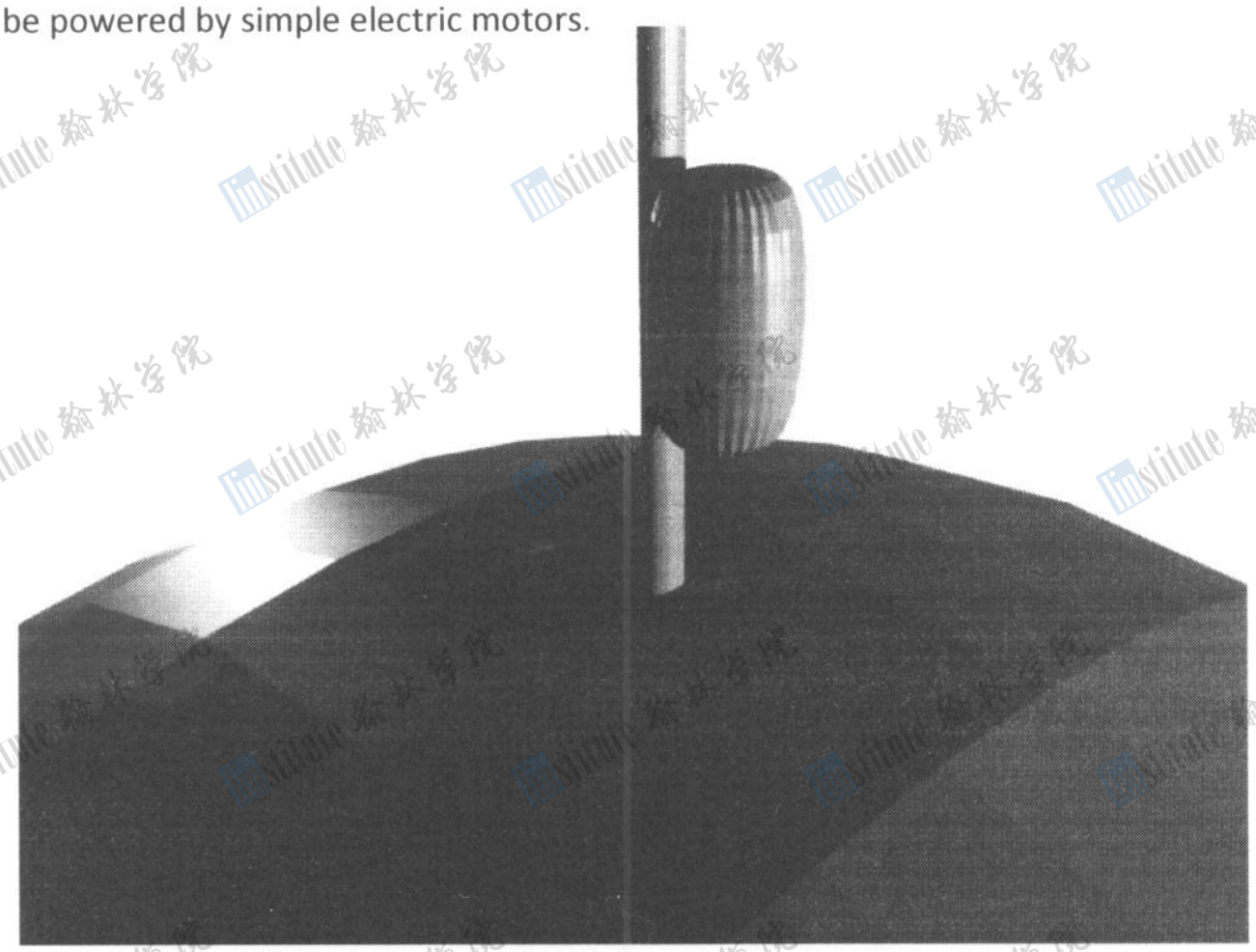


A three story example. We will probably need around 2500 of these houses.



4.3 Safe Access

The safety aspects in transportation is limited. The only automated transportation in the habitation sphere is the elevator. The elevator acts as a way for colonists to change levels. Most same level transportation is accomplished by bicycle. For cargo, slow electric transport will be used to move large masses, but will also us the elevators for transportation. Elevators will also be used to transport colonists between parts of the Columbiat. They will travel along the cables holding the Columbiat together, and be powered by simple electric motors.



An elevator transporting passengers from the Central Node to a habitation sphere might look like this.

Space suits will look very similar to current spacesuits. Airlocks also look similar, and will operate exactly the same as normal airlocks. Our space suits will be made with solid parts and joints, looking more like medieval armor, instead of the current fabric like material that is used. This will allow colonists of the Columbiat to have a shorter time to get ready for a space walk. Because the suit is solid, normal atmospheric pressure may be used, and the long wait while nitrogen is released from the blood will not be needed. This will allow surface response teams to quickly move from inside the habitat, to a space walk, without waiting 2 hours.

A sample space suit may look similar to this.

Security will be taken care of on the Columbiat. A quick response team will be present on each habitat module, and the zero gravity sphere. These people will act as the police force, fire fighters, and maintenance crew of the Columbiat. In the case of a fire, the area will be sealed off with quick seal able walls, and fire extinguishers. They will also act as crowd control and police force, they will be armed with tazers, but never guns. A gunshot in the Colmbiat would wreck havoc. They will also be in charge of the robot crew who maintain the radiation shield and sphere surface. In the case of a pressure failure, each cubicle will be mandated by law to contain emergency atmosphere containers. Finally, in the event of an unknown problem or total habitat failure, the whole population is to be evacuated to the zero gravity sphere until the problem is taken care of.

5.0 Automation Design and Services

Robotics will play a rather limited role in the Columbiat. We have attempted to keep the human factors in construction and maintenance as consistent as possible. This is under the theory that computers are out to get you, and will mess up if there is any possible way. So, in consequence, humans are at least in a supervising position in any task.

5.1 Automation of Construction Process

Construction will be mainly accomplished by a human crew, operating in space suits or spaceships with tool attachments. As such, our robots are mainly in the repetitive tasks such as manufacturing.

Purpose	Task
Mining	Crunches up the asteroid
Girder Manufacturing	Refines metal, extrudes in girder form
Surface Manufacturing	Refines metal, sprays it on surface

5.2 Facility Automation

Robots will also play as little part as possible, but certain, simple, repetitive tasks will be done by robots.

Purpose	Description
Agricutural processor	Harvests and plants hydroponic plants
Food Processor	Turns agricultural products into food
Service Checkers	Maintains and checks surface of spheres
Robotic Crane	Can move large weights throughout the Spheres

5.3 Habitability and Community Automation

Robots will be rather simple machines, only made to complete their tasks and nothing else. So they are rather simple affairs.

Surface Checking Robot

Food processing Robot

Cargo from spacecraft docked to the spacecraft will not actually be unloaded or loaded by robots. Because the docking bay is pressurized, workers may personally transfer the cargo. Because there is no gravity, large cranes will not be needed, as the largest weight can be moved by an attachment of a compressed air engine. Storage will be completely in the zero gravity sphere.

Type of Cargo	Storage Area
Rocket Fuel and Industrial cargo	Zero Gravity Sphere
Waste	Agricultural areas of habitation sphere
Water	Water storage area

Robot repair facility will be a mechanic working out of his garage. All repairs will be done by humans. Filter systems will be spread throughout the space station, to keep dust from contaminating the station.

6. Schedule and Cost

6.1 Schedule

May 7, 2044

Award contract

Begin construction of rockets for transportation

April, 2045

Launch Asteroid interception rockets

Begin manufacturing of carbon nanotube cables

August, 2045

Begin launching rockets with manufacturing facilities

Begin awarding contracts to space construction companies operating out of Bellivistat or Alexandriat

January, 2046

Begin shuttling M-type asteroid back to L2

Begin transportation of nanotube cables to LEO

May, 2046

Assemble industrial complex in L2 by Bellivistat or Alexandriat construction companies

Finish transporting nanotube cables to orbit, begin transportation to L2

November, 2046

M-type asteroid in place in L2

Begin manufacturing Columbiat goods in Bellivistat

May, 2047

Finish assembly of industrial complex

Begin manufacturing Comlubiat parts

November, 2047

Finish Girder manufacturing

Begin assembly of three dimensional grid

Begin manufacturing of surface paneling

April, 2048

Finish surface paneling manufacturing

Begin Interior surface paneling manufacture

Send comet interception rocket

November, 2048

Begin paneling spheres and central node

Begin construction of solar panels

Begin to transport atmospheric gases from earth

Febuary, 2049

Comet intercepted, begin towing back to L2

Finish paneling of spheres and central node

Begin radiation shield manufacture from slag

Begin to attach nanotube cables

August, 2049

Comet at L2

Begin refining water from comet

Finish attaching cables to Columbiat

Begin filling Columbiat with interior paneling, and atmospheric gases

December, 2049

Finish filling Columbiat with atmosphere

Launch final transport rockets with hydroponic equipment, antennas, motors, etc.

Begin filling Columbiat base with water

Attach radiation shields to Columbiat

May, 2050

Put finishing touches on Columbiat

Use rockets to begin spinning motion

Transport industrial complex to Bellivistat, sell it to them

August, 2050

Begin transporting colonists to Columbiat

August, 2051

Finish transporting colonists to their homes

Time from awarding of contract to completion: 7 years, 3 months

6.2 Cost

10000 rockets at $10 million each	$100 billion
Space Construction crew for entire operation	$5 billion
3000 kilometers of carbon nanotube cable	$4.5 billion
Ground control for entire operation	$1 billion
Computers, robotic equipment	$600 million
Zero Gravity Industrial Complex materials	$400 million
Hydroponic equipment	$200 million
Atmospheric containers	$150 million
Other employee costs	$100 million
Fallback	$5 billion
Total Cost	$116.95 billion

7. Business Development

Business will have an incredible amount of flexibility inside the Columbiat.

Transportation and Port Operations

All port functions will be accomplished in the zero gravity sphere. Docking stations will be large enough to accommodate the largest current craft, and be easily reconfigured to handle larger. As well, the spacecraft will have their cargo transferred completely within a pressurized atmosphere, allowing service personnel to work directly, instead of through robots, or requiring space suits.

Passenger traffic is also greatly eased when the passengers load and unload under a pressurized atmosphere. Passengers will not be required to proceed through airlocks, and may proceed directly through to the central node and habitation spheres. The Columbiat is also designed to handle up to 8000 visitors, easily compensating for any mars or asteroid mission.

The Columbiat may be attached as the base of a lunar elevator relatively easily. The rotation of the habitat facilities is on an axis. One side of the axis is taken up by the zero gravity sphere, but the other side of the axis would be a perfect attachment point for a cable stretching to the lunar surface.

The desires of traveler's for activities on the Columbiat will be fulfilled. One of the great points of our design for the Columbiat is that it has plenty of room, and it is also perfectly set up for a capitalistic environment. The cubicles inside the main grid of the habitat spheres may be bought to create amusement parks by prospecting companies, and land in the park area, while more expensive, will be a great place for a restraint with a view of the stars

Medical facilities will be adequate on the Columbiat. Cubicles in both the habitat and zero gravity spheres will be set aside for hospitals, and quarantine areas in the zero gravity section will be completely sealed and have their own air recycling system.

Commerce and Finances

All office may be contained within the two habitation spheres. Large offices such as the 150 man office may be contained within six cubes easily, with a total of 1800 square meters, or 16200 square feet of floor space. Similarly, smaller offices may have fewer cubicles to accomplish their needs.

Banks may do the same as the offices, but they might want to indulge in some land in the park, to give an aesthetic storefront. But otherwise, banks work in the same way that offices do.

A Foundation center on one of the habitat spheres will have a large front in the park area, as well as a large cubicle area directly under it. The Foundation will be given a good 400 square meters of land in the park area, as well as ten cubicles directly underneath, which should facilitate any of their needs.

Each company or individual may own their own computer, and link to the internet by landlines built into the Columbiat. Private communication may also be obtained by companies by stringing their own wire to the Communications Terminal. The Communications and Transportation Terminal, located at the top of each sphere, will serve as the hub of electronic traffic. Information sent across landlines will be sent here, and then if be needed to the central rotational node, where it will be either beamed to a satellite or other space based communications center, or sent to another company. The computer and phone service on the Columbiat will act essentially like that of a city on earth, but with a central processing center.

Provisioning and Maintenance for Spacecraft

Fuel is stored in the zero gravity sphere adjacent to individual docking bays. Each docking bay will have an outlet for each fuel type, with hoses to attach to the spacecraft.

The spacecraft will be under full atmospheric pressure inside the docking bay of the Columbiat. This allows maintenance personnel to work hands on with the spacecraft. This eliminates the need for space suits of robotic maintenance crews. The crews may use relatively simple tools, such as hydraulic arms, cutting blades, and drills.

The large agricultural areas contained inside of the Columbiat will allow for large granaries of excess food. As well, food processing facilities are rather simple affairs, and may process extra food. Both agricultural and food processing sections have been purposely designed to be able to service a community larger than the one contained onboard the Columbiat.

8. Compliance matrix