OUTER SPACE SETTLEMENT DESIGN

By

Debayan Paul

DECLERATION-

I hereby declare that this research thesis is my own original work, that all reference sources have been accurately acknowledged and that this document has not previously in its entirety or in part been submitted to any Institute in order to obtain an academic qualification.

WE SALUTE OUR NATIONAL FLAG

1.Introduction-

A space settlement can be defined as a vast area located outside earth that is fit for human habitation. It is considered to be one of the most challenging tasks ever undertaken by mankind and if achieved successfully, it will definitely without doubt be crowned as the biggest achievement of the century.

1.1 Bharata-The space settlement

Name of the settlement-bharata

Shape of the settlement-Toroidal

The settlement has a central core (hub) for microgravity work. It also consists of multi-leveled interior habitation areas .It is like concentric circles (layout diagram provided).this settlement is made for 20-30 thousand people. (At least).Large amounts of large soil are to be used. For construction ideal material is lunar bricks.

1.2 Why bharata?

Bharata will provide a safe, entertaining and an ideal environment for the inhabitants. Today every human being wants a thrill in his or her life that will make it worth living. They want to cross all boundaries. And we hope that bharata will make this possible. However this change in the mindset of people has an adverse effect. we have stopped appreciating what we have around us and when we say this the first thing that comes to mind is the earth. people dream of building outer space settlement. but few are able to realize that even if they succeed in doing this mammoth task it will all be because of our mother earth.It will make use of the of the magnetic field of the earth for protection from harmful radiation, solar storms and so on. We will provide an environment quite similar to earth and will ensure the sustenance of life as a permanent space settlement.

1.3 Objectives of bharata

1.)Bharata will provide an ideal environment for living in space by using the salient features of our mother earth and also the various technological developments available to us.

2.)It will provide the inhabitants with the thrill of living in space and gazing into its dimensions which they only dreamed of doing while reading stephen hawking's books regarding the universe.

3.)We will try to capture at least some of the vastness of the universe as to give the people an idea of what an outstanding legacy we are a part of today.

4.)We hope that bharata will serve as the purest manifestation of human curiosities regarding space colonialisation.

2.Construction-

The settlement must be strong but not of enormous weight and mass. So strong resistant metals is chosen. They are titanium, aluminum, iron and steel. Titanium and aluminum can be obtained from moon. To get enough iron and titanium, ilmenite can be decomposed. To build different structures in the settlement, lunar bricks can be used. As solar power is the main energy source of our settlement we cannot afford to make the some of th buildings too long as it will block the direct sunlight to be received.

For the outer surface, semi monocoque shell (0.1m thick) and titanium cross section ribs are used. Methods called solid freeform fabrication (sff) and vapour molecular deposition are used too.

Direct sunlight will not be entering Bharata.For this purpose mirrors placed an angle of inclination 45 degrees will be used

3.Structural unit

3.1 Bharata's Structure-

Refer to figure 1

3.2 Construction of Solar Shield and the Control unit

3.2.1 Phase 1-

i. The first step will be to construct the solar shield. Both the parts of the

Shield will be constructed (the opaque part and the translucent part). The solar shield is being constructed in the beginning, because robots need protection from solar phenomena such as solar radiation and solar flares. But the robots building the solar shield will be protected

ii. After the above step, the exterior of the control units will be constructed.

iii. Now, the interior of the Control units will be furnished and pressurized. After this

step, the control units will be capable of performing its routine tasks.

3.2.2 Phase 2-

i. In the first step of the 2nd phase, the exterior of the MIC will be constructed. This has been done to provide manufacturing areas of over 100,000 Square feet, with over 60 foot ceiling.

ii. In the next step of this phase, the interior will be furnished and then pressurized. First of all, the energy storage areas will be installed, so that energy can be supplied without any interruption. Water requirements will be satisfied through imports from Earth and from the poles of Bharata. The Air management unit will also be fully functional after this step. Also the electronics industry will be set up, which will supply robots required for the construction process. But, the rest of the industries, will not be installed now. At this moment, construction of the rest of bharata will be done.

3.2.3 Phase 3 -

i. Now, all the connectors of the entire satellite will be completed. This has been done to provide a preliminary skeleton of bharata, which will facilitate in easy manufacturing. But they won't be pressurized.

ii. After the connectors has been constructed, the exterior of the SIC will be constructed (excluding the domes). Since the domes won't be constructed, the SIC won't be pressurized.

Until this phase, we have seen that the Docking ports haven't been completed.Thus spacecrafts won't have a place to dock. But they can still supply goods or robots or personnel, through their airlocks.

3.2.4 Phase 4 - Construction of the port and the domes

i. In the first step of this phase, the docking areas will be constructed, its interiors furnished, and it will be pressurized. This will open all the import and export lines. Thus personnel,

goods, machinery, robots, etc can be supplied to Bharata for further development.ii. Then, the domes will be constructed. And then the interiors of the SIC will be furnished. After this step, the SIC will be completely operational. Thus further manufacturing can take place at a faster rate .

3.2.5. Phase 5 - Construction of Bharata

i. In the first step of this phase, the exterior all the Arkhomers will be constructed. This also includes the 1 g accommodation for children.

ii. Then, the interiors of all the bharatians will be furnished and pressurized. And thus, the agricultural, waste management, and the water management sectors will be functional after this phase.

3.3 LIGHT-The source of life

3.3.1 Photovoltaic system architecture

The new system architecture is based on a ‘‘parallel’’ or lateral optical concentrating system, which splits the incident solar spectrum into several bands, and allows different optical and photovoltaic elements in each band. The optics and the cells are co-designed to achieve the maximum conversion efficiency of the module. The new architecture integrates optical and solar cell design, allowing a much broader choice of materials, and circumventing many existing cost drivers. This architecture enables the inclusion of multiple other innovations and leads to higher efficiency, both at solar cells and module level. The optical system consists of a tiled non-imaging concentrating system, coupled with a spectral splitter that divides the solar spectrum into a given number of bands. Photovoltaic architecture The lateral solar cell architecture increases the choice of materials for multiple junction solar cells, by allowing the solar cell in each spectral band to be optimized independently of the others. In this way, the lattice and current matching constraints are reduced. Further, since the devices do not need to be series connected, spectral mismatch losses are reduced, important for tandems in terrestrial environments. Finally, by contacting the individual solar cells with individual voltage busses, the need for tunnel junctions is avoided. Since each material requires unique tunnel contact metallurgy, eliminating tunnel junctions is a substantial simplification. An additional benefit of this architecture is the opportunity to use different solar cell

areas within the system which leads to different levels of concentration of the sunlight (the aperture collecting the sunlight divided by the solar cell active area).

3.3.2 Lateral optical system-

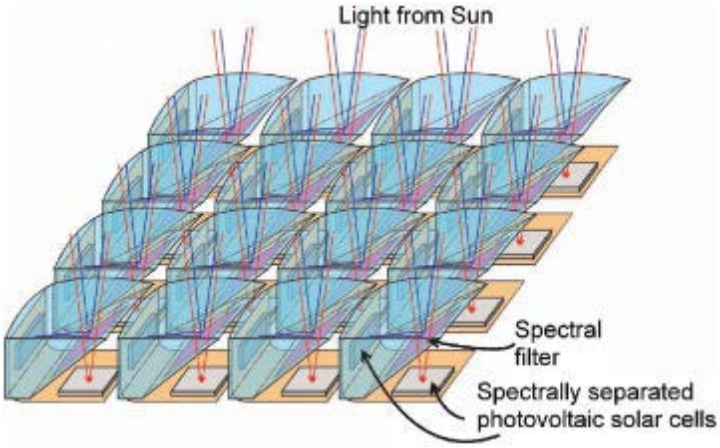
To achieve the benefits of the new PV system architecture, a new optical element is designed, which combines a non-imaging optical concentrator (which does not require tracking and is called a static concentrator) with spectral splitting .that split the light into several spectral bands. This system is called a parallel or lateral concentrator, since solar cells are not placed vertically or optically in series.

These optical elements are tiled, with the overall optical module being an affordable and manufacturable optical element, which incorporates both static

Concentration and a dichroic element for spectral splitting is shown in a picture. The unique features of the optical system are an emphasis on high system optical efficiency, the use of dichroic mirrors for spectral splitting, and the design of

the system to be thin enough to allow integration with other products. For example, previous approaches of static concentrators have not been practical because the thickness of the optical elements is too large for conventional modules. Further, previous optical systems, particularly spectral splitters, have suffered from reduced optical efficiencies. The use of an integrated system and small area dichroic mirrors allows both the efficiency and cost issues to be overcome. The optical system does not require tracking and has no moving parts. The critical metric for the module development is module efficiency. Module efficiency consists of two terms: (1) optical efficiency which is the amount of sunlight that is directed to the solar cells —weighted by the energy in each band of sunlight and (2) the sum of the power from each solar cell .

This system will split the lights into different colors and thwe colors that we do not want i.e those that are harmful will be deflected the other way with the help of mirrors. Also two large mirrors placed at angles of 45 degrees at the top and the bottom of the settlement will reflect the clean and harmless rays of lighjt into the settlement giving the inhabitants an absolutely Earth-like experience



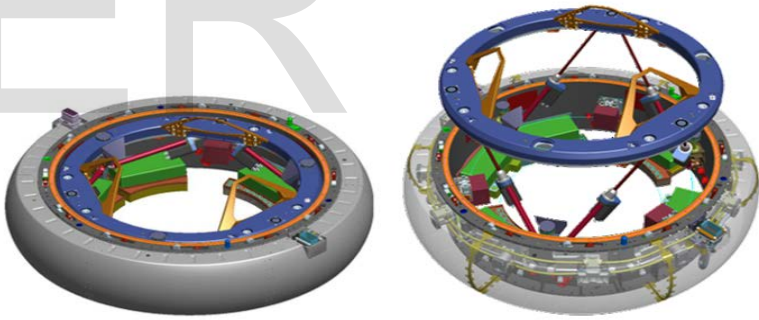
3.4 Docking System-

In the center of the colony, where the two elevator shafts meet, off to one side, there was a docking port for accepting incoming IPVs on resupply missions from Earth. At this stage, bharata was not yet self-sustaining, so these resupply missions were necessary to its continued operation. The docking port could only accept one rocket at a time, and used a modified version of the International Docking System Standard. This version slowly brought whatever craft docked with bharata to the same rotational velocity as bharata. From the actual docking mechanism, the chamber expanded until it reached a radius of 25 m. This served as a "lobby" of sorts for the colony. On the side of this lobby, there was a large door and an airlock for accepting large cargo loads. From the lobby area, people could board the elevators to the habitat modules.

3.3.3 Artificial Light-

Plasma bulbs and Fresnel lamps will be used for artificial lighting purposes. TOLEDs will be covering most of the area of the upper wall of the settlement, i.e, and the floor below the water storage. Since they are transparent, they may allow natural sunlight and also emit their own light when required. SOLEDs will be covering a minor area.

SOLEDs to diffuse the red and blue light, thus creating natural looking environments. Our effort to accommodate residents and maintain psychological wellbeing is helped by Holographic films which create images of sun, clouds and the night s



International Docking System Standard Photo credit: Wikimedia

4. Gravity-

,When the settlement accelerates, its motion is checked by inertia. It happens when it takes a curve. When it tends to continue its motion; a force will pull it from the center. This inertial force is known as centrifugal force, which always points in a direction opposite to the center of the curve.

Therefore Fc=mv^2/r

Here fc= centrifugal force, m=mass of the object

V =angular speed of object and r=radius of the settlement

The acceleration generated by this force will be equal to the force divided by the mass of the object.

So, acceleration= mv^2.r/m

Thus acceleration is generated radially. In this way gravity (artificial) can be obtained.

But in residential areas normal gravity will be present. However it will be balanced by centripetal force. When maintained at a constant angular velocity of ~1.07rpm anticlockwise, the rotation of the station will create a centrifugal force of 0.9g-1g in the residential area of the outer torus. The rationale for selecting the gravitational force of 9.81ms^{-2} for residential and commercial zones is a result of the numerous detrimental effects that both low and high gravity have on the human body.

The settlement's agricultural modules will be maintained at a gravity of between 0.3-0.4g. This lower gravity environment will not affect the crops or poultry as the majority of the colony's food supply will come from aeroponics, aquaponics and in-vitro meat.

4.1 How to generate 1g-

As for the generation of pseudogravity it will be done by the proper balance between the two forces-centrifugal force and centripetal force which both have the same formula-

$FC=mv^2/r$ …….(i)

F=ma ……..(ii)

Equating (i) and (ii) we get,

$mv^2/r=ma$

$=a=v^2/r$

$=a=(2\pi r/t)^2/r$

$=a=(2\pi r/t)^2 .1/r$

$=a=(4\pi^2 r/t^2)$

Substituting the above equation with suitable values,

a=4.3.14.3.14.900/60.60 m/s^2

a=9.85 m/s^2

5. Location of Bharata-

The settlement will be built at a distance from the earth on the l5 lagrangian point i.e. the earth moon orbit. This will once again keep the earth the centre of attention. Bharata will be an earth orbiting settlement and will be built on the moon's orbit. This will be the most stable according to the analysis given below.

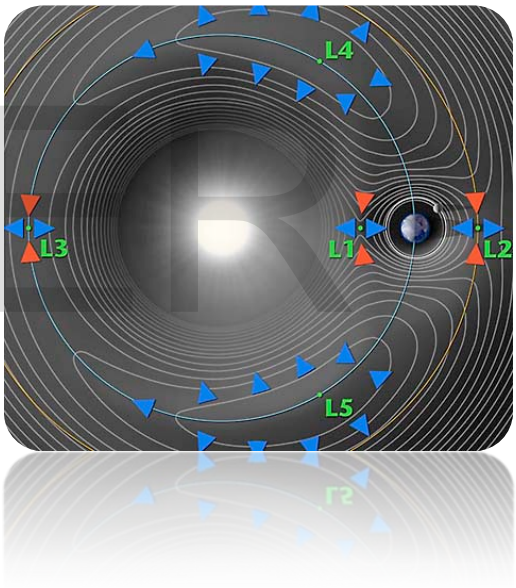


Image credit-wmap observatory,nasa.

There are in all 5 Lagrange or liberation points.

Of these l4 and l5 are the most stable.

If we consider any body that is at rest in either if these liberation points then the forces acting on the body can be derived by the effective potential.now we want our settlement to be as stable as possible so that it is stationary at a liberation point without much movement. The more the strength of the force the more unstable our settlement. Through the image we can see that the force is much weak

when the contours of effective potential are spread out and the forces are stronger when the contours are close together. so we see that in each of the liberation points 1,2 and 3 the effective potential is building up in one direction and is coming out the other thus subjecting our settlement to a very strong force thatcan cause it to wobble out of the liberation points. we see that in case of liberation points 4 and 5 the contours of effective potential are spread across far more thus making the force much weaker and ensuring the stability of our settlement. Of l4 and l5 we believe that l4 is the better position for placing our space settlement.

5.1 Why l4 and not l5?

Both l4 and l5 points are equilibra points.

However we feel that l4 is much better suited for Bharata's positioning.

This is because firstly l5 has an abundance of asteroids known as Trojan asteroids. Till date about 1631 of them have been discovered. Hence we have come to the conclusion tat l5 is not the better position for a space settlement.

L4 is much better suited for Bharata's positioning because it is located at approximately close distances between Earth and Moon.We need quick access to the moon for lunar mining as lunar soil is one of the kost important components of our outer space settlement.

5.2 Velocity needed to achieve orbit-

According to Newton's second law the force acting on the body is proportional to the mass and the acceleration of the body.

F=ma

If we take the force to be weight and the acceleration to be gravity,then from Newton's second law we can derive

Gravity=weight/mass

We want our orbit to remain static and for that to happen the centrifugal force of the settlement must be equal to the gravitational attraction of the Earth.

$FC=mv^2/(R+r)$

$=mw/(R+r)$

Here R is the radius of the earth's orbit and r is thr radius of the radius of the settlement's orbit.

To sum it all up,(R+r)is the distance from the centre of the earth to the centre of the settlement.

Using Newton's law of gravitation,$weight=G.m.M/(R+r)^2$

Equating FC with weight,

$mv^2/(R+r)=G.m.Me/(R+r)$

$=mv^2=G.m.Me/(R+r)$

$=v^2=G.Me/R+r$

$=v=\sqrt{G.ME/R+r}$

6. Rotation-

Thrusters are attached at the center of the settlement where several motors will work together to to apply a torque to the settlement while the angular momentum of the central hub will also play a vital role in rotation. It will act in the same direction following right hand rule and will play one of the most important roles in the rotation of the space settlement.The settlement will be rotating at a spped of 1.25 rpm which is suitable for space habitation.It will rotate at an axis similar to that of Earth.In order to ensure proper and stable rotation we need to make sure that the axis of the settlement is perpendicular to the axis of angular inertia.Otherwise the settlement will wobble between the two axes and will creatre a huge amount of discomfort the inhabitants.

6.1 Day night Cycle-

Time of Day	Duration	Light Intensity
Night	8 Hours	5 – 10%
Sunrise	4 Hours	10% - 50%
Mid-Day	4 Hours	50% - 100%
Afternoon	4 Hours	100% - 65%
Sunset and Evening	4 Hours	65% - 10%

6.2 Thrusters-

Bharata will use helicon double layer thrusters that will play a vital role in the settlement's rotation.

This is a type of thruster that makes of plasma which is a fundamental state of matter. It ejects ionized gases moving at extremely high velocities in order to provide thrust needed for motion. There is a tube like structure consisting of an antenna. Gases enter the tube and the antenna produces electromagnetic waves which ionize the gases and turn them into plasma. Then the plasma is further heated and then ejected at very high speeds.

6.2.1 Reasons for using HDLT thrusters-

- It is extremely safe for an outer space colony.
- Does not need any continuous fuel source just gases.
- It is the best amongst other ion thrusters because it can create a strong electric field without using dangerous components.
- It emits an equal number of protons and electrons.

7. Atmospheric conditions-

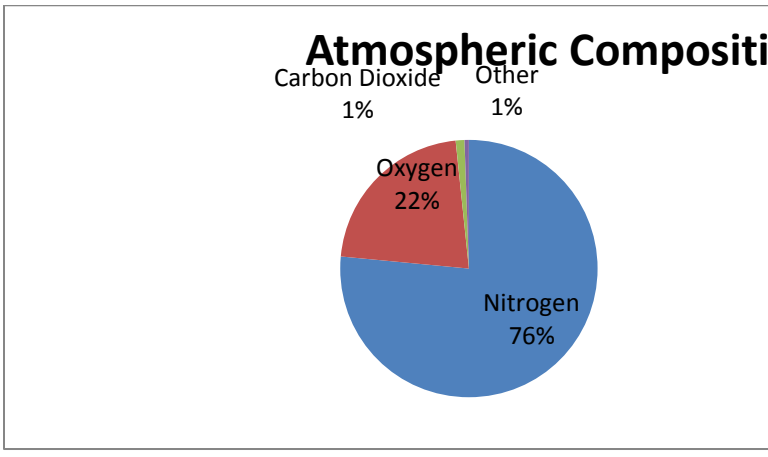
A clean, pollution and dust free and oxygen rich atmosphere shall be provided for maintaining hygienic and healthy living. Automated air purification systems shall be installed in the walls of the hull components that are to be pressurized working constantly to purify air. Domestic robots shall also be equipped with small air purification systems for small scale purification.

For maintaining life processes adequately, the humans need an atmosphere of acceptable composition and pressure. The settlement will have a partial pressure of oxygen as it is necessary for human respiration.

The (po2) can be around 23/-10kpa or 250mmhg.the level of co2

Should be around 0.04kpa (3mmhg). For photosynthesis co2 levels have to be increased but it will not be taking place in residential areas. Relative humidity can be of 40-45% and temperatures around 20-25 degrees celsius.the partial pressure of water vapour (ph2o) can be 2kpa or (15mmhg). The presence of nitrogen is very important.for that reason nitrogen-fixing bacteria can be used.They will release nitrogen gas into the atmosphere. Nitrogen fixing plants in the colony's life suuport system wiil be helpful as there can be a conversion of nitrogen gas into proteins.So it would be better if the nitrogen level is 28kpa or (210mmhg).

Atmospheric Composition-



Keeping the atmosphere in place-

RMS(Root Mean Square)velocity is the speed of particles of a gas.

Escape velocity on the other hand is the minimum velocity a body must attain to escape the gravitational field of a planet, moon, etc.

So, in order to keep our atmosphere in place, the escape velocity of our settlement must be as high as possible. Hence we need to reduce the rms velocity and increase the escape velocity.

Vrms = √3rt÷ m where r is the molar mass constant, m is the molar mass and t is the temperature in Kelvin. In order to decrease the VRMS we need to decrease the temperature because R & M will be constant. Reducing the temperature of a gas will reduce its kinetic energy. When a body is moving away from the center its kinetic energy is converted into gravitational potential energy. According to the law of conservation of energy , energy is conserved and is never lost. The total energy of a body remains constant.

Kinetic energy + gravitational potential energy = total energy (constant)

½ mv^2 + gmm ÷ r = total energy . if we are decreasing its kinetic energy the gravitational potential energy is bound to increase.

√ 3rt / m can also be written as √ 2 E / m. How?

Kinetic energy of 1 molecule is = ½ mv^2

Kinetic energy of n molecule is = ½ nmv^2

K = ½ nmv^2

V^2= 2 k/m

V = √ 2k/m

Where k is the kinetic energy and m is the mass, hence kinetic energy is reduced resulting in the reduction of VRMS.

Escape Velocity = √ 2 gm / r where g is the gravitational constant, m is the mass and r is the radius. Since the gravitational potential energy the escape velocity will also increase. This is because the potential energy will try to act downwards and the more the energy the more is the downward pull that is active on the body and in order to overcome that the body will need to have a higher escape velocity.

The amount of kinetic energy lost will be = to the amount of potential energy gained. So if we reduced the temperature by X Kelvin VRMS is reduced by 2 X as they are proportional. And we are decreasing kinetic energy by Y the potential energy will increase by Y. Also in case of escape velocity if the mass is constant and the radius is reduced in will increase considerably.

Average temperature-

- Summer-25 degrees
- Winter- 17 degrees
- Autumn-19 degrees
- Spring-22 degrees

8. Protection or radiation shelter-

Since outer space is abundant in harmful radiation; the settlement needs shielding. After the actual surface of the settlement, a thick layer of atmosphere consisting of light molecules like hydrogen and helium can be created which will take out the high energy particles. The most effective radiation shielding can be done with the help of water(in the vaporized state).However all of this alone may not suffice.

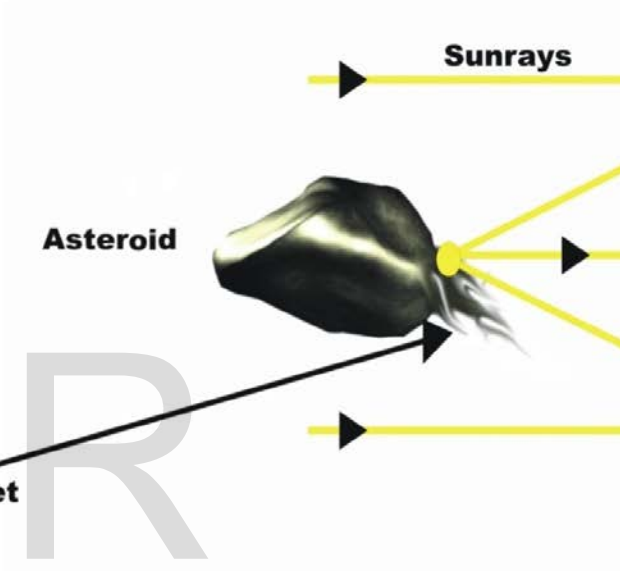
Secondly, lunar soil can be deposited on the certain layers of the settlement.

When Bharata's designers begin to tackle the space radiation problem they will have one saving grace, the designers can implement a passive radiation shielding system. Every habitable module of bharata is coated in a layer of rxf1, a plastic derived from Polyethylene. Metals such as

aluminum will not used because they actually give off secondary radiation when hit with charged particles, much like how a bullet hitting a concrete wall creates deadly fragments of masonry. Rxf1 also absorbs 50% more cosmic radiation and 15% more cosmic rays than aluminum. It is also 2.6 times lighter and 3 times as strong, allowing it to be used as a micrometeoroid shield as well. The rxf1 will be manufactured on Earth and sent to bharata in the form of tiles 10 cm thick. They will be attached to the exterior of bharata external surface using an adhesive. Micrometeorite impacts often caused an individual tile to break, so crewmembers performed frequent EVAs to replace them. Experiments will be conducted to manufacture an rxf1 substitute using local resources. Since at this point, bharata is a transient mining camp and research base, each crewmember was allotted a liberal dose of 50 rem annually, or about the same guidelines for NASA astronauts. For most solar events, the rxf1 shielding proved more than adequate, but there was always the threat of an abnormally large solar storm. The sun operates on 11-year cycles with solar flare intensity steadily increasing towards a solar maximum. If a large flare went off during such a maximum, the radiation would overwhelm the rxf1 shielding and harm bharata's inhabitants. For such a worst-case scenario, the plan is to maneuver bharata so that it's fusion reactor and helium-3 storage area pointed towards the Sun. The inhabitants would then take shelter in the laboratory and docking module behind these areas and would be protected by the bulk of nearly 200 meters of and fusion reactor. In case radiation levels threatened to become really bad, there was a plan to use the Hopper spacecraft docked at bharata to evacuate the inhabitants to Titan where the moon's thick atmosphere would shield them. All plans depended upon adequate warning before the solar event. Warning was provided by a network of satellites locating in the inner solar system.

Parabolic Reflectors-

Today technology has touched great lengths and we would like to make the inhabitants of Bharata feel this in every possible way. As for protection from asteroids there is a missile system as mentioned above. However we want to take as much precaution as possible. And for that there will be parabolic reflectors which will be positioned at strategic points around Bharata and the space hotel. These will consist of mirror like structures positioned in a way such that the sunrays hit them and are reflected in such a way that they all concentrate at the same point or have the same focus. This is quite similar to the way a paper burns when a magnifying glass is placed before it. The asteroid will heat up at a particular point and will then melt thus creating a cavity. This cavity will contain mostly air and it will deflect the asteroid's path of motion away from the settlement.



Aeroponics-

11.2 Hydroponics-

IMAGE CREDIT-agrosysindia.com

The main purpose of this process is to grow plants without the help of soil as in aeroponics.The roots are either dipped in the solution of nutrients or grown in a nonreactive medium like stones, etc.

The main purpose of this process is to grow plants without the help of soil as in aeroponics.The roots are either dipped in the solution of nutrients or grown in a nonreactive medium like stones,etc.

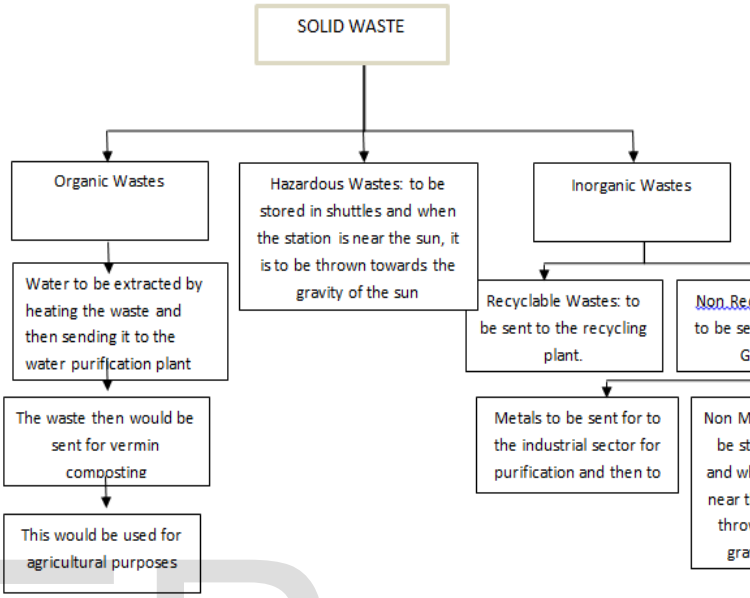
.

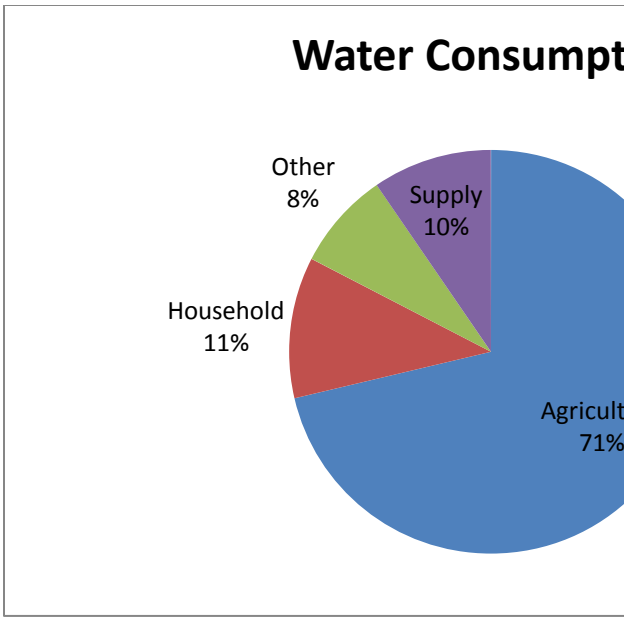
Waste Treatment-

Bharata will employ waste management system to ensure a clean, safe supply for all residents. Many water treatment centers – one on each individual section of the torus – will recycle a total of 300,000 liters of water every hour to meet human and agricultural consumption demands; this allows all water for human consumption to be entirely processed in under 24 hours. A total of 1 million L is stored in each section, allowing for the autonomous function of the areas in the event of isolation. The plant recycles a total of 300,000 L per hour, accounting for all miscellaneous and agricultural water not processed in the residential torus. Storage containers below the terraces are reservoirs to fuel human use; the river flowing through the station provides additional storage.There will be a network of garbage chutes spread across the entire settlement that will empty at one point where all the waste shall be treated.

We will recycle all possible wastes.Also we will use as less nonbiodegradable materials as possible.

Solid Waste Treatment-





INTERPLANETARY TRANSPORT VEHICLE

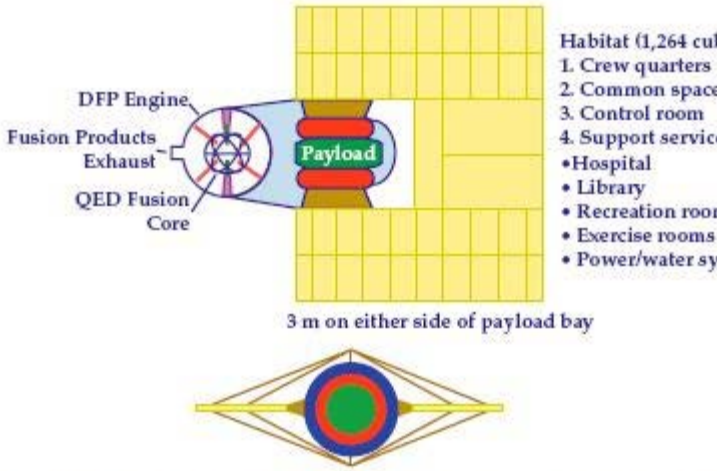


Figure 7 — Schematic outline of LEO/LTO transfer ve

.

Method of exchange of data-

Bharata will make use of laser optical transmission systems with a fan-like ray to relay data to Earth, while data reception will be controlled by a network of highly sensitive Single-Photon Detectors (SPDs). However, the fluctuating distance between Bharata and Earth caused by variations in orbital times poses a challenge for the exchange of internet data packets between Bharata and Earth-based repositories. The weakness of the proposed method involving the use of laser optics lies in the necessity of a linear link between Earth and Bharata, which is often obstructed by Mars or solar conjunction, potentially causing communication delays of up to two months. Signal repeaters consisting of a transmitter, a storage system and a network of SPDs and will be installed at libration points L3 and L4 to prevent attenuation of the optical signal, provide an alternative route when paths between and Earth are obstructed and avoid data corruption in the event of a coronal mass ejection. Exchange of data between Earth and Bharata will rely on the creation of a 'Virtual Net Package' (VNP) consisting of different types of data depending on time of day (Houston Time). This VNP will be streamed to Bharata server using the laser optical transmission system, where one copy will be kept in case of data corruption, and one copy will be used to update Bharata Virtual Net. As the Virtual Net updates instantaneously

Communication with Earth-

Space Transportation

Though, bharata is a self sufficient space colony ,it will not as self-sufficient as our mother planet.. If something broke, the original settlers couldn't just manufacture a replacement part but had to have one immediately shipped in from Earth or risk disaster area. Like a fetus connected to its mother, bharata's survival completely depends on a reliable line of supply to the earth only.

within the Bharata network, users will appear to have instant browsing access and the ability to freely collaborate. Upon the conclusion of the allotted time period, a computer on Bharata network will: log changes made within Bharata network; check for and attempt to prevent data corruption; and create a new VNP to be transmitted back to Earth's servers.

Community design-

Bharata's torus includes residential, commercial, and green areas, which intertwine over four rolling terraces to create an open, organic ambience. All residents have access to a multitude of amenities, living communities, urban centers, and a vast array of parks no matter where the resident is on the torus. Long lines of sight are also incorporated into the community layout. The architectural designs for residential living are separated into many different neighborhoods, offering residents access to different living communities to suit a multitude of demographic shifts. Not any houses arelocated near the commercial areas and incorporate less open space around the housing to create the excitement of an urban environment. The Territorial Style and Bamboo Design are located near major green areas and have more open space between the residences to accommodate individuals who wish to live within a suburban or rural setting. Large windows, beams, and an open air feel unify the designs and provide a pleasing common motif. Roads and Pathways-Residents have access to a multitude of paths throughout the settlement – along the river and in and around the residential, commercial, and green areas. The paths allow residents to exercise – walk, run or bike – while providing a low-cost alternate transportation method, as well as promoting residents to engage in physical activity. Roads and pathways account for approximately 3% of the down area.

Raw Materials-

Industries will be located in areas where the concerned raw materials will be easily available.This will be particularly true of raw materials that are bulky like iron and coal and also raw materials that are perishable like sugarcane.

Availability of power resources-

The availability of power resources is extremely vital because industries need a steady and continous supply of power at cheap rates. which need huge amounts of power will be located near power resource like solar power stations, wind power plants, etc.

-

The means of transport will play a vital role in the location of industries. An effective network of roadways, railways and airways will increase productivity and they will also take care of distribution of finished products to the markets

Bharata's Technology-

Bharata will be home to the most advanced technology available.We want to make our inhabitants as comfortable as possible and let them have a taste of life like never before.We will be using robots for various purposes-from working in industries to surgical robots to serving the inhabitants

These robots will have the sole purpose of serving the inhabitants from doing their cooking to washing clothes to cleaning homes-simply everything. They will have solid bodies made of aluminium and will be controlled by the owner's voice doing what it is

told to do when it is told to do. However every breakthrough has certain restrictions and this is true in our case also. We need to make every possible effort in order to protect the security of our inhabitants. In order to make sure that e=we are the masters of the robots and not the other way around every robot will have a self automated shut down system installed in its hardware that can begin with just one command from its owner. This system will be protected by a separate rotating algorithm as to make it impenetrable. This will ensure that none of the owner's commands cannot be opverridden by anyone not even the machine itself. Through these processes we wish to make these robots the new best friends of man.

This will be true of every type of robot found in Bharata.

Hand motions will manipulate 3D images produced on a prism like medium made of plexiglass.
This is the basic principle behind leap motion technology.

23. Transport-

We want our settlement to be as clean as possible. we want to reduce the pollution as much as possible. Also there will not be an abundant supply of minerals there on earth as on earth. So instead of transport vehicles running on petrol or diesel we will be making them run on electricity as solar power is available in abundance. As for trains there will be maglev trains .and we will also maintain a subway system that will span over the entire settlement. This will make it easier for people to move from one place to another whenever they wish. The colony will not be big enough to need very fast mass transport and vehicles, that is why we will use mostly alternative vehicles, powered either with electricity (Segway, electro cars and others) or with physical power (mostly bicycles). Of course there will be different paths for the different vehicles.

Classical SEGWAY
The Tong City Bike

A moving walkway

AUTHOR-DEBAYAN PAUL
SCHOOL- DPS,RUBY PARK,KOLKATA,INDIA
CLASS-11