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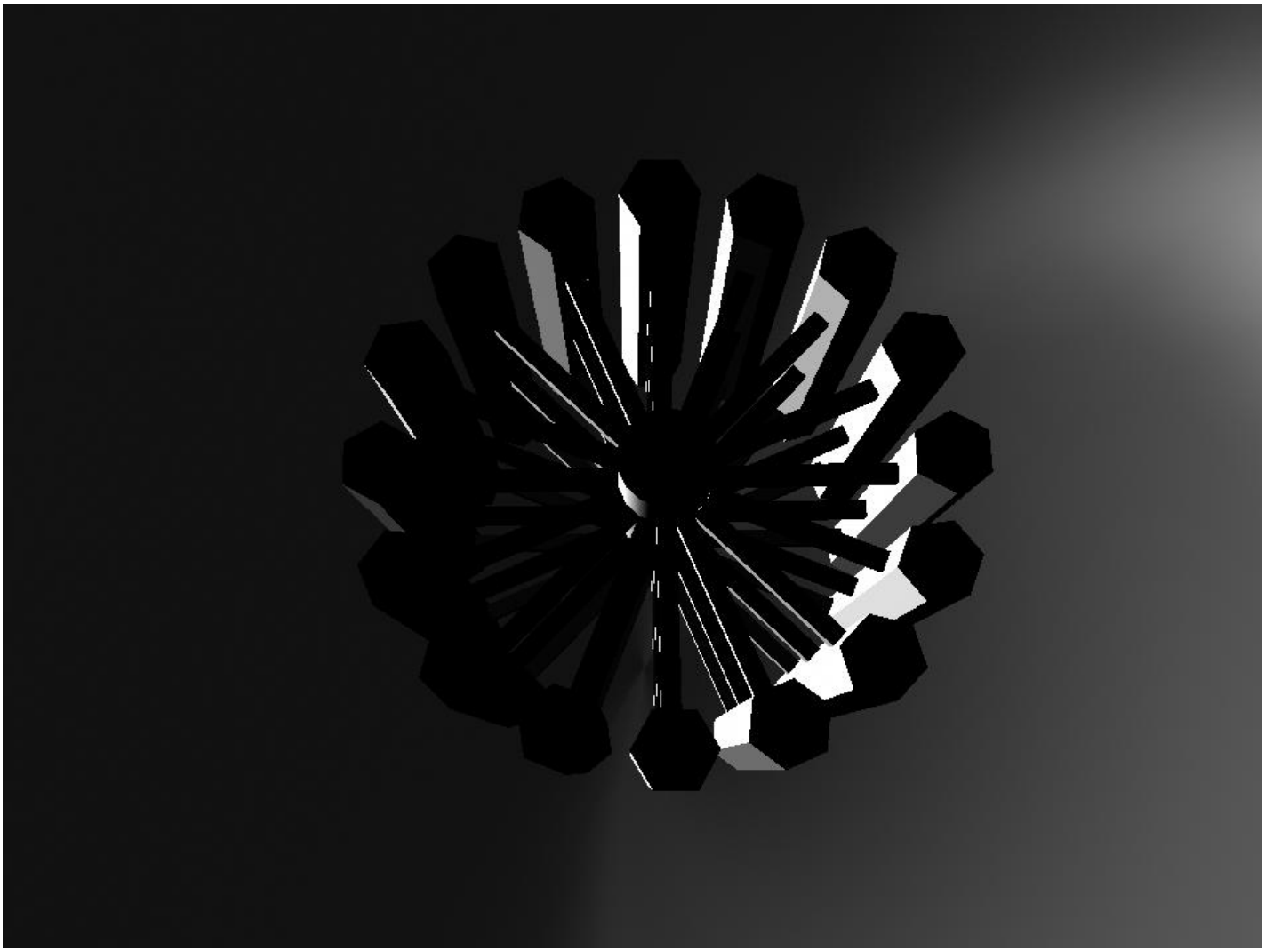

2007 Submission to the

Student Space Settlement Contest

NASA Ames Research Center


Apis

Apis

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(Small team 11th grade)

-small group 10-12 grade-

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2007


Apis

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Acknowledgements

First of all, we wish to thank NASA for offering students worldwide the opportunity to challenge their imagination and knowledge in trying to discover and understand the greatness of the Universe.

The teachers who helped us in elaborating this project are:

- Prof. Maga Cristinel, physics and astronomy teacher at “Ovidius High School” Constantza, who trusted our initiative, helped us with references and suggestions;
- Prof. Vintila Mihaela, English teacher at “Ovidius High School” Constantza.

Last but not least we wish to thank our parents for morally sustaining us during the hard work involved in the project.

We gratefully thank God for guiding us through the difficult still chalenging conceiving of this project.


Apis

FOREWORD

Why the name Apis?

Apis is a bee genus. We choose this name, Apis because our space settlement will use honeycombs structure and interior organization will be similar with the bees one. In order to accomplish our purposes for which we create the space settlement we think firstly we must find an alternative which offers maximum of security for colonists. Therefore we think at bees, more precisely at honeycombs. It is likely that the honeybee constructs the honeycomb based on instinct, and the prevailing theory of biology is that the appearance of such efficient shapes in nature is a result of natural selection.

Also Apis is a constellation that was found in the southern skies, just below the constellation of Crux, the southern cross. It first appeared as Apis in the star atlases of Johann Bayer in 1603. In 1752 the French astronomer Nicolas Louis de La Caille rename the constellation as Musca Australis, the southern fly. The name has since been shortened to simply Musca, the fly. Another obsolete constellation, Musca Borealis, the northern fly, has also been known as Apis, the bee. Musca Borealis can be found immediately above Aries, the ram.

Why is the construction of a space settlement necessary?

The construction of a space settlement is necessary in order to accomplish:

- **perpetuation of the human species** if the Earth will not provide a favorable environment for life development
- **avoiding energy crises** which will be happened if are not take measures against overpopulation, pollution and the lack of energetically resources
- **preserving our planet ,**we may learn new things which will help us to make it to live longer and use solar energy that will be captured from space will reduce negative effects of pollution.

- **tourism ,entertainment and also learning** to appreciate our planet, to realize that if we will not act responsible we will reduce considerably its life and of curse our life
- **better observation of Earth**


Apis

CHAPTER I

Placement of the space settlement


Apis

Placement of the space settlement

In order to make the best choices for the space settlement location we must take into account the purpose for which we create the space settlement. Firstly, we create it to assure the perpetuation of the human species if the Earth did not provide a favorable environment for life development. Secondly, an important reason is the energy crises which will be unavoidable due to overpopulation, pollution and the lack of energetically resources. In these conditions, we must use the Sun and the most efficient way of capturing solar energy is from space.

The accomplishment of the two objectives, life sustaining and the capture of solar energy can be realized if the space settlement location would be in outer space or on a planetary surface.

The advantages of locating the settlement on a planetary surface are:

- resources from that planet even if there is no life
- different sources of energy that can be obtained from various materials found on the planet/satellite for example on the Moon from fusion of He_3
- although planets have different levels of gravitation, it has been proved scientifically that the effects of the planet gravitation are less harmful to the human body than the micro gravitation effects
- the possibility to adapt environment conditions from that planet in order to sustain life
- enough space for scientific researches

The disadvantages are:

- inability of controlling days and nights; they will be correlated with the planet
- gravity leads to energy consume
- the soil structure ;some vital elements can miss
- the distance from Earth at any planet would have negative effect in economy and communication
- although the planetary surface is big ,the settlement will occupy a part of it

Placement of the settlement on orbit

Advantages:

- the settlement that provide all necessary conditions
- more alternatives in locating the settlement
- unlimited energy if it is located in place lit permanently by the Sun
- the possibility of choosing the level of gravitation which will facilitate lot of experiments and scientific researches
- the possibility of creating as many settlements we want without being conditioned by space
- the opportunity to reach another star
- Moon and asteroids resources
- Earth observations

Disadvantages:

- the difficulties in construction as it will be realized in space
- the transport of the materials
- the inability of having such a diverse environment as the one on Earth
- different problems can appear as it has not been a similar process in an atmosphere artificially created

Comparing and analyzing the two alternatives results that the placement on orbit is the best option because our porpoise for creating the space settlement is life sustaining and obtaining unlimited energy. These can be better achieved on orbit.

The two objectives require the placement of the space settlement as close as it can be to Earth because this way we will have access to materials and the distances for transportation will assure efficiency in economy. Another advantage is the possibility to communicate through radio waves in due time because although radio waves travel at the speed of light, the immense planetary distances like Earth Mars cause a delay in voice communications, telemetry and remote operation of devices.

The alternatives, which accomplish all conditions above, are:

1. **Low Earth Orbit(LEO)**
2. **Geosynchronous and Geostationary orbits(GEO)**
3. **Lunar Orbit**
4. **Libration Points**
5. **Transit**

Low Earth Orbit is 200-2000 km (124-1240 miles) above the earth, between Earth atmosphere and Van Allen radiation belts. Most satellites are located in LEO and circle Earth in about 90 minutes. LEO space is very crowded, according to the USSC (U.S. Satellite Corporation), and it contains more than 8000 objects bigger than a softball.

LEO Advantages are:

- communications can be realized in due time so the activities from earth can be controlled
- Earth observation because it is the best zone for taking photographs ,this is already made by satellites Remote Sensing and Weather satellites that offers detailed pictures
- few hours for traveling from Earth to settlement

LEO Disadvantages:

- inefficient usage of energy because having an angular speed grater than Earth it will be a lot of sunrises and sunsets
- short days and nights will affect negatively the people's health and activities on settlement
- pieces of metal from old rockets, broken satellites, even frozen sewage existing in LEO are a potential danger to the less strong parts of the settlement
- a lot of energy spent on maintaining the settlement stabile on orbit
- a real danger for the people on Earth in case of having a defects and the huge settlement falls on Earth
- a lot of energy consumed to reach on orbit

- the distances to the Moon and asteroids would not permit their exploitation

Geosynchronous and Geostationary orbits (GEO) are those orbits on which a satellite rotates around Earth with the same angular speed like Earth and it takes 24 hours to circle the planet. GEO could be included in LEO and presents the same advantages and disadvantages except the fact that because of the rotation in the same time with Earth are possible uninterrupted communications and better research of a particular surface are possible.

The placement of the space settlement on the **Lunar Orbit** has the following advantages: access at different lunar resources, communication in due time, the possibility of making propulsion experiments, although it is near Earth. The main disadvantages are limited exposure to Sun and a careful supervision of the gravity level.

A possibility suggested in movies, novels and TV series is the space travel. This alternative offers the opportunity to study better the space and to perpetuate human species avoiding inevitable end of the Earth and the accomplishment of the supreme challenge, exploration and colonization of the space.

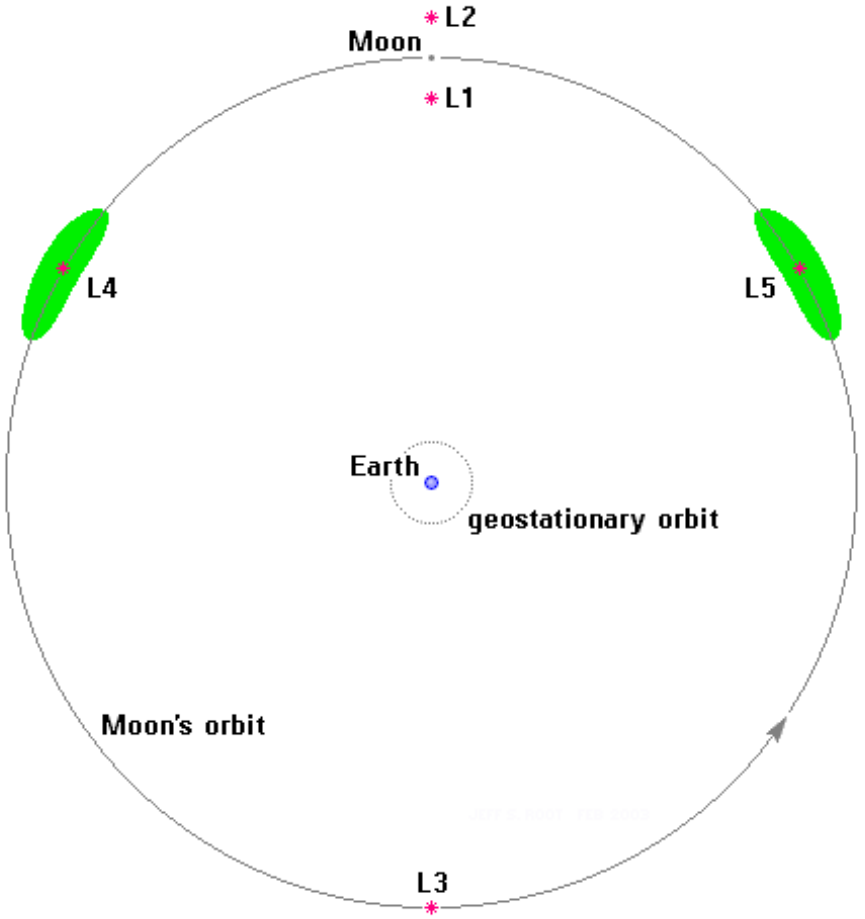
Disadvantages of transit are limited solar energy in some places, necessity of a propulsion system, delayed communication, unknown conditions, crew selection because they are aware of the fact that their children never live on Earth and today technology is not enough developed.

Libration Points

Libration points known as the Lagrangian points was discovered by French mathematician Louis Lagrange in 1772 in his gravitational studies of the 3-body problem: how a third, small body would orbit around two orbiting large ones.

Due to the necessity of being near Earth, the best choice is Earth –Moon system that is represented in the next picture

(* picture was copied from file:///G:/nasa/Lagrange%20Points.htm.)

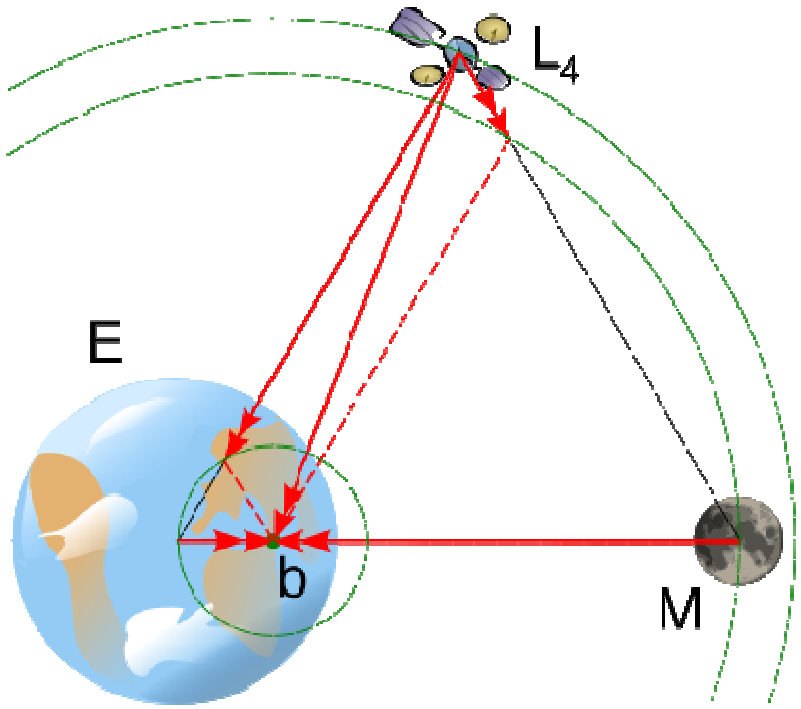


Because of Sun influence, in order to be stable in L1, L2, L3, L4, L5 the settlement should be located on an elliptical orbit around these points, marked with green in the picture.

His discovery was astronomically confirmed in 1906 when the Trojan were discovered orbiting at L4 and L5 of the Sun-Jupiter system. Later smaller objects were discovered at L4 Saturn-Dione and at L4 and L5 of Saturn-Tethys.

Study of the stability of Lagrange point for Earth-Sun system brought precious information for NASA missions. For the moment solar observatory SOHO is located at L1 and MAP (Microwave Anistropy Probe) at L2 and NGST (the Next Generation Space Telescop) will be located at L2.

After studying the stability of each point results that, the best choice for locating the settlement would be one of the points L4 and L5. Stability is very big here and because of that we can compare the placement of the settlement with ball in a bowl.



The advantages of placement the space settlement in L4 or L5 are:

- unlimited solar energy because the points are located on Moon's orbit and they are permanently exposed to Sun
- the possibility to exploit the Moon resources being close to it
- communications allow activities coordinated from Earth because the time delay is just 1,3 seconds
- transit can be made in few days with Apollo and even faster with a propulsion system as it is close to Earth
- stability in L4 ,L5
- the possibility of making a Lunar base which will help to build the space settlement

One disadvantage is that in L4 and L5 are junk objects, which can produce defections. Another disadvantage is the Sun's influence that requires taking measures for maintaining the equilibrium.

Conclusions

In order to achieve our purposes for which we created the space settlement we realized that LEO is not a good choice because it does not offer permanently access at solar energy and in the same time is dangerous to keep something as big as a space settlement near Earth.

GEO like LEO has the same disadvantages being crowded with satellites.

Lunar orbit does not fulfill one of our goal for it is not constantly exposed to the Sun.

Transit, the space travel is very interesting but it cannot be realized nowadays because of the technology.

The best solution represents locating in Lagrange points because of the permanent exposure to Sun, medium distance, and stability, in L4 or L5.


Apis

CHAPTER II

Artificial gravity


Apis

Artificial Gravity

On Earth, our bodies are subject to the pull of gravity but on space, sensation of weight does not exist. Weightlessness can cause grave problems regarding fluid regulation system, respiratory system, neurvestibular system, musculoskeletal system, and immune system. Therefore, for maintaining life we must create gravity artificially i.e. we must find a way to generate pseudo gravity.

Thinking how to make it real we found various solutions but one of them seemed the best choice to all of us. Alternatives were:

- Linear Acceleration - could be convenient if we had followed the starship concept but if we will have in the future a competitive propulsion system it will be the best solution to generate pseudo gravity
- Magnetism -it is not realizable nowadays.
- Tidal forces -it is not good because of the space settlement's size
- Mass - that means it would be naturally gravity but is difficult to make and it has many disadvantages
- **Rotation** this was the most advantageous alternative. In this case, everything inside the station will be forced toward the outside by centrifugal force.

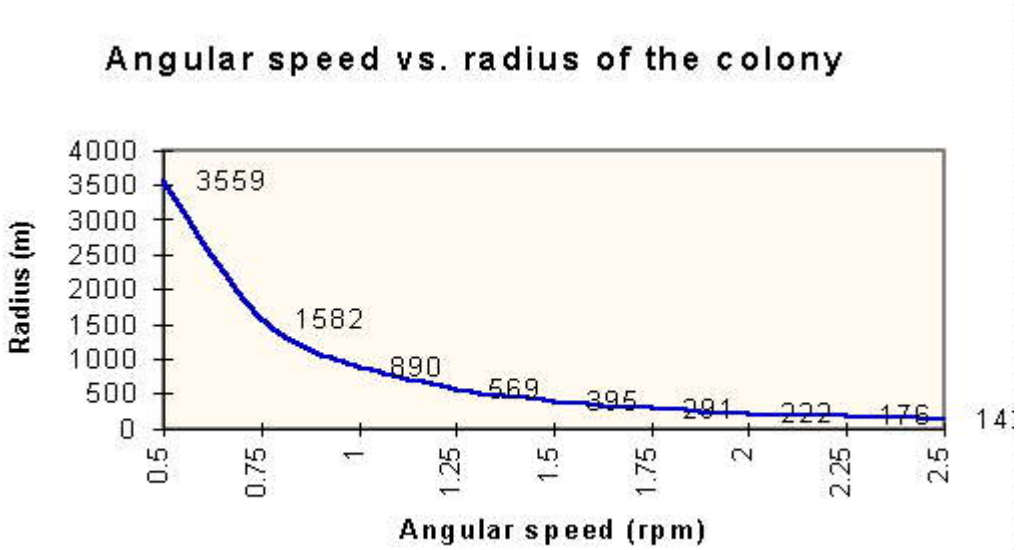
Generating pseudo-gravity through rotation of the space settlement suppose studying next four parameters in order to achieve our main purpose, life sustaining. The four parameters are:

- Radius from the centre of rotation noted with R
- Angular velocity noted with ω
- Tangential velocity , it must to be maximized in order to minimize the ratio of Coriolis force.When people or objects move within a rotating habitat, they're subjected to Coriolis accelerations that distort the apparent gravity. For relative motion in the plane of rotation, the ratio of Coriolis to centripetal acceleration is twice the ratio of the relative velocity to the habitat's tangential velocity.
- Centripetal acceleration noted with a

Expression of the centrifugal force is $Fc = m\omega^2 R$,where m is the mass of the object.

$mg = m\omega^2 R \Rightarrow g = \omega^2 R$

From above formula results that g depends on ω and R.



Calculating the radius for which the simulated gravitational constant is optimum $g = 9{,}8\frac{m}{s^2}$:

$$\left.\begin{array}{l} a = \omega^2 R = \dfrac{4\pi^2}{T^2} R \\ a = g \end{array}\right\} \Rightarrow R = \frac{gT^2}{4\pi^2}$$

$$\omega = \frac{2\pi}{T}$$

From formulas and graphic representation above results that the most suitable rotation period for human body is 127 s. Therefore we can determinate the major radius of the "torus".

$$R = \frac{9{,}8 \cdot 127^2}{4 \cdot 9{,}85} \approx 4011m$$

Considering the psychological needs of the colonists and following to use space as much as we can in beginning conditions we approximate that r the minor radius of the "torus" should be 500 m, the eighth part of the major radius ($r = 500m$).


Apis

CHAPTER III

External and internal structure of the space settlement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Shape

First thing that came to us when we were thinking at space settlement's shape was the reason of creation the space settlement. We must choose a favorable shape for life sustaining independent of Earth and unlimited captation of solar energy.

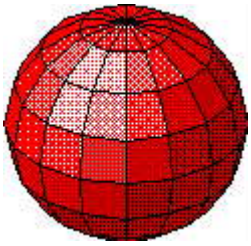
Principled possible shapes were:

CYLINDER $V = \pi R^2 L$

$A = 2\pi RL$

R=Radius, L=Length

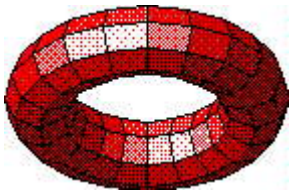
The cylinder sustains the same level of gravity everywhere but compared with the torus is not an efficient option because it demands a larger atmospheric volume.



SPHERE $V = \frac{4}{3}\pi R^3$

$A = 4\pi R^2$

It is not a good option because of the negative difference between livable area and its enormous volume.Another disadvantage is its construction is too risky for both financial and logistical reasons.



TORUS $V = 2\pi^2 Rr^2$

$A = 4\pi^2 Rr$

R=Major (rotation) Radius

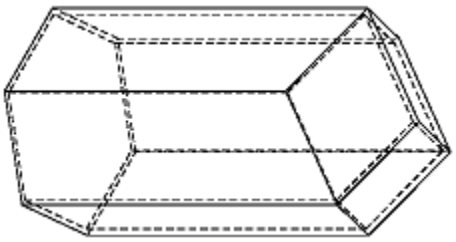
r=Minor radius

Most reasearch shows that the torus would be the best option for a space settlement shape becase: provides the best livable area compared to its size,sufficient sunlight and can be built modular.

(*imagines were copied from: http://www.nas.nasa.gov/About/Education/SpaceSettlement/Contest/Results/96/winner/index.htm)

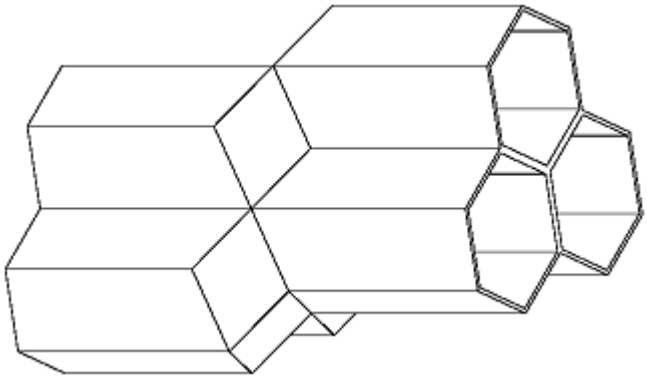
In order to accomplish our purposes for which we create the space settlement we think firstly we must find an alternative which offers maximum of security for colonists. Therefore we think at bees, more precisely at honeycombs. It is likely that the honeybee constructs the honeycomb based on instinct, and the prevailing theory of biology is that the appearance of such efficient shapes in nature is a result of natural selection.

The closed ends of the honeycomb cells are also an example of geometric efficiency, albeit three-dimensional and little-noticed. The ends are trihedral (i.e., composed of three planes) pyramidal in shape, with the dihedral angles of all adjacent surfaces measuring 120°, the angle that minimizes surface area for a given volume. (The angle formed by the edges at the pyramidal apex is approximately 109° 28' 16" (= 180° - arccos(1/3)).)



The three-dimensional geometry of a honeycomb cell.

The shape of the cells is such that two opposing honeycomb layers nest into each other, with each facet of the closed ends being shared by opposing cells.

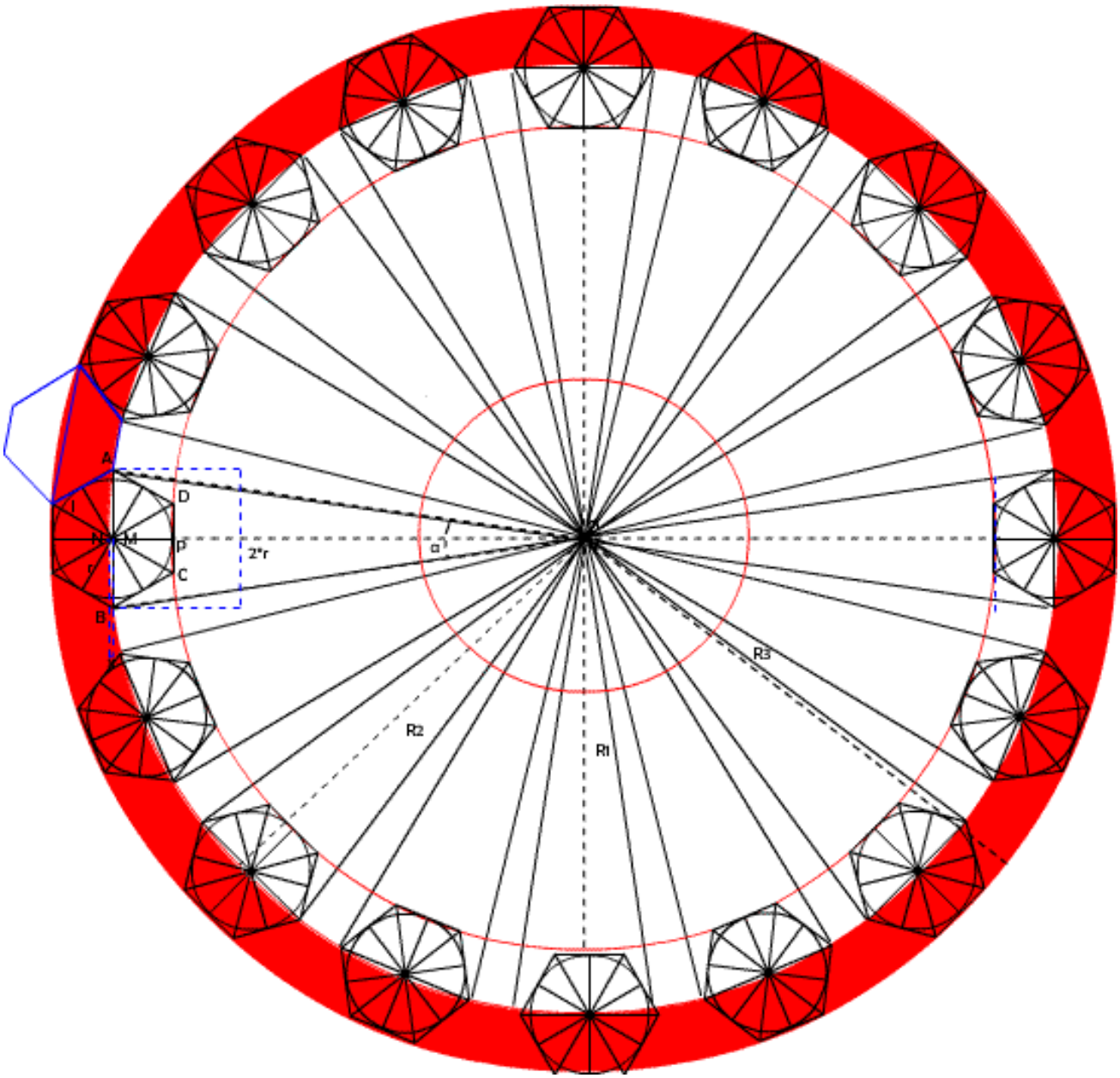


Opposing layers of honeycomb cells fit together.

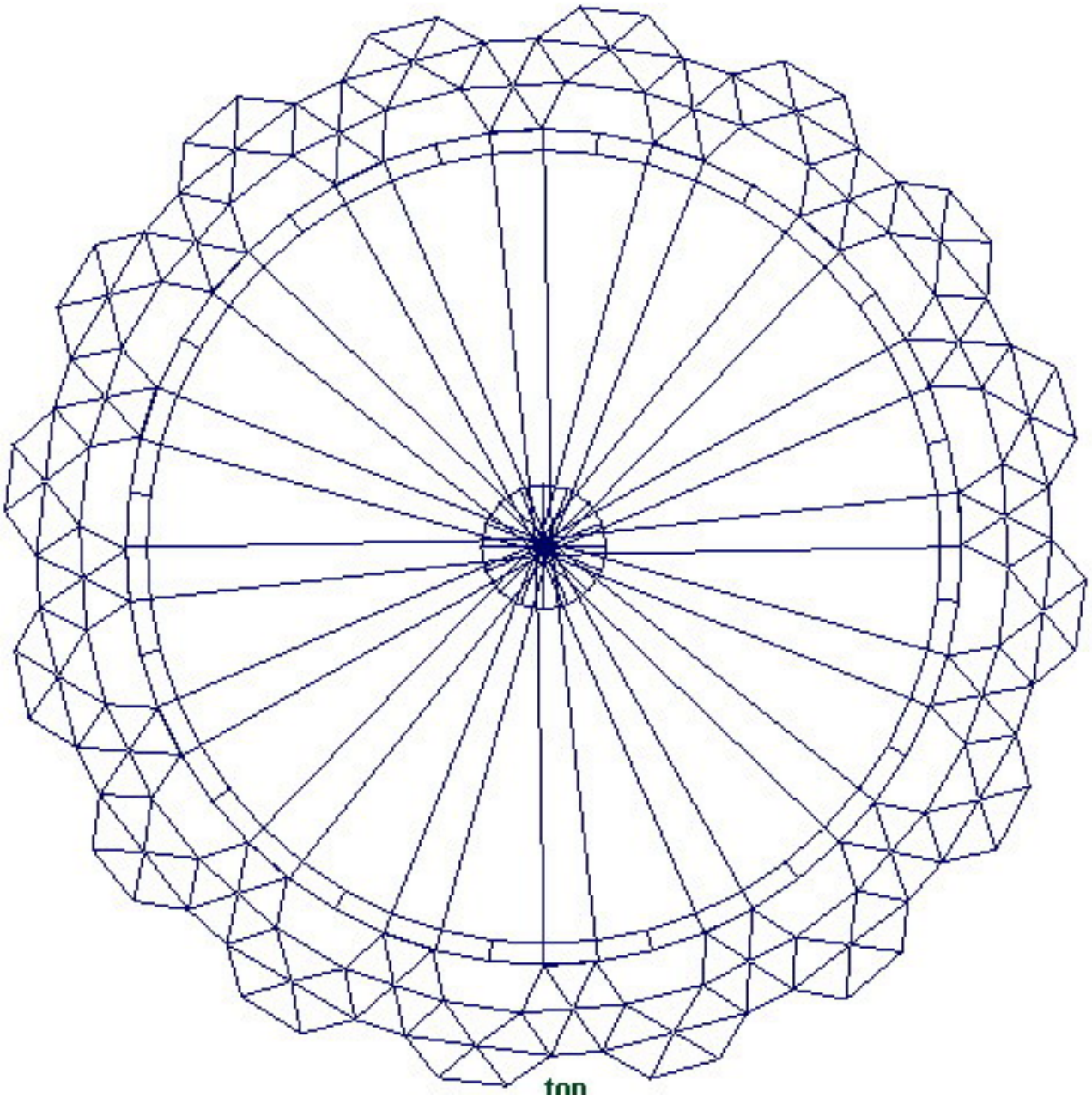
Individual cells do not, of course, show this geometrical perfection: in a regular comb, there are deviations of a few percent from the "perfect" hexagonal shape. In transition zones between the larger cells of drone comb and the smaller cells of worker comb, or when the bees encounter obstacles, the shapes are often distorted.

*imagines copied from www.wikipedia.org

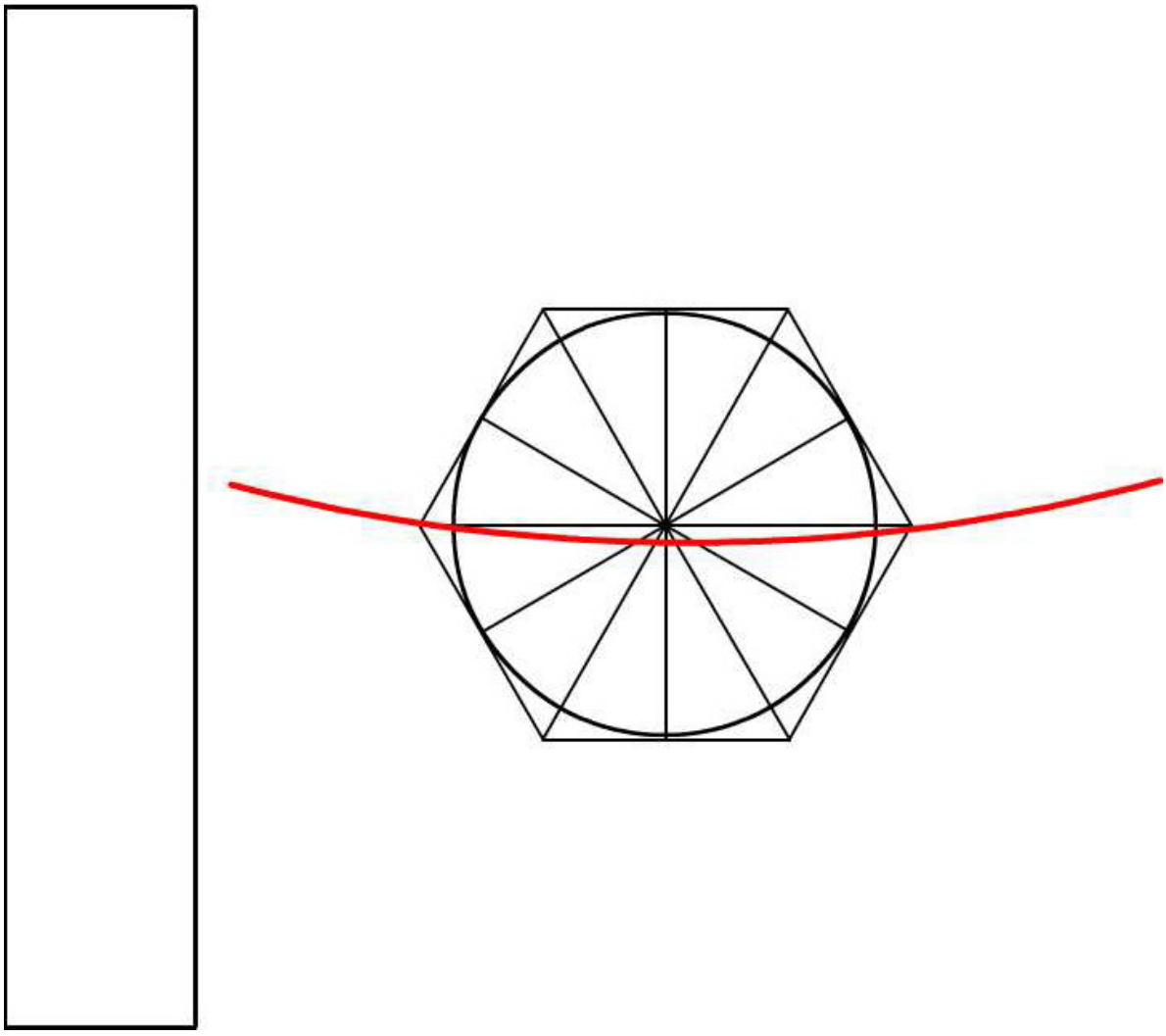
We think to use honey comb shape because it assure security and modular construction. Trying to combine the torus shape and honeycomb shape we reached at the following shape, honeycombs disposed round a circle:



From this previous honeycomb cells we will extend our space settlement building another cells in order to have layers of honeycomb cells fit together.



We disposed honeycombs cells vertically to use maximum space, livable area because of the centrifugal force.

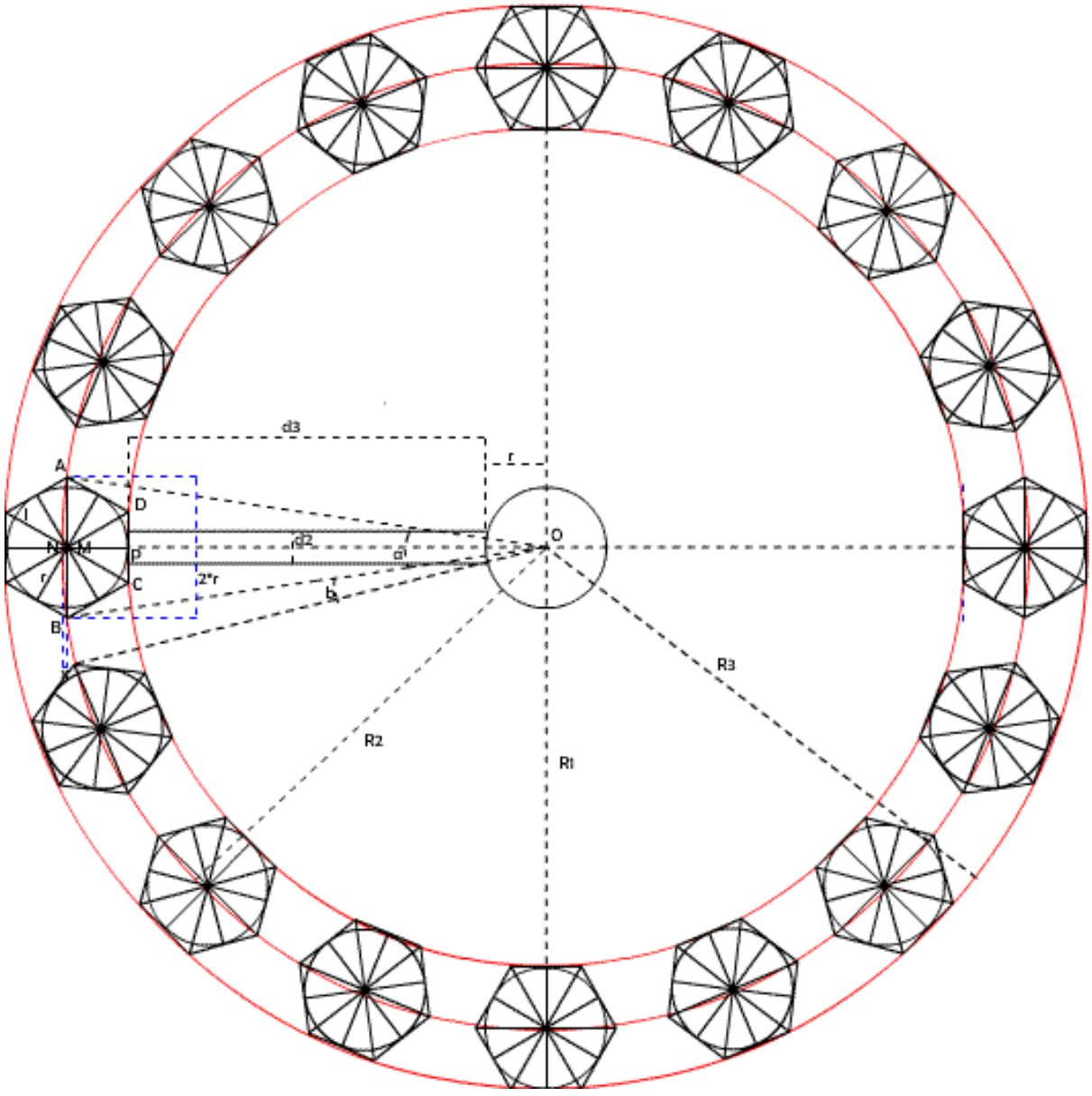


Structure of one element is:

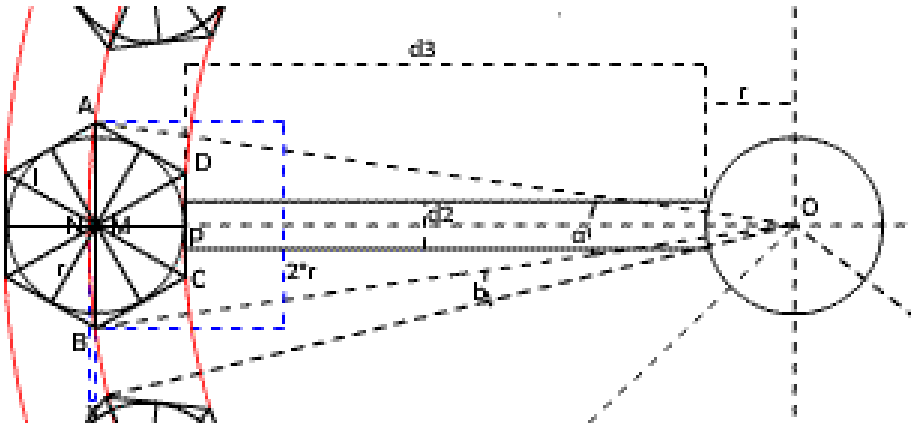
We choose that an element to be structured like this because making green zone including parks and agriculture between home and industry will have 3 important advantages. First of them is that threes and plants will clean the air and the second advantages will be a psychological one because every morning when people will go to work they will go through park and feel like on Earth. People must preserve the green zone and to maintain their health, the best solution to accomplish both would be to bike every morning when going to work.

Dimensions

-Top View-



Thoroughly Top View – SECTION



$$S_{AMBN} = A_{\widehat{AOB}} - A_{\Delta AOB}$$

$$A_{\widehat{AOB}} = \frac{\hat{a} \times \pi \times R2^2}{360°} = \frac{\hat{a} \times \pi \times 4011^2}{360°}$$

$$A_{\Delta AOB} = \frac{ABO \times OM}{2} = \frac{2 \times r \times OM}{2}$$

$$\Delta AOM, m(\widehat{AMO}) = 90°, Th.\ Pitagora:$$

$$OM^2 = AO^2 - AM^2$$

$$OM^2 = R2^2 - r^2$$

$$OM^2 = 16088121 - 250000 = 15838121$$

$$OM \cong 3979{,}71$$

$$A_{\Delta AOB} = \frac{2 \times 500 \times 3979{,}71}{2} = 2009045{,}36$$

$$A_{\Delta AOB} = R2^2 \times \sin a$$

$$\sin a = \frac{2 \times 2009045{,}36}{16088121} = 0{,}249$$

$$\arcsin 0{,}249 \cong 17° = a$$

$$b = \frac{360° - 16 \times a}{16} = \frac{360 - 272}{16} = 5{,}5°$$

$$A_{\widehat{AOB}} = \frac{17 \times 4011^2 \times 3{,}1416}{360°} = 2386726{,}37$$

$$S_{AMBN} = 2386726,37 - 2009045,36 = 377681,01$$

$$\widetilde{AB} = \frac{a \times \pi \times R2}{180°} = 1190,09$$

$$MN = x = R2 - OM = 31,29$$

$$R1 = R2 - r - x = 3479,71$$

$$R3 = R2 + r - x = 4479,71$$

$$r = MP = \frac{MC\sqrt{3}}{2} \rightarrow MC = \frac{2 \times r}{\sqrt{3}} = 577,36$$

$$A_{ABCD} = \frac{(DC + AB) \times MP}{2}; \frac{AB}{2} = DC = MC$$

$$A_{ABCD} = \frac{1732,08 \times 500}{2} = 433020$$

$$S_{ANBCD} = A_{ABCD} + S_{AMBN} = 810701,01$$

We consider the required volume and the average inhabitable surface required by a person as being of 5340,9 m^3, respectively 122,36 m^2. By multiplying it with the total of 62500 people who will live in such a module, we obtain a total volume of 333 806 250 m^3 and a total surface of 7 647 500 m^2.

By knowing the length and the surface of the module section, we can deduce the two heights. The first one, having the volume as a proportion factor, is of 411,75 m, while the second one, obtained by the division to the surface, is of 6426 m. The required height will be the maximum one, i.e. 6426 m.

$$h = max(h1, h2)$$

$$h1 = \frac{5340,9 \times 62500}{S_{ANBCD}} = \frac{333806250}{810701,01} \cong 411,75$$

$$h2 = \frac{122,36 \times 62500}{\widetilde{AB}} = \frac{7647500}{1190,09} \cong 6426$$

$$h = max(411,75; 6426) = 6426$$


Apis

CHAPTER IV

Important functional elements of the Settlement


Apis

1. Electric System

We will consider an apartment inhabited by 3-4 people. Therefore, there will be approximately 1.500 apartments. Knowing this, we can calculate the quantity of energy necessary for the residential area i.e. 84,9 (aprox. 85) MWh. We approximate the quantity of energy necessary for the industrial area at 65 MWh. Therefore, the total quantity of energy required in a certain sector equals approximately 0,15 TWh. The total quantity of energy required for the whole station will be of 2,4 TWh (0,15 * 16 – total number of sectors).

At any given "t" moment, there are only 2 sectors exposed or an equal surface – one whole sector and 2 partially. This is why the quantity of energy developed here must suffice all the 16 modules. 2 * 6426 * 500 = 6.426.000 m^2 = 6,426 km^2 (total surface exposed to the sun at any given "t" moment).

Solar radiation reaches 1366Wh/m^2 in the superior atmosphere layer. Infiltrating through the terrestrial atmosphere, about 6% of the solar radiation is reflected and 16% is absorbed, thus resulting a maximum level of irradiation of 1020Wh/m^2 in the Equator area. We will consider the distance from the Sun to the spatial station located in the point L4 as being approximately equal to the distance from the Sun to the Earth. But the absence of an atmosphere similar to that of the earth will maintain the maximum value of solar radiation at a level of 1366Wh/m^2. This is the quantity of solar radiation that will reach the solar panels which will provide the station with the required amount of energy. The best systems have a transforming capacity of up to 30-35%. Therefore, they provide 455 Wh/m^2. By applying this value to the required amount of energy, we get a 5.274.000 m^2 = 5,274 km^2 surface which must be used with this purpose.

The 1,152 km^2 difference represents the surface occupied by the light receivers (fiber optic tube superior heads). This surface is also covered by solar panels whose function is to recharge the spare batteries or substitute the standard panels. Each of the 16 modules will be provided with spare batteries, used only in the case of damage of the main electric system.

2. The Temperature

The temperature inside the station will be another issue. This has to be kept constant, at about 21-22° C. Due to the absence of an atmosphere resembling the one on Earth, the area exposed to the sun will suffer from excessive heat, while the diametrically opposed area will have very low temperatures. This major issue will be solved with the help of an improved circulation of the air masses among all the 16 modules, so that the temperature will be kept constant at a required level.

In order to prevent possible problems which may appear in the functioning of the ventilation system, the 16 modules will be equipped with auxiliary cooling and heating systems which will function by means of electric power. However, due to the high consumption of electric power, it would be better to use these auxiliary systems only when absolutely necessary.

3. Illumination

The issue of illumination is being treated entirely different from the previous projects. In order to ensure appropriate and uniform illumination, we will use a system consisting of two conical mirrors and a fiber optics network. *Frense* lenses will be used to ensure better focus of the rays of light. These lenses have the same effect as the classical ones, but due to their shape they are thinner, lighter and require less material. All these features make them more accessible in an environment where the lack of raw material represents one of the main difficulties.

Solar panels will incorporate the so-called light receivers, in fact the inferior heads of some fiber optic tubes. These will be located at the level of supporting spokes and through them they will reach the interior module with gravitation 0. This is where the superior head of the first tube will be located, as shown in following pictures. The rays of light will suffer a total reflection phenomenon the moment they reach the separating surface of the conical mirror. Following the reflection, the initial ray will divide into n different symmetrical rays, headed towards the supporting spokes in the central area. Through these, light will reach all the 16 modules. It must not focus only into one spot, therefore it will be evenly distributed inside each module through several fiber optic tubes with relatively reduced diameters, placed equidistantly (dx = 1 meter between two tubes). The same system will be used for providing natural light in closed spaces.

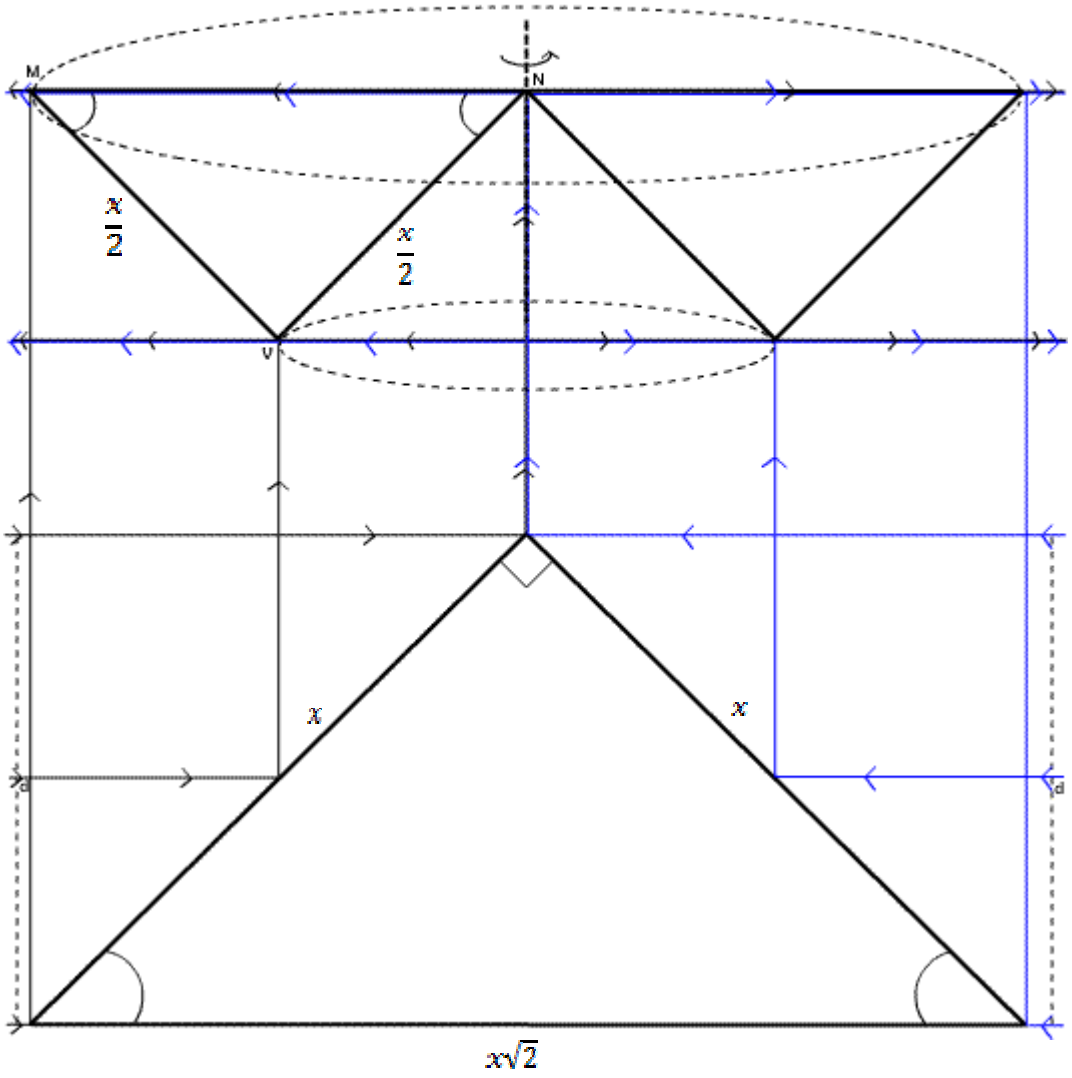
In the case of damages, the natural illumination system will be replaced with a system which uses artificial light until repairs are made.

4. The benefits of natural sunlight

It is a well-known fact that not all light spectrum radiations are beneficent to human beings and their activities. On the contrary, a wide range of such radiations have a negative influence upon the health of humans, animals and plants. In order to solve this problem, filters will be placed inside the fiber optic tubes located in the supporting spokes, allowing the partial transit of light, i.e. the spectrum tolerated by the human body. Another great advantage of this system is the continuous illumination and the light modulation of its intensity through a device resembling the photo diaphragm, which allows the controlled transit of light according to the current requirements. Therefore, day-night transitions will be realized through a simple program implemented in the central computer, allowing the same frequency existing on Earth. This aspect and similar ones will make the object of analysis in a subsequent chapter.

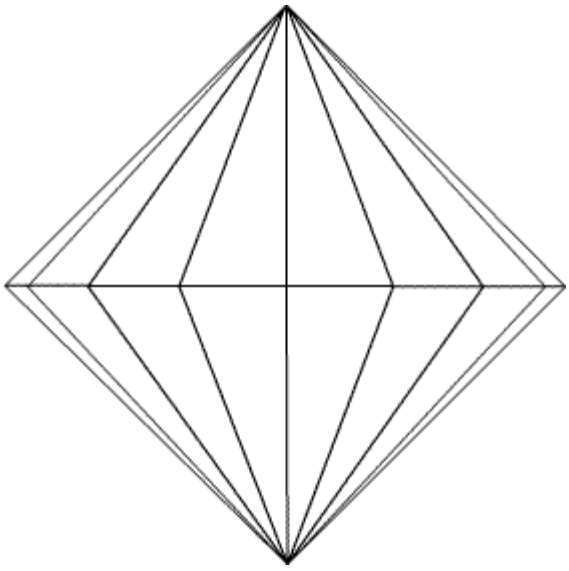
Natural light presents a series of advantages which are essential from our point of view. Among these, we will mention the physical ones, such as tolerance on behalf of the natural bodies. The human and animal body expects a natural light spectrum, according to which its cardiac rhythm is established. Moreover, natural light is considered to have positive psychological effects. Therefore, more psychological disorder cases are registered during the winter than during the summer. Furthermore, some people consider a high level of artificial light irritating.

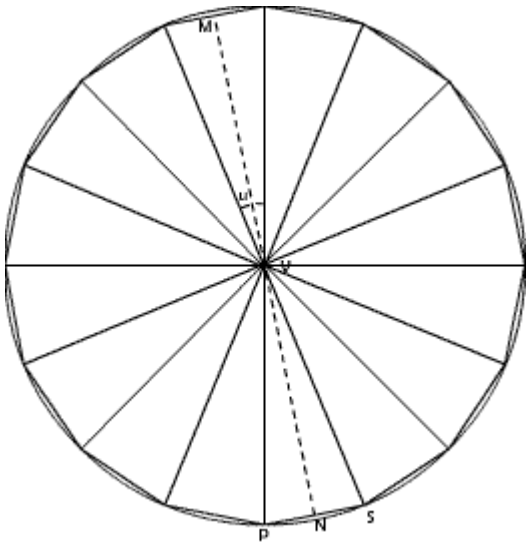
Many studies have shown that a high level of artificial light can damage human health. Excessive light or an incorrect spectrum can produce headaches, exhaustion, low working pace, high blood pressure and other cardiovascular diseases. Some of these effects are being carefully analyzed in order to understand the exact cause.
Generally speaking, excessive illumination occurs when the level of light exceeds 500 lx for accidental light, 800 lx for office work or 1600 lx for special objectives such as microchips quality control. Excessive illumination is also considered a form of pollution.

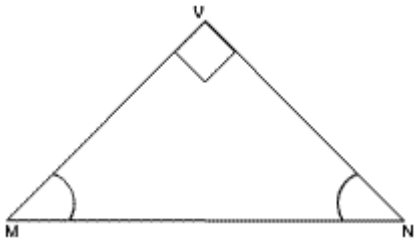


$$\sin 45° = \frac{d}{x} \Rightarrow x = \frac{d}{\sin 45°} = 400\sqrt{2} \cong 564$$

$$x = 564 \Rightarrow x\sqrt{2} = 795{,}24$$

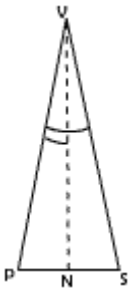






$$VM = \frac{x}{2} = 282$$

$$MN = \frac{x\sqrt{2}}{2} = 398{,}2$$



$$\tan 11{,}25° = \frac{PN}{282} \Rightarrow PN = 282 \times \tan 11{,}25°$$

$$\tan 11{,}25° \cong 0{,}2$$

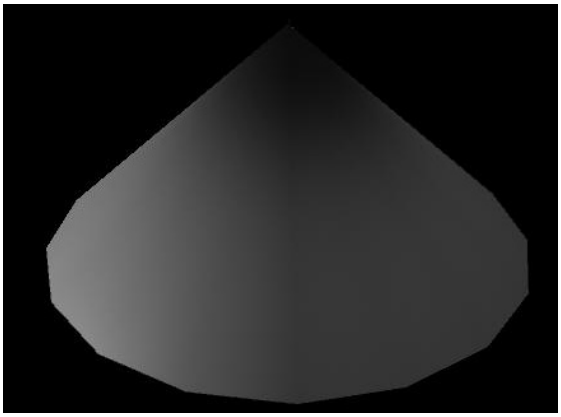
$$PN = 0{,}2 \times 282 = 56{,}4$$

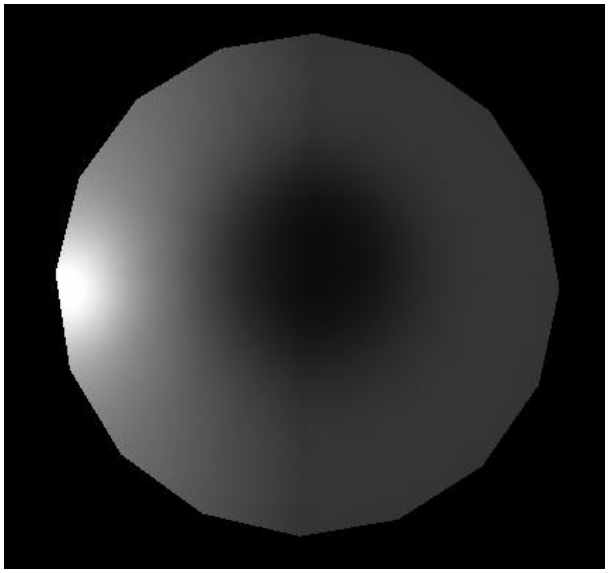
$$PS = 2 \times PN = 112{,}8$$

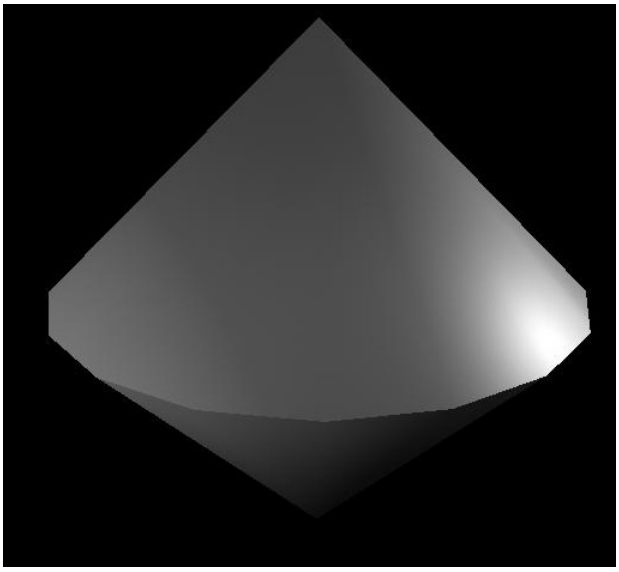
$$\cos 11{,}25° = \frac{282}{VP} \Rightarrow VP = \frac{282}{0.98} = 287{,}75$$

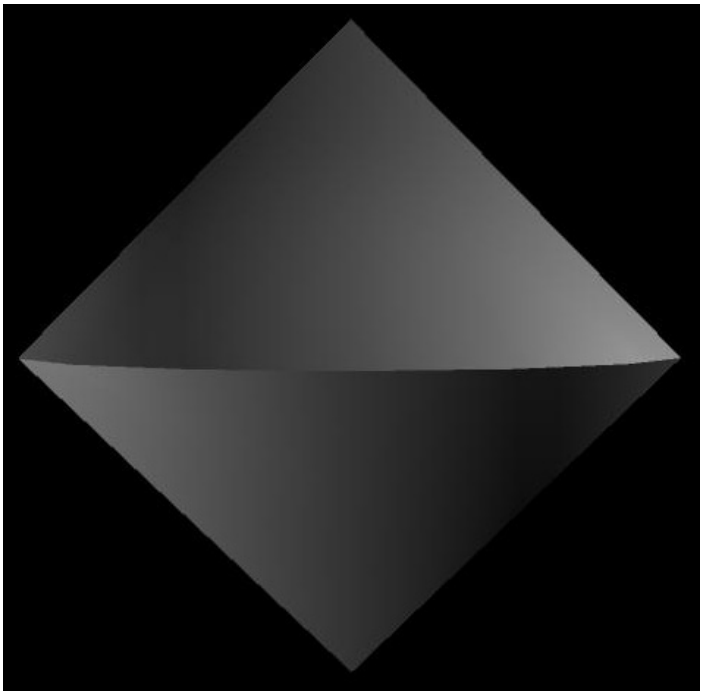
Observation. The double pyramid must rotate itself evenly around the N point with the same angular speed as the whole station assemble rotates around its central axis.

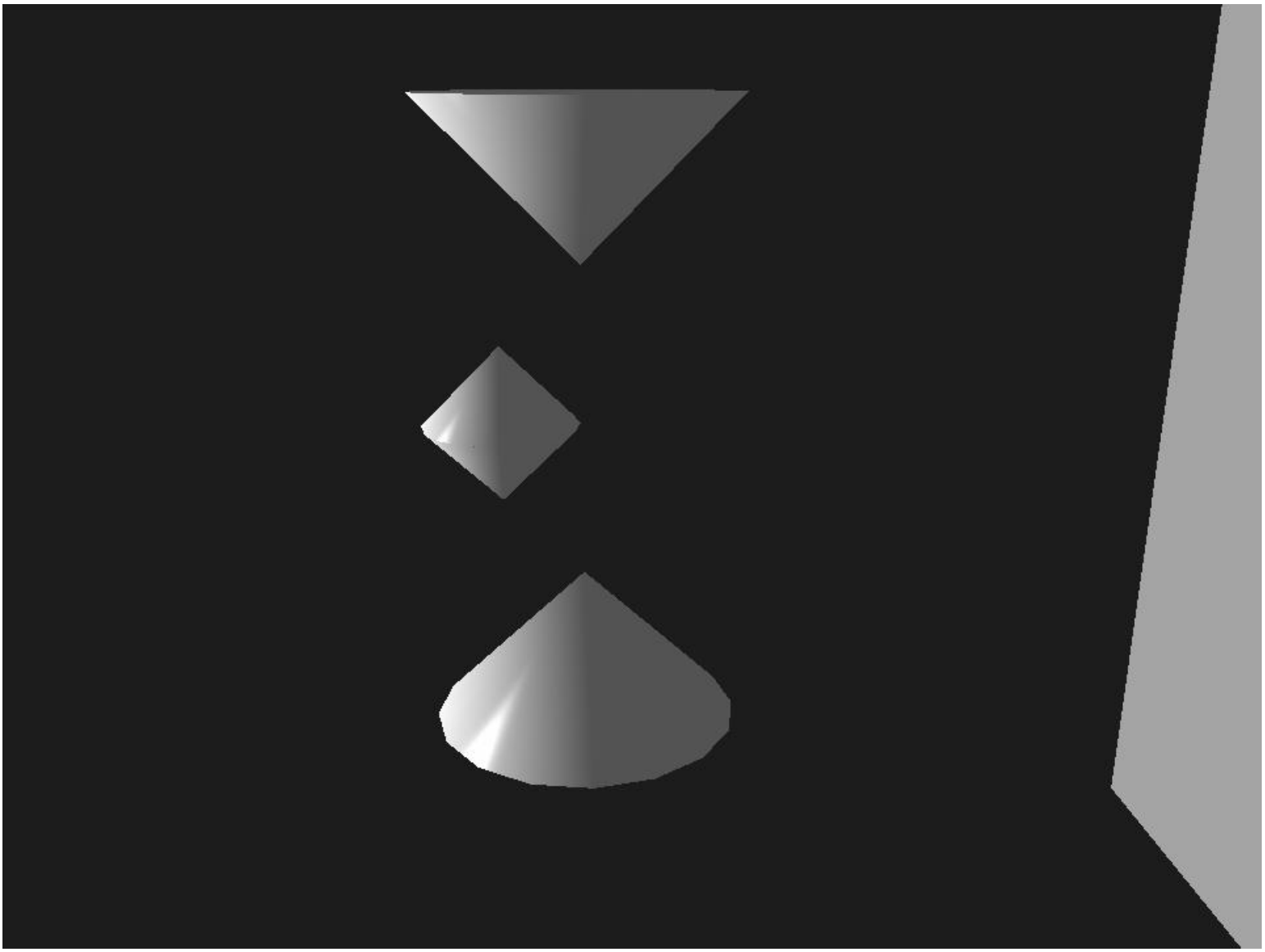
MIRRORS



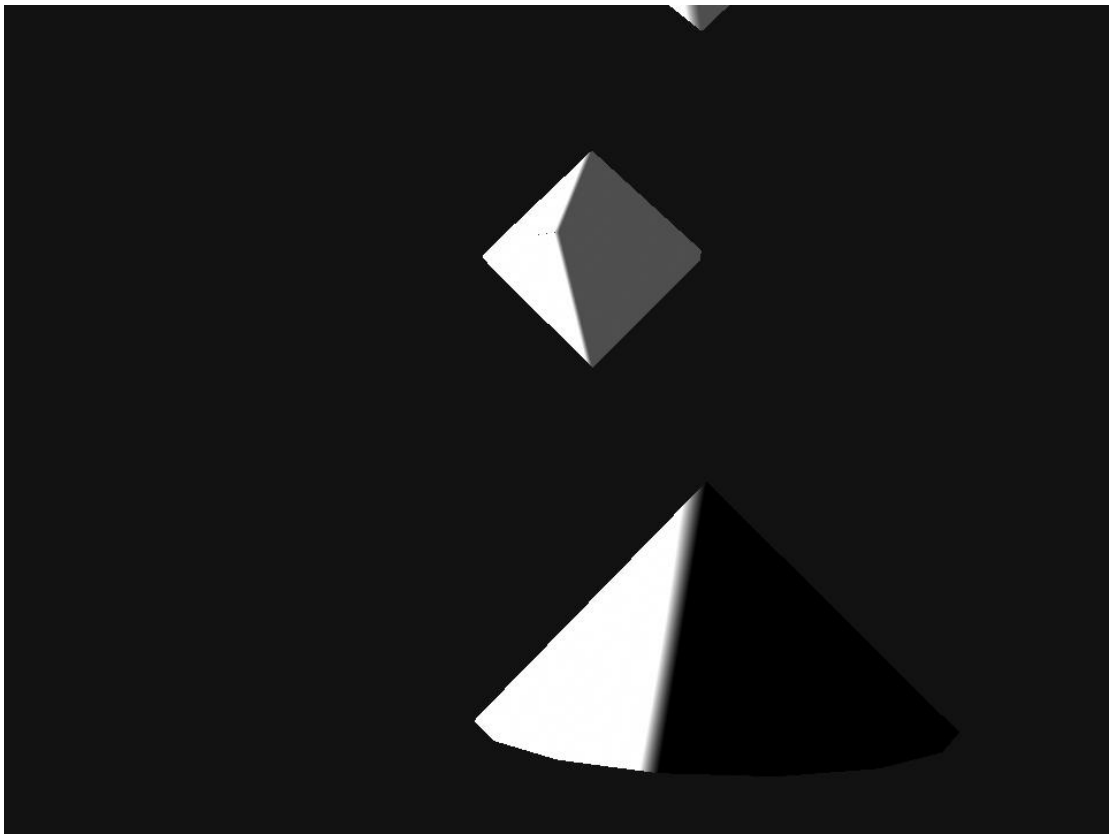


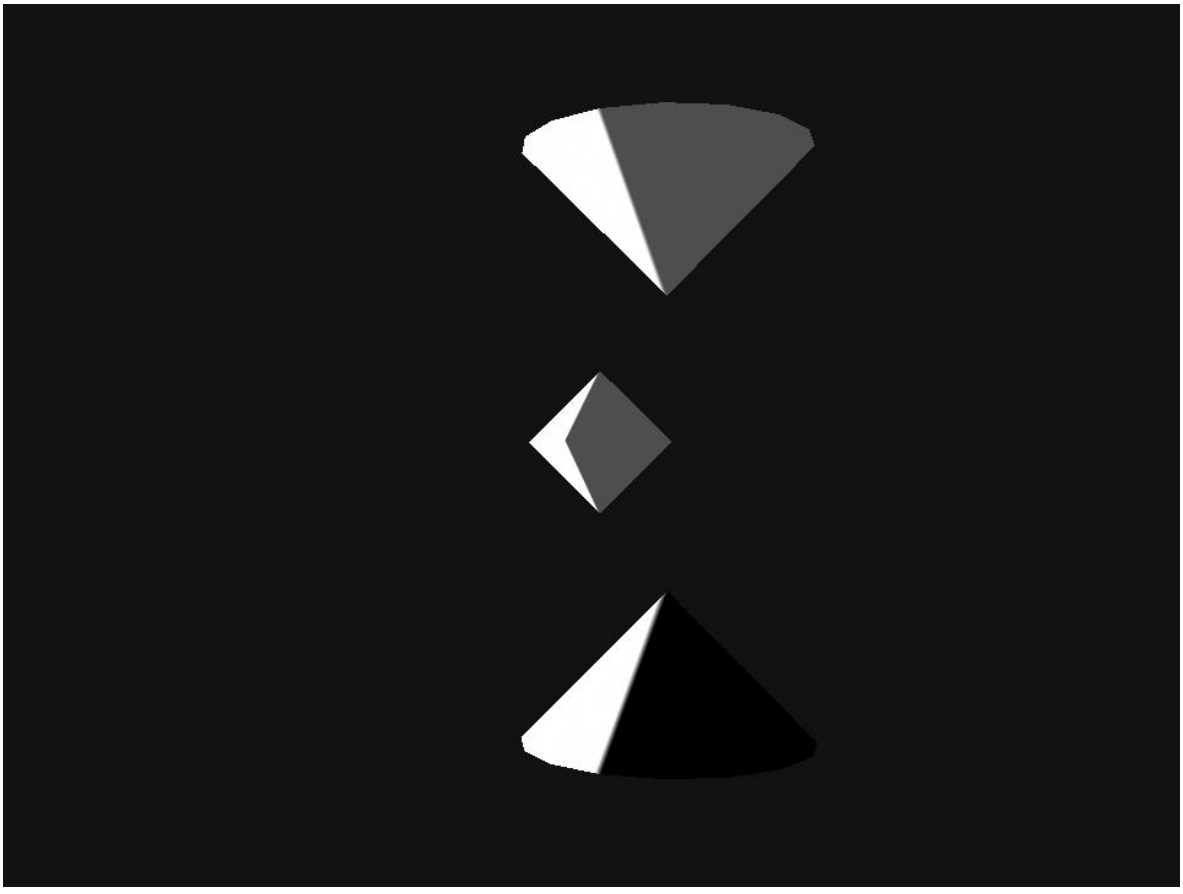




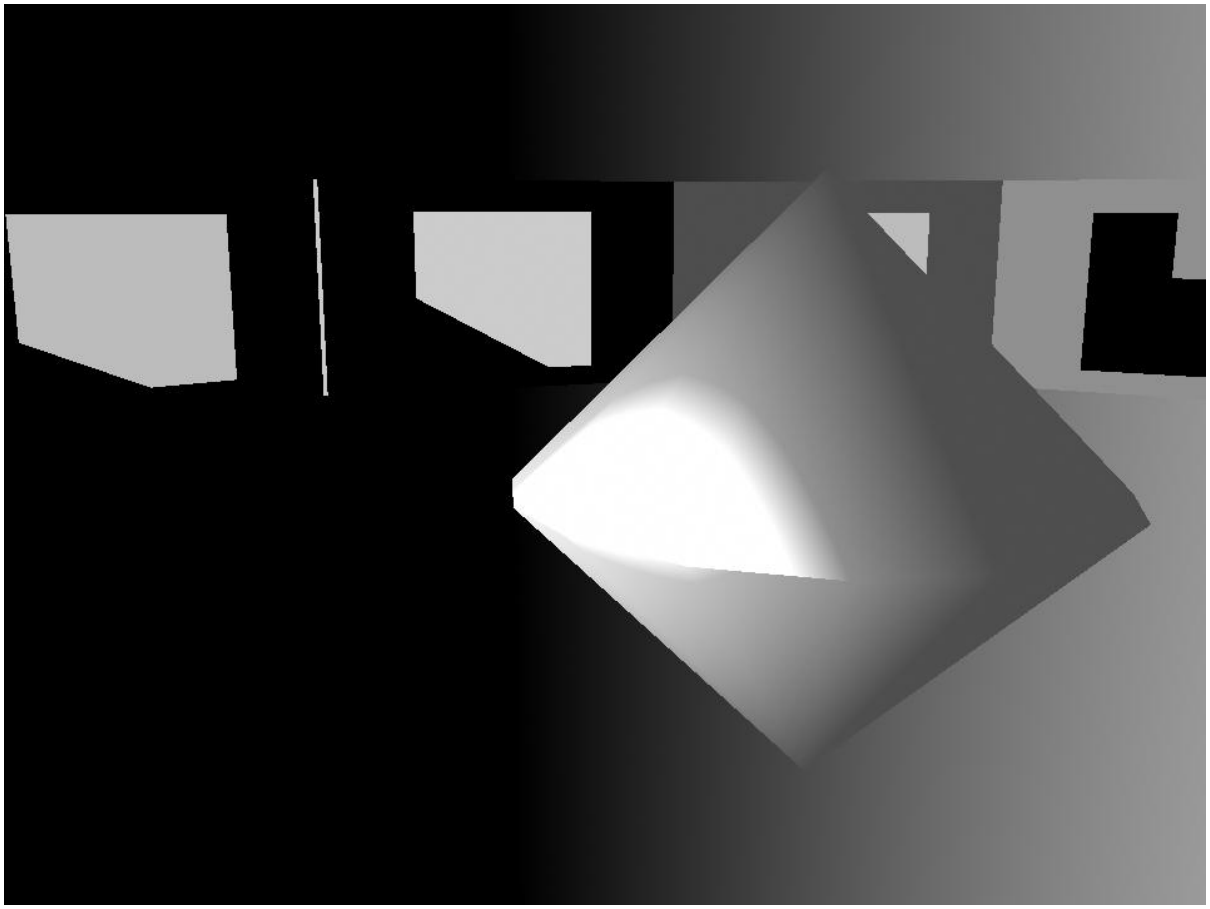


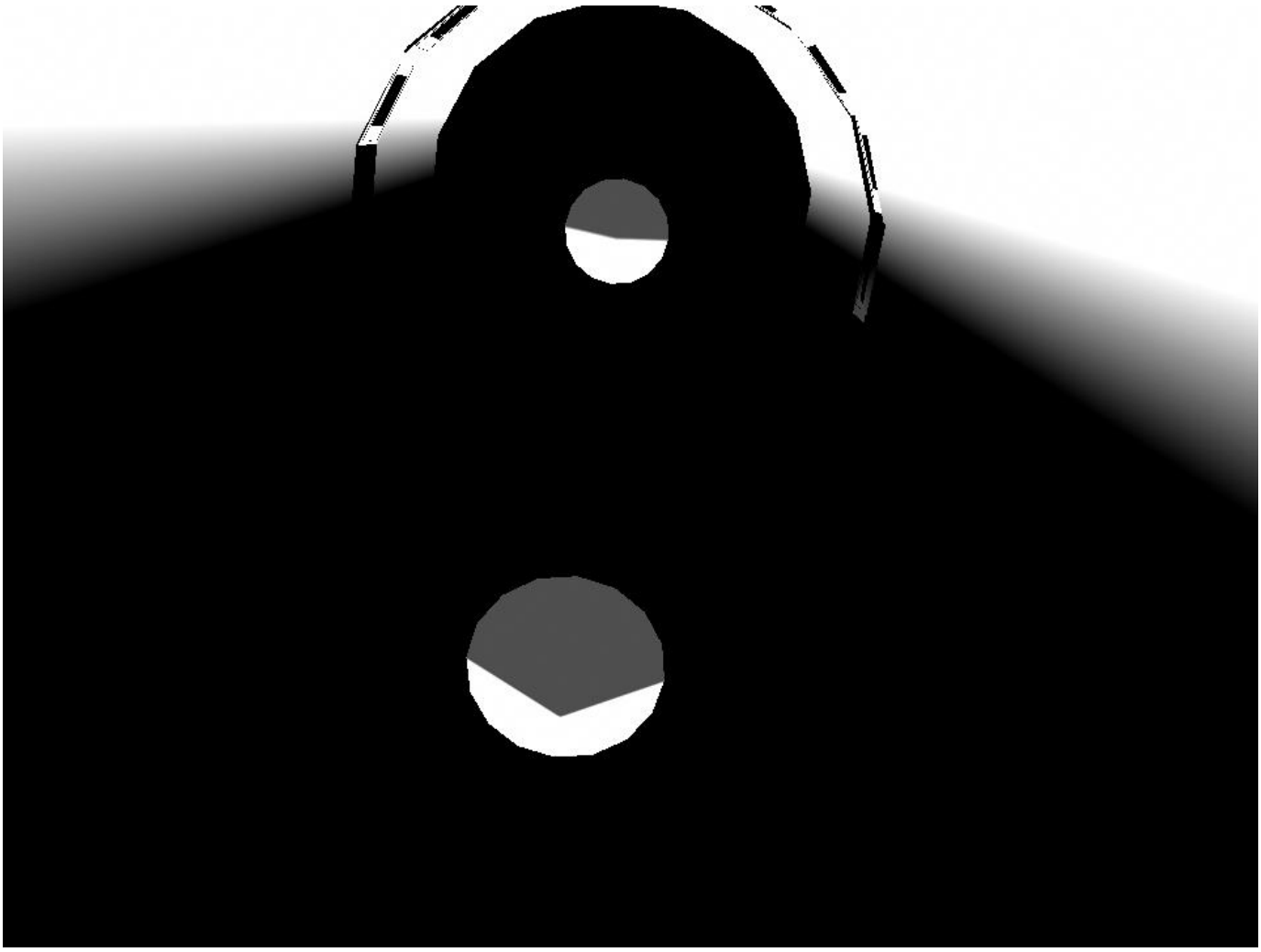
SYSTEM OF MIRRORS

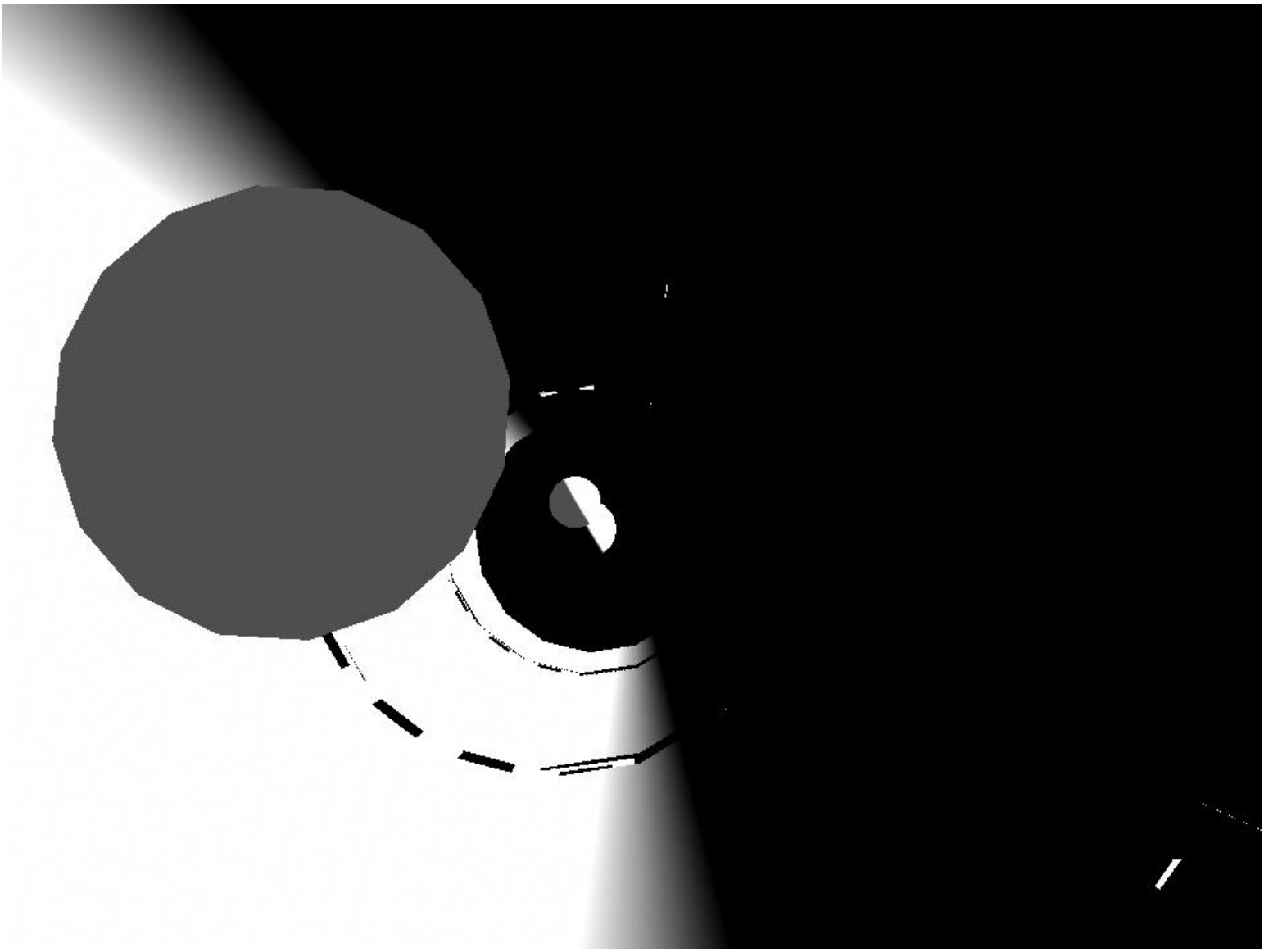




MIRRORS VIEWED FROM INSIDE








Apis

CHAPTER VII

Construction


Apis

1. Where and how?

Before anything will be launched into space, the required material is gathered. Tones of metal, plastic and equipment is accounted for before any shipment is made. The construction will start in lower orbit so that planes will be able to distribute the material, because they unlike space shuttles need less combustible and can carry more equipment and material.

The material will be like a Lego construction made out of pieces that just need to be assembled in a very careful way.

The fist faze will be to create a “skeleton” of the space station, almost entire made out of iron. For this few astronauts, a small propulsion system and lots of shaped metal is required. Planes will constantly distribute the required material and more on more work staff as the station is being put into place.

After the skeleton is constructed the second stage begins, 2 identical hexagons will start to shape up. They will be constructed in a perfect simultaneous way because of the centrifuge force, which needs to be identical in both parts of the station. After this more hexagons are created in the same way.

In all this time while the station is created, the workers will constantly be on a constant move, planes will be bringing personal and material every 8 hours, in which the personal will be exchanged and brought back to Earth with the plane until the 2 hexagons will be constructed.

Even though robots will be used to help the construction very little will be used because the parts are required to be assembled in a careful and precise way and in case of an emergency, difficulty or different settings adjustment humans will clearly be the one’s that need to work there.

2. Material exploiting and processing

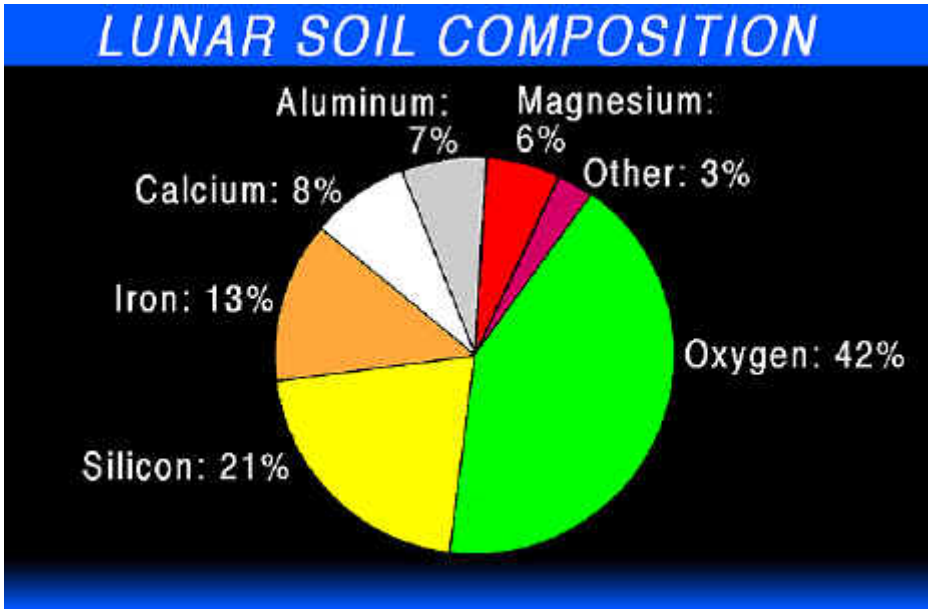
For the construction of the station a huge amount of material is required.
We are going to get that material from 3 places:

-Earth

-Moon

-Asteroids

In the first 2 fazes of the construction we will use only Earth bound materials. After the first 2 fazes are complete launch stations will exist on each hexagon so that material from the moon and asteroids will be brought.



http://www.neiu.edu/~jmhemzac/mooncomp.htm

As it can be seen, the moon has enough resources for the construction of the station so the moon will be our primary resource source after the first 2 fazes are completed. Not only can we use the moon to create the station but also to supply it with air and water.

Consuming the Moons resources will not only give us an edge by not using earth's resources but it will also help us consume less combustible and less personal because of Moon-station travel.

Because the material from the Moon will be in raw form it will need to pass through many chemical and physical changes. These changes will be realized in industrial compounds, existent on each hexagon.


Apis

CHAPTER VIII

Life support


Apis

1. Human necessities

a. What are the human necessities?

On the station we do not need just to live, we also need some special care and "attention" because health is not only physical but also mental.

So what are our necessities?

-fresh and clean water
-fresh and clean air
-the right amount of oxygen and other elements
-food (dry and wet)
-comfort
-medical assistance
-hygiene
-a pleasant environment
-entertainment

The main necessities are food and water but we also need to provide the rest so that life will be as pleasant as possible. What could we obtain by conquering the galaxy or the universe if we aren't happy while doing it?

All that being said we'll have to find in each case ways of keeping life support at its maximum efficiency.

So, how do we provide these necessities?

b. How do we provide these necessities?

First we will discuss the less important factors. *Entertainment* is the least important so how are we going to take care of it?

Well, except TV which will be broadcasted from Earth but also 2-3 special channels that will be provided especially by the settlement, we will have the most used type of media and entertainment possible which will be the internet. Each home will have a TV cable and a wireless internet possibility. Other sources of entertainment like games and different hobbies will be developed by each resident. Also the "fun areas" will be the place where people can relax.

A pleasant environment would be the second so we took care of it by creating fake natural plants in each hexagon, having 3 huge areas just for relaxation and fun.

Comfort will be one of the easiest factors to take care of because each person will have his "perfect home", each home will be designed to fit any general need and having low gravity will also help our relaxation. Job will not be such a problem because people will work 8 hours a day like on Earth but with much more pleasant conditions.

Medical assistance will also be maintained easily because in each apartment we will have a first aid kit and we will have hospitals to take care of almost any injury.

Hygiene will also be very strict so food will be kept in tubes of paste or different plastic containers and the only possible source of filth will be the daily clothes which will be washed. The house will be almost spotless and the few parts of dust will be sucked by the vacuum-cleaner.

Food and water will be bought by each resident so it will be his decision what to buy and when. Food and water will contained in plastic containers, like milk cardboard boxes so no spilling will occur.

As everything will be bought through a card we will know what every resident consumes so in case someone doesn't consume too much of some food and less of the rest or vice versa we will know to attention him.

Food will be prepared where plants and animals will be harnessed and water will be distributed also by that area but unlike food most of the water will be recycled.

2. Low gravity effect on our metabolism

Because most of the traveling that will occur will be at zero-g the inhabitance need to always be ready for such situations. Following the establishment of orbiting stations that can be inhabited for long durations by humans, exposure to weightlessness has been demonstrated to have some deleterious effects to health. Humans are well-adapted to the physical conditions prevailing at the surface of the Earth. When weightless, certain physiological systems begin to alter and temporary and long term health issues can occur.

The most common initial condition experienced by humans after the first couple of hours or so of weightlessness is commonly known as space sickness. The symptoms include general queasiness, nausea, vertigo, headaches, lethargy, vomiting, and an overall malaise. The first case was reported by cosmonaut German Titov in 1961.

Since then roughly 45% of all people to experience free floating under zero gravity have also suffered from this condition. The duration of space sickness varies, but in no case has it lasted more than 72 hours. By that time the astronauts have grown accustomed to the new environment.

The most significant adverse effects of long-term weightlessness are muscle atrophy and deterioration of the skeleton; these effects can be minimized through a regimen of exercise.

Other significant effects include fluid redistribution, a slowing of the cardiovascular system, decreased production of red blood cells, balance disorders, and a weakening of the immune system. Lesser symptoms include loss of body mass, nasal congestion, sleep disturbance, excess flatulence, and puffiness of the face.

These effects are reversible upon return to Earth.

3. Agriculture

The agricultural part has 3 major activities to perform:
-Produces the O2 in the air through plants
-Produces the food, be it from animals or plants
-Produces and researches medicine

These are only the most important factors that this area has to do, but in this area the impurities in the air are consumed and fresh air is ventilated through the entire station,

it helps in way to clean the station and it also consumes all the unwanted natural fertilizer that we produce.

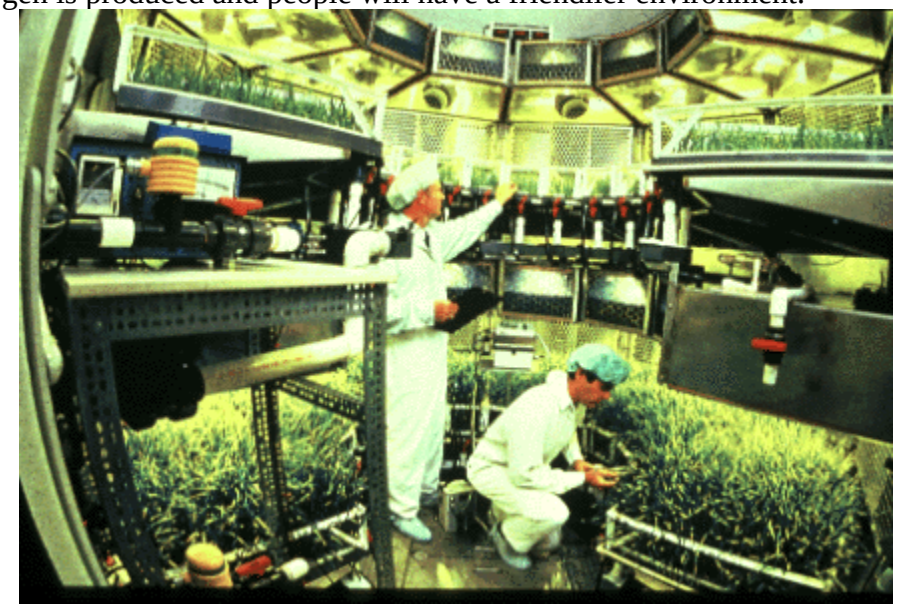
Until about four decades ago, crop yields in agricultural systems depended on internal resources, recycling of organic matter, built-in biological control mechanisms and rainfall patterns.

Agricultural yields were modest, but stable. Production was safeguarded by growing more than one crop or variety in space and time in a field as insurance against pest outbreaks or severe weather. Inputs of nitrogen were gained by rotating major field crops with legumes. In turn rotations suppressed insects, weeds and diseases by effectively breaking the life cycles of these pests.

A typical Corn Belt farmer grew corn rotated with several crops including soybeans, and small grain production was intrinsic to maintain livestock. Most of the labor was done by the family with occasional hired help and no specialized equipment or services were purchased from off-farm sources. In this type of farming systems the link between agriculture and ecology was quite strong and signs of environmental degradation were seldom evident.

Even though we are going to use almost the same method this will be used only for certain crop areas because 99% of the trees will not be over planted.

There will also be trees planted among the city, where inhabitants live so that more oxygen is produced and people will have a friendlier environment.



4. Food supply

A normal astronaut consumes between 1.5-2 kg/day so in order to feed the entire station we need 27 375-36 500 tons of food/year. Except humans we also have 20000 animals to feed. The animals that we feed are herbivores so they will be eating mostly plants and the surplus of food that we produce, under the 100 000 trees on the 100 square meters that each has we will be able to grow enough grass for these animals to eat.

So from where do we achieve that much food?

Because we can create optimal climate control we will be able to make our trees blossom two times a year so more food is produced. So if one tree produce 2 times a year around 75 kg of dry food, 15 000 tons of food are produced by our trees in a year. The rest of 34 000 000 square meters left will be put to use like presented.

Used by	Square meters
Animals	500 000
Plants	15 000 000
Food storage	9 000 000
Food production areas	5 000 000
Other	5 000 000

The food storage will be big enough to hold up to 800 000 000 cubic meters of food. This storage space will be able to hold up 400 000 000 tons of food which will ensure the stations survival for the next 5 years if filled.

Not all plants are used for food production. Some are used in medicine and some for research in different experiments (5%).

5. Water supply

a. Distribution

Water is the key for life existence so we have to be very careful on what and how we use it. Water will be used mainly in 5 things:

1) For drinking
2) For the growth of plants
3) For animals
4) For washing
5) For industrial usage

Water will be distributed in bottles with straws so no spilling will occur and the bottles will be recyclable so nothing is wasted. There will be 2 types of used water:

1) The water that comes out of our home consumption
2) The water that comes out of the industrial consumption

The first type is stored in containers under each building, and when they are almost full, it is taken to irrigate the plants because it is a good method for recycling and efficient because it can be used as a natural fertilizer. The industrial water is taken directly to the industrial areas for filtration.

In normal conditions water can be recycled 90-95% but because most of our water isn't recycled until after a second usage on plants and so on the water recycling rate will rise to 97-98%.

b. Water usage

Water consumer	Quantity(L)/day	Nr of consumers	Total(L)/day
Humans	2	50000	100 000
Industrial Consumption	50	20000	1 000 000
Animals	15	20000	300 000
Other	1	50000	50 000

In total we use 1 450 000L/per day and if we have a 97% minimum recycling capability it means that we will have to produce 43500L/day.

So within 100 years we need to have stored 1587750 tones of water. Consequently, we need 1587750 square meters of space which means a surface of 315m*315m*16m tall which is easily stored under either under the city in special reservoirs or in the agricultural area.

In total under the city can be store enough water to keep the station functioning for the next 10 000 years so if we gather enough water we will not have to worry about it a very long time.

Water will be bought from the supermarkets in the required quantity by each inhabitant so no fuss over water or any other product will occur.

c. Water recyclage

As we said the water recycling will be between 97-98% and the 2-3% percent lost will be recovered trough the water storage which will be constantly supplied by the resources brought by the scavenging of meteorites and other planets.

Water will be filtrated many times before reused. It will be first evaporated in huge containers and filtered of its impurities trough special filters. This process will be repeated several times to be sure that the water is at least 99% pure. After these processes the water will be repute into use.

The impurities left will be compacted and send as garbage.

6. Meteorites

The main treat for our station is clearly meteorites because a station could not have an atmosphere so it is likely for even the smallest of meteorites to damage the station.

What did we do about it?

First and most important is the fact that we have rockets and even nuclear arsenal if that’s that it takes to make the treat disappear.

The second and simplest solution is to move the station out of harms way, because to move something in space is very easy and having the right engines and

equipment will be easiest way to move the station. The station can be moved by the engines or simply by waiting for the station to orbit, depending on how fast we need to get out of the way.

7. Fire

As every structure in history it faces the forever existing treat, fire.
In this station case fire won't be such a big problem because being made out of iron and plastic and all its components separate on from another in case of absolute necessity detaching the incinerated part from the entire settlement. In case of small fire they can be stopped in two ways:
-the traditional way of extinguishing
-or by evicting the certain hexagon and eliminating all the air which will instantly extinguish any fire existing on that hexagon

8. Short circuit

Another general treat is a short circuit so that and many other reasons is why every hexagon and all other parts are independent when we're speaking of energy, electricity more correct so in case one of these hexagons suffers a short circuit the rest can continue to work properly.

9. Other physical factors

Each part of the space settlement is independent and by discarding one of the spheres or by closing all connections so that it will be isolated from the rest could solve most of the problems for the moment. In case of a small incident be it explosion, fire or whatever the problem might be if the exterior part of the sphere won't need repairs the sphere can just be isolated from the rest by closing all connections and repairing the broken part but not detaching it.
In case of a worse incident, the hexagons will be detached from the station and it will be immediately taken and repaired separately from the station and in case an industrial compound or worse is damaged it will be detached from the sphere and mended into space by specially trained astronauts.

10. Radiation

Radiation will be one of the highest risks because if radiation were to spread across the station everyone on the station will die so special precautions will be taken. The only places that radiation can spread will be separately from the hexagons because there we will have nuclear arsenal.

Nuclear warheads are made either out of plutonium either uranium in each case they both emit 4 types of radiation: alpha, beta, gamma and neutron. The most dangerous is gamma because it isn't sopped when passing through material it is only just cushioned.

Because there can't be the necessary obstacles through which the radiation to be stopped we will have to take extra special care in the assembling and maintenance of our nuclear arsenal so absolutely no incidence will occur.

Other types of radiation:
Solar radiation:
-Radio (no effect)
-Infrared
-Visible (easy to shield)
-UV
-X-ray (hard to shield)
Sun's particle output – (hard to shield from)
-Solar wind
-Low & High-speed streams
-Solar-energetic particles from flares (mostly electrons)
-Solar-energetic particles from CMEs (mostly protons)
Anomalous cosmic rays have very low intensity at Earth's orbit with negligible effect.
Galactic cosmic rays are hard, or impossible to shield from.

11. Outer travel costumes

Radiation Risks
Carcinogenesis
- Leukemia
- Solid Cancers

Degenerative Tissue Effects
- Heart Disease
- Cataracts
- Respiratory Disease
- Digestive Disease

Damage to the Central Nervous System
- Motor Skills
- Behavior
- Accelerated Aging

Acute Risks
- Death
- Vomiting/Nausea

Potential Outcomes
- Mortality : Reduced Life Span
- Mortality : In-flight (Acute from SEP Events)
- Performance Degradation

- Morbidity : Post-Flight

12. Garbage

As any city in the world our space ships produces garbage and by garbage I mean the parts that can't be recycled. As previews said garbage is sorted and recycled but not all of it can be recycled.

The parts that can't be recycled are taken to an industrial compound where they are burned as much as possible.

The rest of the ashes that remain will be compressed as much as possible and they will be sent swiftly packed with a trajectory that will lead them into the sun where they will be fully incinerated.

Thus almost no pollution will occur because of this system.

"The Cleaner" will be a program that will take care of all the garbage of every hexagon. Once a day 3 special cargo ships will come and visit every hexagon, the first two will take the plastic material and the other one will take the paper and other material that has been used.

These ships will carry the garbage to the "industrial areas" to be recycled as much as possible.

The program also include the vehicles that will go though the stations every part and clean them too so the station theoretically will be as clean as a whistle.

Because the entire space ship will be monitored by cameras in case someone litters or doesn't respect the laws for the maintaining of the station we will discover them very easy.


Apis

CHAPTER VII

Accomodation


Apis

1. Basic Concerns

a) Climate

- temperature 22*C – maintained artificially by heating or cooling systems of the air and water within the ventilation system

- although on Earth a large variety of interconnected climates which are found in large areas, each with different characteristics, we will not try “to copy” that on our space station because it is not efficient: first of all materials can wear out because of often changes; the limited space forces the agriculture and industry to be very high-tech but at the same time limited, because of that the production must be at a maximum; humans require comfort, safety in the everyday life, especially on a space station, that’s why optimal life conditions are necessary. Because of this reason the temperature in the inhabited spaces will be kept at 22*C and in the other places of the station the temperature will differ in relation with the activities in those areas, although we will try to keep the differences minimal so that the average temperature will be constant.

- wind will be an important component on this station, as long as the ventilation system is very well thought. But in the special cases like parks and gardens where the wind has the purpose to reproduce the conditions of Earth, wind can be produce through processes like pressure differences and/or temperature between different bodies of air, or utilizing systems which “blow” wind with a controlled speed.

- rain will be created artificially in different ways: in agricultural areas there will be installed irrigation systems localized very high from the surface, so the falling water can imitate rain. Controlled through a well thought system this type of rain will assure the optimum humidity for the growing of crops and plants. In the gardens specially designed to imitate the conditions on Earth so the inhabitants will not miss Earth, or for them how Earth is like, clouds will be formed by evaporating a quantity of water and then through the process of condensation . These gardens will be very limited, being living museums of an Earth-like environment. Another type of rain will be used in any inhabited or accessible (by a human) area on the ship. This type of rain(snow, or other types of

precipitation) will be created virtually by using a screen that will mimic the sky, sunsets, sunrises and beautiful landscapes meant to delight the human eye.

b) Illumination

- the day – night cycle – day-time will last for 14 hours and night-time, to be able to maintain the rhythm with which humans and the other living being are used to, because any change introduces a irregularity in the organism, which could have multiple effects like dizziness, sleepiness, etc. which could lead to emotional unbalances, a very bad thing for a person who lives in a terrestrial space, but a limited one at the same time.

- in the case of agricultural areas day-time and nigh-time will have adjustable intervals of time, depending on the crops being grown, for an optimum production.

- in inhabited spaces and gardens the passing from day to night will be made through the usage of sunsets and sunrises, so the organism will have time to adapt to the change.

- illumination will be made possible through a system based on the principle of total reflexion – optic fiber. The light is captured on surfaces existent on the outside of the ship; from there it's transported through the optic – fibers. After that the light will be filtrated in order to eliminate any dangerous elements and that it will reach the areas that must be lighten. The advantage is utilizing natural sunlight, all the elements necessary for the normal development of humans and other living organisms, eliminating ocular problems or problems of the bone system caused by the lack of sunlight. This type of light will be used everywhere so animals and plants can be grown in a natural way, without forcing them through the usage of pesticides or insecticides, without polluting agents, so the food consumed by humans to be as natural as possible.

- because of the fact that light has an important psychological, we will try to recreate all the elements/phenomenons encountered on Earth by using a virtual sky with all the elements and phenomenons encountered in the real nature (sun, clouds, stars, etc.)

c) Vibrations

- vibrations have a negative effect on the ship and it's inhabitants; because of the fact that the ship will be constructed out of multiple fragments(hexagonal tubes) it's structure will not be affected by the activities going on on board, but the population will be affected. That's why a system to isolate the vibrating sources will be created, by utilizing different substances or materials to neutralize the vibration. For example the industry area could be enclosed in a space filled with liquids that would absorb.

d) Noise

- noise would primarily come from the industrial zone of the ship and it could be very annoying for any kind of living being, especially for humans, as a psychological and physiological effect, so the reduction on neutralization of noise will be an important issue, which can be resolved by perfecting this system which absorbs sounds and vibrations. Also walls will be very thick with hollow spaces or spaces filled with different substances to stop sounds.

- because of the fact that the ship has will be built from different tube-shaped hexagonal modules echo will not pose a problem, and so the noise won't multiply, thus becoming unbearable. But in any case, in the inhabited spaces of the station it will be necessary to build interior walls to absorb sounds.

e) Odors

- smell is a very important in those areas where air gets to; thus it is very important to create different types of ventilation systems to remove odors.

- in inhabited areas a good ventilation and purification of the air is necessary; this can be done by passing the air through different substances to retain impurities and particles that come in contact with the olfactive cells in the nose. On the other hand this problem can be solved by sealing the sources of the disagreeable smells and with the

existence of special gardens with will recreate the environment on Earth and thus generating a pleasant smell and fresh, oxygenized air.

f) Food

- The food will be entirely natural, without coloring matter or other chemical agents, grown in special equipped spaces, to determine the people to eat healthy, to be healthy, active both physically and mentally and to bring prosperity and the good function of this station and maybe in the future to others as well.

- A healthy diet will be imposed by the existence of only natural products.

- All the species that are known to be comestible or that can be used in the kitchen will be cultivated but the biggest quantities will consist of: potatoes, wheat, corn, rice, cabbages, tomatoes, soy beans, etc and also of meat: chicken, cow, pig, lamb together with dairy products and eggs.

- A equilibrated diet together with a schedule (work, school, sports, relaxation) will ensure the normal development of the human body and mind.

- The food, although raised in specially equipped spaces, will be let to grow natural.

g) Hygiene

Hygiene is one of the vital conditions of the man which physiologically and mentally affects his body. It also contributes to the formation of the self-image and the image of those around affecting the social life, for which it has to be provided to those on the ship. Because of the necessity to preserve water and recycle it, the agents that will be used for cleansing will have to be as natural and as efficient as they can be, not requiring a lot of water to remove them, to act efficiently, not to be difficult to extract them from water to reuse it. The cleansing agents will be created on the ship in conjunction with the pollution norms – all that is natural doesn't pollute. This way, plants will be grown that have the some substances as those which exist in soap. The baths or any other space designated for hygiene will be connected to the water system, very well designed, along

its length existing a number of water recycling centers because the loss of the water will be devastating.

h) Decors, surfaces and colors

- The way the place that we live in looks is very important to us, and for that reason, the decoration of the space in which we live in within the ship is very important from a functional and also an esthetic point of view: this way there will be more categories of elements to ensure the esthetic function on the ship and also the high spirit of its inhabitants.

- Natural gardens – are spaces in which will be recreated certain ecosystems from Earth, having in the same time functions to recycle water and air, and also cultural, educational and relaxing functions for those who come in contact with this piece of "Earth".

- The living space will be equipped so that the superior part will look like a virtual sky with clouds, a clear sky, rain, snow, stars and moon, etc; the dwelling part and also the free spaces or those in which people walk will be integrated in a huge circuit – with chips or other technologies – to a central computer. This way the whole dwelling area will be a space that can be virtually drawn by the central computer with the agreement of those specialized in public spaces, and with the consent of the respective person for its own private space. The interior of each dwelling will be equipped with the basics, other elements being added by the owner as a form of manifestation of his own will.

- In this way, the decors can be controlled and changed, the man having the right to change everything after his own will.

i) Pests

Diseases, infections, etc are almost impossible to avoid but with a good medical system and a good education for health these things can keep under control any manifestation of bacteria, viruses, etc.

2. Long time aspects

a) Space Settlement, Political System and interior order

The interior order and the assurance of the private and public life of each human on the ship are essential to call him a citizen. The political system is very important because his rules and ethics will have to create the perfect environment for development for a very large number of people, which without rules and organization can lead to major conflicts or to the disturbance of the life on the ship. Because of this, a political system which will restrict the possibility to modify the ship or to protect it from conflicts and at the same time to ensure the liberty of the citizens has to be imposed.

The political regime will be a democratic one, with representatives chosen from the whole population of the ship by universal vote. This way, every individual has the right of opinion. The rules and regulations will be elaborated by people responsible for their respective domain together with a team of specialists which will mediate the interest of the population and the good of the ship as a place and way of life. Every module will be considered as a city state and will be functionally and politically independent from the other modules, having representatives for each minister just like a democratic state on Earth, collaborating at the same time with the “cities” from the other modules of the ship.

The democratic regime will not restrict the freedoms of the citizen, but will impose certain rules which will not allow the modification of the internal structure of the dwellings or other spaces, the use of chemical substances, pollution, etc that will pose a danger to the safety of the ship and to its inhabitants. This restriction to the actions of the man must not be misunderstood as limitations to his freedom, but as a precautionary measure for him and the environment he lives in. This will be made clear by educating the future generations in the spirit of conservation of nature and environment, of protection and care for all that means life. The education and the health system will play a big part in spreading these ideas.

Like any diplomatic regime, the responsibilities will be shared by different departments: economics, industry, agriculture, education, health, commerce, etc.

In the everyday life of those who live on the ship may appear different problems that the “state” will have to fix or at least get involved in fixing them in conjunction with the Human Rights. Whether is homicide, theft or other actions which violate the human rights and the rules for internal order, whether is about a misunderstanding between two families which talk different languages, the “state” has to have initiative in dealing with these problems. Otherwise the families will be placed by certain similar characteristics that will permit a good communication, an important exchange of ideas that are absolutely necessary for the development of a social life, and even more, for ensuring a familiar environment, a friendly one, which they can call “home”, having an effect over their lives and all of their activities.

Studies regarding the lives of those on the ship will be conducted permanently. Their purpose is to develop and improve the conditions on the ship. The round-the-clock surveillance of the crime rate, fires or other provoked or unprovoked disaster will be absolutely necessary, and the measures against there will be very strict and in conjunction with the new discoveries.

Any form of pollution of the ship space is strictly forbidden and will be punished in conjunction with the ship laws. In a limited space with limited resources, the human can’t afford to waste or to contaminate what is the only chance of survival - the ship. Pollution means destruction of life and humans should learn something from what is happening on Earth.

b) Monetary System

The monetary system will be an electronic one.

c) Crew composition and employment

The population will consist in young people with ages between 20 and 45 years old. At the same time, there will be also brought on the ship elderly people and kids who represent the families. This way, on the ship will be a large variety of people, with different ages. In time things will change, but it will be attempted to keep a certain

number of people. This way, the allocated space will not become overloaded, thing which may extremely affect some of the aspects of the people's lives. It will be also tried to preserve a certain percentage of the people's ages so that the number of the active population can fill the number of job places.

The population on the ship will have an equal number of men and women to ensure a balance in the social life as well as on a professional level, ensuring the variety of idea.

Almost every professional activity on the ship will require a staff with a higher than average qualification, that is why a policy of education and study will be promoted in a matter in which it will ensure a steady flow of activities on the ship, but also the advancement of science through stunning discoveries.

d) Health Care

The health care system must be supported by every inhabitant through a fee. This money will be used for the welfare of hospitals, the salaries of medics and for drugs or different treatments. In every module there will be a central hospital, and through-out the inhabited areas there will be certain fast-response and first-aid centers, which will oversee and provide assistance in case it is required. Close surveillance is necessary because this ship represents a first, it has no precedent, and the long term effects of life in space are still unknown. And so we'll be able to keep track of all the health problems for which we might be able to find a cure or changes to the ship's construction so that the people who live there could have a better life.

Disease will try to be prevented trough an accurate examination system, which will hopefully reduce the need for medication. On the other hand it will be experimented with non-conventional cures like: bio-energy, acupuncture, reflex-therapy massage, aromatherapy and others, which will enable us to avoid drugs that are created using chemicals which increase the risk of pollution.

e) Education

The education system must be very advanced, and capable to offer the new generations an adequate education. They will be thought in the spirit of maximizing the human potential, but also in that of protecting the human kind and its habitat. An so school will be divided in stages depending on the persons age and wits, during the first part the student will be thought general information and after only one field in particular. It is very important that period dedicated for the study of the general information is not too long- for example one third of the total study time should be enough- because after that the child starts to lose his originality and his creativity, and with them some new and unexplored ideas that might change the life stile on the ship.

The duration of the instruction will depend on the student, but considering the fact that almost every activity requires a high level of training, it will take about 17-18 years from the life of a new generation.

The need for a god education understandable, because this is the only way people can be thought to protect the environment and our kind at the same time.

On the ship you will find besides the usual kindergartens, schools, high-schools and colleges, you will be able to find centers for children with disabilities and other special centers that will help the young develop their aptitudes.

f) Transports

Passengers and goods will be transported either by elevators or by specialized trains for speed and safety. The main transport routes will be inside the modules, but also in between and even outside the torus – form the central axels support pillars towards the torus.

The entire transportation system mechanized and robotized in order so that it may be controlled for the center. All the machineries (trains, elevators, and tubes) used for transport will be non-polluting and so respecting the ships standards. Depending on how much the journey lasts or on the type of transport (passengers or cargo), the transport utilities will be equipped accordingly being divided into transports between houses,

between two inhabited areas and transports that will take you from the inhabited area to the agricultural one, etc.

The transport towards others destinations outside the ship like Earth will be done by space shuttle.

g) Communications

Communication, may it be between two different modules, or from ship to Earth will represent one of the most basic needs either for information exchange, or used as a way to socialize. Communication will be achieved by using a network that connects both the population's computers and the system that maintain social and economical life on the ship. The network will work using fiber optics, which represent and adequate choice for the ship needs. Another useful method of communication is radio-waves which can also be used with success on the ship. Communicating trough Mail and packages – the old way- will be possible due to the transport system which will ensure one of the habits on Earth.

h) Entertainment

The need for fun, for relaxation, the need to do something different is something that no one can ignore. That is why, to avoid behavior issues and to ensure their well being special places for fun and relaxation will be created. Besides cinemas, theaters and houses, special places will be created where people can meet and do different things depending on their age and their preferences. For relaxation there will be special gardens where we'll try the preservation and adaptation of certain echo-systems form Earth will be attempted. A walk through the garden can be relaxing and interesting at the same time especially for the ships future generations.

i) Psychological needs

Men needs more than air, water, food, a place to live in and a few other vital conditions. He needs to interact with different people; he needs free time, freedom, the right to speech. He can hardly live in an environment that has no color, creativity or no spontaneity. The lack of communication, of interaction among people can lead to serious behavior disorders. Freedom, privacy, freedom of speech, the right to power, access to a relaxing environment or an entertaining one, public life can be added to the list of things a men needs, and for this reason specialists on the ship must make sure they provide all of this and closely supervise their social development.

3.Industry

The Industrial area section will be isolated for sound and vibration, and reducing the danger for sonic or chemical pollution in the agricultural and inhabited area. The industrial area will be mechanized and robotized which drastically reduces the need for human personnel in its activities.

Because the ship is so far away from Earth the ship has to produce all that is necessary. The resources will be able to regenerate, because it will be possible to extract from different celestial bodies. Maintaining the industry with such a low level of pollution is an extremely difficult thing to do, but its success guarantees the longevity of the ship and with the creativity and innovation of the people on the ship it might lead to the creation of new inhabitable space like our space station.

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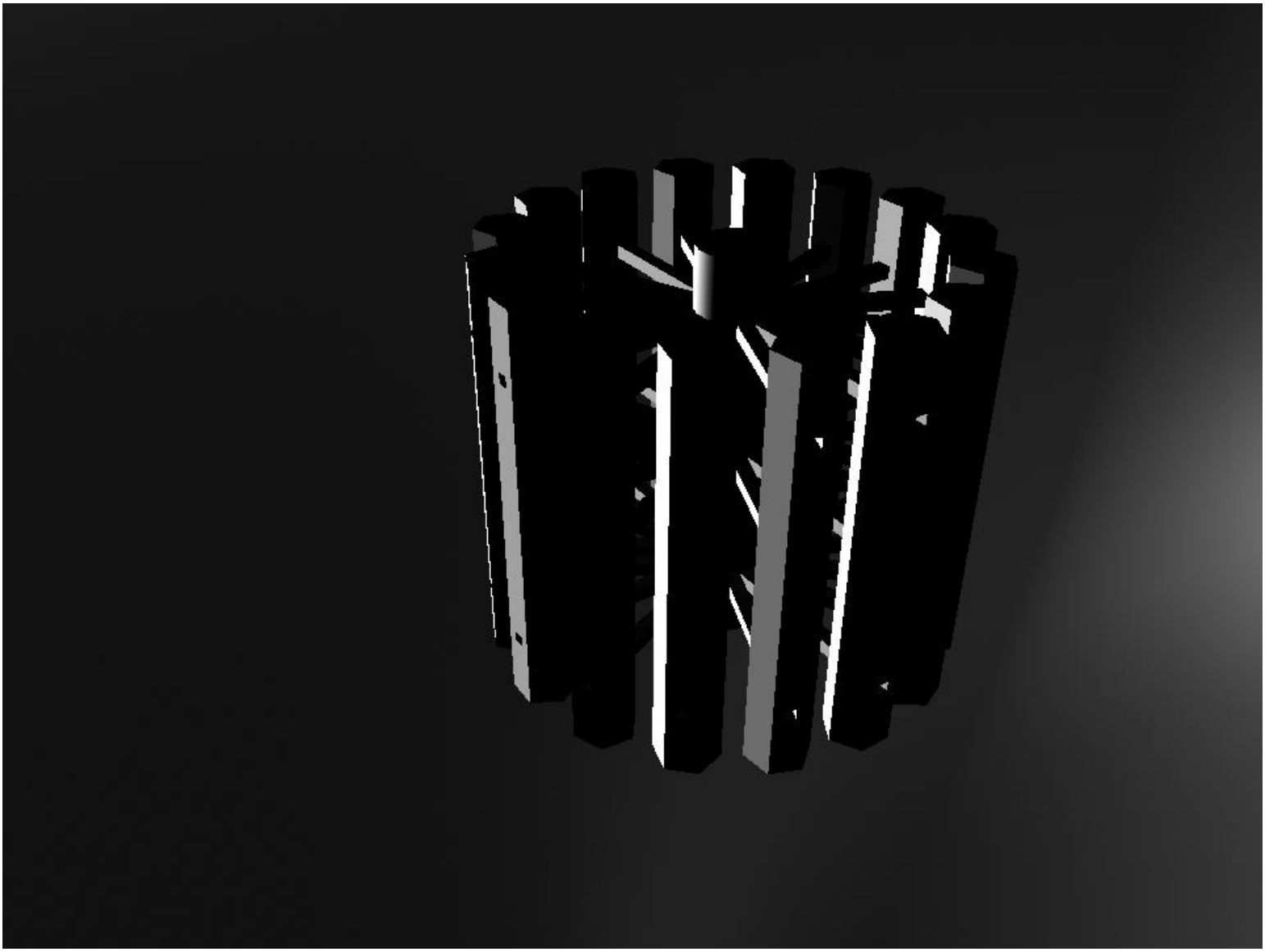
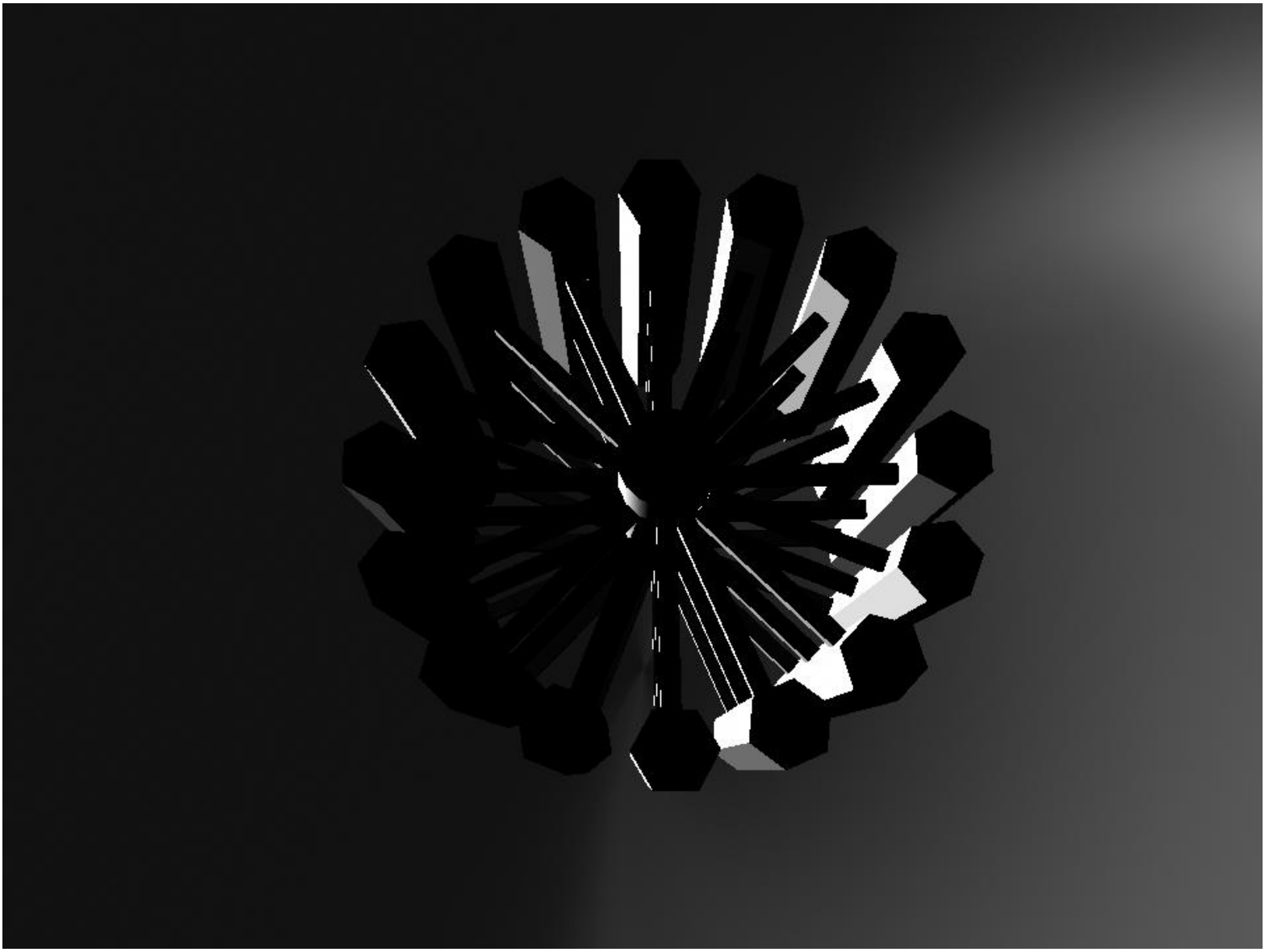
Appendix 1

PICTURES OF THE SPACE SETTLEMENT IN FIRST PHASE WITH JUST ONE FILE OF HONEYCOMB CELLS





APPENDIX 2

MEMORIES

“All men should strive to learn before they die, what they are running from, and to, and why.”

James Thurber

The Romanian Coast, a true open gate to the world, is known and recognized by those who have visited it. This album which tries to present Pontus Euxinus landscapes when the Earth was a proper place to live invites you to be never it and to keep in memory its beauties.

Music: Romanian Rhapsody by George Enescu

Made by Olteanu Oana Elisa

Memories is an album which begins like above. Considering people will leave on Apis and on Earth will not be conditions for life sustaining I think we should start to make albums or movies like *Memories* in which are presented ordinary thins for us now when we have them but in the future will be just a dream. I took our example as we are from Constantza, a city on the Black Sea shore we like walking on the beach and that virtual walk could be a way of relaxation and a way of learning for the next generations from Apis. They will learn about our planet but also about their origin, in my album I chose specific music that represents us Romanian Rhapsody by George Enescu.