'The sky is no longer the limit.'

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1.Executive summary

1.1 Space settlement introduction

A space settlement has been a major interest in the scientific world since the 1950's. Although of high importance, this matter remains unknown to the masses. By developing this project, we became aware of the possibility of finding human shelter in what seemed to be a hostile environment. This is why we want to thank NASA and NSS for giving us the opportunity of elaborating a home away from the Earth.

By making this project we feel as taking part in something bigger than just our ordinary teenage life, as helping nowadays world reach a higher level of evolution. How else could we do that but by expanding our influence into the most gloomy of areas, the outer space. We feel that raising the awareness of students of today will enable humanity to enter a new space era, the era of space colonization. As we consider this possible to happen during our lifetime, we consider our generation responsible for transforming what close minded people regard as a far-fetched dream into reality. This is why we're aiming at helping others our age (and not only) fully understand the potential NASA has for future greatness.

We would like to express our special thanks to our physics teacher, Ioana Stoica, for she has been a backbone for our project. Being our form teacher makes her closer to our hearts. This made her able to give us the necessary moral support throughout all the time we spent working on this project.

One of our most sincere thanks goes to NASA and NSS for making this all possible to happen. By providing us useful bibliography, we were able to inform ourselves. The information we acquired got us interested in space colonization not only for a few months, but for a lifetime. We are grateful that NASA didn't leave this matter to professionals only, but gave high school students the unique chance to get involved in something that will change human life as we know it forever.

Last but not least, we have to thank our parents, friends and school because we couldn't have made it this two months without their help, which was priceless. They brought out the best in us.

1.2. Reasons for having a space settlement

James S. McDonnell believed that “The creative conquest of space will serve as a wonderful substitute for war.”, meaning that the opportunities that the outer space offers us are a blessed way of avoiding calamities and catastrophes on Earth.

For example, the space offers mankind the chance of expanding, of building new lands called ,,Space Settlements’’. For now, this project is just a concept, but in a few decades, who knows what gloomy places in the Universe the man will have visited?

A Space Settlement represents an innovative way of extending our knowledge about the space, microgravity, nanotechnology and many other subjects. For a colonist it represents a lifetime experience, probably the most unique and beautiful of all, because living on such a settlement not only gives the occasion of seeing unforgettable sights, but also of rediscovering the inner-self. Closer to infinity, the man will have reached all the stages of evolution when colonizing the space: a dream came true, a gift.

Another advantage of the settlement is, considering the fact that someday in the future the Earth will no longer be able to host such a numerous population, representing a convenient shelter conceived by humans. This will be due to overpopulation and also to the exhaustion of natural resources.

In conclusion, we believe that such a project shapes our minds in such a way that we are more open-minded, innovative and self-defending.

1.3 Aurora

The most obvious choice for naming our space settlement was a technical name, an acronym related to its fundamental characteristics. However, we figured out that such a choice would be quite tedious. We decided to choose a more vivid name, one who would better fit the idea of space colonization.

Having said that, the name we opted for is Aurora. At first thought, the reasons for choosing this one might not be apparent, but when taking a closer look it becomes self-explanatory.

The word ‘aurora’ is the Latin for dawn, and for what we consider, a space settlement will symbolize the dawn of a new space era, that of space colonization.

Furthermore, Aurora is the goddess of dawn in Roman mythology. Its equivalent in Greek mythology is Eos, daughter of Hyperion and Theia. Born of a bringer of light, the ultimate source of energy and his wife, the Devine she is considered to be the mother of all star and planets. In a similar manner, the first space settlement will become the bringer of human life as we know it in outer space, being the achievement which will boost colonization in the universe.

Our space settlement will travel together with the moon never leaving the place where it’s supposed to be, they’ll stay together like sisters as Aurora’s sister was Selene, mother of the Moon. Brother of hers, Helios, god of the Sun will provide them with light, much needed for the thriving of life.

On the other hand, the name Eos can also be an acronym for Earth orbiting settlement. As this is a simplified version of the definition of our colony we find it most suiting.

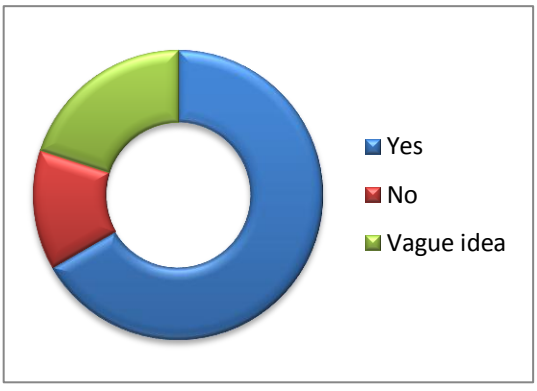
In order to conclude, we believe this name to be a good pick because not only does it have a fitting meaning, it is also catchy, thus arousing interest.

1.4. Social studies

A project such as a Space Settlement is a big step in the scientific history, so public opinion is a highly fundamental matter to discuss regarding this subject. As ideas and opinions are very easily spread, we decided to make a survey in our school in order to get a glance of what other students our age think about this project.

Question 1:

Do you know what a Space Settlement is?



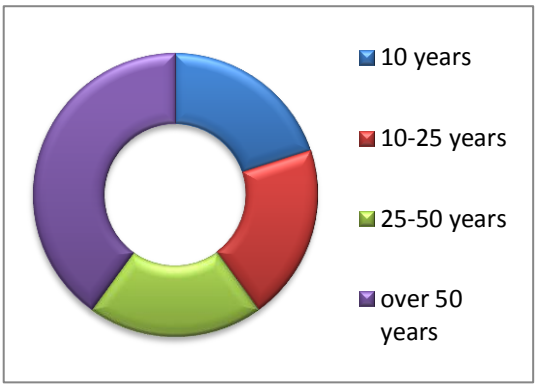
a) Yes - 11 Answers

b) No -2 Answers

c) I have got a vague idea -3 Answers

Question 2:

How long do you think it will take the scientists to be able to build such a project?



a) 10 Years - 3 Answers

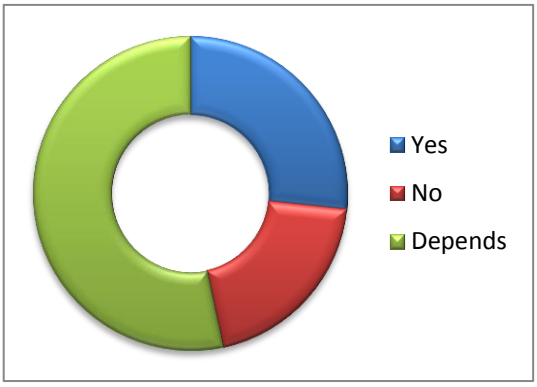
b) 10-25 Years- 3 Answers

c) 25-50 Years- 3 Answers

d) Over 50 Years - 6 Answers

Question 3:

Do you think a Space Settlement is a safe place?



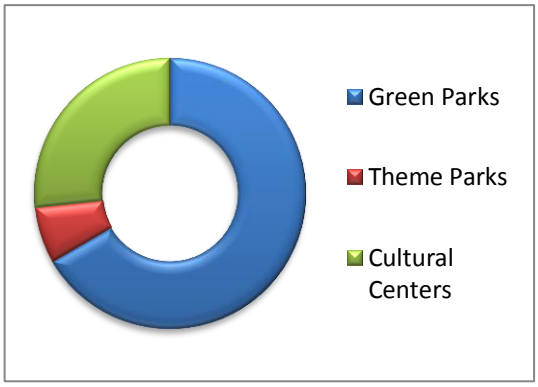
a) Yes - 4 answers

b) No - 3 Answers

c) Depends - 8 Answers

Question 4:

What kind of leisure place would you like to predominate on the Space Settlement?



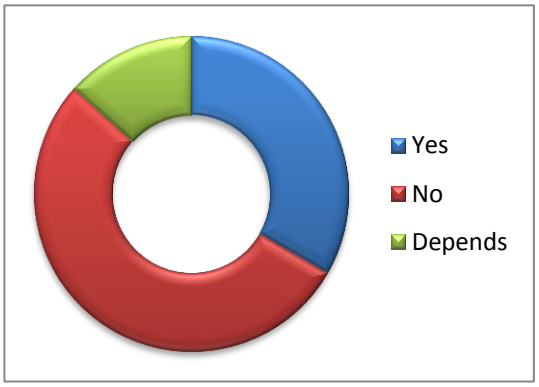
a) Green Parks - 10 Answers

b) Theme Parks - 1 Answer

c) Cultural Centers - 4 Answers

Question 5:

Do you think that life on a Space Settlement is a better version of the life we have on Terra?



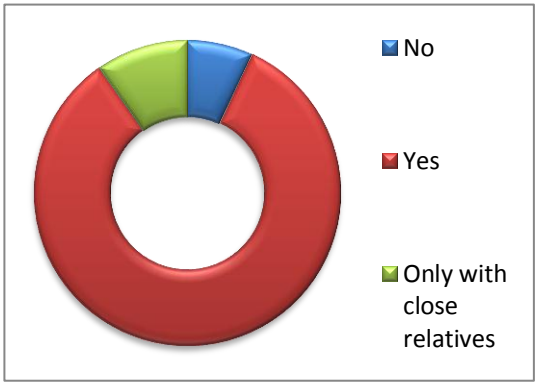
a) Yes – 5 Answers

b) No - 8 Answers

c) Depends- 2 Answers

Question 6:

Would you keep in touch with the people you know on Terra if you lived on a Space Settlement?



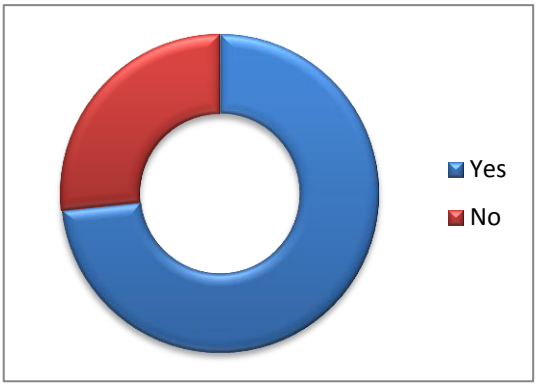
a) No - 1 answer

b) Yes- 12 answers

c) Only with close relatives - 2 answers

Question 7:

Do you think space colonization will reach the stage when Earth will become a deserted planet?

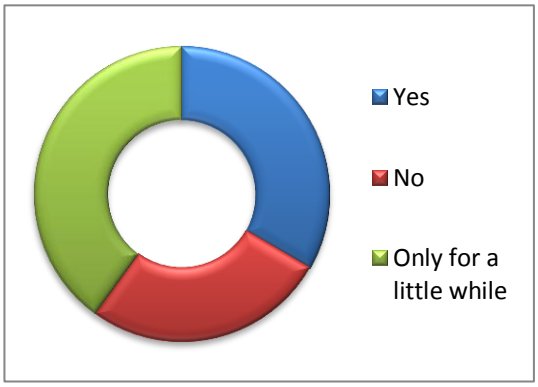


a) Yes - 11 answers

b) No - 4 answers

Question 8:

Would you like to live on a Space Settlement ?



a) Yes - 5 answers

b) No - 4 answers

c) Only for a little while - 6 answers

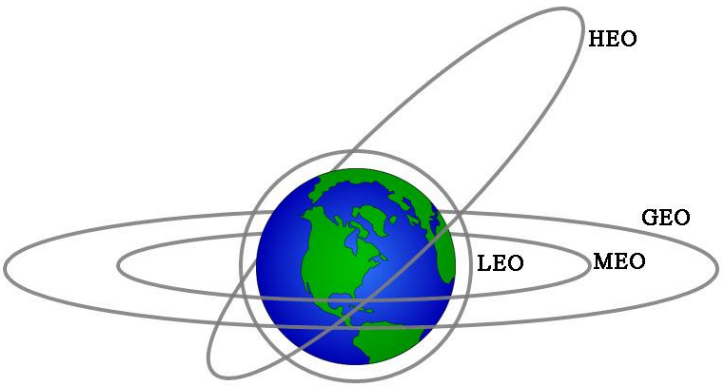
In conclusion, the ideal home in space for students like us is a place located far away in the future, which should provide a safety feeling, offering a quality system of communication with the people on Earth. As leisure points, the preferences go for green parks, where they can be able to take long walks and admire unique sights.

2.Location

In order to decide the most proper location for our settlement we had to consider various factors and analyze more possibilities. Some of the most important criteria's were: the distance from Earth, the ease of acquiring raw materials, the existence of interplanetary dust and the stability of the placement. All these elements had the power to jeopardize any mission even if the design was to be flawless.

A location on the Moon means a constant flow of resources, light metals like Aluminum, Titanium and Iron, Oxygen, Silicon. These materials would prove useful for construction, breathing and making glass. However, there isn't enough Hydrogen and Carbon for maintaining a space colony. Even if there are some advantages, the lack of sufficient gravity and the two week-long nights ruled out this possibility. As the multitude of available materials attracted our attention, we realized that the distance to the moon should influence our final decision of location because it could prove a great source of supplies.

One of the possible choices would be the Low Earth Orbit (LEO). It has the advantage of being situated closely, from the Earth's surface to an altitude of 2000 km and of being continuously sunlit. Due to its placement, within the planet's atmosphere orbits of various satellites decay rapidly. In order to avoid Earth's gravitational pull an object situated here has to travel at great speed and being placed in such an orbit means it will constantly be in need of being pulled back to its initial position. This would mean a constant consumption of fuel which we would like to avoid in order keeping the price as low as possible. The International Space Station is located here but for a larger object, like our space settlement the lack of stability would be fatal.



LEO= Low Earth Orbit(100-1,500km)
MEO= Medium Earth Orbit(5,00-10,000 km)
GEO= Geostationary Orbit(36,000 km)
HEO=Highly Elliptical Orbit

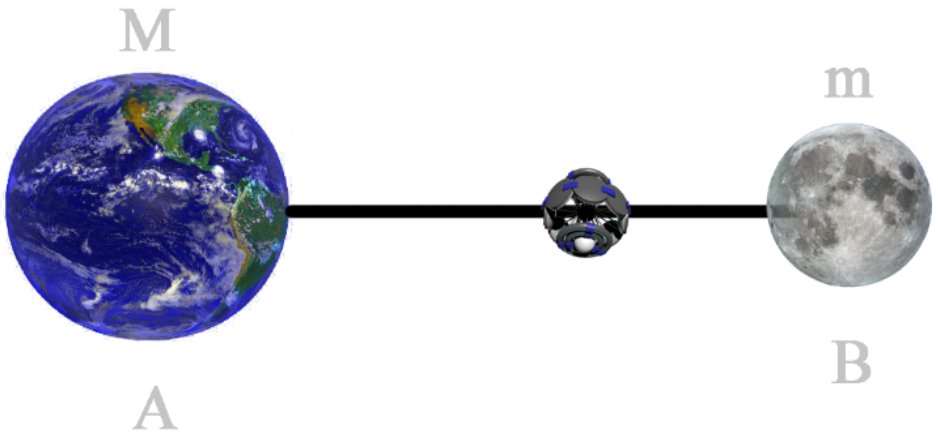
Even if more stable, The Medium Earth Orbit (MEO) isn't a proper choice, nor is the Geostationary Earth Orbit (GEO) which has the disadvantage of being placed in the middle of the Van Allen Radiation Belt. Although interesting for its eight shapes, the

Highly Elliptical Orbit isn't a good pick as it is a very likely place for accidents to occur.

In 1772, Joseph Louis Lagrange discovered five points of equilibrium where gravitational forces and orbital motion balance each other. In a three-body system, one with negligible mass in comparison with the two others can be stationary in respect with them.

We analyzed all 5 points.

The L1 point lies on the line defined by the two large masses M and m, and between them. It is the most intuitively understood of the lagrangian points: the one where the gravitational attraction of M partially cancels m gravitational attraction. It is the only L-point which exists in non-rotating systems.



If M = mass of the Earth, m = mass of the Moon, m_1 = mass of the spacecraft and k is the Newton's constant of gravitation ($G = 6{,}67 \cdot 10^{-11} \frac{N \cdot m^2}{kg^2}$ and D = the distance between Earth and Moon). The distance between Earth and a spacecraft situated in lagrangian L1 point is R:

$$R = \frac{D \cdot M}{m + M}$$

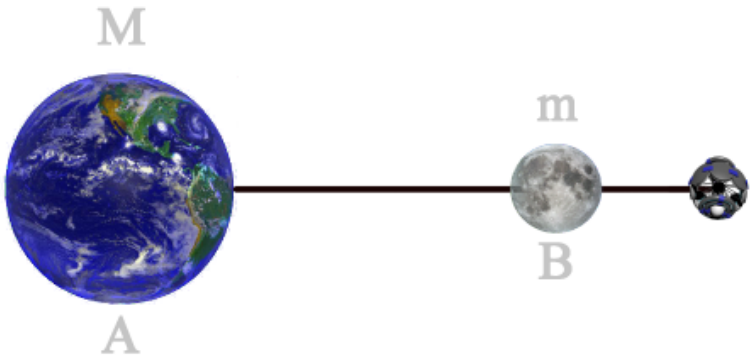
The centrifugal force which acts on the spacecraft is balanced by the attracting forces of the Moon and the Earth. If the spacecraft is running with "v" velocity

$$m_1 \cdot \frac{v^2}{R} = \frac{G \cdot m_1 \cdot M}{R^2} - \frac{G \cdot m_1 \cdot m}{(D-R)^2}$$

Dividing both sides by m_1 results:

$$\frac{v^2}{R} = \frac{G \cdot M}{R^2} - \frac{G \cdot m}{(D-R)^2}$$

The second point L2 is located on the same line, beyond the smaller of the two masses, like in the above figure.



The difference among L1 and L2 points consists in fact that the attracting forces of the Moon and the Earth are now in the same direction and they have to be balanced by the centrifugal forces of the spacecraft:

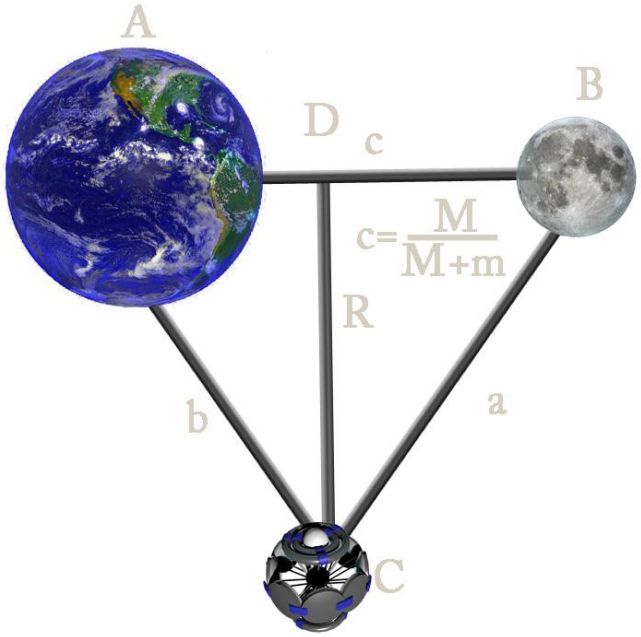
$$m_1 \cdot \frac{v^2}{R} = \frac{G \cdot m_1 \cdot M}{R^2} + \frac{G \cdot m_1 \cdot m}{(D-R)^2}$$

Analogue:

$$\frac{v^2}{R} = \frac{G \cdot M}{R^2} + \frac{G \cdot m}{(D-R)^2}$$

The L3 point is on the line defined by the two masses and beyond the bigger one. In a system consisting of Moon, Earth and a spacecraft L3 is situated on the opposite side of the Sun from the Earth, so it isn't easy to use.

The L4 and L5 points are positioned so as to form an equilateral triangle with the two larger masses. We prove this in the following:



If A is the position of Earth, B is the position of Moon and C is the Spacecraft. The calculation handled in the frame rotating with the Moon. So the spacecraft at point C, which is in equilibrium with the Moon and the Earth, will always keep the same distance from the Moon and from Earth. The center of rotation is the point D and all three bodies have the same orbital period T. If C is motionless in the rotating frame, there exists no Coriolis force. The spacecraft will sense a centrifugal force, as will the Moon and the Earth.

We note with R the radius of rotation of the spacecraft that is different from the one of the Moon, which is $\frac{c}{1+\frac{m}{M}}$, and with V the velocity of the Moon, and with v the velocity of the spacecraft.

Because distance = velocity x time we have:

$$2\cdot\pi\cdot R = v\cdot T \text{ and } 2\cdot\pi\cdot\frac{c}{1+\frac{m}{M}} = V\cdot T$$

$$\frac{2\cdot\pi}{T} = \frac{v}{R}$$

$$\frac{2\cdot\pi}{T} = \frac{V}{c}\cdot\left(1+\frac{m}{M}\right)$$

And from this we have: $$\frac{v}{R} = \frac{V}{c} \cdot \left(1 + \frac{m}{M}\right) \qquad (1)$$

The centrifugal force on the Moon is

$$F_{cL} = \frac{m \cdot V^2}{\frac{c}{1 + \frac{m}{M}}} = \frac{m \cdot V^2 \cdot \left(1 + \frac{m}{M}\right)}{c}$$

and it is balanced by the pull of the Earth

$$F_a = \frac{G \cdot m \cdot M}{c^2}$$

where G is Newton's constant of gravitation.

$$\frac{G \cdot m \cdot M}{c^2} = \frac{m \cdot V^2 \cdot \left(1 + \frac{m}{M}\right)}{c}$$

Dividing both sides by (m/c) gives our second equation:

$$\frac{G \cdot M}{c} = V^2 \cdot \left(1 + \frac{m}{M}\right) \qquad (2)$$

If we note m_1 be the mass of the spacecraft, the centrifugal force which act on it is

$$F_{a1} = \frac{m_1 \cdot v^2}{R}$$

and that must be balanced by the attracting forces F_e of the Earth and F_m of the Moon. Only the components of those forces along the line R are effective in opposing the centrifugal force.
So,

$$\frac{m_1 \cdot v^2}{R} = F_m \cdot \cos\beta + F_e \cdot \cos\alpha$$

Where α and β are the two angles into which R divides the angle C.
But $F_m = \frac{G \cdot m_1 \cdot m}{a^2}$ and $F_e = \frac{G \cdot m_1 \cdot M}{b^2}$ and with these the equation becomes:

$$\frac{v^2}{R} = \frac{G \cdot m}{a^2}\cos\beta + \frac{G \cdot M}{b^2}\cos\alpha \quad (3)$$

The forces pulling the spacecraft in directions perpendicular to R must cancel. So, $F_m \cdot \sin\beta = F_e \cdot \sin\alpha$

$$G\frac{m_1 \cdot m}{a^2} \cdot \sin\beta = G\frac{m_1 \cdot M}{b^2} \cdot \sin\alpha$$

We divide with $G \cdot m_1$ and results $\frac{m}{a^2} \cdot \sin\beta = \frac{M}{b^2} \cdot \sin\alpha$ (4)

Squaring both sides of equation (1)

$$\frac{v^2}{R^2} = \frac{V^2}{c^2} \cdot \left(1 + \frac{m}{M}\right)^2$$

Multiply both sides by c^2 and divide them by (1 + m/M):

$$\frac{v^2 \cdot \left(\frac{c^2}{R^2}\right)}{1 + \frac{m}{M}} = V^2 \cdot \left(1 + \frac{m}{M}\right) \quad (5)$$

Using the relation (2) in (5) results:

$$\frac{v^2 \cdot \left(\frac{c^2}{R^2}\right)}{1 + \frac{m}{M}} = \frac{G \cdot M}{c}$$

Now we multiply both sides by (1 + m/M), divide them by c^2 and multiply them by R.

$$\frac{v^2}{R} = \frac{G \cdot M}{c^3} \cdot R \cdot \left(1 + \frac{m}{M}\right)$$

The relation (3) told us that $\frac{v^2}{R} = \frac{G \cdot m}{a^2}\cos\beta + \frac{G \cdot M}{b^2}\cos\alpha$, so it results:

$$G \cdot \frac{M}{c^2} \cdot \left(\frac{R}{c}\right) \cdot \left(1 + \frac{m}{M}\right) = G \cdot \left(\frac{m}{a^2}\right) \cdot \cos\beta + G \cdot \left(\frac{M}{b^2}\right) \cdot \cos\alpha$$

We divide everything by $G \cdot M$:

$$\frac{1}{c^2} \cdot \left(\frac{R}{c}\right) \cdot \left(1 + \frac{m}{M}\right) = \left(\frac{1}{a^2}\right) \cdot \cos\beta + G \cdot \left(\frac{M}{b^2}\right) \cdot \cos\alpha \qquad (6)$$

And we also have the relation (4):

$$\left(\frac{m}{a^2}\right) \sin\beta = \left(\frac{M}{b^2}\right) \sin\alpha$$

From now on we suppose that triangle ABC is equilateral so a = b = c = r and all its angles are 60 degrees.

In this case, if the above equations are multiplied by r^2, the factors $(1/a^2)$, $(1/b^2)$ and $(1/c^2)$ all disappear, and results

$$\left(\frac{R}{c}\right)\left(1 + \frac{m}{M}\right) = \left(\frac{m}{M}\right)\cos\beta + \cos\alpha \qquad (7)$$

$$m \sin\beta = M \sin\alpha \qquad (8)$$

From here

$$\frac{m}{M} = \frac{\sin\alpha}{\sin\beta}$$

We substitute this on the right side of (7) and results

$$\left(\frac{R}{c}\right)\left(1 + \frac{m}{M}\right) = \left(\frac{\sin\alpha\cos\beta}{\sin\beta}\right) + \cos\alpha$$

We multiply by sinβ

$$\sin\beta\left(\frac{R}{c}\right)\left(1 + \frac{m}{M}\right) = \sin\alpha\cos\beta + \cos\alpha\sin\beta$$

But $\sin\alpha \cdot \cos\beta + \cos\alpha \cdot \sin\beta = \sin(\alpha + \beta) = \sin C = \sin B$

We divide now both sides by R, and results:

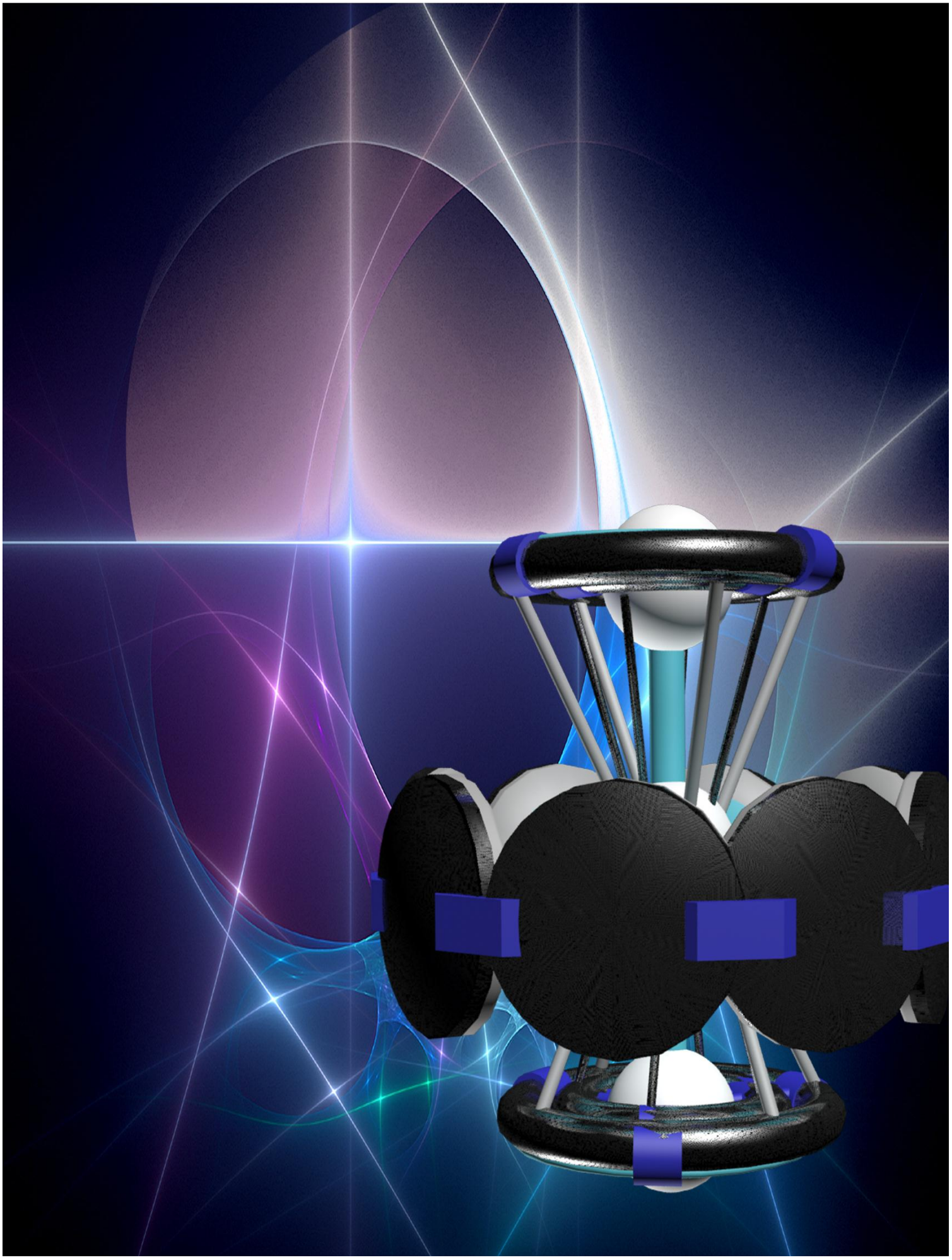
$$\frac{\sin\beta}{\frac{cM}{M+m}} = \frac{\sin B}{R}$$

The relation above is the law of sines in the triangle CDB. That denotes that our prediction that the ABC triangle is equilateral goes to truth.

The L4 and L5 are by far the most stable of the five as a result of the action of the Corriolis force. Even if perturbations can interfere with the body placed in one such point, it will drift back toward its initial position. This is why we consider these two points to represent the best decision we can make for the placement.

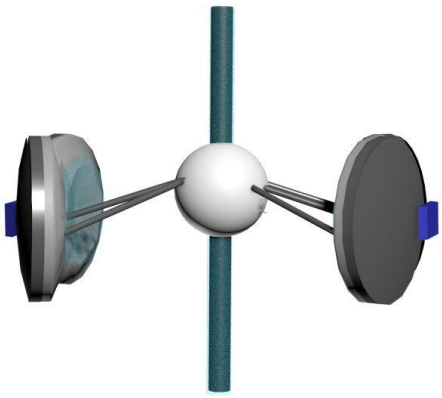
A good plan to consider is the possibility of placing the first settlement in the center of L4, and afterwards, when the space colonization industry will grow, to place the second one in L5. This way the two points could be compared more subjectively.

3.Structural Design



3.1 Construction phases

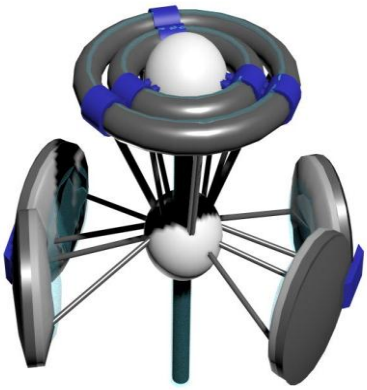
Phase of construction	Estimated time of completion
1. The construction of the settlement will start with the central cylinder. This shall be built first because all of the other pieces will be assembled on it. This cylinder must be built from its upper end where there will be a spaceport. This needs to be built in an incipient phase because the spaceships which bring the parts of the settlement from the moon need to have a special space to dock to. For economy of material the spaceport can be made from a woven metal frame structure. From the landing site the people and the materials will be carried inside the settlement by a lift. The transition from the unpressurized to the pressurized area inside the settlement will take place in an “accommodation room”. In this room there will be no pressure initially, than after the entry of people air will be introduced until the pressure is equal with that from inside of the settlement. Afterwards, the doors will be opened in order to permit communication with the interior. This will also make us avoid pressure loss from the interior.	**2 years** 

2. The second step will consist of building a sphere situated on the central cylinder at its middle. This will be a place for recreation and entertainment. A wide range of sports that can be practiced in 0 g will be available and settlers will be able to experience the effect of weightlessnesss From this sphere the spokes that connect the bubbles with the central cylinder will start.	**2 years** 
3. The next step will represent the construction of four of the eight bubbles. After they are completed 6000 of the inhabitants will have the possibility to move in. the placement of this bubbles will resemble a cross. Not all the bubbles will be placed at once as the construction wouldn't be completed up to this stage. We consider that for a start four symmetrically placed bubbles are enough.	**4 years** 

4. In the next step we will build the agricultural area and the food processing industry, placed near the spaceport. These areas will consist of two tori of the same minor radius and a sphere, the docking area. The tori will be utilized for agriculture and livestock growing. This part will be built before the arrival of people as crops and animals need to grow in order to provide a stable source of food. Viewed from above surfaces will look like concentric circles whose radii decrease towards the center.

The area will be a pressurized one even if people will not be too deeply involved in agricultural processes because everything will be automated. People will only be present in these areas to control the automatic activity and to interfere in case of failure.

3 years

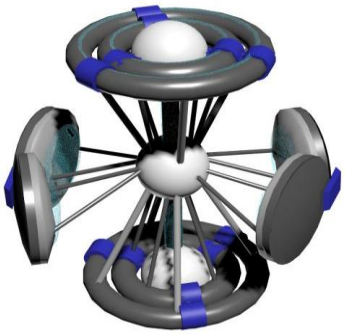


5. The next step is building the industrial area that is located opposite the central cylinder from the agricultural area and has the same features with it.

Unlike on earth, there will be new industries which will aim to produce oxygen from metal oxides on the moon and to ensure water circulation.

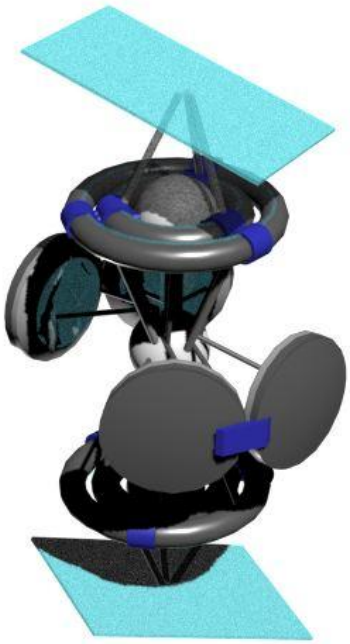
This area of the settlement will be home for a particle accelerator designed for a deeper study dedicated to physical phenomena. We will also have an observation room for the universe where a powerful telescope will allow new research of space. Apart from being scientifically important, it will be a method of entertainment.

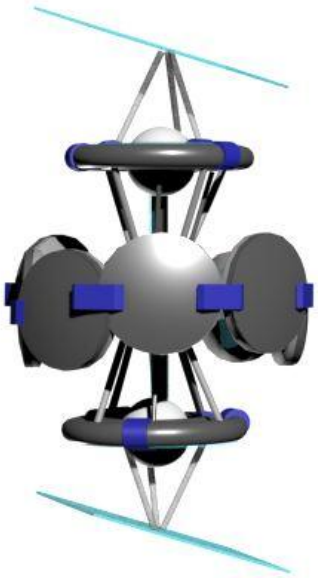
2.5 years



6.Afterwards we will mount two mirrors that reflect the sunlight to the settlement. Light from the sun will be reflected by the two mirrors and redirected to the windows of the settlement with other mirrors mounted outside the sphere of 0 gravity.

1.5 years



	4 years
7. In the last step we build the last four bubbles that complete the settlement . Bubbles will be connected through some corridors which can be crossed by shuttle. Each corridor has the ability to block access from or to a bubble in case of failure.	

Total duration of construction for Aurora : 19 years.

However, we expect this term to be slightly exceeded by a matter of 1-2 years.

3.2 Artificial gravity

We can't imagine how living would be without gravity. The absence of gravity would dramatically change the way we perceive life. We can't imagine a planet without gravity.

When considering building a space settlement, lack of gravity is one of the first things which comes into our mind. We might think it would be a completely new way of life which we could adapt to. In fact, things aren't this way at all.

Life without gravity offers, indeed, many more possibilities than we can imagine. It seems a very attractive opportunity. Humans can perform impossible tasks on Earth and large masses require no support.

However, there are two main disadvantaging factors when talking about 0G life : psychological facts and medical facts.

Human beings aren't made to live in no-gravity conditions. The lack of gravity will lead to bone decalcification at rates of 1-2% / month, in order to correct the electrolyte balance, causing bone mass to decrease and make our bones vulnerable to minor impacts. Studies show that over long time, electrolytic balance is not achieved. Furthermore, hormone imbalances also occur. Astronauts who were subject to 0G life for a longer period of time showed increased hormone levels, unstable protein and carbohydrate states, as well as hypoglycemia and increased heart rate. Even though these effects are reversible after a short period of time, but we don't know if they can be inverted after prolonged weightlessness. Vascular changes, variations in muscular reflexes, decrease in the effectiveness of the immune system may become irreversible.

The psychological factor is also important. It takes a short to medium period of time to adapt to an environment with 0g, or some individuals may not adapt at all. The transition between 1g and 0g environment may cause a complex psychological phenomenon, which is undesirable.

One of the easiest and most practical ways of generating artificial gravity is by spinning. The centrifugal force will act as the gravity force, helping us make our environment similar to the Earth.

In order to generate the desired gravitational acceleration we must spin the settlement with a certain velocity and the residential constructions must be located at a precise radius from the central spindle. We can determine these values as it follows.

We have 8 residential bubbles with a radius of 345 meters each. Therefore, each one's diameter will be of 690 meters. They describe a circle with the length L = 2πR = 8d, where d is the diameter of one bubble. Therefore : $2\pi R = 8d \rightarrow R = 8d/2\pi = 4d/\pi = 878\, meters$

In order to generate a certain gravitational acceleration, we use the following physical ecuations

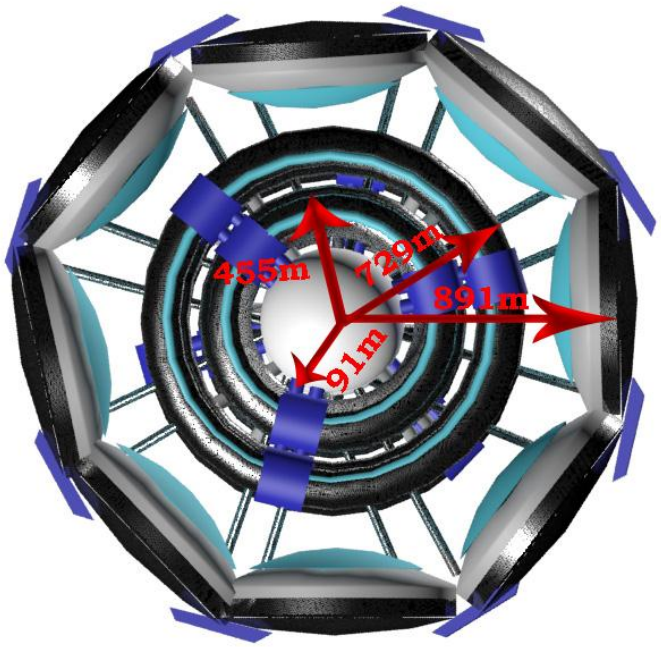
$$F = m \cdot a$$
$$F = m\frac{v^2}{R}$$

Dividing by m in both sides we obtain

$$a = \frac{v^2}{R}$$

Therefore

$$v = \sqrt{a \cdot R}$$



In case of our residential constructions situated at a radius of 891 meters and we want to obtain a g of 9,85 $\mathrm{m/s^2}$ we must obtain a speed of $v = \sqrt{9{,}85 \cdot 891} = 93\frac{m}{s}$

This means that one full rotation will take 59,35 seconds, which is 0,99 rpm.

Considering that we want different gravitational acceleration for our other spacecraft modules, we must calculate their position from the central axle in order to obtain the desired effect.

When calculating the values of the radius for the other components for a specific g, we get :

$$\frac{4\pi^2 R^2}{t^2} = R \cdot a$$
$$4\pi^2 R = a \cdot t^2$$

$$R = \frac{at^2}{4\pi^2}$$

Using this formula can determine that in order to obtain 0,1g on the central hub spheres, they must have a radius of 91,52 meters, one of the tori which will have 0,5g should have its big radius R = 455,18 meters. The other tori, the largest ones will also have 1g and will have the same parameters as the bubbles.

In order to generate the effect of rotation we will use 2 electrical thrusters, which will be situated on diametrically opposed sides, connected to joints of 2 bubbles. This way, they can be located farther away from the axis of rotation, and, as $\mathrm{L} = \mathrm{r} \times \mathrm{p}$, the higher the position vector, the less the force required.

3.3 Bubble particularities

In order to keep a stronger resemblance to Earth we chose to have different types of environments inside of each bubble. This way, inhabitants would adapt better as the probability of finding a place more similar to home increases. A very important characteristic is the fact that the people are able to travel between the bubbles.

The methods of repartition will be flexible, depending on the requests.

3.3.1.1 City bubble

For the residents who prefer an exciting lifestyle, the City is the perfect resolution. With a multitude of restaurants, pubs, nightclubs, café's, cinemas and shops this bubble can offer a suitable environment for those who are dynamic. The best alternative for flexible inhabitants who yearn for opportunities and want to extend their lives in multiple domains.

So, what are we going to find there?

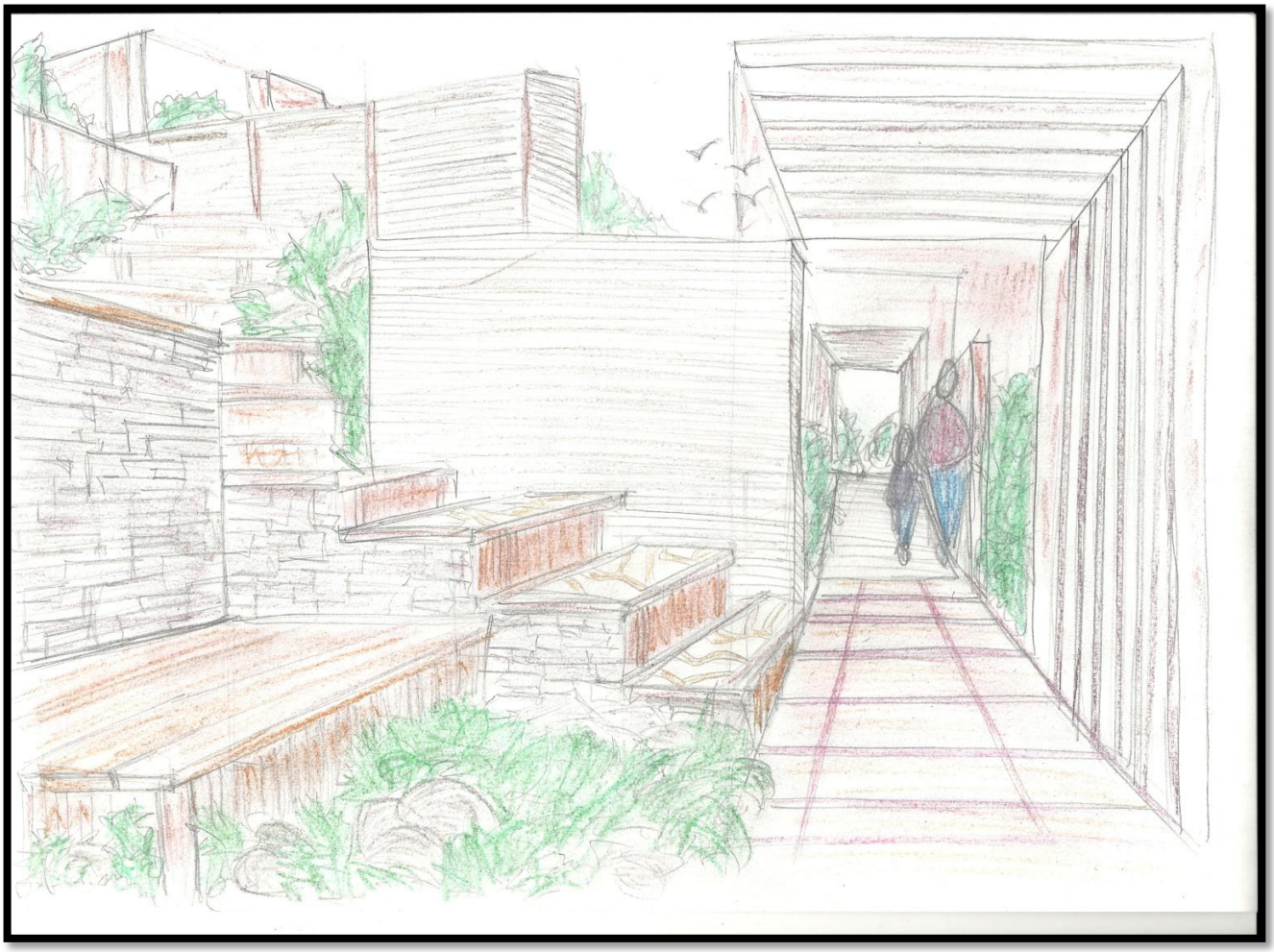
First of all, modern residences for the inhabitants.

For education we should provide a school with all the necessary modern facilities and a university which will include every branch of education the graduates require for their future jobs. In order to aid the young learners the City should also have a library. There will also be an Art museum, providing the young artists the opportunity to present their work.

There will also be different types of restaurants, especially franchised well-known brands which will take part in an auction in order to open branches on Aurora.

A cinema is also a necessity provided that it will play the latest movies, as well as multiple café's bars and clubs spread around the city. There will also be some shops with local products as well as designer goods.

The necessary green space will consist of two larger parks and additional green areas.



3.3.1.2. Countryside bubble

This area will contain houses with big gardens and will represent a quiet place for those who want to escape from the crowded cities. They will be able to lead relaxed lives, taking long walks and tending to their plants.

The inhabitants of this bubble will have the possibility to raise animals and grow crops in their gardens if they would like to take this up as a hobby. This is the only place where inhabitants will be allowed to do this.

In this area green space will be predominant. Besides houses, there will be a general store and a small market where the colonists will be able to sale and purchase home-grown produce.

3.3.1.3. Riverside city bubble

This area is suitable for a more luxurious lifestyle, inspired by the sights of Seattle. It is a more select option, keeping the same characteristics as the city but being more cosmopolitan.

It is the best option for the ones who want to live in a stylish, yet relaxing place. The river is going to be the main sight attraction, and it will guest restaurants and other social places among its docks.

The riverside city bubble will serve more as a home than as a fun area. However, in this place the inhabitants will be able to practice nautical sports, such as swimming, water polo and canoe.

3.3.1.4. Suburb bubble

The Suburb will be mainly designed for residential buildings. It will have a higher population density than other regions of our settlement. It is intended to be populated with people who are going to work in the agriculture and industry sectors of our habitat (i.e. the 4 tori designed for that).

Here there will also be the place where big grocery stores, as well as supermarkets and hypermarkets will be found, in order to ensure all the required products for the population.

Depending on the needs, there will be several types of houses available to the colonists, ranging from smaller cottages or bungalows to larger, more spacious villas. There will be houses with 3 rooms for new families without children. If needed, these smaller houses will be extended (added a room or two) in order to accommodate new family members.

We want to promote the formation of new stable families with children. In order to do that, the suburban bubble will have parks and areas for children to play in as well as some courts and pitches. We will encourage applicants who want to have a family to pick this bubble as their first choice.

3.3.1.5. Seaside resort bubble

Living by the seaside, isn't it just a dream came true? Within our space settlement we will fulfill the wildest dreams of our colonists turning this bubble into a water paradise.

The bubble will resemble a relaxing, yet fun resort in which seaside lovers can value their opportunities by swimming in the artificial sea and practicing nautical sports. Also, they will be provided with a beach , a multitude of summer sports terrains and beach bars. This area is going to contain general stores, spas, designer shops. The vegetation in this seaside bubble will be abundant with Mediterranean plants, and the architecture will also be inspired by the Mediterranean style.

3.3.1.6. Hillside city bubble

This bubble is perfect for valuing a quiet and relaxing atmosphere and a great place for indoors and outdoors sports, such as horse riding, hiking, basketball, volleyball, tennis etc. The main attractions are going to be the sports center and the cultural center. In the centers, there will also be café's and bookshops.

The hillside city will provide wonderful sights for mountain lovers and will be suitable for families with kids or teenagers because it is going to have kindergartens and schools.

The homes will be constructed out of materials that will resemble wood and glass materials keeping a modernist valence.

3.3.1.7 Lakeside village

The Lakeside will be one of the most picturesque locations of our settlement. There will be a large lake situated in the center of the bubble, and most of the buildings will be built by its banks. The lake will have both touristic and economic functions. It will mainly be designed for fishing and growing aquatic animals, but it will also be a place where people can rent boats to take a relaxing ride and admire the beauty of the landscapes.

Most of the houses located in the proximity of the lake should be assigned to people who like fishing so that they can monitor their growing animals. Each bigger creature will be marked with a special chip, so that their situation could be checked at all time, in order to ensure a good development of the industry.

We intend to design three artificial islands which will each host a modern hotel where people could spend their holidays. The hotels will actually represent an association of futuristic bungalows, placed next to each other by the shore. Designing separate bungalows instead of hotel rooms will have the role to make visitors feel more like home.

3.3.1.8. Downtown bubble

The downtown will be the main business, political and educational centre. Besides that, this bubble will host a vibrant nightlife and will provide the settlers with a state of the art shopping centre.

With little room for residents, the colonists chosen to live here will be selected carefully. The homes here will be mainly for the political leaders and the business managers. Furthermore, teachers and scientists will have the possibility to live here if they want to. This will also be a place to live for highly skilled students from Earth, who will be accepted to study at this university.

The biggest university will be found here. It will have the necessary laboratories for teaching all the courses and will have the largest library. The library will be open for everyone but for full access to all the books a small fee will be required which will be used in order to increase the volume of available books. After receiving a code, colonists will be able to download all desired material.

All the business centers will be located here. As well as them, the city hall and People and Goods Administration Council (P.G.A.C) will have their quarters here.

Other than a business hub this will be an awesome location for entertainment. Different types of restaurants will be available and also a wide range of clubs, pubs and café's. The shopping centre will provide a modern environment for a more pleasant and easy shopping experience. People will buy the clothes on their own and they will have a series of computers with cameras which will aid them in choosing the clothes which fit best.

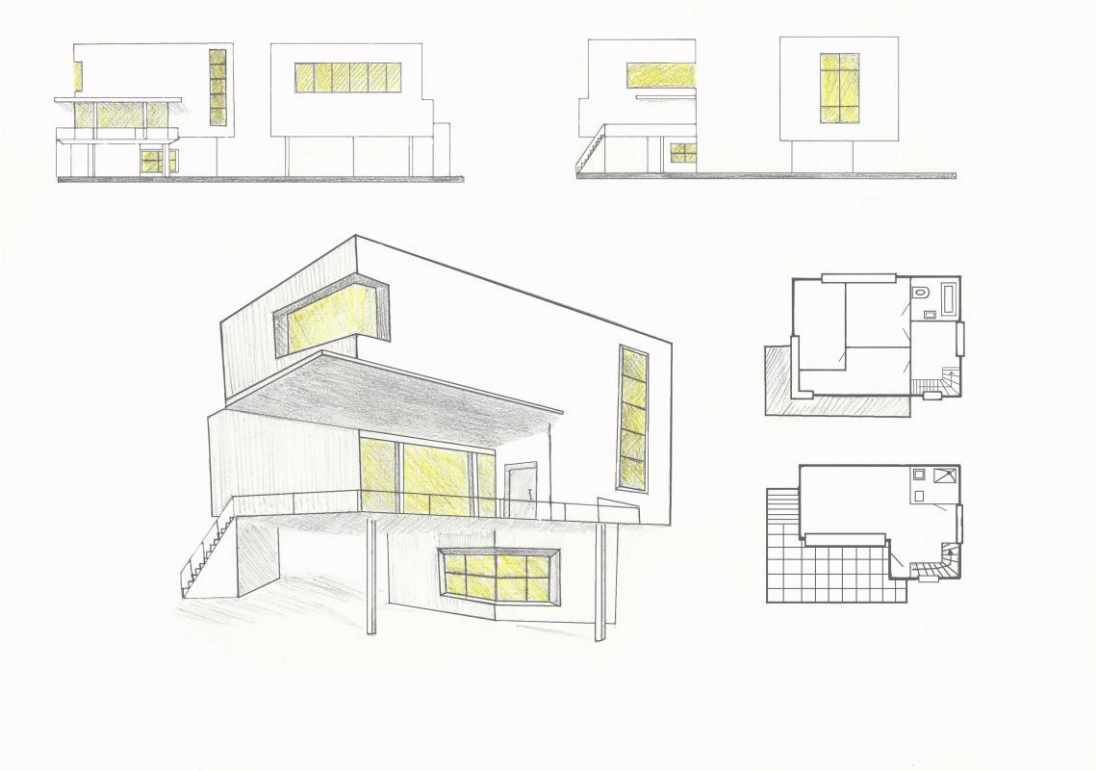
Moreover, the park which will spread randomly throughout the entire available surface will also be a museum. Exhibits or virtual replicas of them will not only be displayed in the open air pavilions but also in the green spaces. The space will represent both an arts and a science museum. The exposed items will be both reproductions of significant artifacts from earth and new works of art created by the colonists.

3.3.2 Houses

The construction of houses on the settlement has to be fast, effective and well organized in order to be cheap. Therefore, the houses will be designed after the same pattern. However, adaptation of the plans is still necessary as the environment from every bubble will differ.

3.3.2.1 House design

The houses will be designed after a certain pattern. In order to keep the diversity, residents will have the possibility to personalize their house as they will. The chosen pattern is depicted below:



The average house will have 4 rooms:

One living room with kitchen

2 dormitories

1 study

2 bathrooms

The surface of such a house will be of 250 m^2, with the print on the soil of about 100 m^2. If need, one extra room can be added to the ground floor.

3.3.2.2 House construction

The method of construction needs to be as efficient as possible. Therefore, the houses will be built in a mobile construction site.

3.4 Materials

An important part of our preparatory work will be finding an efficient and continuous supply of raw materials during the construction of our space settlement and later on.

One option would be the Earth, as we can find everything we need. But being given its inconveniences, most important its high gravitational force.

When studying space, propulsive effort required to get from a point to another one is measured in the total change of velocity (Δv) . Studies show that the required Δv to go from LEO to the lunar orbit is 4100 m/s, which is only a little over the one required to achieve the geosynchronous orbit. This shows that the most effort is required to get off the first 100km from Earth. If we compare the travel time and the required effort, we can conclude that even though it takes a lot less to go from Earth surface to LEO than travelling from LEO to the lunar orbit, which takes around 5 days, the effort required in the first case is more than double.

Even though the Earth may represent a complete source of materials, we can reduce the overall costs by choosing other alternatives. For example, the Moon is a very good and accesible source of Aluminum, Iron, Titanium, Silicon, as well as Magnesium, Chromium, Calcium, Sodium, Potasium and Phosphorus. Another good point is that Oxygen is an important by-product of the refining of lunar materials, which can be used as a propellant or for later use in the atmosphere. The external structure of the settlement will be made of strong and reliable materials which can be mostly found on the Moon surface. Another important fact we had to take into account was that by importing materials from the Earth, we would drain its resources and therefore may cause difficulties to its inhabitants. Therefore, putting everything in balance, we consider that the Earth's natural sattelite is the best option in providing the necessary raw materials.

The process of constructing our space colony will consist of 2 stages :

1.Building a Moon Extraction Factory which will extract the metal ore;

2.Building the space settlement.

I. Building the Moon Extraction Factory

The first thing we are going to do once we get our crew there is to build places where they can live.

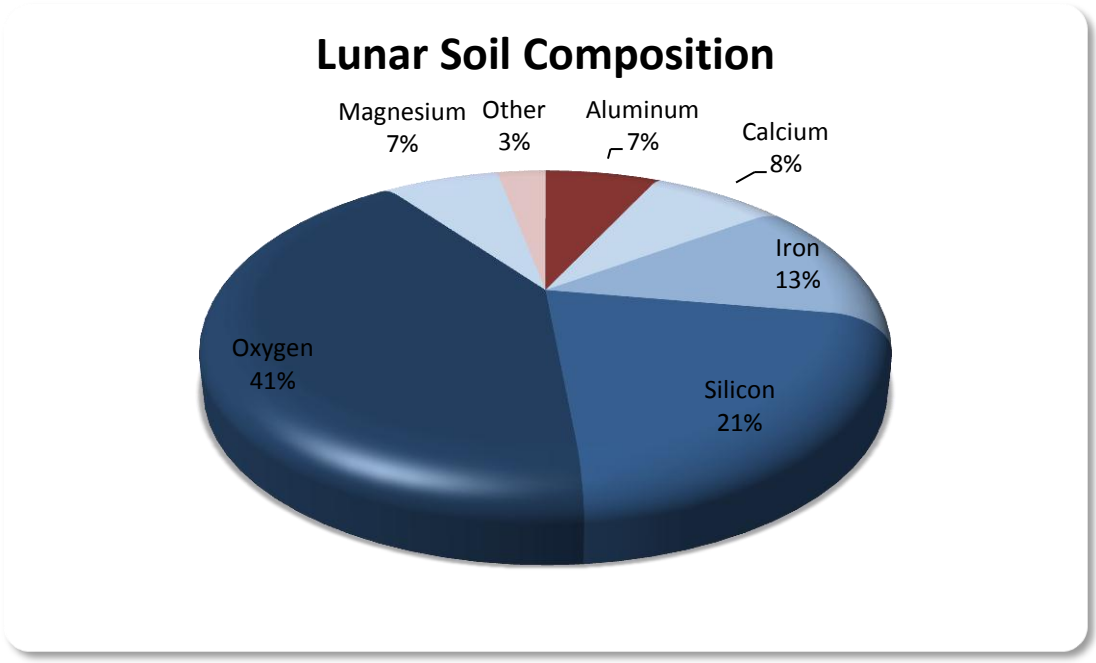
It is very expensive to send a lot of people into space, that's why we must send only qualified personnel. They have to build first the Moon Base, where they live, to extract materials and to build settlement's modules.

The following table shows the distribution of the people who will be assigned to the facility.

POPULATION REPARTITION	
Qualification domain	Number
Metallurgic specialists	18
Mining & refining workers	40
Mechanics	12
Electronics technicians	12
Vehicle operators	10
Chemists	5
Computer programmers	8
Communications	5
Doctors	2
Biologists & Physics Researchers	8
Astronomers	2
Agronomists	6
Nutrition specialists	5
Managers	3
TOTAL NUMBER	136

On the Moon's surface, the elementary metals such as iron or aluminum cannot be found in a pure form on the ground, but we can find minerals where atoms of aluminum are bonded to atoms of oxygen and silicon. These are called silicates. In order to dissociate the atoms, the material must be processed at special conditions (heat, chemicals, electrical current). The industrial facility corresponding to the process is called „smelter".

The selenar surface contains „anorthite", a similar to the ore „bauxite" on the Earth, from which the aluminum is produced on our planet. Anorthite consist of aluminum, oxygen, silicon and calcium, with the chemical formula CaAl2Si2O8. After being processed , from the ore we will obtain pure aluminum metal and also calcium, oxygen and „silica" glass (SiO_2). Another option would be processing to obtain lime (CaO) and „alumina" (Al_2O_3) instead of the metals, or other silica glasses with various properties.



Metals are usually found in the shape of metal oxides. These oxides bond to silica and produce various minerals, though they can sometimes be found in their basic oxide state, without silica.

One of the great advantages of the lunar soil mining is that we can obtain oxygen, which will be afterwards used to support life on our space colony. In order to obtain oxygen from the Moon surface, we need to subject the molten silicate to electrolysis.

During this process, the metal cations are reduced at the cathode to form metals, while at the anode the silicate polymer chains are oxidized to form oxygen.

The reactions are as follows :

$$Fe^{2+} + 2\,e^- \leftrightarrow Fe^0$$
$$Si(IV) + 4\,e^- \leftrightarrow Si^0$$

The anodic reaction producing oxygen is the following

$$4\,(SiO^-) \leftrightarrow 2(Si - O - Si) + O_2 + 4\,e^-$$

The only problem here is the $Fe\,2^+$ ions which oxidate.

$$Fe\,2^+ \leftrightarrow Fe\,3^+ + e^-$$

So, basically the idea is that the higher the concentration of the Fe 2+ cations, the lower the efficiency of oxygen production is.

The energy necessary to keep the process going is fairly considerable, which is why we will need to have suitable power sources. We will use solar panels for daytime and also several nuclear reactor plants instead of a single big plant, as smaller plants can be transported and assembles more easily, as they will need to be refueled every one or two years.

3.5 MEF (Moon Extraction Factory)

In order to properly exploit the riches of the moon we will need to build a facility, a Moon Extraction Factory (MFT). Its characteristics and the way we will develop it is fully described below.

3.5.1 The beginning

As a start, the facility only requires specialized personnel that has previously had experience in material extraction. A small number of engineers specialized in different areas will depart from Earth with a space shuttle. They will carry withthemselves the necessary for spending two months without further assistance from home. The equipment transported with the first shuttle will represent the first step in building the facility.

The moon miners will have to assemble the first building which will serve them as a base. They will develop a space where they will grow food on their own with the aid of a hydroponic system which for increased ease will be an aeroponic one. The production of food will start with fast growing vegetables (i.e. salad) and vegetables that have an increased caloric content (i.e. soya, beans, mushrooms, peas).

Besides the material need for the construction of the base they will have a moon buggy which will be used for testing different areas of the moon in order to choose the ones that are the most suitable for a more abundant extraction. The robot will automatically examine different assigned regions of the highlands or 'terrae' and the lowlands also known as 'Maria'.

We already know that the concentrations of required materials are different in the two regions. However, the robot will be used for discovering deposits that shall turn out as more profitable.

3.5.2 Sending materials

A great advantage of the use of the moon as a materials source is its escape velocity, the speed an object needs to escape a gravitational field.

The formula of the escape velocity is as follows:

$$V_e = \sqrt{\frac{2GM}{r}}$$

- G is the universal gravitational constant, also known as Newton's constant (G ~ 6.67384(80) * 10^{-11} $N(m/kg)^2$)
- M is the mass of the body
- r is the distance from the centre of gravity
- GM is the standard gravitational parameter (μ)

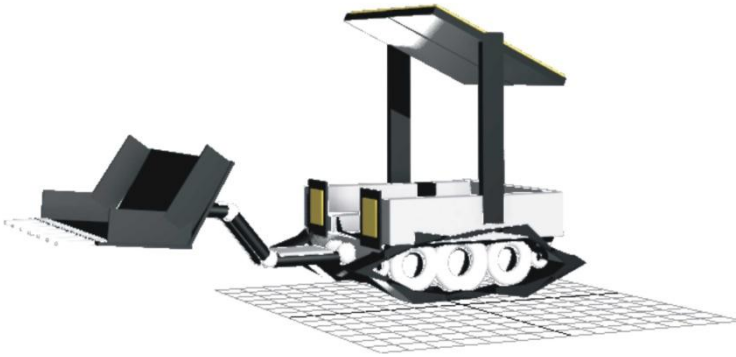
By calculating we realized that compared to that of Earth (11 km / sec), the Moon's escape velocity is smaller, one of around 2.2 km / sec. This will allow an easier transport of materials from the moon factory to the L4 point.

3.5.3 Extraction of lunar materials

The lunar materials will be extracted by specially designed robots which will scoop the lunar surface and afterwards load the acquired material into transporters which will carry it to the factory for its separation.

The robots will be manufactured in the main base. The parts for the first ones will be sent from earth but afterwards they will be made out of extracted materials, mainly from aluminum and iron.

Moon extraction excavator



Their design will provide them with endurance to extreme temperatures in order to be able to work all over the moon. As mining materials from a very cold surface could prove as a challenge, robots which will have this as a task will have an efficient system of heating.

3.5.4 Processing of lunar materials

For the processing of the materials a wide variety of methods will be used. The whole transformation from scoops of lunar soil to ready to use materials for the construction will take place in the complex of factories.

Some of the methods are listed below:

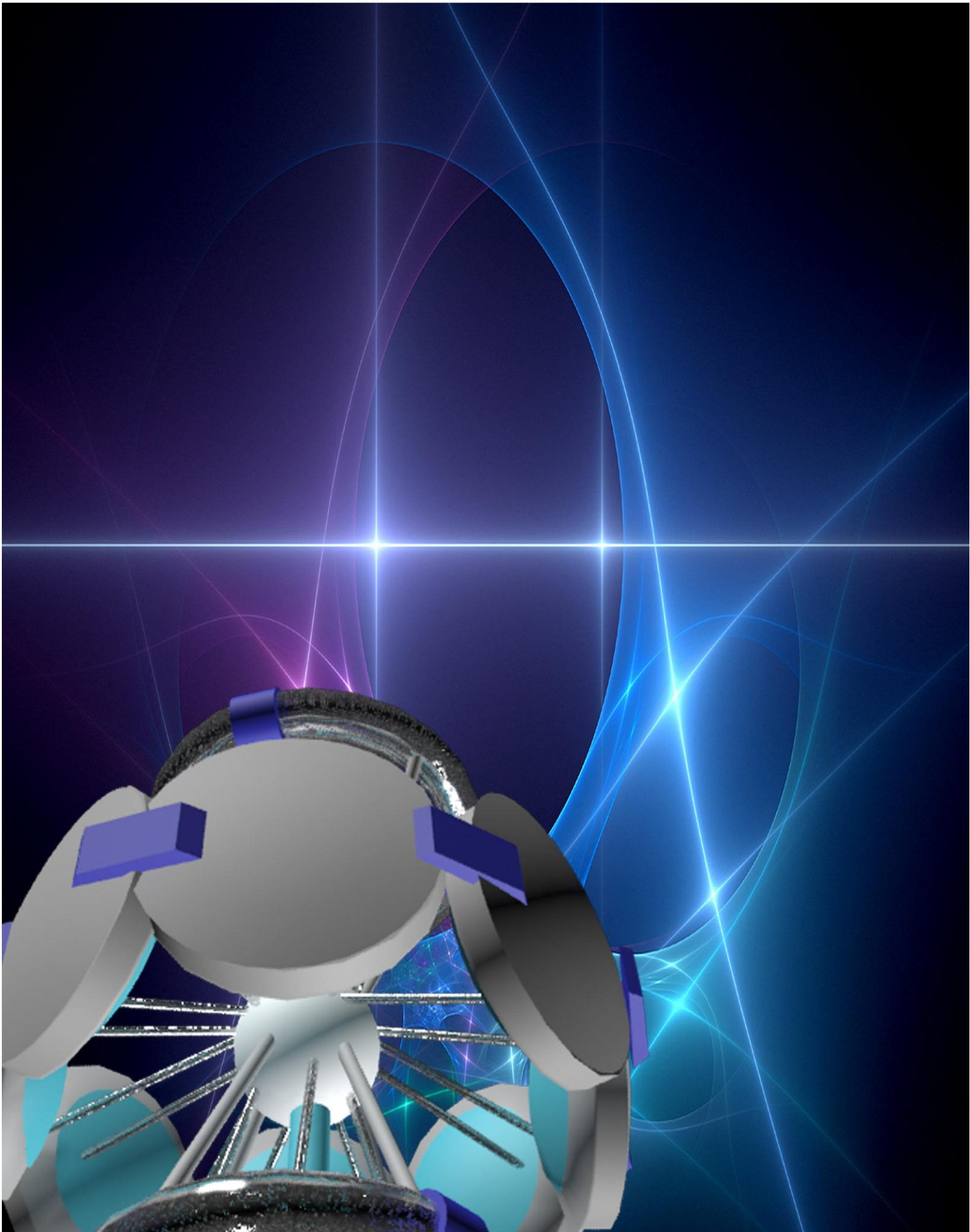
- Thermal extraction
- Electrolysis
- Pyrometallurgy
- Sintering (i.e. spark plasma sintering, selective laser sintering)
- Magnetic separation
- Electrophoresis
- Melt-quench-leach process

3.5.5 The main base

The main base is the place where all the pieces that will be afterwards used for the construction of Aurora, will be manufactured. The necessary materials will be brought by transporters.

In order to be an environment well protected by radiations, the whole base will be covered with lunar soil.

4.Science And Technology



Today, we are again like children walking on the seashore. But the ocean that Newton knew as a boy has largely disappeared. Before us lies a new ocean, the ocean of endless scientific possibilities and applications, giving us the potential for the first time to manipulate and mold these forces of Nature to our wishes.

Michio Kaku

A more advanced world, a place for the best in the domain of science and a dream location which will make it possible to engage in the pursuit of previously unthinkable progress. This is what Aurora will offer.

What exactly do we hope for? Well, as our era is ending from a scientific point of view, we believe that our settlement should be the first of many advancements of the new world. We want a deeper and thoroughgoing understanding.

4.1 Research

Being a scientifically advanced habitat, Aurora will give its inhabitants and visitors to chance for unique research opportunities that would push the limit of our understanding up to unimaginable levels. Having said that, we consider that scientists who stand out on Earth should be given the chance to come to study on the space settlement. Excellent students will also get scholarships as we want to bring as many brilliant minds as possible.

So what will the research opportunities be? Of course, they will come from within the fields of mathematics, physics, chemistry and biology, basically all the sciences.

We decided to take a closer look on the research we hope to undergo on Aurora. Therefore, we analyzed the laboratories and instruments present on the settlement, mentioning some of their characteristics and possible discoveries that we hope to make.

4.1.1 Particle accelerator

A particle accelerator is a device that propels particles at very high speeds and contains them into well-defined beams. The machine does this by using electric and magnetic fields. We wish to make use of the whole potential of the station. We want to take advantage of the presence of physicists on Aurora and of the fact that the station is constantly showered by cosmic radiations. In order to increase our knowledge in particle physics we decided that our space settlement will have a particle accelerator.

4.1.1.1 Location and components

The particle accelerator will be situated in the lower medium torus, next to the industry torus.

The accelerator will have different types of structures, each one designed especially for a specific task. The main categories will be: linear particle accelerator and circular or cyclic accelerators. In the accelerators there will be:

- Parts where particles will move and will be accelerated
- Parts used for steering particles
- Parts use for measurements.

For a particle that penetrates with v_0 = constant, perpendicular to lines of a uniform electric field of constant intensity, $\vec{E} = constant$ the force acting on the particle oriented on the Oy axis is:

$$\vec{F} = q\vec{E}$$

On Ox axis, Newton's second law applied on the particle:

$$F_x = 0$$

$$v_{0x} = v_0 \quad , \quad x = v_0 t$$

On Oy axis, Newton's second law applied on the particle:

:

$$F_y = qE$$

$$ma = |q|E \Rightarrow a = \frac{|q|E}{m}$$

$$v_{0y} = 0$$

$$v_y = at = \frac{|q|E}{m}$$

$$y = \frac{at^2}{2} = \frac{|q|E}{2m}t^2$$

The trajectory equation for the particle is:

$$x = v_0 t \ \Rightarrow t = \frac{x}{v_0}$$

$$y = \frac{|q|E}{2m}t^2 \qquad \Rightarrow y = \frac{|q|E}{2m} \cdot \frac{x^2}{v_0^2}$$

The particle that penetrates with v=constant perpendicular to the lines of a uniform magnetic field of induction B, the Lorentz's force acting on the particle is:

$$\overrightarrow{F_L} = q\vec{v} \times \vec{B} \ .$$

In a linear accelerator, particles are accelerated in a straight line by the two fields electric and magnetic:

$$|q| \cdot E = |q| \cdot v \cdot B \Rightarrow v = \frac{E}{B}$$

The linear accelerators are often used to provide an initial low-energy kick to particles before these are introduced into circular accelerators.

In the cyclic accelerators, the particles are injected so that velocity is perpendicular to the magnetic field. So, the velocity magnitude does not vary and the trajectory is a circle of radius R:

$$F_L = |q|vB \sin\frac{\pi}{2}$$

$$ma_n = F_L$$

$$m\frac{v^2}{R} = |q|vB \Rightarrow R = \frac{mv}{|q|B}$$

If the velocity of the particle is near the velocity of light, the problem will solved relativistic:

Electric field:

$$\overrightarrow{F_y} = q\vec{E} \quad , \quad F = qE$$

On Ox axis:

$$dp_x = F_x dt \quad , \qquad F_x = 0 \;\Rightarrow\; dp_x = 0 \;\Rightarrow\; p_x = p_0 = mv_0$$

On Oy axis:

$$dp_y = F_y dt$$

$$p_y = \int qEdt$$

$$p_y = qEt + k \;, t_0 = 0 \,, p_{0y} = 0 \;\Rightarrow\; k = 0$$

$$mv_y = qEt$$

$$v_y = \frac{qE}{m}t$$

$$m_0^2c^2 = p_x^2 + p_y^2 + p_z^2 - \frac{E^2}{c^2}$$

$$E = \sqrt{c^2\left(m_0^2c^2 + \frac{q^2E^2t^2}{m^2}\right)}$$

There are many methods for accelerating particles. However, the DC field is the simplest one so we decided to use this one.

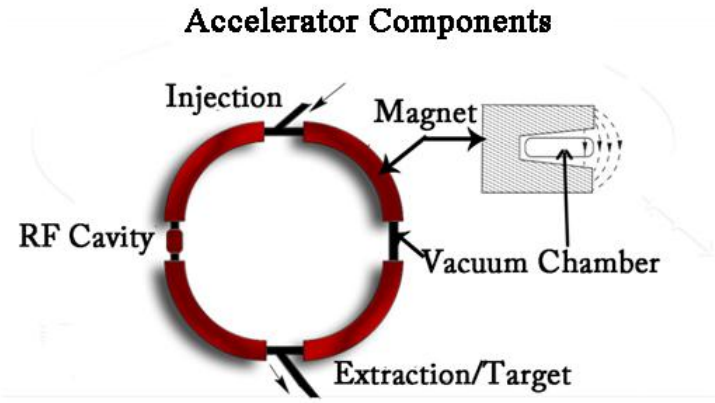
4.1.1.2 Concept

As it doesn't make sense to make a replica of an accelerator situated on Earth because of its smaller size, the concept behind our accelerator will be different.

Cosmic rays, energetic charged subatomic particles originate in outer space. This is why we considered studying them. We figured out that we could use these radiations to collide atoms. As a result, positrons will appear particles which we will us in our accelerator.

The radiation will be captured in a room with residual gas and the particles which will result after the processes that will be undergone will have been studied.

We will prove the existence of the Higgs Boson and we will pick up proofs in order to confirm or infirm The Standard Model. Not least, one of the goals will be to study the black holes.

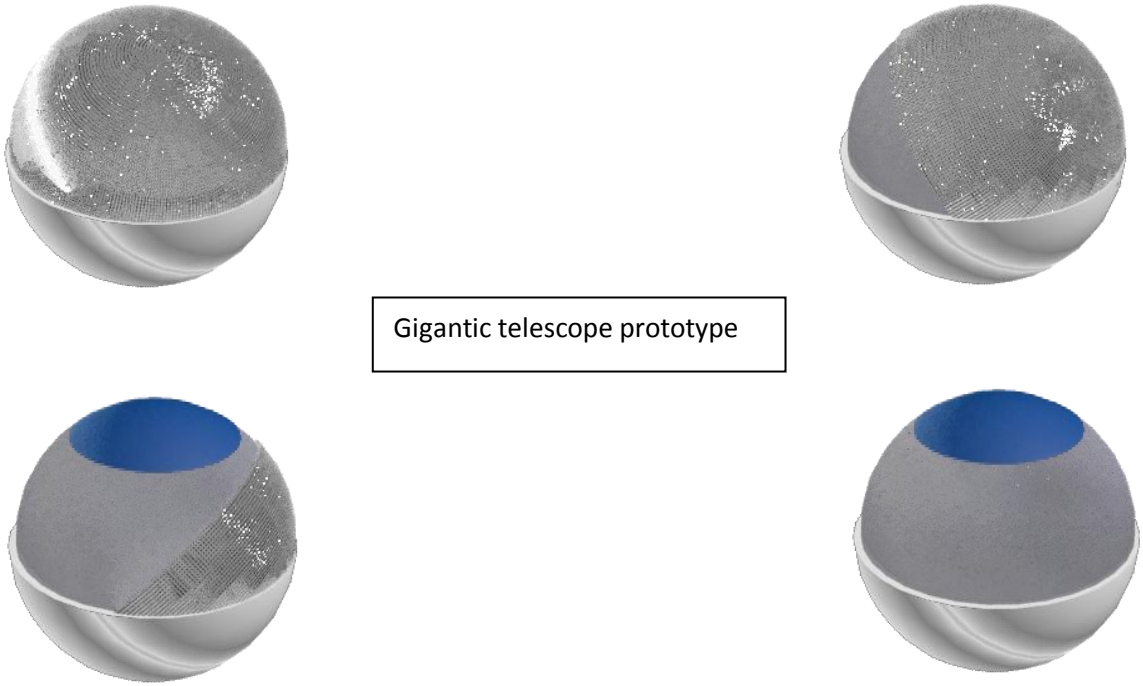


There are many methods through we can accelerate particles. However, the DC field is the most simple one so we decided to use this one.

4.1.2 Gigantic telescope

As Hubble already proved, a telescope placed outside the atmosphere of the Earth can make pictures of a higher precision due to the absence of atmospheric gases or lights. Even if there are a lot of telescopes none has a very large size due to the necessary expenses for developing a really big one. It doesn't only represent a great way of discovering new and unique landscapes, but it also is a mean of considering new scientific resolutions.

Therefore, we believe that allocating space on Aurora for this kind of project will be well worth even if we lose some of the available space.



Gigantic telescope prototype

4.1.2.1 Location and design

The telescope will be placed in the lower bubble, next to the particle accelerator.

The half exterior part of the bubble will represent the telescope's "eye". This part will be made out of Silicon brought from the moon. The "eye" will have no covers as it will work non-stop. We will have special robots that will be used to clean the eye every day, at a specific hour when research will be interrupted.

The pictures that are taken will be analyzed by a special computer, designed to do the most precise calculations, observations and predictions. Access to full data will only be available to a restrictive number of trusted scientists. However, some specially selected pictures will be published in Aurora's magazines. At the end of each week an article regarding possible discoveries will be available to inhabitants.

4.1.2.2 Expectations

The telescope has four major goals in its research: the first one is keeping science lovers up-to-date and the second is studying the existential possibility of celestial bodies to posses pre-biotic Earth conditions. The next one is looking for signs of extra-terrestrial life and their level of self-consciousness. Finally, its last and most grand of all is searching for planets that could host humans in the future, under the valance of the probability of being destroyed by a great calamity.

4.1.3 Microgravity laboratory

The prospect of research in microgravity is already possible but only in certain places. It is known that ISS regularly hosts experiments in 0 g. We are familiar with projects like "Plants in Space" and "Butterflies in Space", having been involved in

such kinds of research activities. Moreover, conditions from outer space can be reproduced artificially on Earth.

Even if such kind of research is already being done, we believe that having an environment with continuous microgravity is still to be regarded as important from a scientifically point of view.

4.1.3.1 Goals

Micro-experiments conducted in microgravity will lead to the discovery of new materials, which will be specially manufactured for their future possible task. The industry will benefit new industrial application which will be urgently sought. Looking from a medical point of view, patients with muscular problems and semi-paralysis conditions will be treated in a specially designed 0 gravity medical care center, because of the ease of movement that microgravity gives to people with disabilities.

Even if bones don't grow properly in microgravity environments, experiments showed that proteins develop faster and become larger. This could lead us to the production of drugs for previously incurable diseases.

Such an environment could be used for growing crystals. Even if they could turn out to be a source of profit, we will not use them for such purposes, as the costs to transport them to Earth would be too high. However, tourists will be potential buyers.

The crystals collected from the plantation will be used in medicine in order to create nanorobots on Aurora. Another application of this type of crystals will be found in the design and the glass industry.

4.1.4 Downtown laboratories

These types of laboratories will resemble the ones on Earth. Even if the approach will be a traditionalistic one, the machines available in these spaces will be state of the art.

In these laboratories students will carry out their research. They will be available for everyone because in here the research is going to be based on

improving the technology on Aurora: starting with robots and ending with gadgets improvements.

4.2 Gadgets

The multitude of gadgets available on the settlement will be overwhelming. As they cover such a wide range of products possible to produce from a technological point of view, analyzing each of them would be impractical.

We decided to focus on the most important part of the settlement, the "interactive glass" concept.

4.2.1 Our concept

Because transporting gadgets can be uncomfortable and because nowadays gadgets occupy a lot of space we decided to base our design on a special type of smart glass that will interact with the inhabitant's phones or tablets.

4.2.1.1 Multifunctional tablet

Every inhabitant will have a multifunctional tablet. The sizes of such a tablet will be of 15 centimeters in height and 27 in width.

The tablet will serve for a multitude of tasks. Beside, the well known applications of taking photos, sending messages, browsing the internet and phoning, it will contain data about its owner. As each inhabitant will have such a thing, the tablet will be:

- One's ID: The identity cards from e Earth will be reproduced in an electronic card but it will contain more information about its owner (i.e. fingerprints, DNA and blood analysis)
- A credit card: Everything on the settlement will be paid for with the card. The currency will be represented by Aurora dollars.

- A criminal record: Any penalty and violation of the law, however minor, will be registered on the tablet
- A health record: The results from test results and daily analysis will be stored on the tablet. This way, when a settler goes to the doctor an archive with all the details will be available in an instant. Also, in case of an accident doctors from the emergency department will be able to use it.
- A direct connection to Earth and all the news from the settlement: The tablet will represent a way to stay informed.

The tablet will have the capacity to give phone calls to people from the interior but through a special connection. The tablet will produce holographic images of the callers, creating the impression of a face to face encounter.

4.2.1.2 Multifunctional phone

The multifunctional phone will have the same characteristics as the tablet, differing only by it size, a smaller one. Its design is especially made for an easier handling.

4.2.1.3 Flexible display electronic paper

Paper as we know it is day by day becoming less and less utilized. This is mainly due to the fact that trees are an important part of environment and people want to preserve them. Bringing paper from Earth would be expensive and cutting trees on Aurora for this motive will be pointless. Therefore, in order to keep the same aspect we decided to create a flexible display electronic paper.

As the name says it, this gadget will have the appearance of a sheet of paper, preserving the same physical proprieties of being bent. By using nanotechnology, this concept becomes realizable.

The gadget will have the capacity of storing the information. Writing with special pens will be possible on it but it will also have a keyboard.

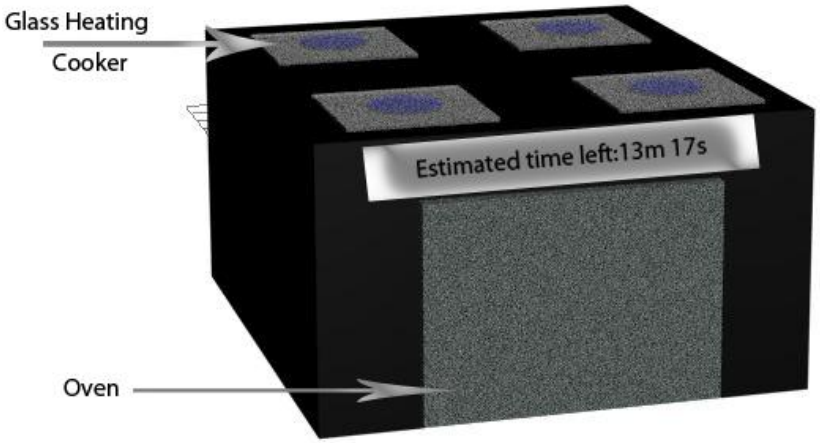
This paper will be a replacement of the traditional one, thus being utilized with the same purposes.

4.2.1.4 Intelligent glass

By referring to “intelligent” glass we introduce the concept of a type of glass that is interactive. This means, a photosensitive, durable, damage resistant material that has a touch-screen display.

The applications for such a material will be found in:

- Tables
- Mirrors
- Windows
- Kitchen counters
- Kitchen appliances (i.e. fridges, cookers, microwaves)
- Blackboards
- Wall-format display
- Transport vehicles
- The multifunctional tablets
- The flexible electronic paper
- Multifunctional phones
- Computers



Cooker working on the intelligent glass concept

When in contact one with another, two devices made by using the intelligent glass technology can synchronize displays, which makes their usage significantly easier in order to preserve a modern and unique lifestyle. Just imagine, video phone calls using devices as big as windows, recipe books written directly on the walls of the kitchen, and many more, all these facilities improve a colonist's way of life.

Fridge working on the intelligent glass concept

4.3 Robots

As the settlement is going to be a self-sufficient environment, it means that it is able to find the needed resources in order to function properly. However, the population will be way evolved in the future in order to do several tasks that are necessary. So, this is where the robots' duties have to interfere. Robotically done missions would not only mean the evolution of the scientific research, but it would also mean avoiding waste of human resources. Another advantage of using robots is

the fact that they can be programmed in such a way so they execute their task more accurate than a human being.

4.3.1 Types of robots

The robots are going to be categorized minding the type of task they are appointed to do, as following:

- Agriculture robots

  The agriculture robots are going to be placed in the agriculture torus and their task is to harvest the crops, using several mechanical arms and each is specially designed in order to pick up the products with minimum effort and loss. They also transport them on tracks to the storage torus, where they are prepared to be used in the industry. Their work is also explained in chapter 5.2.Crop growing.

- Medicine robots

  The robots that are going to be used in the medicine field represent a future resolution of nanotechnology research evolution. They are divided in three categories, the ones that can give a prospect to the patients with supervising from a doctor, the large ones, which will be used in surgeries and are able to successfully cut and treat a person, and last, but not least, the microscopical robots, which can infiltrate in the human body with the purpose of removing ill cells. Their work is explained in chapter 7.6.Medicine.

- Transport robots

  Transporting requires capable drivers that are available 24h/24h. Our opinion is that in the future, such a job as a conductor is impractical since the existent technology can replace humans to do this task, because they are more efficient and safe. The robots in this category will be equipped with advanced GPS service, the ones working in the tourism domain being able to understand and execute voice commands. In chapter 7.6 Tourism and 7.5 Transports their duties are also mentioned.

- House-holding & cleaning robots

The house-holding robots will be the most domestic ones, having a large range of tasks that they are able to do:

-Gardening

-Cloth cleaning

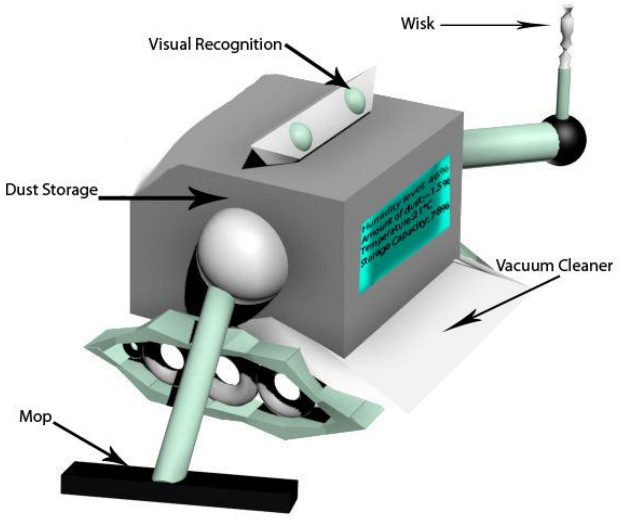
-Cooking

-House cleaning

-Baby-sitting

-House reparations

-Garbage disposal



House-cleaning robot

Each residence and building will be provided with such robots in order to keep a clean environment and to ease the colonists' effort, so that they can have enough time for relaxation and life enjoyment.

This category also hosts the robots which are designed to clean the surface of the settlement and other public spaces.

Specially designed robot used for cleaning the giant telescope's ''eye''

- Animal harvesting robots

  As well as the agriculture robots, the animal harvesting ones have to collect animal products using different types of adaptable hands.

- Lunar mining robots

  These robots have to collect materials from the moon and transport them to the factory that processes them in order to be suitable. Their work is detailed in chapter 3.5 MEF

- Laboratory & science practical robots

The laboratory robots are used for research and help scientists do their work. They have access to the laboratories and are provided with equipment that can repair other robots.

- Construction robots

  Their work is described in chapter 3.3 Bubble particularities, Design

- Entertainment& delivery robots

  The entertainment and delivery robots will be spread around the settlement and can help visitors or colonists to make the tour of Aurora, to provide information or to accompany them.

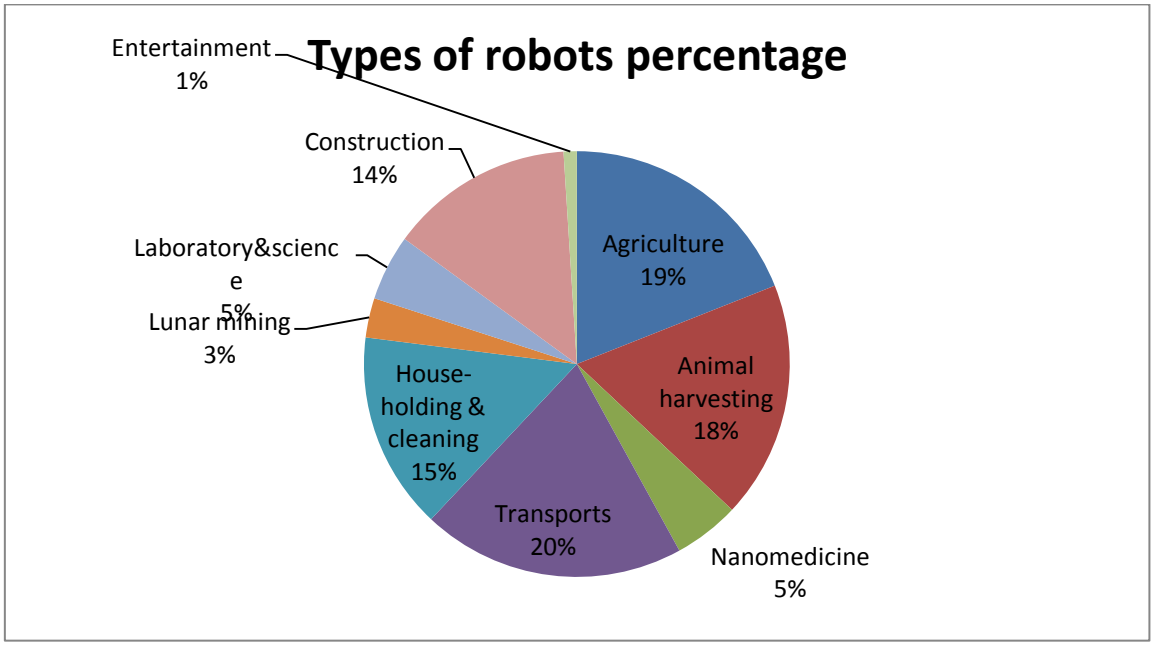
They are designed in such a manner that they are very friendly and talkative.

4.3.2 Particularities

The robots are going to be constructed using materials found on the moon, like: magnesium, aluminum, iron and silicon and are going to be designed by scientists on Earth. They should be constructed in such way that they are perfectly sealed and water resistant.

When a robot breaks, it should be repaired by the machines provided by the laboratories, as explained in chapter 7.3. Industry.

The machines are going to work using solar and nuclear provided power on the Settlement.



4.4. Energy

4.4.1 Solar energy

In space, we have only two sources of energy that can be converted into electricity in order to sustain the settlement. These sources are solar energy, and nuclear energy, Solar energy is much more easily to obtain, after placing all the required solar panels.

We have decided to cover with small modular sollar cells all the exterior of the settlement. Photovoltaic cells are made of semiconductive materials and use the photovoltaic effect to transform electro-magnetic energy (waves) into electric energy.

One of the facts which is not widely known is that in space solar energy is easier to obtain than on Earth. Beyond Earth's atmosphere the solar energy flows more steadily and more intensely from the Sun than that which penetrates to the surface of the Earth. One square meter of solar cells facing the sun may supply up to 7.5 times more electrical energy than on Earth. This is also caused by the fact that on our planet half of the day it would be dark, while space has continuous solar illumination.

We will use Gallium arsenide (GaAs) solar cells. These cells have a higher efficiency than the usual silicone cells. The photovoltaic arrays will be composed of triple-junction solar cells based on GaAs with germanium and indium gallium phosphide layers which can have an efficiency of over 32% and can operate also with light as concentrated as 2,000 suns.

Another advantage of the Gallium Arsenide is that it has a higher saturated electron velocity and higher electron mobility, allowing transistors made from it to function at frequencies in excess of 250 GHz.

All the energy gathered from the solar arrays will be converted to electrical energy and afterwards stored into nanocapacitors. This is a new form of storing electrical energy and may be even 10 times better than older technologies without sacrificing any power. Such devices exploit unique combinations of materials, processes, and structures to optimize both energy and power density.

4.4.2 Nuclear energy

Another important source of energy for our settlement is going to be the nuclear energy. In order to generate high amounts of energy in short time with very few losses we intend building a nuclear fusion reactor similar to the one used in ITER.

Inside a fusion nuclear reactor the atoms are sped up to such a high speed that they collide. One example is the Sun itself, where the temperatures reach 15,000,000 degrees Celsius. There, hydrogen atoms collide, despite their electrostatic repulsion and from two light hydrogen atoms (H-H) a new heavier element, Helium, results.

The most efficient method to produce energy to reproduce the reaction in a laboratory is by using two hydrogen (H) isotopes deuterium (D) and tritium (T). This reaction requires the lowest temperatures and ensures the highest energy gain. The temperature required is almost ten times the one on Sun, about 150,000,000 degrees. The fusion between deuteirum and tritium will produce on helium nucleus, one neutron and energy.

$$^{2}_{1}D + \ ^{3}_{1}T \rightarrow \ ^{4}_{2}He + \ ^{1}_{0}n + 17.6\ MeV$$

One of the major problems of this system is that it both requires and generates lots of heat. After the collision occurs about 80 percent of the energy taken away from the plasma field by the neutron which has no electrical charge and is therefore unaffected by magnetic fields. The neutrons will be absorbed by the surrounding walls, transferring their energy to the walls as heat.

The reactor's main requirement is the temperature which must get as high as 150,000,000 degrees Celsius.

Heat transferred using high-intensity electrical current, known as the ohmic heating is limited to a certain level. Therefore, we must use alternative heating methods to reach our target temperature.

Two families of external heating methods, the neutral beam injection and high-frequency electromagnetic waves will support ohmic heating to bring the plasma to temperature.

The natural beam injection consists in sending high energy particles in plasma. Charged deuterium particles are being accelerated to a defined energy level. The ions then go through an „ion beam neutralizer" where their electrical charge is removed. The high velocity particles can be afterwards injected into the heart of plasma where they transfer energy to plasma particles.

This heating power of millions of watts boosts the temperature closer to the level where fusion occurs. But still, a third source of heat, high frequency electromagnetic waves, will be required to reach 150 million °C

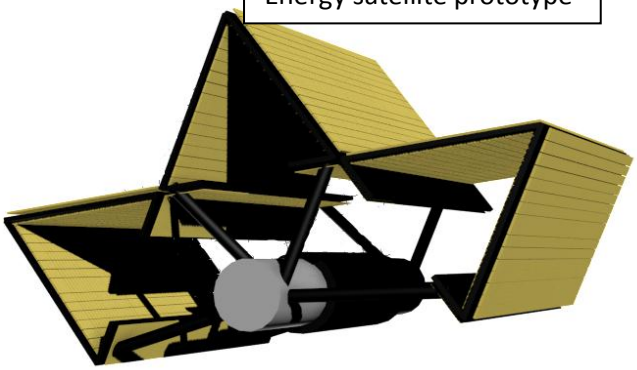
The energy of high-frequency waves introduced into the plasma increases the velocity of the particles' chaotic motion and their temperature as well.

Ohmic heating, neutral beam injection and high-frequency waves will work together in the plasma to a temperature where fusion can take place.

The big advantage of fusion reactors over fission is that the reactive waste amounts is hundreds of times less.

4.4.3 Energy Satellites

Energy satellite prototype



For safety reasons, in case of unexpected events, we will deploy 2 satellites in the orbit equipped with solar panels which will constantly gather sun light and transform it into electrical energy. The energy generated by this satellites will be stored into nanocapacitors, and, once they reach their maximum capacity, energy will be transferred to Aurora by „powerbeaming". The energy will be converted to light, and a monochromatic LASER beam will be directed to the photovoltaic cells located on the colony.

By using all these methods, we will generate way more energy than our settlements needs. Considering that on Earth the energy demand is getting higher and higher as time passes, it would be a good idea to find a way to transfer energy to out mother planet, as its natural resources are getting wasted more and more, and inexhaustible resources are not used at the maximum capacity.

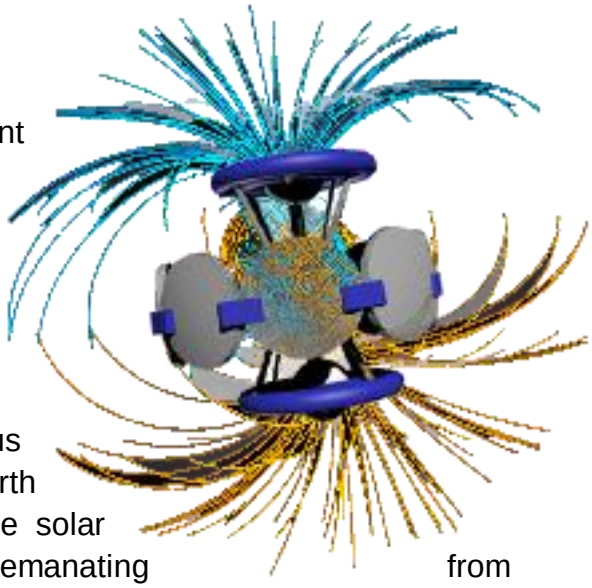
Therefore, we consider using a system of satellites which will send electricity through microwaves. We shall build 2 receiving stations on the Earth, placed diametrically opposed. On a straight line, at geosynchronous orbit (at an altitude of about 35,800 km). Apart from this, another satellite will be launched into orbit an around 200,000 km from Earth. This will act as a receiver – transmitter between Aurora and geosynchronous orbit satellites.

Air and water quality and temperature control will be measured and controlled non stop. All data will come to a central computer. Also this computer will collect data from all sensors that are placed on the surface settlement and continuously

measuring radiation levels but also the integrity of the surface. Any damage to it will spread from the central computer to security center of the settlement which is equipped with devices which can occur in a short time to repair the fault occurred. Even if a larger defect may affect the lives of people they can be evicted from the bubble in which they are living or doing business and may return after the defect will be repaired.

4.5 Protection

4.5.1 Magnetic field



After making such an enormous investment making sure everything will go as planned is essential. Therefore we considered the events that could jeopardize our mission and devised systems that should protect Aurora.

We must protect our settlement from dangerous radiation that could affect the people. On the Earth the its magnetic field protect the planet by the solar wind, a stream of energetic charged particles emanating from the Sun. The Earth is acting like a magnet with North pole at the South pole of the Earth, and the South magnetic pole at the North magnetic pole. This magnetic field deflects most of the charged particles.

We think that we can make a similar magnetic field using a powerful electromagnet. An electromagnet is creating by running electric current through a wire. This wire will pass through the walls of the settlement creating a magnetic field that is not harmful to humans.

A magnetic field is sustained by special conceived networks of wires. This network of fires will be located beneath the solar panels. This network is powered directly from inside from an energy source. It must be a DC energy source.

For a solenoid (a long helical coil) the expression for the magnetic flux density can be written in the equation form:

$$B = \frac{\mu \cdot N \cdot I}{l} = \mu \cdot n \cdot I ,$$

Where:

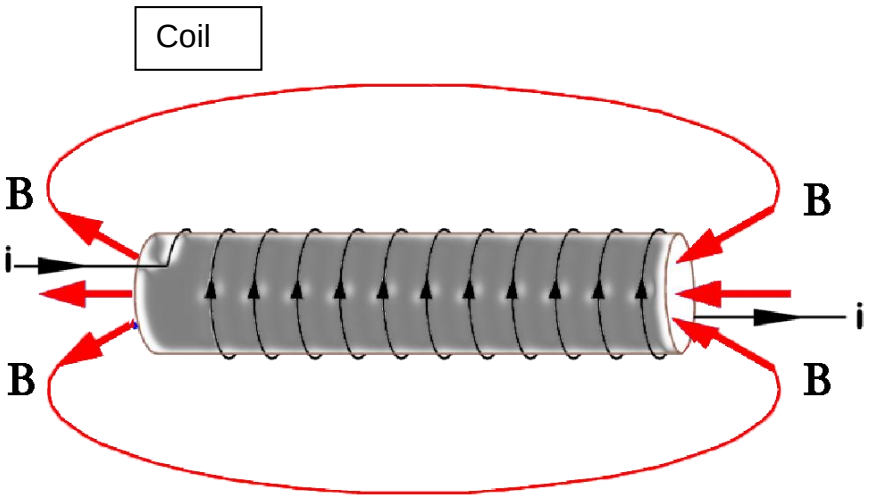
I= current

μ= permeability of free space

N= number of turns

l= length of the coil

N=number of turns per unit length



4.5.2 Impacts

In case an asteroid approaches the path of the settlement we will see this in time because of the radars that are mounted in the observation room and are connected to the central computer. People will be announced and the panic control system will start. From their arrival to their new home, inhabitants will be trained in order to be able to face such situations. If such a warning is launched, we will invert one of the motors used to create gravity so that they both generate thrust in the same direction, allowing the space station to move and avoid impact with major asteroids or any other dangerous moving bodies.

After the danger gets past, we can invert both engines to replace our settlement back to its equilibrium point, and then re-start generating gravity.

For increased safety, we will also have rockets ready to be launched in case of major emergency. These will be aimed at any asteroid approaching the station whose size would be fatal to our construction. These rockets should divide it into smaller parts, thus reducing the damage.

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5.Food, Water And Climate

5.1 Diet

An unhealthy diet is a major risk factor for a number of chronic diseases. These include cardiovascular diseases, metabolic diseases (i.e. diabetes, obesity), cancer and musculoskeletal health (bone health, osteoporosis). Therefore, the best will be done in order to ensure a good nutrition for the colonists, meaning a well balanced diet combined with physical activity.

5.1.1 A healthy diet

The diet chosen for an average settler with the age of 35, height of 1.70 m and with a weight of 70 kilos who does an average physical effort will be composed of:

- 15 % proteins
- 25 % lipids
- 60 % carbohydrates

By knowing the percentages of nutrients and the caloric intake of 2500 kcal per day we can calculate how many kilocalories of each category are needed. Thus:

- For proteins: $\frac{15}{100}$ * 2500 = 375 kcal per day
- For lipids: $\frac{25}{100}$* 2500 = 625 kcal per day
- For carbohydrates $\frac{60}{100}$* 2500 = 1500 kcal per day

By using the required formulas we can now calculate the necessary amount in grams.

- For proteins: $\frac{375}{4}$ = 93.75 g per day
- For lipids: $\frac{625}{9}$ = 69.44 g per day
- For carbohydrates $\frac{1500}{4}$ = 375 g per day

A recommended diet plan that will meet the ordinary settler's needs for a healthy diet is suggested below.

Aliment	Quantity	Proteins	Carbohydrates	Lipids
Bread	200 g	16 g	100 g	-
Potatoes	100 g	2 g	20 g	--
Pasta	100 g	4	20 g	
Fruits 10-15 % (1)	500 g	2 g	50 g	-
Fruits 20 % (2)	200 g	1 g	40 g	-
Vegetables 5 % (3)	500 g	0 g	25 g	-
Vegetables 10% (4)	200 g	2 g	20 g	-
Cheese	30 g	7.5 g	1 g	9 g
Milk / Yogurt	500 ml	10 g	10 g	10 g
Eggs	50 g	7 g	-	6 g
Oil-bearing plants	25 g	3 g	5.5 g	16 g
Leguminous plants	50 g	12 g	26 g	0.5 g
Oil	10 g	-	-	20 g
Butter	10 g	-	-	10 g
Meat / Fish	100 g	23 g	-	8 g
Sugar	20 g	-	20 g	-
Hams	30 g	2.5	-	6 g

(1) : i.e. apricots, cherries, strawberries, grapefruit, mango, oranges, peaches, tangerines

(2) : i.e. bananas, grapes, dates

(3) : i.e. green onion, cucumbers, cauliflower, green beans, tomatoes, spinach, green salad

(4) : i.e. carrots, beetroot

! Smoking is going to be forbidden on Aurora because of the next reasons:

-It is an unhealthy habit, and it doesn't correspond to the ideas set

-There is not enough space on the agriculture torus in order to plant tobacco

-The atmosphere would be altered by the harmful eliminated gases

5.1.2 Physical activity

As specified in the acceptance criteria (pag : xx), every inhabitant should be physically fit. Physical inactivity is considered to be the fourth leading risk factor for global mortality. This serves to strengthen our sureness that the colonists should practice sports with regularity.

According to the study “Global Recommendations on Physical Activity for Health” devised by WHO (World Health Organization) the optimal physical activity differs mainly on three categories: children from 5 to 17, adults from 18 to 64 and elderly people from 64 and above.

A table of the recommended activities for every age group and time that should be spent doing them in order to improve health is listed below:

Age group	Physical activity	Recommended period of practice
Children from 5 to 17	Sports (i.e. bicycle riding, swimming, canoeing, etc.) Play (i.e. games that involve running or other physical activities) Muscle-strengthening activities (i.e. gymnastics, push-ups, rock climbing, use of resistance bands) Bone-strengthening activities (i.e. jumping, running, tennis, basketball)	At least 60 minutes a day At least 3 times per week
Adults from 18 to 64	Moderate-intensity training (i.e. walking) Muscle-strengthening activities (i.e. weight lifting) Vigorous-intensity aerobic activity (i.e. jogging, swimming) Muscle-strengthening activities (i.e. push-ups)	150 min / week 2 times / week 75 min / week 2 times / week
Adults from 64 and above	Moderate-intensity aerobic activity (i.e. walking, cycling) Muscle-strengthening activities (i.e. heavy gardening)	150 min / week 2 times / week

Together with the diet suggested above, this physical activities plan will guarantee our average inhabitant with a healthy lifestyle, thus lowering the risks of developing a certain amount of conditions.

5.1.3 Health Control System (HCS)

A typical diet for an ordinary inhabitant, why not enough?

First of all, everyone is different, designing one plan and expecting it to work for everyone is unrealistic. On the other hand, ones may have some problems (i.e. lactose intolerance) or may want to lose weight. So what is the solution for this?

A very efficient solution to this matter is implementing a Health Control System, which, in our vision would represent a method of remotely monitoring a colonist in order to comply with a plan for sustaining the health condition. Therefore, the best option to reach is conceiving a device based on nanotechnology which will aid the inhabitants in order to test themselves in the medical domain. Every colonist is going to have the obligation of using this device and send his data to a clinician computer via a communication network. Such a computer will analyze the information and provide the patient a suitable diet which may consist of certain aliments and medication. If necessary, the inhabitant will have to consult a doctor and withstand surgery.

Each colonist is able to choose the form of the device over a given variety:

- Multifunctional bracelet
- Insulin pen
- Multifunctional tablets

5.1.4. Cooking

Cooking can be regarded as a means of eating a wide variety of healthy food. The technology available will replace this activity. However, this can be regarded as a hobby. Therefore, our inhabitant will be able to choose between the traditional way of preparing food and a more atomized one.

5.1.4.1 Traditional cooking

By traditional we do not mean cooking like ages ago, we mean cooking the way we do it today: electrical cookers, microwaves, fridges, pots and pans. All of this will be available if wanted.

Books with recipes will be available for download. In order for an easier lecture, they will appear on the kitchen counter. The smart glass will be a touch screen that will interact with everybody's tablet, as explained in chapter 4.2 ''Gadgets''.

Ingredients will be available for online buy. When deciding to prepare a recipe, all the necessary aliments will be delivered at home.

Recipe application

In order to learn how to cook, an application specially designed will be available in the store. Worldwide cuisine will be present in our multicultural environment. Every recipe will have 4 parts:

- Ingredients
- Preparation mode
- Serving
- Caloric intake

We described every part below.

The ingredients will be listed, together with pictures of them. Over the counter, aliments for sale in the online store will be projected in order for a more precise pick. After the settler chooses what he needs and wants, everything will be delivered at home in about 5 minutes.

Afterwards, the preparation phase will start. In the five minutes before the delivery the program will give advice related to the following processes.

After the aliments arrive the instructions will appear on the counter. For every phase an image of how the dish should look will be projected. For young or inexperienced learners the projections will also show the way you should stir, mash, heat or fry.

Recommendations of how everything should be served will appear after the dish is ready.

Furthermore, the program will display the calorical intake and the amount of proteins, carbohydrates and lipids every plate contains.

Inhabitants will have 4 levels from which to choose, according to their experience: for dummies, easy, intermediate and experienced.

5.1.5 Technology in dishes

Day by day, less people cook as already prepared dishes are available everywhere. Therefore, we thought of some systems for automatic cooking. In order to create an easy to use system we decided to have a main machine that could be used for almost everything.

This robot will be able to cook the ingredients that are introduced in it. The inhabitant will only have to choose the aliments and the recipe and after a certain amount of time, different on each occasion, take out the dish and enjoy any of the recipes available in the online catalog.

5.1.5.1 Molecular gastronomy

If they want, the inhabitants of Aurora will have the opportunity to cook dishes that follow the principles of molecular gastronomy. With the help of special appliances that will make practical use of physical and chemical transformations, the range of foods available will increase.

Some examples of techniques and appliances are listed below:

- Centrifuge
- Food dehydrator
- Syringes (for injecting fillings)
- Addition of carbon dioxide (for adding bubbles and making foams)
- Usage of liquid nitrogen (for instant freezing and shattering)
- Use of maltodextrin (for turning a high-fat liquid into a powder)

5.2 Crop growing

The space settlement should be as economical as possible. Thus, we realized that the present agriculture techniques are inefficient as crops require a lot of space to grow, also needing soil that is fertile and rich in nutrients. Bringing soil from Earth

or recreating it on the space settlement is expensive, so another system of growing plants needed to be devised.

5.2.1 Hydroponics

The most suitable decision would be using a system that would enable us to grow crops without soil. The most practical approach is using a hydroponics system. This method meets with all our needs. While taking up less space, it also makes plants grow beautifully, larger and healthier than the ones grown in normal conditions. Also this kind of agriculture is a time saver as labor that is necessary in traditional practices is cut down a lot.

After participating in the “Plants in space” project organized by NASA we became aware of the way plants grow in microgravity, therefore we know that the crops on Aurora will be placed in a 1 g area in order to provide conditions similar to those on earth. As natural light won’t be enough we decided that the needed light will be provided by diodes, same lighting source we used during our experiment, as they have a proper intensity and they don’t cause heating. Since O_2 absorption decreases with a decline or raise in temperature the growing environment will have one of 20° to 30° degrees Celsius (68° F – 86° F)

The solution in which plants are going to be grown will be a nutrient enriched water-based solution. It will contain necessary minerals for the best development of the crops. The nutrients are listed below in order, from the ones that are required in a bigger mass to the ones that are the so called micronutrients:

- Nitrogen
- Potassium
- Calcium
- Magnesium
- Phosphorus
- Sulfur
- Chlorine, Boron, Iron, Manganese, Zinc, Copper, Molybdenum

Without Oxygen water and nutrients absorption ceases. Therefore, the solution will be oxygenated by an air pump for providing the proper amount of air supply. Because response to a poor nutrition is fast an indicator will send information about the concentration of each nutrient to the computer which will mechanically add more substance if required. Their levels will be influenced by the stage of growth the plants are in and by the need to cover a deficiency. The solution will be placed in the storage tanks, at the base of the air pomp for a more even spreading.

5.2.2 Systems structure

There are 6 types of well-known hydroponics system. From the 5, some do not call for a fertile soil but they still need a growing medium (i.e.: sand, gravel). For economical reasons we didn't choose the drip or the wick system.

The rest of the systems are showed in the table below for comparison:

System	Components	Operating mode	Advantages	Disadvantages
Water / Deep water	~ Floating platform used for holding the plants ~ Water tank ~ Air pump	~The floating platform holds the baskets with the plants half submerged in the tank. ~The air pump oxygenates the nutrient solution.	~No growing medium required ~Ideal for water-loving plants (i.e. lettuce)	~There are a lot of plants which won't develop well in this system
Nutrient Film Technique (N.F.T.)	~ Oblique placed platform with baskets for plants ~ Water tank ~ Air and nutrient pump	~A constant stream of water is maintained on the bottom of the grow tray. ~The ends of the roots are placed in the solution which flows back in the tank through a tube placed at the end of the tray.	~No growing medium required ~Efficient utilization of space as it can be built almost vertically.	~Plants can dry out quickly if the water flow is stopped
Ebb and flow	~ Growing tray ~ Water tank ~ Air and nutrient pump ~ Timer	~The grow tray is flooded with water from the tray and then the solution flows back into the tank through a tube. ~The nutrient pump is controlled by a timer, for a regular watering.	~Any growing medium can be used (maybe one made from lunar materials)	~The grow tray should be filled with a growing medium

Aeroponic	~ Platform used for hanging the plants in the air ~ Water tank ~ Air and nutrient pump	~The plant baskets placed on the platform are hanged in the air. ~A nutrient pump sprays a mist of solution over the roots at regular intervals every few minutes.	~No growing medium required ~Doesn't take up a lot of space	~In case of a nutrient pump failure plants can dry out quickly

5.2.3 Our systems

By analyzing the data we decided that the aeroponic and N.F.T. system are the most suitable. They take up the least space because of the possibility of placing them vertically and also give the wanted results in crops growing. Also, for a small number of plants we will use the Ebb and Flow system.

Even if we chose both of them we consider the aeroponic to be more efficient, thus it will be the main one. It consumes less nutrient solution, 1.5 milliliters per minute, in comparison to one liter. Moreover, the time spent without water helps the plant absorb a larger amount of oxygen. Also, no pesticide is required and the risk of diseases is minimized.

5.2.3.1 Aeroponic system

- The aeroponic system works better if the roots are already developed as the larger the surface provided for water absorption is, the better. Therefore, we think that the plants should be held in a water culture system for their first stages of growth. Afterwards, they should be moved, depending on their type in an aeroponic one. Because moving the plants would be space, time and labor consuming, we consider that our system should be able to metamorphose when needed.

A table of the components and their uses is listed below:

Components	Use and characteristics
• **Water tank**	• The water tank will be the place for the storage of the solution.
• **Nutrient pump submerged in the tank**	• The nutrient pump will be used only in the second stage of the growth, spraying a nutrient mist over the already-grown roots.
• **Platform for plant baskets**	• The platform will have holes for the baskets. After the first stage is over, the platform will be lifted by the pistons.
• **Pistons**	• The pistons will be used to lift the platform and lower it after harvesting.
• **Air pump**	• The air pump will be turned on all the time, being used for the oxygenation of the nutrient solution.
• **Indicator**	• Used for measuring water temperature and levels of nutrients.

• Transformation process:

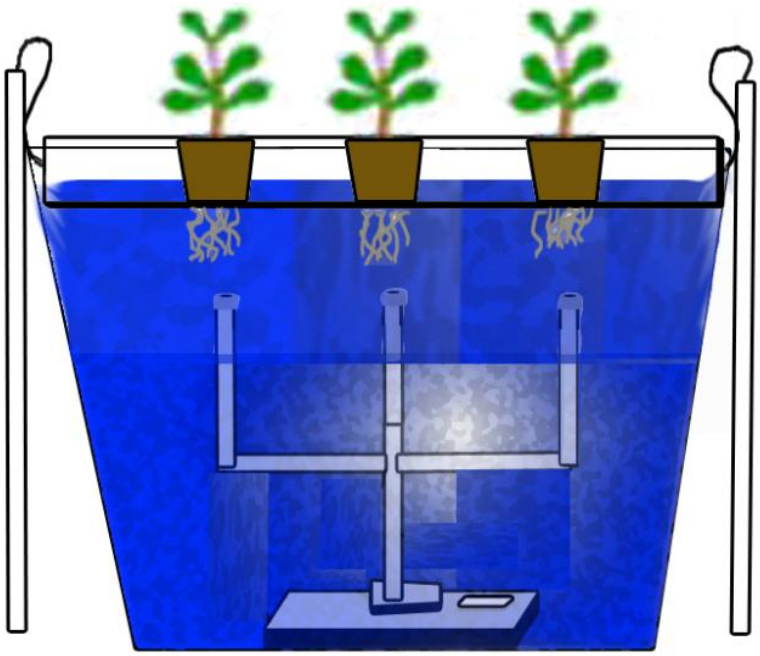
After the plants reach their second phase of growth (when they have roots that are long enough) the platform will be lifted into the air by the automated pistons for easier aces to roots. The arms of the submerged nutrient pump will also rise and will start spraying the nutrient solution every few minutes on the roots. The water level in the tank will lower, as the quantity of solution needed for the process isn't as big. The evacuated water will be sent to the purification centre in order to be recycled for its next use.

After the termination of the growing process and the harvest, the platform with new plants will be lowered again and the process will repeat.

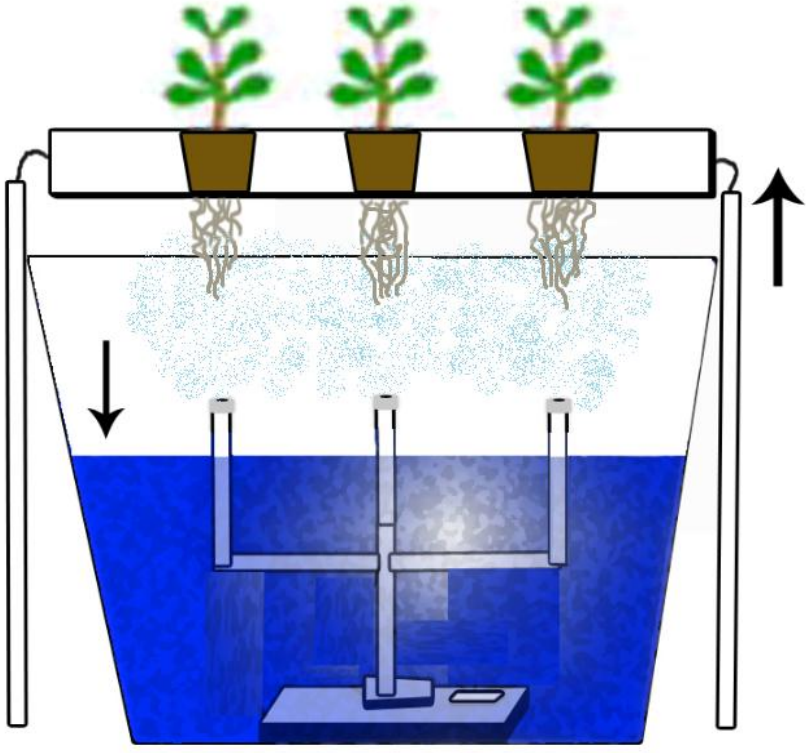
• Placement of tanks

Each tank will have 9 places, so as to give enough place for every plant to grow.

There will be three tanks placed one atop of the other. All three tanks will be connected by a pipe in which the evacuated water will go. For safety reasons, not all the tanks will be connected by pipes in order to avoid spreading a disease which might appear in one area. The purification areas will be different for every type of aliment.



Transformation of hydroponic/aeroponic system



5.2.3.2 Other system

- Nutrient Film Technique system (N.F.T.)

The oblique platform will be provided with nutrient from the tank below. The flow of water will return to the tank through the orifice at the end of the tray. The water will be changed at regular intervals.

- Placement

The platforms will actually have the form of a tube. They will be placed so as to form a right-angled triangle, with the angle of inclination of the tubes of 45°. The evacuated water will also be purified in different areas, sorted by the type of plant.

- Ebb and flow system

The Ebb and Flow system will be used for plants like rice. The placement of the tanks and the harvesting robots will be the same as the ones used for the aeroponics.

5.2.4 Mechanics

For the comfort of the settlers most of the agricultural process of growing crops will be automated. Robots will do the work humans have done for years, as far as possible. Even if machines will do most of the work, Aurora will also need farmers for a better monitoring of plants. The so-called “farmers” won’t do their usual task; they will program the computers and adjust their measurements, helping as to a better caring for the crops.

5.2.4.1 Materials

The choice of the material from which we are going to make the robots is a very important one. On Earth, aluminum would be a viable solution due to its characteristics and its abundance. But on Aurora, will it be the best we have?

This metal has a lot of proprieties which will come as an advantage when using it:

- It is a light-weight material
- It is ductile and malleable
- It is soft but durable

However, it is not enough to be a proper material because a easy to use source needs to be available. With Earth out of the question, our best option is the moon. The extraction of aluminum from anorthite and its transport to the moon is described in chapter 3.4 Materials.

Therefore, all robots used in agriculture will be aluminum-based.

5.2.4.2 Types

- Harvesting robots

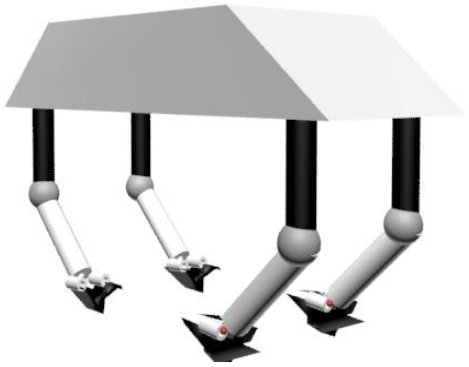
The harvesting of the crops will be done by robots.

~ In the aeroponic and Ebb and Flow systems, the robots will move along rails placed over the areas designated for growing. They will start collecting from the plants in the tanks that are placed on the ground and after finishing with the area they are assigned to they will move upwards to the next set of tanks. After grabbing the plant the robot will put it on the conveyor belt placed between the tanks which will send it further for storage or packaging.

Design

The robots will have the shape of a rectangular parallelepiped; they will have the height of about 20 centimeters, the length of one meter and the width of 50 centimeters.

Each robot will have four flexible arms. For an easier production the same robots will be used for every type of plant. However, for a more efficient process of harvest, at the end of their arms they will have removable tips, which will be different for every crop. Another important element will be a scanner which will help the machine detect the element that needs to be collected, eliminating plants if they are not reaching the required standards. For some categories of plants the first two hands will be used for selecting and placing the required part of the plant on the conveyor and the others for taking the remaining parts and placing them in the trash.

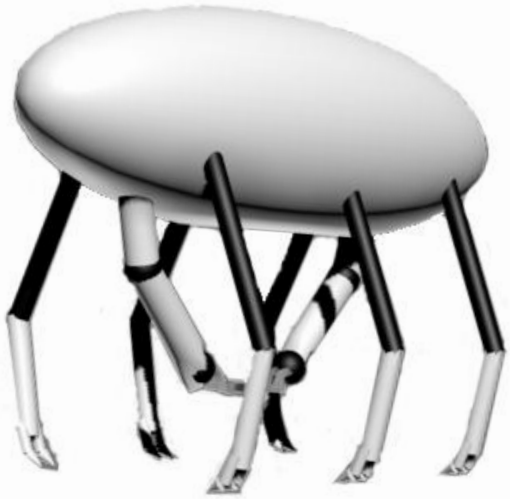


The removable tips will consist of blades and a variety of flexible hands used for collecting.

~For the Nutrient Film Technique system (N.F.T.) the robots will be completely different. They will resemble bugs, having an ellipsoidal shape and 6 long articulated legs on the side. They will move up and down on the tubes where the plants are grown. They will be more independent and will not require any rails for their movement.

Design

The robots for this system will have the shape of an ovoid. On their sides they will have six legs which will be articulated in three places in order to allow freedom and ease of movement. In the middle, it will have two flexible arms placed longitudinally which will be used for collecting plants and disposing of unwanted parts.



Even if this kind of robot may seem independent, the tubes will be projected so as to not allow any other movement than the one the machine is programmed to do.

- Conveyor belts system

The farm will have a complex system of distinct conveyor belts that will be used for the transportation of plants, leftovers and other necessary goods throughout all the available area. Their main functions will be:

- Transportation of plants from the growing place to the packaging or storage areas
- Transportation of the parts that are not edible to the recycling unit
- Transportation of parts needed for reparation
- Transportation of baskets or other objects needed for growing the plants

5.3 Livestock, poultry & fish

The food supply, other than plants, will be based on animal products. A healthy nutrition requires more than vegan food, which will be provided on Aurora by the animal farm torus. Excluding the possibility of daily transporting food from Earth because it would cost much more and would contradict the purpose of a self-sufficient Space Settlement, the solution left to this issue is building a farm in the capacity provided by the upper torus.

5.3.1 Noah's arch project

In order to have animals on the settlement, we have to find a way of transporting them from Earth.

The animals will be brought in the preliminary stages of the construction in order to have time to reproduce. This way, we won't have to bring such a big number of animals from Earth, making an important economy. The stage in which we will bring them is presented in chapter 7.5 Transports.

5.3.2 Productivity calculation

Animal	Required food	Required water	Life expectancy	Reproduction	Products and quantity
Cattle	Diet composed of grass or grains (i.e. corn) 15 – 30 kilo per day	38 – 57 liters per day	15-20 years	Sexual maturity period: 15 months – 9 years 1 calf per year	Milk Meat Leather
Goats	Hay, Silage	3-5 liters / day	From 15 to 18 years	Sexual maturity period: starts from 3-15 months	Milk : 2.7 liters per day Mohair
Sheep	Ruminant	4-6 liters / day	10 to 12 years	Sexual maturity period: starts from 6-8 months; 5 months pregnancy	Wool Milk Meat
Pork	Corn, wheat, oats, barley	10-15 liters a day	10-15 years	6 - 8 months; 115 days gestation; 18-27 pigs per sow per year	Meat Leather Brushes
Chicken	Chicken feed, grains;	0,3 Liters	2-3 years	5-6 months.	Meat Eggs
Goose	Whole wheat, cracked corn, grass	0,3 Liters	3 years	Sexual maturity at 2 years, lays 3-8 eggs which incubate for 24-28 days.	Meat Feathers Eggs
Catfish, carp, salmon, tuna fish	Fish feed, algae		10-12 years	Reproduction starts at age 3-4 (salmon) , and 10-12 (catfish and carp); lay over 300.000 eggs a year	Meat Roe

The animals are going to be divided in two categories, the ones that will be used to produce meat and the one that won't.

- Animals that won't be used to produce meat

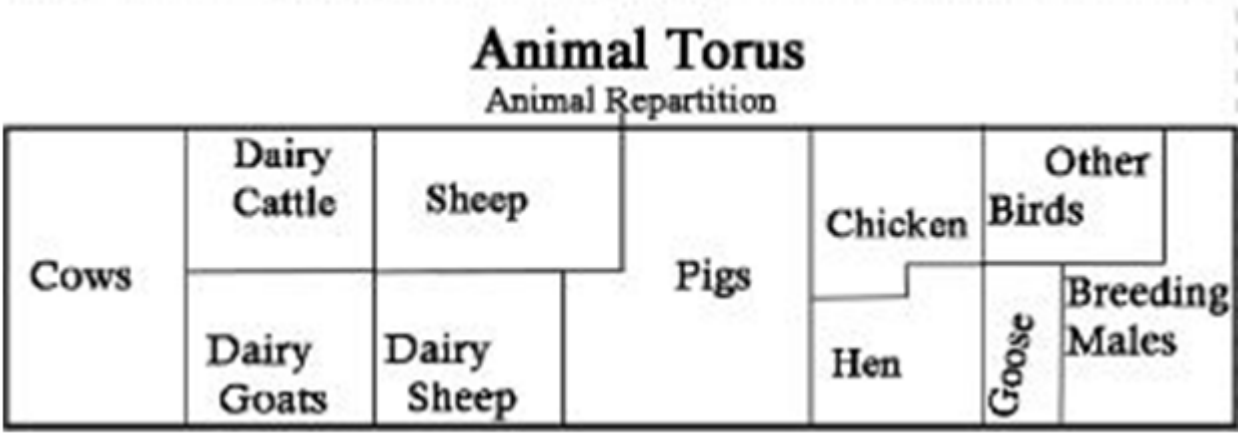
Animal	Amount of milk/year	Amount of eggs/year	Amount of roe/year
Dairy cattle	9000 kg	-	-
Goats	860 kg	-	-
Sheep	454 kg	-	-
Pig	-	-	-
Hen	-	300	-
Geese	-	80	-
Catfish, carp, salmon, tuna fish	-	-	2500 eggs per year

- Animals that will be used to produce meat

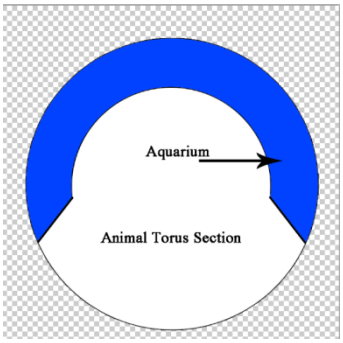
Animal	Amount of meat(market weight)
Dairy cattle	232 kg
Goats	-
Sheep	45 kg
Pig	136 kg
Chicken	2.5 kg
Goose	5 kg
Catfish, carp, salmon, tuna fish	1,5 kg

5.3.3 Animal repartition

The livestock and poultry will be distributed as in the diagram below, throughout the Torus:



As for the farmed fish, they will be provided with a gigantic aquarium suspended along the ceiling, equipped with compartments which separate different species of fish. This is an optimal solution in order to save space. Even if fish can have side effects from living in microgravity it was shown that after 3 to 4 days their sensory system comes back to normal.



5.3.4 Living conditions

The conditions in which the animals are going to live will be similar to the ones on earth. For example, the cattle are going to be placed in barns and will be milked by special cow-milking robots. The diet will be supervised by robots in order to avoid obesity or other diseases. Every department (e.g. poultry, fish) will be provided with a vet capable to diagnose each sick animal.

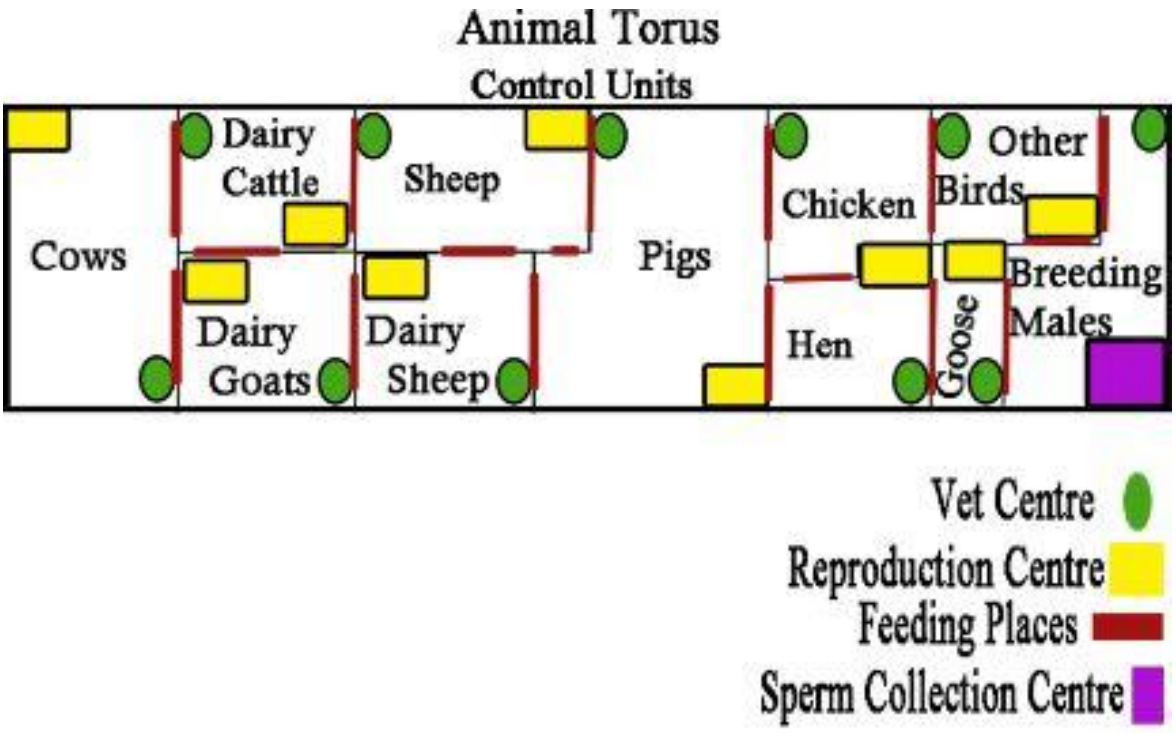
The fish are going to be fed by special robots that are able to glide on tracks, and in order to collect them and their eggs there will be used special collector robots as well.

The livestock, poultry and farmed fish are going to be placed in the D torus, which provides enough space for production and reproduction.

Every material on the settlement will be recycled so the torus will be connected to the recycling area.

5.3.5 Control units

Each ground department will be provided with a vet center, a reproduction center and food containers as in the scheme below:



The reproduction center will be opened only in special periods. Here the collected sperm is brought from the males in order to fertilize the females.

The vet centers are cottages provided with special equipment fitting every animal's needs.

5.4 Water management

As water can be a rather difficult resource to obtain, a plan for managing available resources needs to be carefully devised. Below we presented the required amounts of water, the methods we will use to produce it and the way we'll store and reuse it.

5.4.1 Water requirements

An average adult, who weights 70 kilos, lives in a normally warm environment and takes the recommended amount of 60 minutes of exercise per day, should drink

2.065 liters daily. In the table below we presented the main requirements of water of an inhabitant:

Water requirements for an inhabitant	Amount needed (liters/day)
Drinking water	2.065
Cooking water	0.70
Washing water	7
Toilet flush	0.5
Dish wash water	3
Clothes wash water	3
Total :	16.265

A little amount of water will be necessary for clothes and dishes cleaning as the available machines will be economic. Also, due to advancements in nanotechnology clothes will have the capacity of self-cleaning.

Other than for humans, water will be needed for animals, agriculture, cleaning, entertainment and various other processes.

After we calculated the necessary amounts of water we decided that the total quantity available on our settlement should be of around 20 000 000 liters.

5.4.2 Water storage

The water will be stored in tubes, in every torus. The water in the channels will be aerated for a better oxygenation. The cylinders containing water will be interconnected with the central hub from where the pipes used for water distribution will start.

Furthermore, the purification unit will be linked to it. After the water is clean and ready to reuse, it will be sent in this tube.

Even if the tube will only have 5 main sections each of them will be divided into more parts used for different purposes, from drinking water to water used for flushing and water used for cleaning.

There will be 5 different sections in the channel, each one designated to one category:

Destinatary	Available storage space (liters)
Humans	~268 372,5
Agriculture	~5 000 000
Livestock	~7 000 000
Manufacturing	~5 000 000
Miscelanous	~2 731 627,5
Total	~20 000 000

5.4.3 Water production

Because all the amount of needed water would be difficult to bring from Earth we considered some different ways of obtaining it. Therefore, we also considered moon as a source. By analyzing various chemical and physical processes we chose the ones that would be most suitable.

5.4.3.1. Moon's Crust

As lunar crust also consists of ice, the moon could also prove to be a source for extracting water. More abundant at the north pole, water could be extracted from the ice even if the temperatures are really low and this could prove as a challenge.

However, this will require really powerful robots which will have instruments that will be used for heating the soil. Robots are explained with more details in chapter 3.5 MEF.

5.4.3.2 Iron extraction

One of the methods used for obtaining iron will be from ilmenite, a crystalline iron titanium oxide.

The chemical formula for ilmenite is $FeTiO_3$. The reaction of reduction of ilmenite is as follows:

$$FeTiO_3 + H_2 \rightarrow Fe + TiO_2 + H_2O$$

This process will be used mainly for production of iron and titanium but water will be a precious by-product, increasing our supply of the much needed liquid.

5.4.3.3 Sebatier process

The Sabatier chemical reaction is a process through which carbon dioxide and hydrogen react at elevated temperatures and pressures. This happens in the presence of a nickel catalyst. The chemical substances that result from this process are methane (CH_4) and water.

The nickel catalyst can be replaced with an aluminum one which would be easier to obtain.

The chemical reaction is as follows:

$$CO_2 + 4H_2 \rightarrow CH4 + 2H_2O$$

Methane is a useful substance as it can be a good source of fuel for our space transporters and shuttles. Therefore, we consider this reaction to be a suitable one as it gives us two useful by-products.

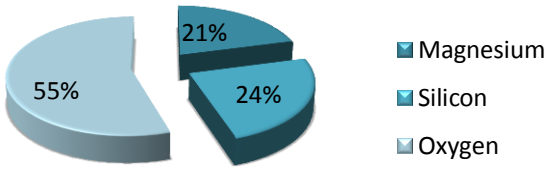
0.2 kilograms of hydrogen and 1.2 kilograms of carbon dioxide would be enough for the production of 1 kilogram of H_2O.

5.4.3.4 Other chemical reactions

The Sebatier process has methane as a by-product. Other than for fuel this substance could be further be used in other reactions in order to produce water

$MgSiO_4$ is a substance composed out of:

MgSiO4



When mixing it with methane the following chemical reaction takes place:

$$MgSiO_4+CH_4 \rightarrow MgO+Si+CO+2H_2O$$

This reaction can be used for obtaining Magnesium oxide, Silicon, Carbon monoxide and most importantly, water.

The Carbon monoxide resulted from this reaction can be used to produce water with the help of another reaction:

$$CO+3H_2 \rightarrow CH_4+H_2O$$

5.4.4 Water cycle

A key element to having the necessary amount of water will be the method of reusing it. Therefore, we will describe the processes used for purification and we will also design a water cycle. For more efficiency, we will use a wide range of methods, each resulting in a different quality of water, depending on what its purpose is.

5.4.4.1 Microfiltration and Ultrafiltartion

Microfiltration is the process that involves the use of a membrane in order to remove contaminants from water. The membranes used have pores sized from 0.1 to 10 μm (micrometers).

This method could help in the biological wastewater treatment. Because not all the impurities can be eliminated with this first process we could regard it as a first step for a more efficient method of filtration.

Ultra filtration involves the same concepts. However, the size of the pores is reduced form the maximum of 0.1 to 0.001 μm. this type is more precise but it is still far from perfect.

5.4.4.2 Reverse osmosis

The reverse osmosis process is also a thin film composite membrane separating technique. However, the difference consists of the fact that it involves using pressure.

Even if the method is largely known for its ability to separate salt from seawater, it is highly dependent upon the conditions in which the fluids find themselves.

What can be called “a pursuit for balance” is the easiest way of describing this process. When two substances with the same solute but of different concentrations are put into contact the tendency is to mix until reaching uniformity. When adding a membrane the fluid with lower concentration will go through the membrane to the substance with a bigger concentration.

It is normal for the heights of the column of liquid to be different due to the effect of osmotic pressure.

The reverse process starts by applying a pressure that exceeds the previous one. This way fluids travel back through the membrane while solids that aren’t dissolved remain in the other compartiment.

5.4.4.3 Nanofiltration

Nanofiltration a process mostly used for drinking water purification. It is based on membrane separation and also utilizes pressure but it is more precise than the methods presented above. The retention of monovalent ions is, however, limited.

5.4.4.5 Disinfection

There are several techniques used for water disinfection. Some of them are:

- Ozone disinfection
- Ultra-violet (UV) disinfection (Solar water disinfection)
- Chlorine dioxide disinfection

5.4.4.6 Sand filters

The process of sand filtration uses sand or other granular media in order to remove impurities. This type of method can join in in a multi-stage treatment.

Even if maintenance nowadays proves a little difficult we believe that this won't be a problem on Aurora. Therefore, this process is a good one also.

5.4.5 Water types, by purity

Water with different levels of purity can be utilized in various ways. It makes no sense to use water of the greatest quality for flushing, does it? Therefore, we separated water by type into 3 main categories:

- Ultrapure water

  Used in pharmaceutical industry

- Drinking water

  Drinking water will have to meet the quality standards given by the World Health Organization (WHO). Therefore, we will use processes that will eliminate

- Water with a small amount of impurities

  Used for other purposes than drinking (i.e animals, crops, flushing, shower, sink)

5.5 Climate

We believe that the climate of the area is a very important factor regarding a colonist's convenience, meaning that it is necessary discovering the right temperature for optimal living conditions, resembling the ones on Earth.

When conceiving a climate we have to take into consideration the following aspects: temperature, humidity, atmospheric pressure, wind and precipitation.

Because the environment in every bubble will be different temperatures will vary but they will stay in a comfortable range, between 18 to 28 degrees, which proves optimal for an adequate living.

In the areas that are not designed for living the temperatures will be selected in order to meet the needs of each space. For example, the agricultural and animal torus will have different temperatures within, adjusted to the needs of the species living in a specific area.

There also are some areas in our settlement that won't need heating. Therefore, areas used for storage (e.g. grain storage) will be maintained at lower temperatures. Also the spokes won't be heated as it is only necessary to heat the elevators inside.

5.5.1 Particularities

On Aurora, there are going to be two main seasons: the cold one(winter) and the hot one(summer).

In the periods between these two seasons, there will be a transition monsoon, corresponding to the spring or autumn. It is mentionable the fact that the temperatures in the table are the optimal options, but in reality they are going to vary on a scale of 1or 2°C.

Temperature table:

Bubble	Summer temperature(Celsius)	Winter temperature(Celsius)	Transition temperature(Celsius)
1.City Bubble	23.3°	5°	14.5°
2.Countryside Bubble	21.66°	3°	12.33°
3.Riverside city Bubble	16.7°	7°	11.8°
4.Hillside city Bubble	20°	-1°	9.5°
5.Seaside resort Bubble	25°	14°	19.25°
6.Suburb Bubble	21.2°	2°	23.2°
7.Lakeside village Bubble	23.1°	0°	11.55°
8.Downtown Bubble	23°	10°	16.5°

The atmospheric pressure will be kept at the normal standard, 760 mmHg.

The precipitations are going to take place at an established time, being abundant on the Riverside city Bubble, Hillside city Bubble and Countryside Bubble, moderated in the City Bubble, Suburb Bubble and Lakeside Bubble and seldom on the Seaside resort Bubble and Downtown Bubble.

The humidity will be kept at normal conditions, ~44%, avoiding possible health inconveniences of the colonists.

The winds, as on Earth, will be stronger during the winter time and weaker during the summer time. At the Seaside resort Bubble there are going to be sea

breezes and on the Hillside city Bubble there are going to be cooler breezes during the entire year.

Rain will be produced using sprinklers attached on the ceiling of the bubbles, which are connected to water containers.

In the agriculture and animal's torus the medium temperature will be held at optimum values during the year in order to support fast growth, meaning 22.5° Celsius. All the other climate compounds will be kept at normal standards.

In the industrial torus and storage torus there will be no need of high temperatures, so in there the thermometers are going to measure ~10° or less.

5.5.2 Climate control

5.5.2.1 Methods

The methods we will use for thermal control will be separated into four main categories. Our systems will be based on heat exchanges. Therefore, we will try making machines that use conduction, convection, mass exchange or radiation. In order to keep within a price range, the machines that control the climate will be made out of affordable materials and will use solar power as an energy source because it is available in large quantities.

- Thermal conduction

The thermal conduction is the transfer of energy or heat between matter. It is a transfer with collisional and diffusive proprieties of kinetic energy of particles with ponderable mass.

The heat thereby flows through the body itself due to a series of vibrations of the molecules.

We could use conduction to heat the floors or wall by using metal plates that will collect the heat directly and afterwards spread it out evenly.

- Thermal convection

This method is based on fluids used for transferring the heat. Fluid movement generates what we call a conductive heat transfer and what we generally know through the image of radiators.

This method of thermal control could be also used on Aurora, under several occasions. For example, we could still keep the concept of radiators for heating the main components. However, bringing radiators into homes is not efficient.

- Mass exchange

During this process thermal energy is transported by a physical transfer of either a hot or a cold object around one place.

It's main application is hydraulics.

- Thermal radiation

Thermal radiation involves the transfer of heat between objects undisturbed by any intervening matter. Engineers consider it a fundamental method of heat transfer.

5.5.2.2 Systems

There will be a main computer, located in the central hub which will control climate all over the station. Each bubble will have 8 main heating control units.

Each control unit will be composed of large fans which will generate the required temperature. As some sections of Aurora will be hotter environments than others the unit will transfer heat from those areas to the cooler ones. This way, using the methods presented above, heat won't be wasted.

5.5.3 The ceiling

The ceilings of the Bubbles, although are going to reflect the light during daytime, as the hours would pass and the sun sets, they have got to be opaque during the evening and night in order to create an Erath-like artificial environment.

Using nanotechnology, the ceiling will have the ability of getting more or less opaque at certain hours, with the purpose of creating the illusion of day and night on the settlement. It is going to be adjusted in order to copy the exact behaviour of sun rising and setting depending on the season, just like in the diagram below:

- Summer season

- Winter season

- Transition season

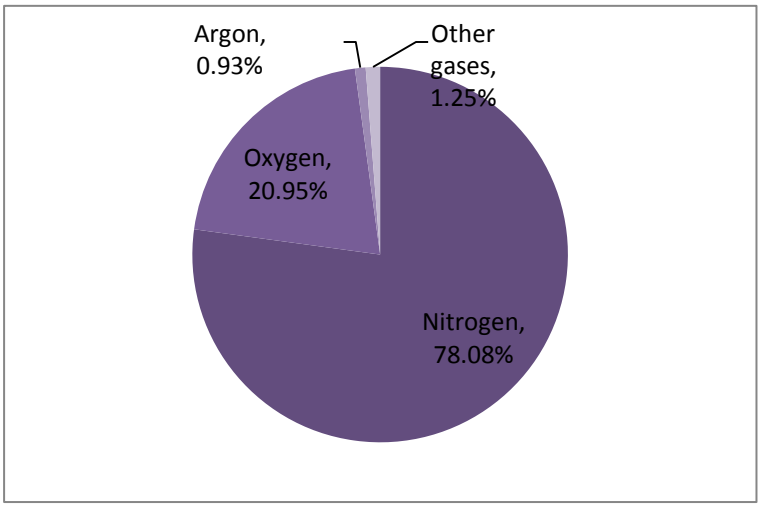
As the ceiling would grow more opaque, the temperatures would also lower in order to fit day/night characteristics.

5.5.4 Atmosphere

5.5.4.1 Atmospheric composition

In our try to make the settlement feel as home-like as possible we consider that the atmosphere on Aurora should perfectly copy the one on Earth. Therefore the concentrations should be as following:

Atmospheric composition chart



The gases needed in order to create the artificial atmosphere are going to be brought from the moon and Earth in spaceships provided with sealed tanks. These volatile substances will firstly be subject to several chemical processes in order to be pure and optimum. Then, they are going to be transported inside the bubbles and tori throughout sealed tubes.

5.5.4.2Purification systems

Provided that the settlement is a closed self-sufficient ecosystem, the gases which compose the atmosphere should be preserved. This is why we decided to take into consideration an air purification system . When the gas is contaminated, its properties(pressure, composition) change, therefore it is easier to detect any

deviations using nanotechnology. Small sensors are going to be placed on the inside walls of the settlement in order to control the atmospheric conditions.

The extinction of the impurities in the air is going to be done by nanotechnology air impurity removal system, which is basically going to filter the gases.

The oxygen is going to be produced on Aurora using chemical processes and it is going to replace itself continuously. Also, the plants will convert carbon dioxide into oxygen.

The carbon dioxide and monoxide are going to be absorbed and extincted.

5.6 Recycling

On a space settlement it is very important to reduce consumption, reuse and recycle everything for good reasons like before:

-Raw materials are a limited resource – we might not always be able to replace what we throw away

-Energy and resources are wasted whenever an item goes to landfill.

Everything we use has to come from somewhere and must go somewhere once we're finished with it.

A price of an item must reflect the energy used in the item's production and the impact it will have after we use it, when we throw it away. The environmental cost of an item isn't just a reflection of what's needed for its production.

What items can we recycle? Well, almost everything. Some of the items are shown in the following table. Even food waste can be collected for composting. Almost anything that will decompose naturally can be used for compost. However, as we don't have enough space for storage the natural processes will be speeded up by chemical and physical phenomena. In every bubble there will be a food waste collection centre that will turn food waste into green energy, giving it a new purpose that contributes to a cleaner, greener settlement.

The recycling equipment technology includes optical equipment to sort, waste grinders, glass cleanup and recycling systems, over belt magnets, eddy current separators and industrial can densifiers.

6.Social Infrastructure

6.1 Acceptance criteria

In a much smaller society, like the one we are planning to develop, any small discrepancy between inhabitants of the settlement can become a conflict that can turn a hitherto peaceful environment into an unpleasant place to find oneself. Therefore, we have to carefully devise some acceptance criteria for the future space settlers.

The selected adults will be aged between 27 to 40 years.

1. No one suffering from medical conditions, infectious diseases or terminal illnesses should be accepted.

2. In this phase of the project the inhabitants should not present mental disorders in order not to put themselves or others in danger or generate conflicts.

3. Neither should they be disabled in any way because these people may be the rest and thus may be exposed to greater risks.

4. The criminal record of everybody should be clean, as we don't want anyone who has had antecedents with the police in our habitat.

5. Everyone should be physically fit and able to pass the ordinary tests for astronauts.

6. People with a lot of self-control should be selected, in order to resist in crisis situations.

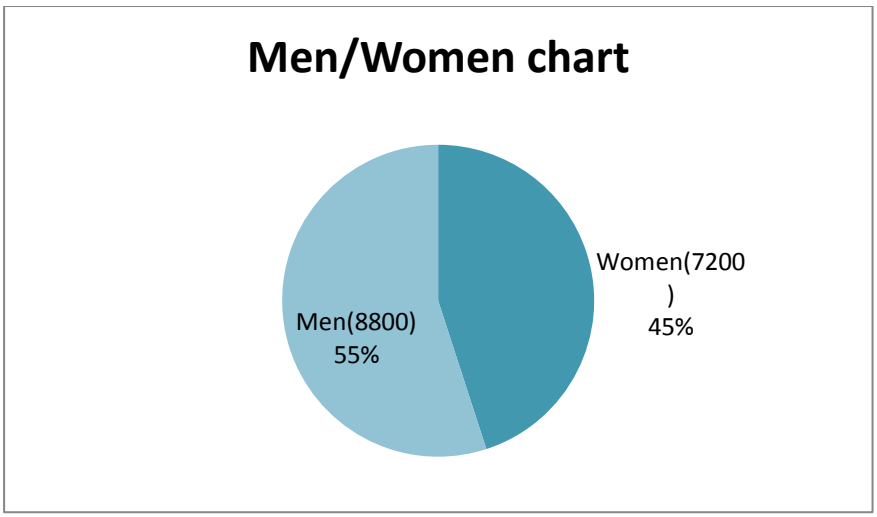
7. All of the future inhabitants which are adults should have previously proved themselves from an intellectual point of view. Having graduated university is a requirement as we need capable men on the settlement in case of anything unexpected is to happen. Also work experience in their particular domain is a must.

8. The IQ of every adult inhabitant should be more than 110.

9. Every child should have a good command of English and every adult should have an average level of C1 after the Common European Framework of Reference for Languages, as English will be the official language.

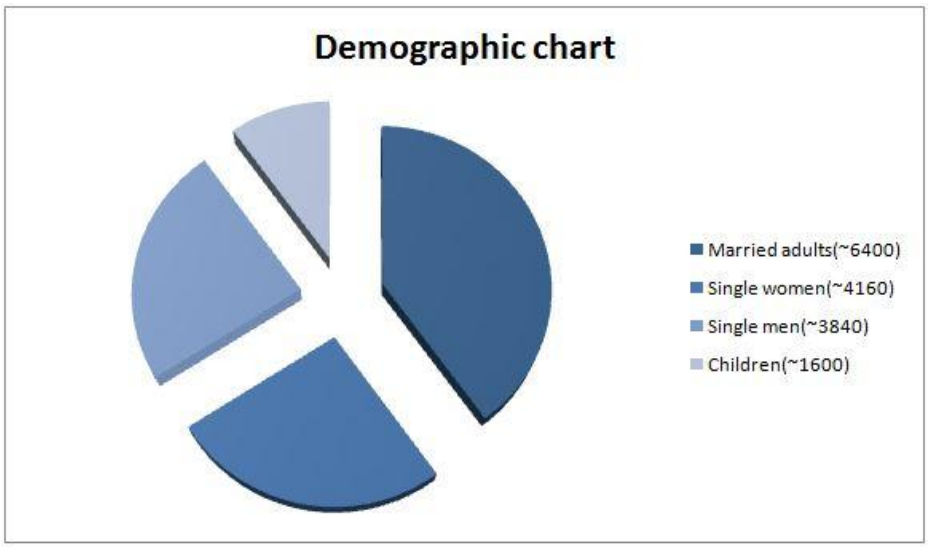
6.2. Demographics

Because Aurora will be a closed environment with a limited number of people, the selection of people must be made regarding the ways people decide to get married and have children. The number of male and women needs to be in an equilibrium because having an unstable balance would result in difficulty in finding a partner. The percentage of children that are brought on board can't be a high one because the human work force needed to sustain the settlement is of a large number even if robots will do a lot of work for people. Therefore, we decided on the following percentages of men, women, married adults and children, considering the fact that at first we will bring on the settlement 16000 colonists:



We chose the percentages for various reasons, one of the most important being the trend of population feminization caused by the higher life expectancy that women have.

Also, we have to take into consideration the percentage of married adults, single women, single men and children:



6.3 Industry

In our try to make Aurora as self-sustainable as possible we needed to carefully plan an independent industry. Industry refers to the production of goods within an economy. Our space settlement will have its own economy, and therefore will have its own products, not only its own produce.

What we hope to achieve is an industrial society, capable of mass-producing from a technical point of view.

The industry will be divided in categories, according to the products it deals with. The categories are presented in the table below in an alphabetical order:

Industry	Percentage of specific industry from the whole production process
1.Chemical industry	0.5 %
2.Computer industry	10 %
3.Construction industry	5 %
4.Defense industry	0.5 %
5.Energy industry	20 %
6.Entertainment industry	1 %
7.Food industry	15 %
8.Health care industry	2 %
9.Manufacturing industry	5 %
10.Robotic industry	20 %
11.Mass media industry	1 %
12.Telecommunications industry	5 %
13.Textile industry	5 %
14.Water industry	10 %

Note: the industries mentioned in the table are only the ones that Aurora will have after the construction process is finished and all the residents have moved in

The industries will be located in the industry torus, the lower big torus.

6.3.1 Chemical industry

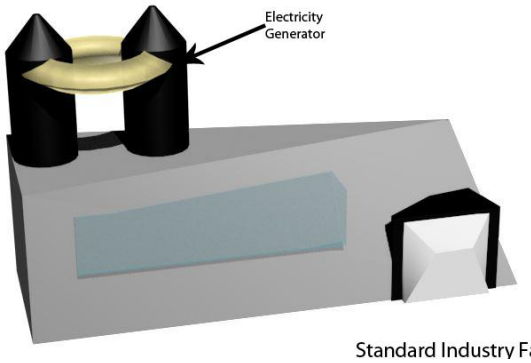
This industry will convert raw materials into new products, using a variety of chemical reactions. This kind of industry will provide pharmaceutical products.

A most important task for this industry will be the production of water and oxygen. Moreover, it will also have the task of removing toxic gases from the atmosphere in order to maintain optimal air conditions.

6.3.2 Computer industry

The computer industry will have an important role on Aurora as everything will be automated. The main computer will have an amazing storage capacity and it will be able to control everything that happens on aurora. Computers from homes will be interconnected and will work as a unitary machine.

The computer industry will produce highly advanced software needed for the powerful research apparatus. Moreover, complex computer infrastructures will be designed because the technology from Aurora will also evolve.



Standard Industry Factory

6.3.3 Construction industry

When our settlement will reach its final stage, when all the residents will move in, everything will be already constructed. Therefore, our construction industry wouldn't be a major one. The only use it will have will be replacing items that have been damaged.

Two of the construction robots will remain on Aurora in order to add extra rooms to homes, if need, as described in chapter 3.3.2.1 Design.

6.3.4 Defense industry

The defense industry will provide Aurora with the systems needed for protection, as described in chapter 5.5 Protection.

6.3.5 Energy industry

The industry will transform nuclear and solar power into the much needed electrical energy. The solar panels and the nuclear reactors will provide the settlement with large amounts of energy.

Extra energy will be transferred back to Earth as described in chapter 4.4 Energy.

6.3.6 Entertainment industry

All of the machines designed for entertainment will be produced in the same industry, the entertainment industry. Elements necessary for practicing sports, for the parks and theme parks, cinemas, bars and club.

6.3.7 Food industry

The food industry will have the role of packaging and storing the food. The food will be stored in proper conditions. Grains will be stored in dry places, fruits in cold places and animal produce in fridges.

Agriculture will be divided in four parts the range of food will be mainly composed of fruit, vegetables and grains (70%), textiles like cotton (10%), plants needed for beverages (i.e. tea and coffee beans) and medical purposes (10%) and others.

6.3.8 Health care industry

This industry will make machines needed for the medical system. Even if the robots will be mainly constructed in the robotics factory, the elements needed for investigation will be produced here.

6.3.9 Manufacturing industry

The manufacturing industry will be used for processing raw materials in order to build replacements or parts that are needed for addition or the completing of different systems.

6.3.10 Robotic industry

The robotic industry is going to construct the required types of robots. All this systems are described in detail in chapter 4.0 Science & Technology, 5.3 Robots.

The reparation of the robots will be done in this section. All broken parts will be brought here and replaced. These parts will be afterwards recycled in this section also because the molten metals will be reused for the same process.

6.3.11 Mass media industry

The mass media industry will have more occupations. It will be used for:

- Broadcasting
- Film industry
- Internet
- Publishing (newspapers, magazines)

6.3.12 Telecommunications industry

Being an important subject, communications are described in particular in chapter 6.4 Communications.

The communication industry will have the task to manufacture the systems that are required. The tablets will be assembled in this factory. The necessary cables will also be made here and the plans that engineers will make over time for the improvement of the communication will be followed in order to create new systems.

6.3.13 Textile industry

Inhabitants will take clothes with them from Earth but it is obvious that the production of clothes should start at an early point because they are essential.

Before the inhabitants leave Earth an auction will be made. In that auction, the designer stores that pay most will have the chance to open shops on Aurora. The money received from this auction will be used for bringing the first materials for the local brand. The stores that decide to come will have to cover for the transport expenses.

Even if some brands will be brought from earth, the settlement will have its own brand. This brand will be used for the production of smart underwear that will help medicine, analyzing the liquids that the body perspires for detailed diagnosis.

The local producer will make clothes out of materials grown in the agricultural section (i.e. cotton) and will put them for sale in the local shopping centers.

6.3.14 Water industry

The water industry is thoroughly described in the chapter dedicated to this subject, chapter 5.4 Water management.

6.4 Communications

"The way we communicate with others and with ourselves ultimately determines the quality of our lives"

Anthony Robbins

A futuristic civilization should be designed in such a way that communication from any point to another should not only be possible, but also fast. Therefore, we elaborated a competent system which allows the inhabitants to communicate thorough technical means between each other and between them and Earth.

6.4.1 Internal communication

Regarding the internal communications, it is desirable that the colonists can always be up-to-date.

Instead of the usual telephones and TV sets we now have on Earth, the colonists are going to use multifunctional tablets of different sizes depending on their purpose. The small tablets will work as a cellphone, newspaper and internet browser. It is portable and always connected to WI-Fi. The email is going to be highly secured, as well as every account which requires password. Instead of the satellite communication, the phones are going to sustain 3D holographic calls through internet.

The medium tablets should be easily used and they serve as kindles, shopping guide books, newspapers and small TVs.

As for the large tablets, they are TVs , and they can be hanged on the walls. Whilst on stand-by, these have an wallpaper image which should fit to the interior design of the house.

The settlement will host a fast wireless network which all the inhabitants have unlimited access to.

Medium tablet

6.4.2 External communication

As our survey revealed, most of the people living on the settlement would find rather vital communicating with their acquaintances on Terra. The communication with Earth will be done by using Earth's communication satellites. This implies the fact that the receiver device should be a very advanced one, and kept away from

populated spaces in order to avoid artificial disturbances. This is the optimum way for speed voice and video calls, file sharing or holographic conferences.

6.5 Transports

Transport of the mails, transport of the human voice, transport of flickering pictures- in this century as in others our highest accomplishments still have the single aim of bringing men together.
Antoine de Saint-Exupery

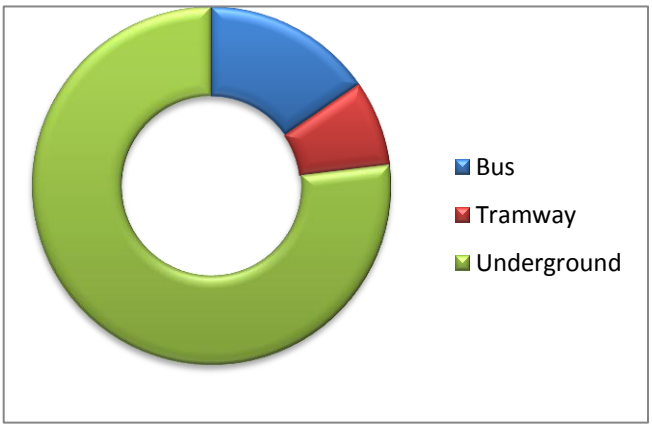
Since early times, transport has not only represented a process, an activity, but also a lifestyle, a way of surviving and a skill. Nowadays, transport is measured in time, money, materials as convenience. This is why we believe that transferring throughout our settlement is a very important matter to discuss.

6.5.1 Transport survey

Because the transport is related to the mass of population, we decided to make a survey in our class, asking student several questions regarding this issue.

Question 1:

What do you think it is the easiest mean of transport?



a) Bus - 2 answers

b) Tramway - 1 answer

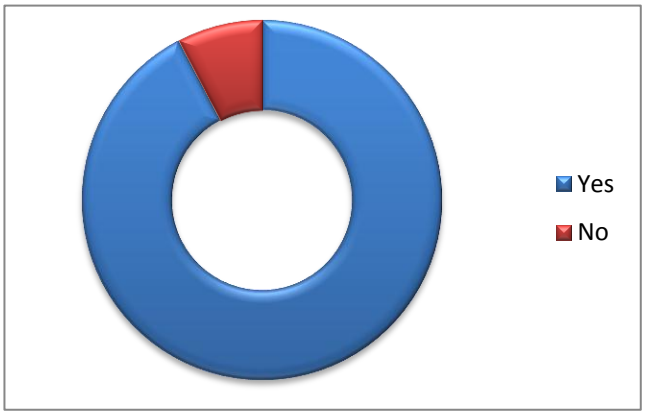
c) Underground - 10 answers

Question 2:

Do you often use public transport?

a) Yes - 12 answers

b) No - 1 answer

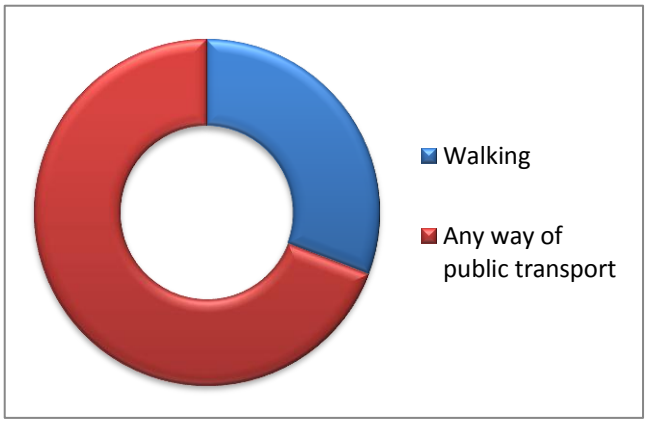


Question 3:

Do you prefer walking or using a mean of public transport?

a) Walking - 4 answers

b)Any way of public transport - 9 answers



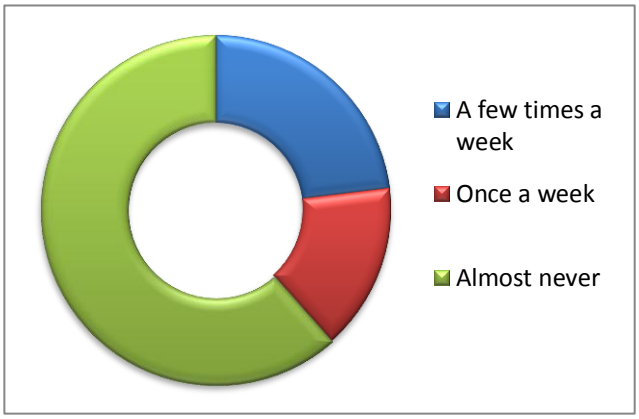
Question 4:

How often do you order a taxi?

a) A few times a week - 3 answers

b) Once a week - 2 answers

c) Almost never - 8 answers

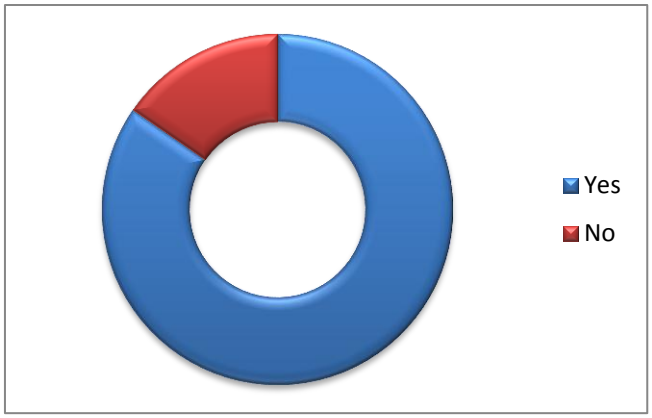


Question 5:

Would you feel comfortable in a mean of transport driven by a robot?

a) Yes - 11 answers

b) No - 2 answers

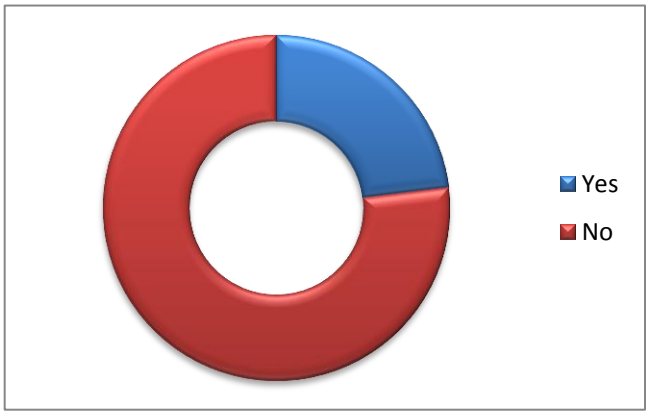


Question 6:

If you would have to get to a place near you, would you use public transport?

a) Yes - 3 answers

b) No - 10 answers

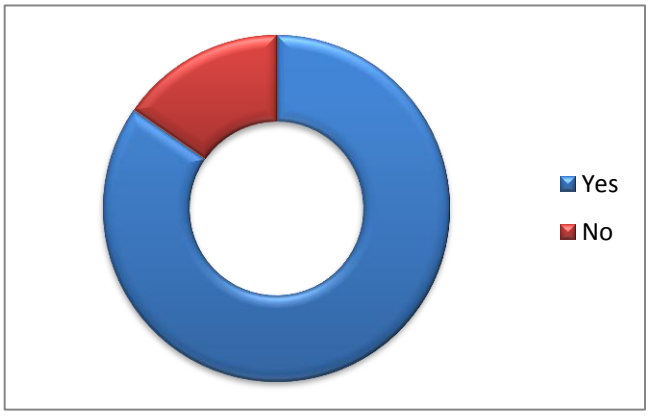


Question 7:

Do you think bus stations should be close one to another?

a) Yes - 12 answers

b) No - 2 answers



Question 8:

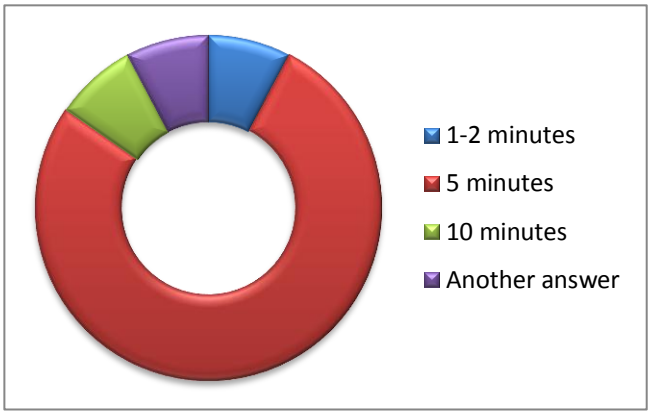
How often do you think public transports should arrive at stations?

a) 1-2 minutes - 1 answer

b) 5 minutes - 9 answers

c) 10 minutes -1 answer

d) Another answer - 1 answer



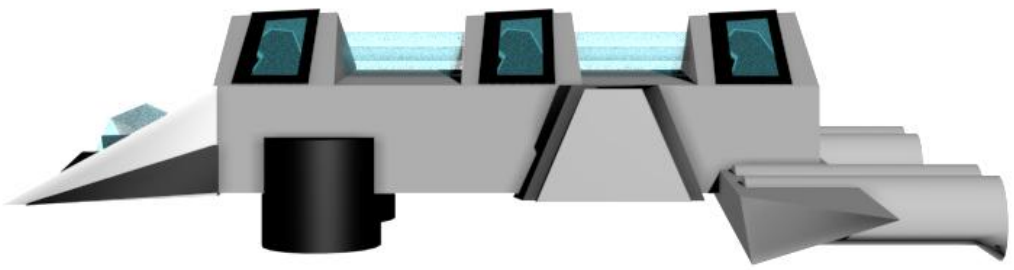
This survey stand as a reference regarding public opinion. We believe that any component of the settlement should be studied both ways, theoretically and practically in order to get an optimal product.

6.5.2 The transportation from Earth to Aurora

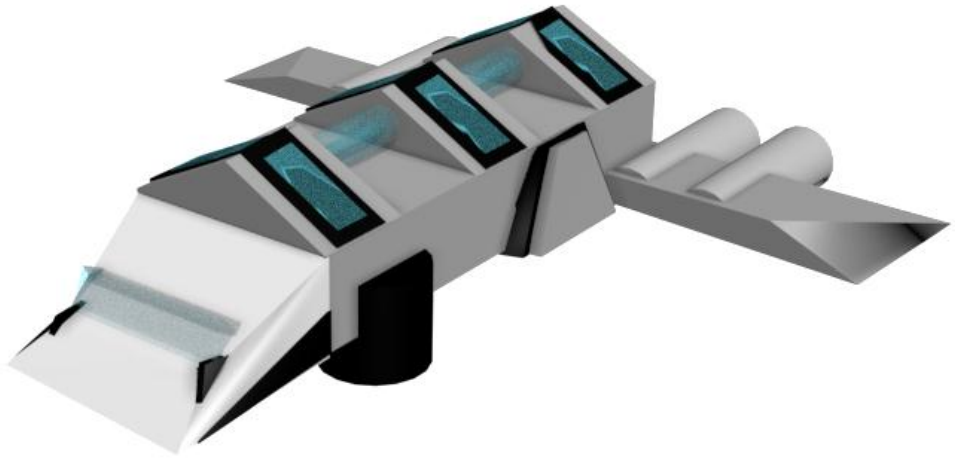
After the agriculture torus will be built and prepared for the growth of the crops, special stock spaceships are going to be sent from Earth loaded with the needed grains. The stock spaceships are multifunctional and can also be used for luggage or other Earth-Aurora transportations. They do not provide breathable air, so they are going to be driven by a computer.

When the animal torus is ready to host the living creatures, they are going to be transported using bigger spaceships provided with spacious platforms. The atmosphere on these ships and the temperature are going to be kept at normal standards. These machines will also be provided with a storage place for the animals' food.

Finally, when the settlement is equipped in order to be habitable by humans, the first step is transportation of the colonists' luggage and personal goods, followed by the second step, which consists of transporting the people from Earth to Aurora.



Colonist transporter

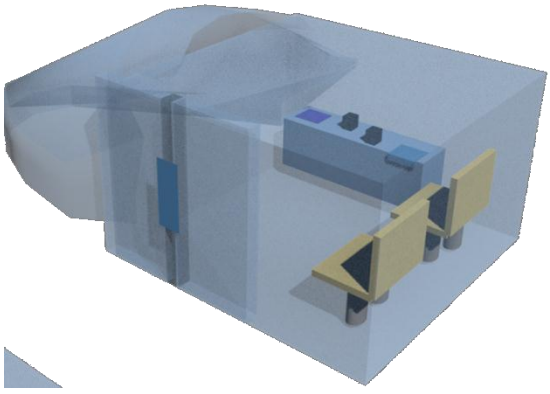


6.5.3 Public transport

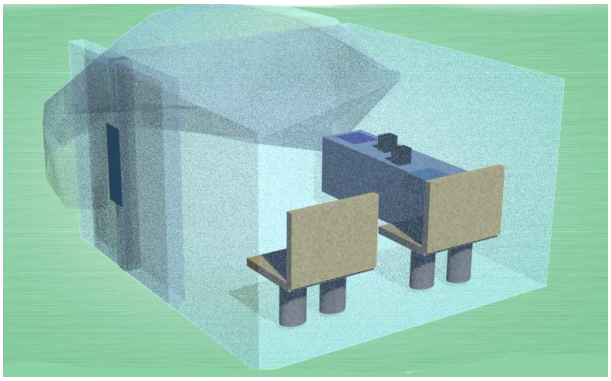
6.5.3.1 Bubbles

Regarding the fact that the settlement is not big enough in order to have its own highways or roads for cars, the main conveyance will consist of underground tubes (U.T.) divided into three sizes: small, medium and large. The U.T.s will be designed in such a way that they are going to be driven by computers.

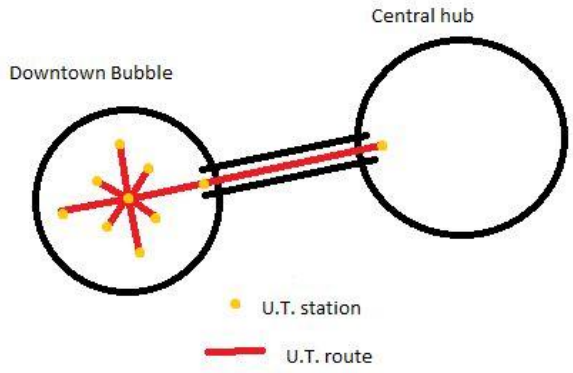
The small-sized U.T. is able to host up to 2 persons and is going to be found in the Downtown Bubble.



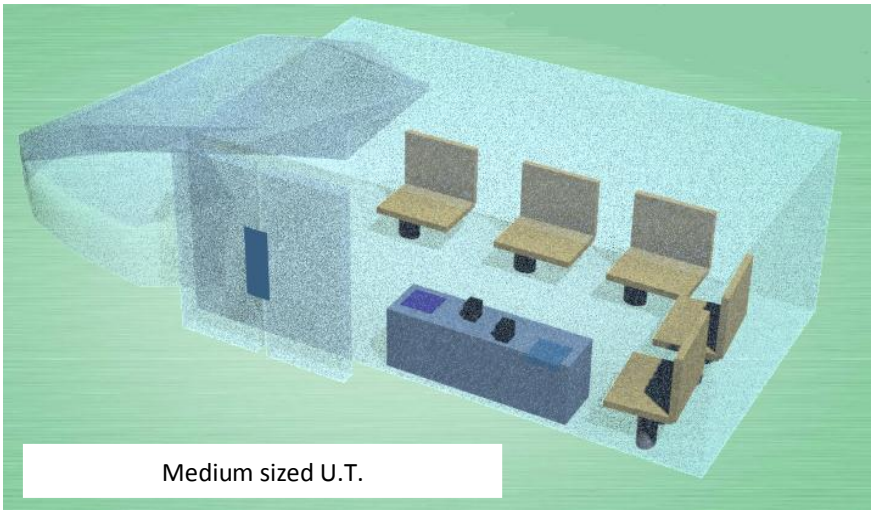
Small sized U.T.



The gaps of time between 2 arrivals are going to be of 3 minutes each during daytime and 8 minutes during night-time. It is going to be able to link the Bubble to the Central Hub. The stations are going to be equally spread around the area in order to provide a premium service.



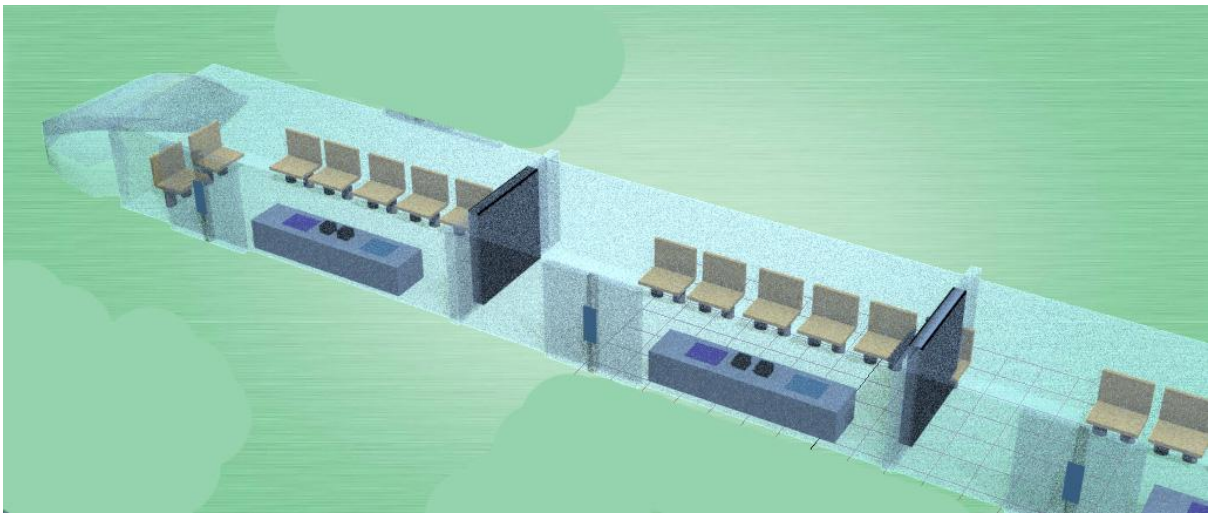
The medium-sized U.T. has a capacity of 3-4 persons and it provides the best comfort of all. It is basically a larger version of the small machine. The gaps of time between two arrivals will be 4 minutes during daytime and 5 minutes during night-time.


Medium sized U.T.

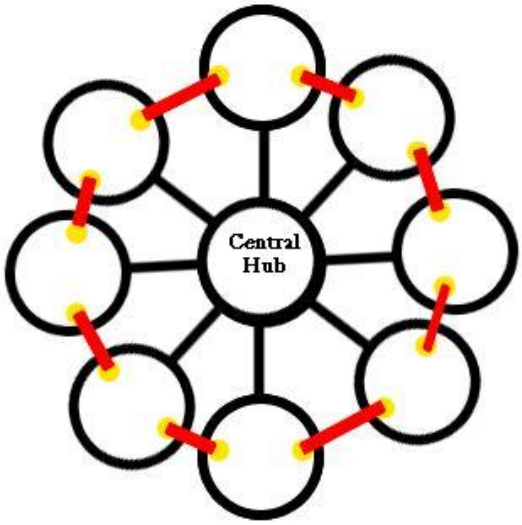
It is going to be available on all the bubbles excepting the

Downtown and it also links the bubble to the Central hub. The stations are organised just as the ones for the small-sized U.T.

The large-sized U.T. has a capacity of up to 8 colonists. Any two large-sized U.T.s can be linked one to each other in order to create a bigger train(e.g. for school trips, crowded stations). It has the same route as the other U.T.s but it also links the bubbles one to another throughout the spokes. The gaps of time between two arrivals will be 4 minutes during daytime and 5 minutes during night-time.

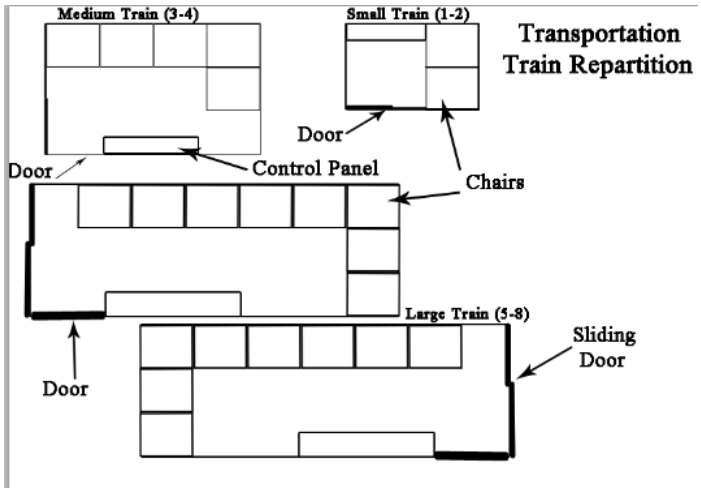


Linked large size U.T.s



Large-sized U.T.s inter-bubble route map

In the diagram below it is represented the repartition of the space inside the U.T.s:



The U.T.s are going to use magnetic methods of moving on guide ways. The magnetic cushions exert less friction, therefore, the speed is higher.

Every tube is going to have chargers and will provide LCD screens showing on the walls the time, date, temperature, exact time of arrival and news.

6.5.3.2 Central hub &Torus

The Central hub will be connected with the bubbles through the U.T.s route. Inside its area though, the colonists are going to use spacious elevators. These elevators connect the hub to the 0g Sphere and the Torus.

6.5.4 Taxi

Since public transport is sometimes not enough to satisfy everybody's needs, we came up with a taxi design which would represent a faster solution to the U.T.s and also a more comfortable one. A certain number of small taxis is going to be found in each bubble. Any colonist can order one by simply calling a number. Immediately his or her location is going to be stored and in a few minutes a machine would arrive in the exact place. The taxis will be driven by robotised computers.

Each taxi has a capacity of three persons and a trunk for luggage. The user can easily choose from a touch-screen which music she or he wants to be played and which scent to spread. The multifunctional tablet provided would also be Wi-Fi connected.

A taxi can set from anywhere in a bubble and arrive where the passengers want.

Taxi prototype

6.6 Tourism

,, The voyage of discovery is not in seeking new landscapes but in having new eyes.''

Marcel Proust

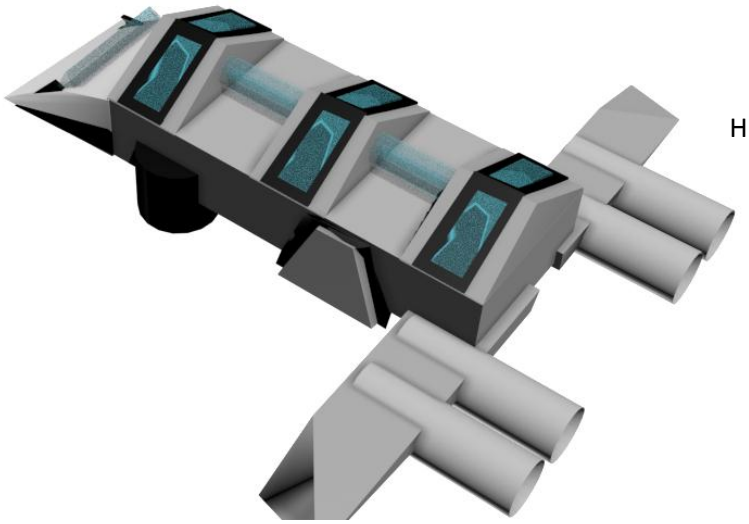
6.6.1 Earth-Settlement tourism

One of Aurora's purposes is finding new possibilities through travelling in the outer space, so our duty is to conceive an easy, relaxing and capable tourism system. For Aurora it represents a source of money, but also an opportunity for publicity.

The people from Earth will be able to visit the settlement for leisure or business purposes because Aurora not only provides a great source of unique landscapes, an extraordinary experience, but also a very good opportunity for affairs. Before setting to the outer space, the visitors are going to be tested in order to see if

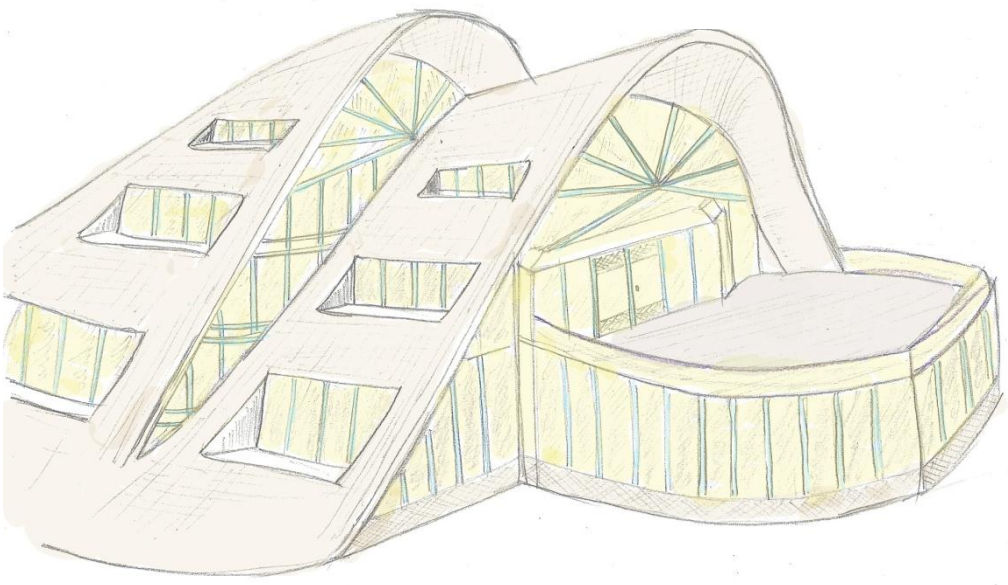
they are physically and emotionally capable to complete such a journey. They are going to travel using commode and fast spaceships equipped with state of the art technology . Although the costs are going to be very high at first, as the space

settlement concept will grow more and more popular and will extend, such a journey will be affordable.



Human transport spaceship design

Hillside cabin prototype



Inside the settlement the visitors from Earth will be provided with a spa resort in the Seaside Bubble, cabin logs in the Hillside Bubble and a lush hotel in the Downtown Bubble.

Also, in the 0g Sphere there is going to be arranged a special place where the inhabitants can have fun floating through the air.

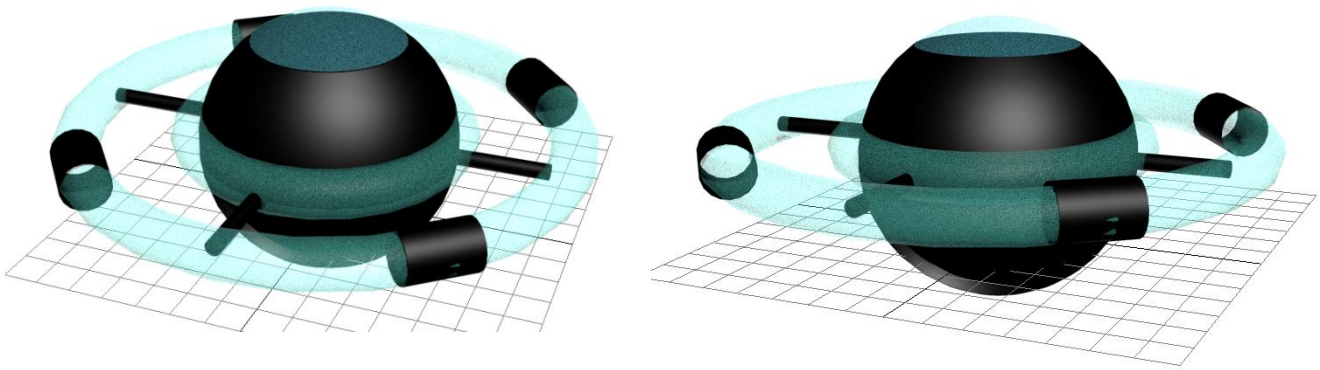
Inside the bubbles, the green zones, boulevards, cafés and cinemas are going to be the main attraction. Each of them being equipped with last generation gadgets, they are going to represent unique and relaxing leisure points.

6.6.2 Recreational space transport

The recreational space transport can be ordered by any person currently staying on the settlement and it will fulfill everybody's expectations regarding the outer space tourism.

The mean of transport will be represented by spherical spaceships provided with glass tubes, whose purpose is to make observation of the outer space more facile.

In order to consume less energy, these spaceships driven by computers will be launched from the docking sphere and won't consume any fuel during the journey. When it is time for returning on the settlement, they are going to be caught by fuelled robots called catchers, which will transport them on Aurora.

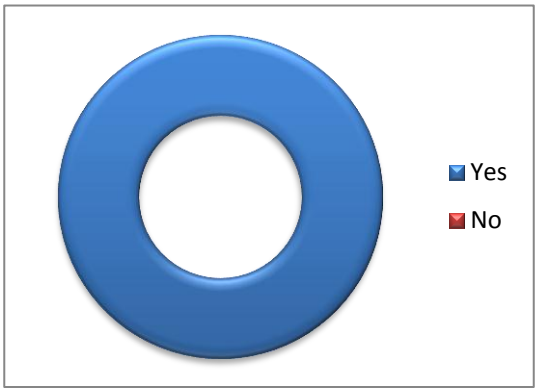


Recreational space transport ships

6.7 Medicine

Doctors, they currently represent some of the most important people from a community. But what if we stated that their tasks will decrease at an enormous rate, would you believe us? Well from the survey we carried out in our class, we are certain that this is what our classmates also think.

6.7.1.1 Medical survey



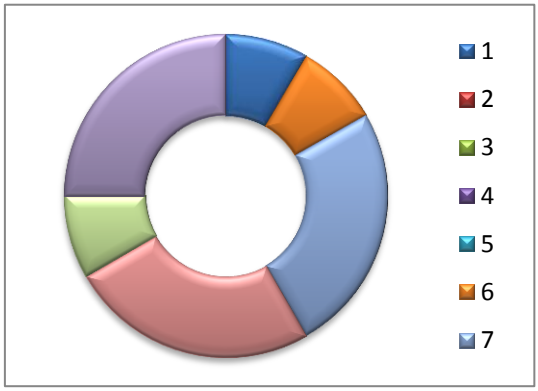
Question 1:

Do you think doctors will exist by the time our Space Settlement will be built?

a) Yes - 12 answers

b) No - 0 answers

Question 2:



On a scale from 1 to 10 what importance do you think robots will have in the medical system?

1 - 1 answer

2 - 0 answers

3 - 0 answers

4 - 0 answers

6 - 1 answer

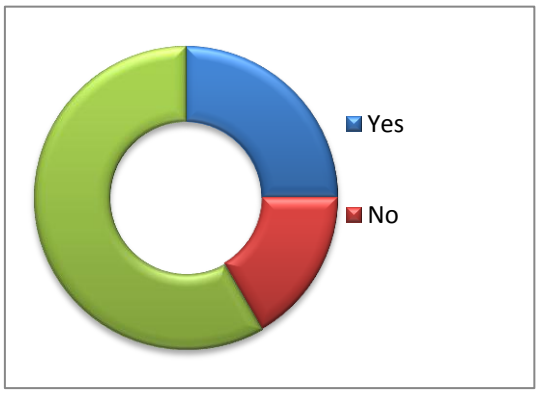
7 - 3 answers

8 - 3 answers

9 - 1 answer

10 - 3 answers

Question 3:



Do you believe that automated machines will have the ability to make precise diagnosis and recommend drugs?

a) Yes - 3 answers

b) No - 2 answers

c) Only with help from doctors - 7 answers

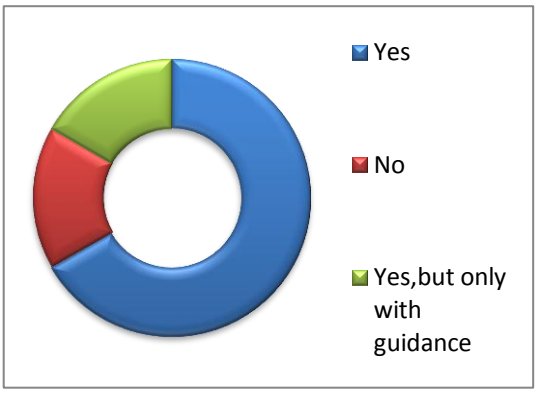
Question 4:

Do you think that microscopic robots will be able to travel through the body, find malicious cells and destroy them on the spot?

a) Yes - 8 answers

b) No - 2 answers

c) Yes, but only with guidance - 2 answers

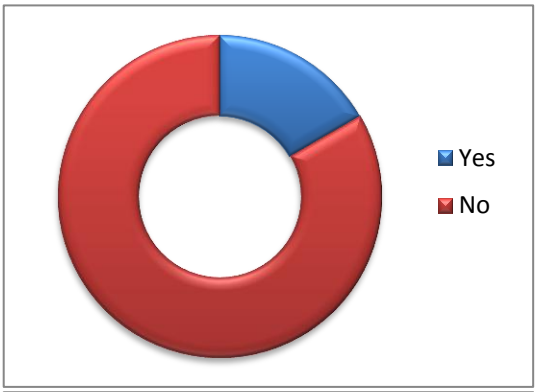


Question 5:

Would you feel comfortable if throughout your stay in a hospital to only be treated by robots?

a) Yes - 2 answers

b) No - 10 answers

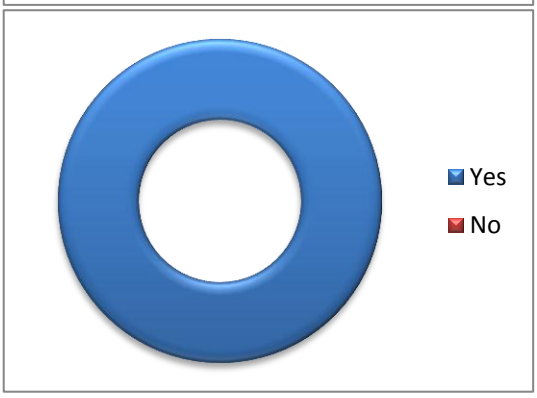


Question 6:

Do you think that an early diagnose gives you more chances of survival?

a) Yes - 12 answers

b) No - 0 answers



The changes that we predicted to happen within the years until our settlement is constructed are presented below. The topics we related to are the ones we consider of greatest importance, therefore the medical system from Aurora will become self-explanatory after we detail these ideas.

6.7.1.2. Doctors

As we said before, we consider that the duties of a doctor will change dramatically. However, the preparation for a future doctor will be as rigorous as possible as medicine is a science that provides future.

The role of socialization with patients will become more important even though the surgery and prescriptions will be more accurate. As robotics, whether we speak about nanorobots or surgery robots will have tighter connections to everyday health-care the patients will feel the need to talk to someone, rather than listen to a computer.

Also, the task of operating will fall to robots for a greater precision. However, the robots will be programmed by the doctors. Machines that will be similar to today's MRI's (Magnetic resonance imaging) will create 3D replicas of the patient's body, thus helping the doctor to program the robots.

6.7.1.3 Nanomedicine

So what is nanomedicine? Its simplest definition states that it is the application of nanotechnology in medicine. How could it help us? Well, we're going to explain this because the opportunities it seems to give are already exciting.

Fields where applications could be found:

- Drug delivery

An application well known in the domain of nanomedicine is drug delivery. The method of administration of drugs will change dramatically as nanoparticles will be used. Their special characteristic will be the ability to transport the drugs exactly to the source of the malicious cells, ensuring a direct delivery system.

This will guarantee more precision and smaller time periods for healing as patients won't have to take an antibiotic for a week at least before it makes its effect. This kind of particles will attach to cells like cancer tumors in order to heal the illness. However, in order not to be recognized as foreign material they will need to be covered or made out of proper substances.

Sending this kind of particles into the body will be a breakthrough in medicine. However, what we hope to achieve is a constant flow in the blood vessels. Therefore, we will introduce particles that will have different tasks in every inhabitant's blood:

- Control particles / Location particles (they will patrol through the blood vessels, and if they find any threat they will send a signal)
- Transporter particles (particles that will encapsulate the drugs)
- Aluminosilicate nanoparticles (particles that will help for the coagulation of blood)
- Stimulators (used to encourage cartilage growth)
- Iron oxide nanoparticles (used for better results of MRI's)

- Diagnosing

Nanoparticles will be used for an early diagnose. From the ones mentioned above, the first and the last will be of great help. The control particles will be used for diagnosis in early stage. Moreover, magnetic nanoparticles will improve magnetic resonance imaging by making tumors more visible.

- Healing and cell repair

The advantages of nanomedicine are more extensive, thus drug delivery won't be the only technique used for healing. Nanoparticles will have the ability of healing infections. Also, they could be used to repair cells and do surgery at the cellular level.

6.7.1.4 Daily analysis

An important focus that medicine will have on our space settlement will be prevention. In order to avoid the progress of a condition, settlers will be continuously monitored in order to detect any signs of a developing one.

Every house will have various systems in order to detect anomalies in every family member's health. The main computer will scan their body temperature in order to detect any anomaly. Also, the smart toilets will make urine tests and the toothbrushes will test oral health. Showers will be sophisticated devices which will be capable of taking radiographies and scanning cerebral activity.

What is more, every inhabitant will have more sets of intelligent underwear. Its main characteristics and the benefits it will bring to medicine are outlined in the chapter designated to industry.

Of course, for better and more complex examinations the settlers will have the possibility of going to the clinic.

6.7.1.5 Surgery

The results of our previous survey show that over half of our classmates believe that doctors won't do surgery anymore. This is exactly what we also believe. However, even if nanotechnology will be advanced enough to replace some basic surgeries, patients will still need operations.

In order to maximize the percentage of success, surgeries need to be done with more precision. Nowadays doctors are being trained in order to achieve this level. Until full preparation mistakes can be done during the training process. This is why we think that robots will do both minor and major operations on the settlement.

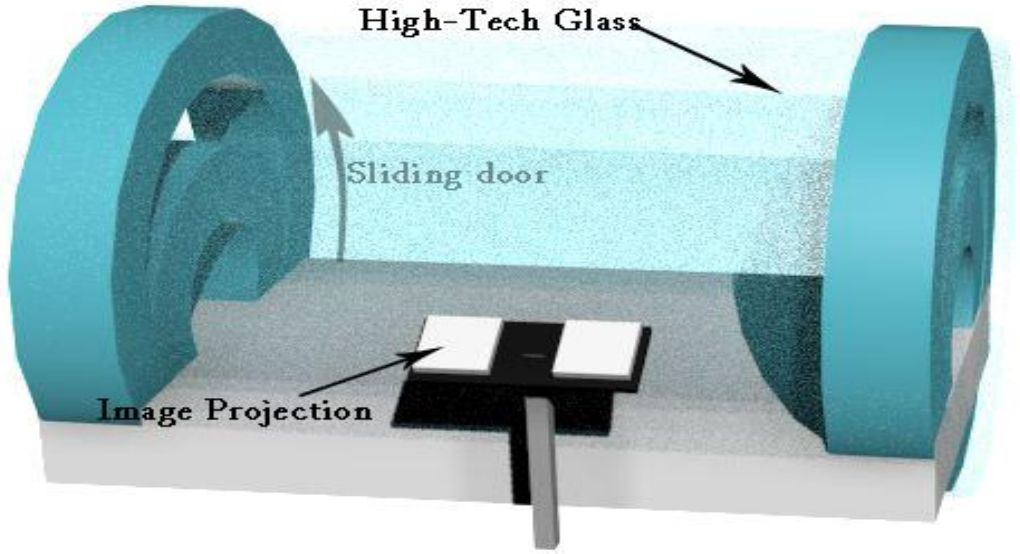
6.7.1.5.1 Resonance imaging technique

Medical appliances like MRI's will evolve taking medicine to the next level. The machines will create replicas of patients in 3D. In one room the patient will be scanned while in the other one the replica will appear on a table similar to the surgery table.

The doctor will be able to select sections from the projected body lifting them and carrying them with him wherever he finds it useful. Also, any part of the body can be removed in order for a closer study.

The MRI's will be more accurate with the help of magnetic nanoparticles.

MRI machine



6.7.1.5.2 Surgery robots

After taking the MRI the doctor will start planning the surgery. When the best solution is found, he will perform the surgery on the replica. If the procedure turns out to be successful, the robots will make it in exactly the same way on the patient. Also, for the most common surgical procedures, the robots will be able to operate on their own, supervised by a doctor but without the data coming from the replica of that exact pacient.

6.7.1.5.3 Artificial blood

Because blood transfusions may be necessary and blood is difficult to store we believe that artificial blood should be produced. This would reduce the need of blood donations and would eliminate the risk of not finding a suitable donor.

6.7.1.5.4 Organ farm

As medicine will reach the stage where organs will be artificially reproduced we considered that our space settlement should have an organ farm. Organs will be created on-call, reproducing the exact ones that should have been replaced. The section for this farm should be allocated in the main hospital for easy access. This will eliminate unnecessary waiting hours for patients in need of a transplant.

6.7.1.6 Hospitals

Even if treatment received at home is clearly more popular, we decided that Aurora should also have a hospital. This will serve for major surgery and research. However, for recovery, patients will also have the choice of staying home. We feel that it is unnecessary to have clinics because it is more comfortable for an inhabitant to find all the needed assistance in one place.

6.7.1.6.1 Main hospital

The main hospital will have a pleasant appearance in order to make patients feel as good as possible. Because the design of nowadays hospitals is quite tedious we will try and make this one more welcoming.

It will be placed in the Downtown bubble. Having large rooms and grand hallways, the hospital will resemble a gallery. The specialists of different domains will be spread out, on categories. Therefore, when coming there not only will the settlers feel like home, they will also have all the required assistance available in the same place.

The hospital won't have more than 50 beds which will host the patients that have infectious diseases and the post-surgical ones that need permanent surveillance.

Some of the departments of the hospital will be:

- Surgery
- Dentistry
- Infectious diseases
- Emergency department
- Neonatal care unit
- Pediatrics

6.7.1.6.2 Home hospitalization

If some patients are more comfortable with staying at home this choice should be available. Therefore, one home in each room will have the ability to metamorphose in a typical hospital room. If quarantine conditions are needed glass walls will seal the room. The beds will be adjustable and the nightstands will have the instruments needed for perfusions. An emergency button will be placed close to the patient if anything unexpected happens.

6.8 Political system

6.8.1 General information

Although a space settlement represents a futuristic concept, any form of human colony should have its rules and a group of nominated people to represent them. This is the reason why our team has decided to conceive a lucrative political system, in order to make the inhabitants feel as they belong to something bigger.

The form of organization for Aurora is going to be republican, following a democratic regime. It is implied that considering the fact that a space settlement is a new form of organisation, new systems have to be introduced. This means that the settlement will be represented by an elected prime-minister and a government made of several members who are going to depict a number of departments such as: education, work and pensions, health, internal and external issues, culture, media and sport etc.

We consider that at this point there is no need for a president since the population only consists of 16k inhabitants. Anyways, the absence of a president does not mean that the colony won't be represented by a person. The prime-minister will be

the one who is appointed to manage the civil service and execute the directives of the head of state.

6.8.2 Election phases

The elections are going to be organised before the departure of the colonists in space.

After choosing the inhabitants and having all of their contact details, there is going to be introduced a mail-based information campaign in order to find suitable candidates for prime-minster and ministers. Each of the mentioned positions is going to have up to three nominees.

The nominees are going to be given time to organise campaigns, which will consist of informing the future colonists about their capabilities, what qualifies them to occupy a certain position, publishing their CV's , recorded speeches. A candidate can also apply for more than one position.

When the election time comes, the voters will be provided with a mail voting system, with name codes and passwords, keeping a high web security. This represents a fast way of calculating the percentages and spreading the news. At this point, each of the ministers should have been elected, and the run for prime-minster will hold place between the candidate with the most votes and the first runner up.

After a nominated time, the colonists are going to have to vote again for the position of the prime-minister.

Also, each bubble is going to have a mayor and there will be provided a department which will take care of the area administration.

6.8.3 Positions , duties and requirements

The highest position will be occupied by the prime-minister. He is going to represent the population of the settlement and seek for their safety and prosperity.

N.B. The politics will not occupy a big part of the colonist's lives. It should represent a natural way of organisation, not at all a scandal source or a corruption space.

Requirements:

-degree in politics/law

-presentable figure

-strong-willed person

-possessing the qualities of a leader

-experience

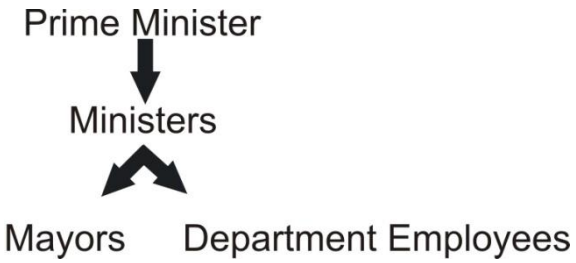
One step lower on the scale there are going to be placed the minsters, which are going to form the government.

Name of the department	Requirements	Duties
Business, Innovation and Skills	Law degree/business degree/economics degree, possessing qualities and skills for the position experience	business regulation and support, customer affairs, innovations, trade, training, provide laws and conceive projects
Culture, Media and Sport	Possessing qualities and skills for the position experience	Administrate arts, creative industries, historic environment, libraries, museums, sports issues, provide laws and conceive projects
Health	Possessing qualities and skills for the position Most likely to posses medical experience	Administrate the health system, hospitals, provide laws and conceive projects
Transports, environment, food and rural affairs	Possessing qualities and skills for the position Experience	Administrate agriculture, animal health, flooding, food, waste management, conceive projects and provide laws, administrate transport issues
Education and Tourism	Possessing qualities and skills for the position Experience	Child protection, education, school and university issues, tourism matters
Work and pensions	Possessing qualities and skills for the position Experience	Administrate the welfare and pension policy, ensure social stability, provide laws and conceive projects
Energy and climate change	Possessing qualities and skills for the position Experience	Energy efficiency, administrate electricity, oil and gas, provide laws and conceive projects

The next position on scale is represented by members of mentioned departments, whose duties are to help the ministers and provide fast solutions to any question put to light. Such a member can be part of up to 5 departments and also have another job on the settlement.

The paper work is going to be replaced my robots and computer programmes in order to minimize human effort and resources and avoid afferent errors.

Each bubble will also be provided a mayor and an administration elected after the arrival of the colonists on the settlement.



6.8.4 Headquarters

The headquarters of the government and other administrations are going to be located in the downtown area, in modern designed buildings and the access to them is going to be based on digital amprents.

6.9 Law and order

Just like any other society, Aurora should guide itself on a thoroughly designed set of laws whose purpose would be to ensure the welfare of its inhabitants.

6.9.1 Laws

Firstly, laws regarding all the aspects of life and all the institutions on the space settlement will be issued and then gathered to make up a constitution. As life on Aurora is meant to be as similar as it can possibly be to the one on Earth, so will be this constitution.

6.9.2 Keeping the law

As far as this aspect is concerned, we hope that the selection method we chose for the people taking part in this will prevent any major crime from happening. However, to ensure that not even the smaller law offenses are being committed, Aurora will have a Police Department which will supervise the inhabitants by various methods:

- To begin with, access to different parts of the toruses or to different buildings will be allowed only for people working or leaving in those places. Depending on the type of building, visitors/ outsiders will have free access only with a well defined reason or during an emergency. For example, people not working in a hospital will enter the building only when coming to consult the doctor on a medical condition or when visiting a relative with a medical condition, people not working in the Police Department will go there only when they have to make a complaint or when being called by a police officer and so on. In this way, we hope to avoid situations such as insane men coming to school with weapons to harm children, thieves stealing from a shop or unauthorized people messing around with the power supply system of the space settlement.
  Furthermore, all this will be achieved with the help of a security system installed on the doors of Aurora which will recognize people wanting to pass through the door by their fingerprint and which will permit or prohibit the access after consulting a complex and well structured database. This system's purpose isn't only to prevent such extreme and rare cases of criminality as presented above but also to keep track of the location of the inhabitants which might come in handy in different situations.

- In addition to the door installed security system, Aurora will have security cameras supervising some of its major objectives: hospitals, banks, government buildings etc.

- In case of any law offense which might happen, people only have to call the Police Department which will be ready to intervene and investigate the case, or if necessary, put an end to the unpleasant situation. Among the police facilities, there will be police cars, weapons, radars, an inner communication system, a well equipped laboratory for conducting investigations etc.

6.9.3 Breaking the law

If any inhabitant breaks the law he will suffer the consequences. Criminals will be judged and punished according to the severity of their crime. On Aurora there will be different levels of punishment according to the crime committed.

For instance, perpetrators of foul play will be deported to Earth for prosecution. Prior to this they will be held in a confinement aboard Aurora awaiting the next transport to Earth.

Less serious law offences will lead to imprisonment onboard the space settlement for a number of days according to the sentence. Upon the release they will be closely scrutinized. Any violation of their release agreement will lead to further imprisonment.

Finally, for misdemeanors, the punishment will be a fine, or community work.

6.10 Education system

As our space station will be a self-sustainable community, devising a compulsory and free education system is necessary for our younger inhabitants. Our system must provide the integral and harmonious development of human individuality and the formation of self personality.

While we know what the system should offer the real dilemma is what should our students learn in order to be prepared for the requirements of their later life. It is clear that the teaching methods won't be the ones we are currently familiarized with and the curriculum will suffer major changes.

Even if the technology required for electronic learning will be available, we think that the students should be given the opportunity to choose whether they want a computerized way of learning or whether they prefer the classical approach of having a teacher. Either choice, they will still have to come to school for practical sessions and at least two days for theory courses. We feel that not only does a teacher have the ability to make children want to learn, also learning within a group can develop competitiveness and thus desire to know better.

We believe that the curriculum should include various subjects. A table of the main categories and recommended subjects can be found below.

‘

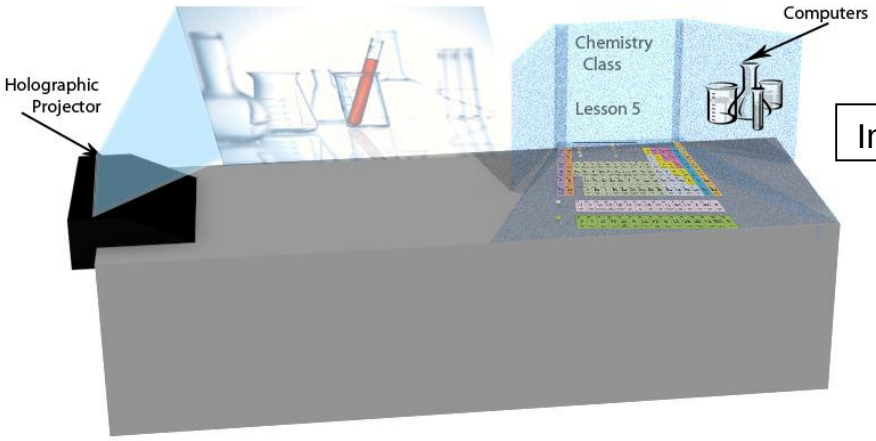
Category	Subjects
General knowledge	• History • Geography • Economics and Politics • Earth Studies
Science	• Mathematics • Physics • Chemistry • Biology • Computer Science
Astronomy	• Astrophysics • Observational Astronomy • Theoretical Astronomy • Solar System studies • Cosmology
Engineering	• Spacecraft engineering • Automatic engineering • Power Engineering • Nanoengineering
Optionals	• Arts • Literature • Cooking • Philosophy • Psychology

The students should have the freedom of choosing the subjects they are interested in and have more classes of the chosen courses. However, they should not neglect the rest of them.

The students will be assessed monthly at each category with a written exam and a practical test. Once every year they will pass a global examination and will afterwards be sorted by their level, not by their age. Students of all ages will learn together, without being pulled down by the average level present within their age group. Every child will have to attend at least 9 years of school, starting with the age of 7. If they get at the highest level in the classes they are interested in they will have the possibility to attend university courses related to the subjects and they will have to attend school courses related to other themes. For the average student there will

be 12 years of school, time that should be enough to finish at least 3 classes related to the same subject.

Physical activity will be mandatory. Each student will have to practice at least two sports to keep fit, one of them being a team sport in order to increase cooperation skills. They will have to choose from a variety of sports, ranging from basketball or hockey to extreme sports such as snowboarding or sky-diving to new-generation sports practiced in the 0G sphere.



7.Costs

In order to estimate the final costs of our settlement we must calculate the total surface of all the modules, described in the following table :

Component	Surface	Volume	Materials used
Central 0g spheres	104009 m^2 / sphere 312028 m^2 total	3154950 m^3 / sphere 9464851 m^3 / total	0,75 m thick stainless steel
Two small tori	2153336 m^2 / torus 4306672 m^2/ total	129200198 m^3/ torus 258400396 m^3/total	0,75 m thick steel, also glass
Two large tori	3453710 m^2/ torus 6907420 m^2/ total	207222624 m^3/ torus 414445248 m^3/ total	1 m thick Titanium + glass
Living bubbles	784850 m^2 / bubble 6278800 m^2/ total	18686925 m^3/ bubble 149495400 m^3/ total	1,25m thick Titanium, 1,25 m thick reinforced glass on the roof
Connecting spokes 18 spokes (500m x 15m) 15 spokes (840m x 20m)	1215180 m^2	5546025 m^3	Made of stainless steel 0,75m thick
Central axle (1800m x 50 m)	282600 m^2	3532500 m^3	Build from 0,75m thick steel ; 1600m covered with mirror surface.

Total material price

Material	Price (USD)
Steel	31,602,458,200
Titanium	77, 841, 820, 800
Glass	9, 382 ,931, 290
Total	118, 827, 210,290

Total robot price

Robot type	Number of robots	Price of a robot (in US dollars)	Total price (in USD million)
Agriculture	102	3, 000, 000	306
Animal harvesting	97	2, 500, 000	242.5

Construction	75	1, 000, 000	75
Entertainment	6	1, 000, 000	6
House holding & Cleaning	300	2, 000,000	600
Laboratory & Science	27	7,000,000	189
Lunar mining	16	6 ,000,000	96
Medicine	27	5, 000,000	135
Transports	108	8 ,000,000	864
Total	448		2513.5

Total devices price

Electronic Devices	Number of units	Price / unit (in USD thousands)	Total price (in USD million)
Phone	16,000	0.5	8
Medium tablet	16,000	0.4	6.4
Big tablet	8,000	0.700	5.6
Computers	16,000	2	32
Total			52

Other expenses

Name	Price (USD million)
Transport	13,500
Worker retribution – $125,000 / year / worker	1,250
Moon Extraction Facility	21,000
Solar Satellites	12,500
Fission Reactor	40,000
Particle accelerator	12,000
Residential Houses	3,200
Other costs	10,000
Total	112,950

Total costs for Aurora: $ 234,342,710,290

Provided that the ratio between quality and price is the optimal one, we consider that the total costs for Aurora will be worth spending.

Epilogue

Even if the amount of work we put in for this project was enormous we feel that the experience was one of the greatest we had during our years as students. Not only was the idea of having an orbital colony absolutely inspiring, but when we were given the chance to make a design of our own, our enthusiasm grew even more.

This enthusiasm had an important role in keeping us motivated during all the problems we encountered and all the nights we didn't sleep in order to thoroughly finish the project.

Learning about new concepts and technical details was exquisite. However the greatest part was the fact that the decision of becoming affiliated with such a domain now seems to be a probable one as through this project, NASA gave us the opportunity to think through possibilities that have never before crossed our mind. We discovered new side of ourselves, improving our communication skills and our ability to work conscientiously.

For us, Aurora is a dream place, the place where we hope our children and grandchildren will spend their lives.

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