



Acknowledgements

DACIA'S offered us the opportunity to spend our teenage time efficiently, practicing our imagination, dreaming of the human civilization at a high level of evolution. For this reason we want to gratefully thank NASA Ames Research Center for offering this competition contest also to the European countries. It was a challenge that DACIA'S members accepted. The future is in our hands! It depends on us if science fiction will became reality in a shorter time and people will inhabit on-orbit space settlements or terraform other planets.

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1. INTRODUCTION



1. INTRODUCTION

"SCIENCE IS ALL ABOUT SEING WHAT EVERYONE ELSE CAN SEE BUT THINKING WHAT NO ONE ELSE HAS THOUGHT..."(Baroness Susan Greenfield) "IT'S OUR DESTINY TO COLONISE THE OUTER SPACE"(M.T.SAVAGE)

DACIA'S- the name comes from the team members name's initial letter:

Daiana Adela Claudiu Iren Alexandru

Sevda

It also means "Design for an Artificial Continuance on an Interplanetary Assemblage Settlement".

We have chosen this name because it does not only have a personal importance, but also the fact that Dacia was the most important prehistoric Romanian folk and they gave high importance to the scientific research (astronomy, medicine, plants); "they were also interested in progress and development of the science, like Greeks" (Iordanes). There was not just a simple coincidence. This also made us create strong connotations and connections related to its aim (you can see the territory of ancient Dacia from Earth, marked with red on the project's cover). Dacian tribes preferred a nonpolitical organization, conjunctly between the departments. The system is based on adequately criteria for example the best workers from the industry department are selected to organize its activity. We don't take in consideration the eventual mental problems, because the residents were tested (even their previous family members), carefully selected, before inhabiting the settlement. The risk of conflicts and fights is inexistent; the only aim of the Dacians is to dedicate their life and activity to the research and expansion of the human beings around Earth, in the Solar System and why not in other Solar Systems.

• Why did we need to build DACIA'S?

DACIA'S was built in the year 2088 due to the fact that the Earth was overpopulated. The human health treatments and means to avoid getting ill have reduced the human mortality rate. The so called "Century diseases" have vanished due to the high technology and new body science achievements. The energy crises have happened because measures against overpopulation, pollution and Earth's evanescent energetically resources have not been taken.

For this reason all the countries collaborated and forgot about fights and wars and reached the conclusion that it is better to build together an interplanetary settlement for 600 000 people, in order to expand the human beings in the Solar System as the time runs. This was the only solution that could be found, because the Earth was out of resources, and



the main reason for the human existence was to evolve, to forget of the primal instincts that could easily transform it into a dead planet through wars, atomic bomb and starvation.

At first it was really hard for people to imagine that it is possible to build and sustain life on such a huge structure. Science fiction books seemed cheaper to buy than to invest in such a dream. They had all the technique that they needed in order to offer a new place to live, but the major problem was the mentality. It was hard to come to a consensus with all the Earth's countries and collect money, workers and astronauts for over 25 years time. The process of technology evolution in the past 50 years was really high. The first true challenge was changing the way we think, in order for us to create a self sustaining orbital settlement, an ecosystem and to balance it. At first engineers and astronauts were sent to Moon by Earth to Orbit ships. There, some modular factories and antennas were put, for easily Moon-Earth communication. "Super Adobe" domes were built as a place where the industrial processes took place and where the astronauts lived, worked and supervised the activity of robots. Each worker was allowed to spend 6 months on Moon, because the lower gravity affected their health (cardiovascular changes, red blood cell loss, muscle damage, bone damage, immune system changes, degraded sense of smell and taste). The construction schedule lasted 28 years, and the settlement was built through modular pieces produced on Moon (ex: FeTi70 equilateral triangle shaped wall pieces). In 2088 DACIA'S was finished and its activity was prosperous.

The achievements through building the settlement were and are still great, because it opens a new gateway to space and breaks one of the greatest boundaries known to man: human life in outer space.

Besides Man's natural instinct to explore, to lean, to build for future generations there are other important reasons for looking beyond Earth. Among the most important are the following:

- <u>Providing the survival of the Earth's species:</u> The main goal was to design a permanent community in space that is sufficiently productive to maintain itself, and to exploit actively the environment of space (Moon, asteroids) to an extent that permits growth, replication, and the eventual creation of much larger communities. This initial community is to be a first step in an expanding colonization of space. All that belongs to the horizon regarding the satisfying of material necessities such as commodities and security means "civilization". For this reason we have created the "DACIA'S civilization" that knows very well its aim and develops research (one of the most important activity of the settlement), technology, mining to ensure the survival of Earth's species. It fosters a viable social community that has its own civilization in order to satisfy all the human cultures taking into consideration that people all over the world, strictly selected, live there. The habitat has to meet all the physiological and medical requirements of a permanent population and for this reason the engineers have worked hard.
- <u>Environmental</u>: the mother planet Earth was getting more and more polluted, and the by moving away from Earth, we have reduced straining Earth's environment and allowed it to live longer and save some animal, plant extinction. We may even learn how to preserve it better through research in outer space. A new type of environment is created and as such, a new type of human: the human born and raised in space: a human who understands the concept of artificial gravity, its importance and life sustaining mechanisms from the moment he is born, because his life depends on it. He will understand at an early age the importance of air and water, and why is it so important to preserve and to try to maintain equilibrium in the artificially created geo-



ecological. This improvement will make us appreciate our planet, the way it was created and research on the terraform of other planets like Mars.

- <u>Economic</u>: The capability to process the raw materials from the asteroid, lunar mining is made through the technology and knowledge that DACIA'S benefits of, and also by the researches that it permanently develops. The abundant natural resources available in space inspired the Dacians and therefore they have created and or developed techniques to benefit from them. These have enormous economic value since its are in an adequate supply, the capability to process them is provided, and we have adequate transport systems for trade items. The investors will be governments and organizations from Earth interested in obtaining all kind of profit from the extracting spatial industry, solar energy, scientific breakthroughs and spatial tourism. All the Earth's worldwide countries participated with the same amount of money so the fight for manipulation will be avoided by sharing the goods (cheaper energy, rare ores). At first the commercial activity developed between DACIA'S and Earth, but after its construction ended, the Dacian robots started an intense mining of ores and after 5 years the first modular component for the second space settlement was built. Trade is essential for DACIA'S!
- <u>Tourism and Entertainment:</u> it stands in the nature of the human kind the wish to explore to know and see more. We dream ourselves astronauts, in a ship, or even exploring the Moon, Sun or stars since we are children. Some of our dreams are possible, but others are too much futuristic even nowadays. All the ancestral human beliefs have a common point: the respect of the Moon, planets from our Solar system and stars. What DACIA'S offers as a tourist attraction are the beautiful views from outer space (special components that have an opposite rotation to the settlement's), different neighbourhoods' design from what we can see on Earth, the devices used to maintain life, the artificial day-night cycle, the way of living itself on such an artificial structure is something that attracts visitors. Other popular facilities are the entertaining DACIA'S' games that take place in 1- 0g and also the "trips" to the mined asteroids and Moon. The cultural life of the settlement offers museums with different mineral rocks took from the asteroids and Moon, cinemas, theatres, special dishes, and celebrating days... all unique!
- <u>Safety</u>: DACIA'S provides a better observation of Earth. In case if an asteroid represents a danger for our mother planet we dispose of weapons and robots that can destroy or deviate it from its trajectory long before. We protect and inform Earth about the eventual emergencies with weeks in advance, and we also receive support from them when we need.

DACIA'S is a new country of 600 000 people that was "built" by the worldwide countries, with an important aim: to assure the evolution of the Homo Sapiens. Inhabiting the outer space is one of the solutions that have been found, for providing a "back-up system" for the human race, plants and animals.



2. LOCATION





2. LOCATION

DACIA'S space settlement is located in Lagrange point 5 between Earth and Moon. The reason for this choice is the relative stability that the settlement has with respect to the Earth-Moon reference system.

In the plane determined by the rotation of the Moon around Earth there are 5 points, called Libration or Lagrange points, that provide to any object placed there a state of equilibrium. This is because the 3 forces that act upon it – gravitational force generated by Earth, gravitational force generated by Moon and the centrifugal force due to the system's rotation around its center of mass – annihilate each other. Because the settlement has a mass much lower than both Moon and Earth, we consider that the center of mass for the three bodies is the center of mass of Earth-Moon system.

Despite points L1, L2 and L3, situated on the axe uniting Moon and Earth, points L4 and L5, disposed symmetrically laterally describing along with Moon and Earth two equilateral triangles, have the advantage to offer the settlement a stable equilibrium. This is due to the Coriolis force, which appears for each perturbation of the settlement's normal movement around the center of mass, when the station gains a speed in Earth-Moon reference system. When the settlement is placed in Lagrange 4 or 5, the Coriolis force, perpendicular on the relative speed vector gives the settlement a curved enclosed trajectory around the Libration point. From a energetic approach, we might say that Lagrange points L4 and L5 are potential pots, isolated places with smaller potential energy than the surroundings. An object, placed inside the pot and than dragged to the exterior with a small enough velocity for a short amount of time will continuously circle the potential pot.

The reason why Lagrange point 5 is an equilibrium point in the first place is that the distances from both Moon and Earth are equal, so the attracting gravitational forces two forces acting upon the settlement are in the same ratio with the masses of the two bodies. In this way, the resulting force acts on the direction of the center of mass, that is also the rotation center for the entire system, so the centrifugal force is on the same direction and opposite to the resulting gravitational force.

Taking these facts into consideration, we can say that the settlement is positioned at approximately the same distance of 400.000 km from both Moon and Earth.







3. SETTLEMENT DESIGN





3. SETTLEMENT DESIGN

DACIA'S provides necessary space for permanent living of 600 000 inhabitants (and for the industrial activities) in a space settlement, whose design was chosen as torus.

For the shape of the station, we chose the torus because of its advantages in comparison to the other shapes suitable for a space station. This is an analysis of the other shapes and theirs drawbacks in comparison to the toroidal form.

A. Analized alternative designs

A.1. The cylinder

As one of the first options, the cylinder has a major advantage that it can be expanded as much as needed in order to obtain a bigger livable area, with small changes in artificial gravitation. As disadvantages, it demands a larger atmospheric volume, and that means that rotating the cylinder needs more atmosphere, and also a bigger amount of material is needed to construct it.



Fig. 3.A.1 Cylinder

A.2. The sphere

The sphere is another option which was not the optimal one because of the small surface of the residential area in comparison to its big volume. The optimal pseudo gravity would be obtained only at its equator; that's why from its large volume are only a small part could be used by the people. It would also need a lot of material to be constructed. In addition, the construction of a sphere can be also risky because of financial and material transportation reasons, and it is hard to be compartmented.







A.3. The dumbbell

The dumbbell has its own big advantage because it provides the necessary radius needed for an optimal pseudo gravity value while saving material. Its livable area is almost as big as the sphere's, but it provides little volume in spite of the necessary material quantity. Another disadvantage is the impossibility of expansion and the



Fig. 3.A.3 Dumbbell

necessary transportation between the two small spheres; and as a psychological factor, people should not live so separated, in opposite directions.

In conclusion, the best option remains the torus, the most efficient shape for a space settlement. Compared to its size, it provides the most efficient space usage for livable area. The pseudo gravity on the end capes is constant and in the center the gravity is zero, which enables the heavy industrial activities and space shuttles fixing. It can be easily compartmented,



Fig. 3.A.4 Torus

divided in segments and it offers a big volume of atmosphere; the torus also provides the largest habitable area per ton of nitrogen.

DACIA'S is a construction composed of three linked tori that have common, straight walls. We concluded that by joining the three of them we save material, rather than covering them with one, big cupola as in the case of a single torus. And we also obtain a larger livable area. Each one of these tori is divided in 8 sectors, in order to ease their administration and also to obtain an optimal number of inhabitants per each segment. Each structure is independent of the others and the tori are provided with emergency exits and there are 6-7 different ways of evacuation, in case of a blaze, contamination, unpleasant odors, impact with an asteroid etc. These exits are: 4-6 exists with the neighboring tori (depending on its neighbors) and the radial spoke.

The sectors are connected through the spokes with the central axle of the settlement, where the industrial activities occur (because of the 0g that facilitates the heavy industry operations). These sectors are pressurized and the atmosphere composition inside the sectors is similar to the Earth's. At this level, the pseudo gravitation is 1 g, to provide a good development of skeleton and muscles of the colony's inhabitants. The settlement's main energy source is the solar energy, thus the outer surface of DACIA'S is covered with solar panels, which end in the upper margin, the upper limit where light reaches the tori. The solar panels follow the shape of the three tori.

Dimensions					
No.	Name	Symbol	Value	Unit	Formula
1	Number of tori	n	3	-	
2	Large radius	R	4500	m	
3	Small radius	r	750	m	
4	Floor width	l	1375	m	
5	Floor to center distance	d	299,73	т	$\sqrt{r^2 - \left(\frac{l}{2}\right)^2}$
6	Floor to outer wall distance	d'	450,26	т	r-d
7	Center to common wall distance	t	707,1	т	$\sqrt{r^2 - \left(\frac{y}{2}\right)^2}$
8	Common wall height	У	500	m	
9	Height up for transition	h	49,74	т	$d-\frac{y}{2}$
10	Overall height	H	3534,29	т	4t + 2r
11	Torus sector length		2827,433	m	$\frac{2\pi R}{8}$



Fig. 3.A.5



B. Volumes destinations

B.1. Central Axle

The central axle has the shape of a cylinder, which serves as a support pole for the spaceports, the sun observing room ("Sun bath&Stars"), the atmosphere filtering chamber, the platforms and the industry structure. Any structure that needs Og can attach to this axle, for example factories, hospitals, decontamination rooms and even space shuttles. The link between the central axle and the sectors of torus is made through the spokes.

Inside this cylinder are elevators that can take people to the sun observing rooms and they can also transport ships, goods and all kinds of materials between the industry modules attached to the central axle.



Fig. 3.B.1 The central axle

B.2. The spokes

The spokes are structural units that link the center of the settlement with one of the torus sectors. Every spoke is similar to a net that enables two elevators to move through them, elevators transporting people as well as materials. Each of them acting like a counter-weight for the other. All the eight spokes converge to the center where they meet inside a cylindrical platform where people arrive and continue their way to any destination.



Fig. 3.B.2 Spoke structure



The spokes tubes are protected of radiations, because people can climb inside this structure; for more details, see section 14. Entertainment.

On the spokes, research laboratories are also attached because studies made in this module can be made at different values of pseudo gravity and thus they can move along the spokes on the rails. By changing the distance from the settlement's rotation axis, the pseudo gravity modifies.

B.3. Spaceports

The settlement's spaceports are mainly a lattice whose shuttles can be docked. We chose to make latticed platforms because of material saving reasons, their usage being to couple the shuttle to the platform, not to support the whole space shuttle's mass. In order for the shuttle to land on the settlement, this will have to stop and position itself on the same orbit with the station, and stationary relative to the central mobile part, which rotates opposite from the station, to facilitate the landing . Slowly, the docking systems attach the shuttle to the platform. Then the mobile part start rotating in the same direction with the settlement until it reaches the same rpm. Then, depending on the shuttles' destinations, it passes through different locations: decontamination room, loading and unloading bay, transport module, docking bay, production zone, located right under the docking area.

The transport module is a device to which the shuttles can attach in order to be transported through the central axle. This way the shuttle passes through the decontamination room to reach the loading/unloading zone and finally to the docking area.

B.4. The sun observing rooms "Sun bath & Stars"

The sun observing rooms are especially for sun baths necessary for people living on DACIA'S to provide exposure to natural sun light for at least 10 minutes per day. They are placed on the central axle and are movable, have an opposite rotation movement to the settlement in order to observe the outer space. This room is provided with quartz glass windows that permit to UV rays to pass ensuring the necessary vitamin A, needed for skin and bones.





Fig. 3.B.4





They are situated above the tori to have a better view of the stars, for space observation, because they have the function of telescopes for the astronomers. This room has also telescopes to enable the space exploration and antennaes for wireless communication and



frequencies analyzers to listen for extraterrestrial intelligence. For more details see section 13.1.

B.5. The platforms

Three platforms, one for each torus, serve as stations for the elevators that come from the residential zones. Inside, people can go to their destination, another torus sector, the "Sun bath&stars", spaceports, an industry module or another platform. These platforms are also supporting points for the industry structure and, during the construction stages, for the mobile modules.



Fig. 3.B.5

B.6. The industrial zone

The industrial zone is modular; each factory attaches to the metallic structure, and places itself depending on the other factories that require its goods, and depending on storage areas. We have used the metallic structure because it isn't necessary to completely isolate every industrial module and we don't need to include the whole industry in a regular shape. This way, the amount of needed materials decreases, thus a smaller cost for building the industry area. Tubes connect each of the industry modules to form corridors and materials transportation paths. For more details about the central industry structure and modules' function, see section 8. Industry.



Fig.3.B.6



B.7. The mobile Bio labs

On every two spokes corresponding to the three tori are positioned two research laboratories, each of them placed in the opposite direction to the other. On the first two tori' plane there are four biology laboratories and in the last torus' plane there are two industrial laboratories. In order to make specific experiments in different values of g, they are mobile and can go further or closer to the center to have different pseudo gravity. They have a cylindrical form to provide a larger usable space by using multiple floors and the approximately the same pseudo gravity everywhere. (For internal arrangement, pictures and other details at "Cylindrical bio lab" and "Cylindrical industrial laboratories").

B.8. Water supplies reservoirs

The water reservoirs have a toroidal shape and are placed in the exterior of the station, in front of the solar panels. This way, we can take advantage of the UV radiations, which enables a better purification of the water, and reducing costs on special carbon filters to clear the water. Water is pumped through each pair of reservoirs, to assure a continuous flow. There is a pair of cylinder-shaped water tank for each torus sector. For more details and pictures, see section 7.3 Water management.

B.9. Quartz module

On the central axle, this module with quartz glass panels is attached. This room is placed above the tori, so light and radiation can reach inside. Here, atmosphere is continuously pumped inside, so it can be filtered naturally by UV radiations. The radiations can easily eliminate all the impurities and bacteria that can live in the air and be a potential risk for the colony's inhabitants. Figure 1.B.9 pictures the module with quartz glass, with a refractive index of 1.55 and reflections. For more details and pictures, see section 7.1 Atmosphere.



Fig.3.B.9



No.	Name	Symbol	Value	Unit	
1.	TorusA volume (superior)	V ₁	58,305,168,859	m^3	$V_f - v'$
2.	TorusB volume (central)	V_2	66,645,465,437	m^3	$V_f = 2v'$
3.	TorusC volume (inferior)	V_3	58,305,168,859	m ³	Vf - v'
4.	Volume under the floor torus	V	12,617,053,943	m^3	$\left(\frac{\pi}{2}r^2 - r^2\sin^{-1}\frac{d}{r} - \frac{dl}{2}\right)2\pi R$
5.	<i>Cut volume to merge tori</i>	v'	-8,340,296,578	m^3	$\left(\frac{\pi}{2}r^2 - r^2\sin^{-1}\frac{t}{r} - \frac{tl}{2}\right)2\pi R$
6.	Complete torus volume	V_{f}	49,964,872,281	m^3	$2\pi R \pi r^2$
7.	Residential volume-torus A	V _{c1}	45,688,114,916	m^3	$V_1 = v$
8.	Residential volume-torus B	V _{c2}	54,028,411,494	m^3	$V_2 - v$
9.	Residential volume-torus C	V_{c3}	45,688,114,916	m^3	$V_2 - v$
10.	Total volume	V	183,255,803,154	m^3	$V_1 + V_2 + V_3$
11.	Total cupolas volume	V_c	145,404,641,325	m^3	$V_{c1} + V_{c2} + V_{c3}$
12.	Residential area per torus	S_t	38,877,209.1	m^2	2πRl
13.	Total livable area	S	116,631,627.3	m^2	3 <i>S</i> _c
14.	Minimum surface per person	S _{min}	92.45	m^2	
15.	Population	Р	600,000.00	-	
16.	Amplification coefficient	С	1.5	-	
17.	Total residential surface	Srez	83,205,000	m^2	$S_{min} \cdot P \cdot c$
18.	Minimum agricultural surface per person	S _{min agr}	350.00	m^2	
19.	Total agricultural surface	Sagr	315000000	m^2	$S_{min} \cdot P \cdot c$

Dimensions

No.	Name		Symbol	Value
1	Central axle	radius	r1	30 m
2		height	h1	4500 m
3	Sun observing room	radius	r2	35 m
4		height	h2	46 m
5	Space port	radius	r3	1000 m
6		height	h3	200 m
7	Space port chambers (pressurized)	radius	r4	200 m
8		height	h4	200 m



4. CONSTRUCTION SEQUENCES





4. CONSTRUCTION SEQUENCES

4.1 Lunar facilities

Before the beginning of DACIA'S Space Settlement construction, some modular lunar facilities are built with the purpose of gathering construction materials and processing them for preparing construction components. Each modular facility is made of many iglooshaped structures connected with a special landing and take off space in center. The iglooshaped structures are constructed with the Superadobe technique, which benefits from the lunar soil.

The exterior structures are responsible for gathering harvested materials. The medium structures are responsible with processing the materials into modular components required for the settlement's construction. The interior structures disposed around the landing site are responsible with depositing the construction materials until the arrival of Cargo Ships. At the beginning, some of the modular facilities are adapted for building Cargo Ships and construction ships used in the construction of DACIA'S main settlement in L5 Libration Point.

The lunar facilities are also used after the settlement's finishing, for extracting prime materials used in the industrial processes undertaken on DACIA'S.

In fig 4.1.1 be observed a modular base with a Cargo Ship being loaded with materials by robotic arms inside the docking space (landing/take off space).



Fig.4.1.1



4.2 Main settlement construction sequence

Stage 1

The main settlement construction begins with the arrival of 6 construction ships from

the modular facilities previously built on Moon. The construction ships start building the upper central platform, the upper spaceport and the corresponding segment of the central tube. The construction ships come already filled with materials required for building these components. Then, Cargo Ships will begin to arrive from the Moon, using the upper spaceport for docking and unloading new materials for construction. The materials are transported through special industrial elevators from the upper space port to the upper platform, where construction ships can reload.



Stage 1 (complete)

Stage 2

The construction ships start building the beginnings of two opposite spokes, and then the Mobile Cylinders around them. The mobile cylinder begin then to operate on their own (coordinated by people inside them), building the two spokes symmetrically, from the interior to the exterior, step by step (the same Moving Cylinders that are later used to provide variable gravitation for different experiments "Cylindrical industrial lab" and "Cylindrical industrial laboratory"). The Moving Cylinder has inside many Ant Builder robots, which are used after for building the corresponding torus segment. Meanwhile, other 8 construction

Stage 2 (partial)

Fig.4.2.1

arrive from the Moon, and Cargo Ships continue to bring modular construction components.

Fig.4.2.2



Stage 3

After the two spokes are completed, the 14 construction ships already available go to the exterior, to the just finished endings of the spokes (7 to each part). First, 4 construction ships carry each Moving Cylinder back to the platform, and position them for beginning the new spokes. Then, the construction ships, assisted by Bee Builder robots they carry and the Ant Builder robots (brought by the Moving Cylinder and left inside de spoke) begin constructing the torus segment. After the structure is completed, only Ant Builders and Bee Builders continue to work for the interior finishing. While the LOX-LH2 thrusters begin to function in order to put the entire already built settlement in circular motion, the two torus segments are then pressurized and tested, and people brought from earth with Earth-to-Orbit transportation ships move inside. The two operational torus segments also provide a more comfortable shelter for people forming the crew of Construction Ships and Cargo ships that worked until that moment. Meanwhile, other newly arrived construction ships build the second central platform, the corresponding central tube segment and two other Movable Cylinders, so at the time the first two pair of torus segments in the upper torus are ready, the second platform and its pair of Movable Cylinders are also ready.

Stages 2 and 3 form a repetitive pattern that will repeat 4 times for each torus (each time, 2 new spokes are built followed by two torus segments, from the total of 8 that form the torus). For each pair of spokes, the two Movable Cylinders are taken by 4 construction ships (2 for each), moved and positioned for starting the new construction



Fig. 4.2.3

Stage 4

The second pair of spokes and torus segments from the upper torus is built simultaneously with the first pair of torus segments in the medium torus. In this way each new torus segment will be built supported by at least one previously built torus segments, and the efforts implied by building during rotation are considerably diminished. Meanwhile, other newly arrived Construction Ships build the third (lower) central platform, the corresponding central tube segment and the two corresponding Moving Cylinders.





Fig. 4.2.4

Stage 5

The third pair of spokes and torus segments from the upper torus is built simultaneously with the second pair in the medium torus, and with the first pair in the lower torus. Also, during this stage, the lower space port is built, allowing a more efficient supply of material.



Stage 5 (final)



At the end of **stage 6**, the upper torus is finished, the medium torus has 3 pairs of torus segments and the lower has 2.





At the end of **stage 7**, the medium torus is finished, and at the end of **stage 8**, the lower torus is also finished.



Fig. 4.2.7



Stage 8 (final)

Fig. 4.2.8





During **stage 9**, construction ships finish the central industrial areas and the 0G spherical labs.



During the entire construction process, the settlement is continuously supplied with materials brought from the Moon by Cargo Ships. Also, water and people are brought from Earth with Earth-to-Orbit Transport Ships. The population gradually increases while new torus segments become operational. The water is transported by special pipes inside the spokes to the interior light-industry area inside each operational torus segment, where it is deposited in special tanks. A considerable amount of water is converted into LOX and LH2, and then transported to the exterior light-industry area, where thrusters use these products in order to maintain the settlement in rotation during the construction process (for more details, see Dynamics).

4.3 Construction devices

The construction of the main settlement requires construction ships, Cargo Ships and automated construction robots.

Construction ships (fig. 4.3.1 and fig. 4.3.2)

Construction ships have special adaptations for settlement construction. In front side, each construction ship has a command room for 6 working people, with a total crew of 18 people. Also, the ship has all life sustaining facilities for the entire crew. In the center, the ship has an empty assembly space for



Fig. 4.3.1





Fig. 4.3.2

different complex components made of primitive modular components, and behind, a depositing space for these primitive modular components. Around the empty space, there are 4 robotic arms for maneuvering and fixing components. Other 4 smaller welding arms are disposed symmetrically between the

fixing components. Other 4 smaller welding arms are disposed symmetrically between the other 4 maneuver arms. The 4 welding arms only work for assembly of complex components inside the empty space, but the 4 maneuver are long enough to move assembled complex components to the body of the settlement and primitive modular components from the depositing chamber to the assembly space or directly to the body of the settlement. For welding different components (complex or primitive) with the already built body other bigger, laterally disposed welding arms are used. During construction process, when the ship remains without materials, it returns to one of the three central platforms for reloading. The ship is propelled by two VASIMR (Variable Specific Impulse Magnetoplasma Rocket) engines for long distances, and by 4 mobile LOX-LH2 thrusters for short distances and for positioning.

Cargo Ships

Cargo ships are used to transport primitive modular components from the surface of Moon to the temporary storage facilities in the central area of the settlement. The main body of the ship has the shape of a cylinder. It has in the front side command spaces and life-sustaining facilities for people (30 people total crew), and from the center to the back side, it has an interior storage area with a cylindrical shape. On the exterior, the ship has 3 extensions with the double purpose of fixing to other structures (space port docking system), and the purpose of thermal adjustments through radiation. The Cargo Ship also has three other extensions





disposed backwards for propulsion. The ship is also propelled by 3 VASIMR engines. The ship has 6 additional LOX-LH2 thrusters disposed backwards but at higher distances from the



main body, and 12 disposed in various positions on the extensions with the purpose of adjusting direction and speed.



Fig.4.3.4

4.4 Construction robots

In construction, smaller robots are used because they have access inside spaces where arms of Construction ships can not reach. Robots are also used for interior finishing. The two main types of robot used are: the Bee Builder and the Ant Builder. The names were chosen because they refer to small animals that work hard and in groups, which is also available for these robots. The robots communicate between them, and each group is coordinated by a central computer placed inside a Construction Ship, so humans can interfere in the process.

1) The Bee Builder is a flying robot, with two maneuver arms laterally disposed, for small components (like beams), and one adaptable clamping system for bigger components, behind. It also has four welding arms, two beneath and two above and two clawed anchors with adjustable length ropes, also one beneath and one above. In the center, it has a storage space for small components. Behind, the robot has 4 adjusting thrusters for movement and positioning. The robot uses the two pairs of rope-anchor for fixing on the already build resistance structure (the settlement will begin rotating at a given moment, and the robot should remain fixed when working on the exterior, because circular trajectories are difficult to obtain just through jets).





Fig. 4.4.1



Fig. 4.4.2



2) The Ant Builder is a non flying robot, with 4 special legs adapted for clamping and moving through beams or on surfaces. The Ant Builder also has 2 maneuver arms laterally disposed and one long welding arm behind (it resembles more with a spider). This robot is used more for building the interior structure.

In construction, all welding arms used by robots and construction ships use plasma jets. Plasma welding is more efficient than thermal or electric arc welding, in void, because nothing stops the plasma void.



5. SETTLEMENT'S DYNAMIC



5. Settlement's dynamic

5.1 General settlement dynamics

The position chosen for the settlement, Libration point 5 in Earth-Moon system, implies a constant rotation of the settlement around Earth with, or more exactly, around the center of mass of the two body systems. The angular velocity of this rotation is given by the formula $\omega_E = 2\pi/T_E$, where T_E is the rotation period around Earth, the same with the Moon's period of rotation around Earth.

So T = 27 d 7 h 43.1 min = 49343.1 min = 2360586 s, and $\omega_E = 2.66 \text{ rad} / \text{ s}$. The average orbital speed is $v = \omega_E \cdot D = 1.022 \text{ km} / \text{ s}$, where D_E is the average distance from Earth: 384,399 km.

Due to the rotation of Earth-Moon system around the Sun, the Settlement will also have a rotation around the Sun, with the angular speed: $\omega_s = 2\pi / T_s = 1.98 \cdot 10^{-7} \text{ rad} / s$.

In order to sustain a normal artificial gravity of $g_0 = 9.81 m/s^2$ at a distance equal with the distance from the center of the settlement to the residential area: d=4800m, the settlement will have another rotation around its axe with the angular velocity:

 $\omega = \sqrt{g_0/d} = 0.045 \, rad/s$, which corresponds to a frequency 0.007 Hz or 0.43 rot/min.

The angular momentums for the 3 rotations we described above have the following formulas:

 $L_{E} = M \cdot \omega_{E} D_{E}^{2}; (around Earth)$ $L_{S} = M \cdot \omega_{S} \cdot D_{S}^{2}; (around Sun) \text{ where M is the total mass of the settlement, and } I_{0}$ $L_{0} = I_{0} \omega.(around its axis)$

is the inertia momentum around the settlement central axis.

We estimated that the entire settlement has a mass of approximately $M = 3 \cdot 10^{12} kg$, and an inertia momentum of $I_0 = 3 \cdot 10^{19} kg \cdot m^2$, so the angular momentums have the following values:

$$L_{E} = 11.7 \cdot 10^{23} \frac{kg \cdot m^{2}}{s}$$
$$L_{S} = 13.36 \cdot 10^{21} \frac{kg \cdot m^{2}}{s}$$
$$L_{0} = 1.35 \cdot 10^{18} \frac{kg \cdot m^{2}}{s}$$

While the entire settlement rotates with the specified angular velocity with respect to Earth-Moon reference system, there are parts of the settlement that sometimes spin in the opposite direction, in order to ensure immobility with respect to the same reference system. It's the case of the docking system that exists in the center of each space port, and the two "Sun bath & Stars" room, placed around the center axis.

The docking system inside each space port has the purpose of ensuring a safe and easy docking for incoming space ships, especially large ships. The space ports are places in the center, where the settlement's rotation speed is low (on the central axis, the speed is 0). However, even inside the space port, the rotation speed increases as we go further from the center. The Docking system is actually a cylindrical shaped structure that rotates in the



opposite direction in order to cancel this effect. When the ship approaches, the structure starts rotating until it reaches the desired speed. Then, the ship enters from above and stabilizes inside, while arms with special clamping system fasten the ship. When the ship is secured, the structure gradually loses velocity (with respect to the settlement), until it stops (the ships achieves the settlement's angular velocity). Afterwards, the ship can be moved inside the settlement for different procedures).

5.2 Settlement advanced dynamics

After the first pair of torus segments is built, the settlement begins rotating, powered by special LOX-LH2 thruster, placed on the exterior, with all required facilities in the exterior light industry area, orientated tangent to the torus. The settlement achieves the desired angular velocity with a relative ease, because the preliminary settlement has a small inertia momentum. After the desired angular velocity is achieved (0.045 rad/s), the settlement's construction sequence continues, and material is continuously brought to the exterior. Consequently, the settlement inertia momentum rises, and according to the angular momentum conservation law, the angular velocity must drop. The angular velocity is kept constant using the operational thrusters (there is one thruster in each operational torus segment). For example, during construction stage 4, the settlement is kept moving with the same angular velocity only by two thrusters, and during construction stage 5, by 6 thrusters.

We present the following formulas for calculations related to thrusters.

$$F = I_{sp} \cdot \frac{dm}{dt} \cdot g_{0}$$

$$F = m \cdot a = m \cdot \frac{dv}{dt}$$

$$M \cdot \frac{dv}{dt} = I_{sp} \cdot \frac{dm}{dt} \cdot g_{0}$$

$$F = m \cdot a = m \cdot \frac{dv}{dt}$$

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$$f = m \cdot \frac{dv}{dt}$$

$$f$$



$$F = I_{sp} \cdot \frac{dm}{dt} \cdot g_{0}$$

$$n \cdot F \cdot R = I \cdot \varepsilon = (I_{0} + n \cdot m \cdot R^{2}) \cdot \frac{d\omega}{dt}$$

$$(I_{0} + n \cdot m \cdot R^{2}) \cdot \frac{d\omega}{dt} \cdot \frac{1}{n \cdot R} = I_{sp} \cdot \frac{dm}{dt} \cdot g_{0}$$

$$i = I_{sp} \cdot \varepsilon = (I_{0} + n \cdot m \cdot R^{2}) \cdot \frac{d\omega}{dt}$$

$$i = I_{sp} \cdot \varepsilon = I_{sp} \cdot \frac{d\omega}{dt}$$

$$i = I_{sp} \cdot \frac{d\omega}{dt} \cdot \frac{1}{n \cdot R} = I_{sp} \cdot \frac{dm}{dt} \cdot g_{0}$$

$$i = I_{sp} \cdot \frac{g_{0}}{R} \cdot \int_{m_{0}}^{m} \frac{dm}{m + I_{0} / n \cdot R^{2}}$$

$$i = I_{sp} \cdot \frac{d\omega}{R} \cdot \ln \frac{m_{0} + I_{0} / n \cdot R^{2}}{m + I_{0} / n \cdot R^{2}}$$

$$\Delta \omega = \omega_{2} - \omega_{1} = \frac{I_{sp} \cdot g_{0}}{R} \cdot \ln \frac{m_{0t} + I_{0} / R^{2}}{m + I_{0} / n \cdot R^{2}}$$

$$\Delta \omega = \omega_{2} - \omega_{1} = \frac{I_{sp} \cdot g_{0}}{R} \cdot \ln \frac{m_{0t} + I_{0} / R^{2}}{m + I_{0} / R^{2}}$$

(1)

We observe that the angular velocity variation does not depend of n, only of the total mass of fuel and the initial total mass of fuel

At a given moment during construction, when the inertia momentum of the settlement rises from I_0 to $I_0 + I_{ad}$, where I_{ad} is the additional inertia momentum caused by adding new material (usually, $I_{ad} = M r^2$, where M = mass of added material, r = distance from the rotation center) the angular velocity will drop according to the angular momentum conservation:

$$\Delta' \omega = \omega' - \omega = -\omega \frac{M \cdot r^2}{I_0 + M \cdot r^2} \quad (2)$$

The former angular velocity is reestablished by using a number of n thrusters, placed at R distance from the center, according to equation (1), taking into consideration the new inertia momentum $I_0 + M \cdot r^2$:

$$\Delta \omega = \omega_2 - \omega_1 = \frac{I_{sp} \cdot g_0}{R} \cdot \ln \frac{m_{0t} + (I_0 + M \cdot r^2) / R^2}{m_t + (I_0 + M \cdot r^2) / R^2}$$
(3)
$$\Delta \omega = -\Delta' \omega$$
(4)


From equations (2), (3),(4) results:

In order to maintain the initial angular velocity, after adding mass M at distance r from the center, the mass of consumed fuel is given by the following expression:

$$\Delta m = m_{0t} - m_t = m_{0t} - [m_{0t} + (I_0 + M \cdot r^2) / R^2] \cdot e^{-\omega \frac{M \cdot r^2}{I_0 + M \cdot r^2} \cdot \frac{R}{I_{sp} \cdot g_0}} + (I_0 + M \cdot r^2) / R^2$$
(5)

In order to find out the initial quantity of fuel necessary (quantity of water expulsed) to rotate the settlement from 0 to 0.045 rad/s, after construction stage 3 is completed, we use an equivalent form of equation (1), where $\omega 1 = 0$ and $\omega 2 = \omega = 0.045$ rad/s:

$$\Delta \omega = \omega_2 - \omega_1 = \omega = \frac{I_{sp} \cdot g_0}{R} \cdot \ln \frac{m_{0t} + I_0 / R^2}{m_t + I_0 / R^2};$$

$$\frac{m_{0t} + I_0 / R^2}{m_t + I_0 / R^2} = e^{\omega \frac{R}{I_{sp} \cdot g_0}};$$

$$m_t = e^{-\omega \frac{R}{I_{sp} \cdot g_0}} (m_{0t} + I_0 / R^2) - I_0 / R^2; (1')$$

If we assume that use the entire fuel that we have at the beginning, $m_t = 0$, then:

$$m = m_{0t} - m_t = m_{0t} = (e^{\omega \frac{R}{I_{sp} \cdot g_0}} - 1)I_0 / R^2 = 9000000 \text{ t}$$

for R=5250 m, and I_{sp} =250, and (for the first two torus segments) I_0=2.46 10¹⁸ kg m²

The exterior thrusters are also used for moving the settlement on vertical direction, in case of major asteroid threatening. All thrusters are orientated vertically, each generating a

force of
$$F = I_{sp} \cdot \frac{dm}{dt} \cdot g_0$$
, so the total generated force is $F_t = nI_{sp} \cdot \frac{dm}{dt} \cdot g_0$. The

settlement moves with constant acceleration (a) for a period of time (t), and then decelerates with the same constant acceleration. The laws of motion for both acceleration and



deceleration phases are equivalent with: $d = \frac{at^2}{2}$, and the total distance is 2d. Also, lex secunda states $F_t = M_t a$. From all equations above and from the fact that the force is kept constant results that the total consumed mass of fuel is

 $m = \frac{2t \cdot F_{t}}{nI_{sp}g_{0}} = \frac{2t \cdot M_{t}a}{nI_{sp}g_{0}} = \frac{2t \cdot M_{t}2d}{nI_{sp}g_{0}t^{2}} = \frac{2t \cdot M_{t}2d}{nI_{sp}g_{0}t^{2}} = \frac{4 \cdot M_{t}d}{nI_{sp}g_{0}t};$

The station is moved during 120 hours (5 days) with a vertical distance of 5km, so the required mass of fuel is 2301 t for each thruster.

5.3 Solar eclipses

Solar eclipses on DACIA'S space settlement appear when light from the sun is blocked by either the Moon or the Earth. The eclipse lasts as long as the settlement remains in the cone of shadow behind Earth or Moon. In a simplified model, we can consider the moon Earth and Sun moving in the same horizontal plane. The figure below describes the Moon Solar eclipse. The eclipse happens when the Settlement Moon and Sun are perfectly aligned. The following are the relations required to calculate the time a solar eclipse of Moon lasts, if



Fig. 5.3.1



we consider that light from the Sun is parallel, neglecting the fact that the settlement actually passes through a cone of shadow (so we consider the worst scenario).

 $v=v_L=v_S=v$ settlement tangential velocity

 $v=\omega R$, $\omega=angular$ velocity of settlement and Moon around Earth: $\omega=2\pi/T$ $v_r=2v^*\cos\varphi=relative$ speed of settlement with respect to the Moon $\Delta t = D_L/v_r = D_L/(2v^*\cos\varphi) = D_M/(2\omega R^*\cos\varphi) = D_M/[2^*(2\pi/T)^*R^*\cos\varphi] = T^*D_M/(4\pi R^*\cos\varphi)$

 $\Delta t = T^* D_L / (4 \pi R^* \cos \varphi) = \text{the maximum time of eclipse caused by moon}$

R = Earth-Moon distance = 384400 Km

T=period of revolution (of Moon and settlement) around Earth = 27 days 7h 43.1 min = 2360586 s $\phi=60^{\circ}$

 D_M = Moon diameter = 3471,94 Km

		angle between direction of settlement and Moon
φ	60	relative to Earth
Т	2360586 s	Moon period of rotation around Earth <s></s>
ω	2,66171E-06 rad/s	2*Pi / T
V_L	1,023km/s	Moon tangential velocity
V_S	1,023km/s	Settlement Tangential velocity
V_r	1,023km/s	resulting velocity
DM	3471,94 km	Moon Diameter
R	384400	Distance Earth-Moon
Δt	3393,35s	Period of eclipse (one during each month)
	56,5min	
	0,94h	
Pi	3.1415	

In reality, a solar eclipse caused by Earth does not happen once each month. In fact, they are much rarer. The reason is that the Moon rotates around Earth in a different plane than the plane in which the Earth rotates around the Sun (the ecliptic of the Moon is different than the ecliptic of Earth). A real solar eclipse caused by Moon only happens when the Sun, Moon and settlement are on the same direction in 3D space, not only in the horizontal plane we represented in the figure above.

The duration of solar eclipses caused by Earth can be calculated in a similar manner.

Eclipses caused by Earth last for longer periods of time. A required condition for these eclipses to happen is that the settlement, Earth and Sun to be perfectly aligned from a view from above the Earth's ecliptic. However, the condition is not sufficient. The only points where real eclipses caused by earth might happen the orbit of the Moon (and also the orbit of the settlement) intersects the ecliptic of Earth are the only points where real Solar eclipses caused by Earth happen.

The duration of Earth caused eclipses in the worst case scenario is given by the following formula:

$$\Delta t = \frac{D_E}{v} = \frac{6400 km}{1.023 km/s} = 6256s = 104 \min.$$



6. DACIA'S PROTECTION



6. DACIA'S PROTECTION

6.1 Exterior wall

The settlement's protection is done through the materials that have been used for its building, from the Moon's mining. The DACIA'S shelter against radiation has 2 types of consistency depending on its disposal. The walls exposed to the Sun's radiation are covered by solar panels (see picture number 6.1.1), while the other ones are not (see picture number 6.1.2).



Fig. 6.1.1

The layer of solar panels provides the energy necessary for sustaining the life



conditions. Under this layer there is an artificial magnetic field produced by copper conduction wires (7m thick), that protect the settlement from gamma noxious radiation.

The next layer of the structure is made of FeTi70, a strong and corrosion resistant alloy. It has 30 cm wide, the pieces used are modular, prefab with an easily connecting system. The shape is triangular and their side has 6 m (see picture number 6.1.3).



<u>Fe-Ti70 alloy advantages are:</u> -resistance to impact -protection against corrosion -composition FeTi70: Ti 70%, Fe 2-10% ,and traces of Al,Mo has low density, protect against erosion agents Ti formed on the home perform

-Ti found on the lunar surface

Properties of Fe-Ti70	Value (Metric)
Density	4.85 g/cc
Tensile strength	890 MPa
Coefficient of thermal expansion, linear 20°C	8.5 μm/m-°C
Specific Heat Capacity	0.525 J/g-°C
Maximum ServiceTemperature, Air	315 °C



Fig. 6.1.4

Other- includes Titanium ores 1.1% to 2.8 %. Landing site soil values provide the reference for a regression curve from which Ti concentrations in 137 regions of adequate counting statistics are calculated. Mare Tranquillitatis contains the highest, and Mare Crisium the lowest Ti concentration, and regional values in the western Maria range from 1.1% to 4.1%.

The iron pipes structure with "Super Adobe" and microbots is an important layer that avoids the air leek and security of the settlement (0.5m wide). The microbots are also intermingled through the wall structure so that when an object hits the respective section, the microbots rapidly fill with material the hole, thus avoiding air leaks.



Polymers such as polyethylene heavily impregnated with hydrogen (0.2 m) are used for the protection against high-energy protons, neutrons, alpha particles and gamma radiation. The interior of DACIA'S has special bunkers on each segment of torus near the spokes that protect women, pregnant women and children when the solar flares are strong and dangerous for their health. A bunker is the area from a torus, where each component of the settlement's protection shield is doubled from the usual size of 8.4m to 16.8m.

In case in the settlement is in major danger because of an asteroid impact, we can move the settlement up and down for about 1.5 km (see Settlement Dynamics – Advanced Dynamics) and/ or destroy it with our space fleet and weapons. We also protect the Earth from danger and inform it about the "space weather".

Small pebbles and asteroids smaller than a grapefruit may be the most important worrying factor for our solar panels. Automated systems with robots check, change, and move them when needed.

6.2 Electro-magnetic shield

In order to ensure protection against high energy charged particles, we decided that an active, magnetic shield would be effective. In each torus segment, the magnetic field is sustained by 6 special conceived networks of wires that we called AMSSWAS (Active Magnetic Shield Spatial Wire Arrangement System) each having 7 meters width. The six AMSSWAS are placed beneath the Fe-Ti layer and solar panels. These networks are powered directly from inside the exterior light industry area, directly from the DC shield sustaining power plants, as it is specified in section 12. Energy production and distribution.

The charged particles are deflected by the magnetic fields generated inside the AMSSWAS, due to the Lorentz force. This force acts perpendicular on both the speed and induction vectors. -alpha particles are the most difficult to

The Lorentz e-m force: $\vec{F}_{l} = q\vec{v} \times \vec{B}$; $F_{l} = qvB$; The centrifugal force: $F_{cf} = \frac{mv^{2}}{R}$; $B = \frac{mv}{aR}$.

Lex secunda: $F_{cf} = F_l;$

mass:
$$m = 6.644656 \cdot 10^{-27} kg$$
;
-alpha particle charge is
 $q = 2e = 3.2 \cdot 10^{-19} C$;
-we consider that their entering speed
is $v = 1000$ km/s = 1000,000 m/s.
-we want to deflect alpha particles with
180 degrees for perpendicular entry, so
the trajectory radius R equals half of
the AMSSWAS width: R = 3.5m;
-the resulting necessary electro-
magnetic induction is:

deflect, because they have the biggest

B = 0.0059 T;



We have tried different shapes for the AMSSWAS. The first was chosen more for reasons of symmetry and ease of calculations, and we display it for better understanding of our approach. Wires are perpendicular on the plane and are represented as circles with point/'x', depending of the direction of the electric current.



The red, blue and black arrows are magnetic induction vectors generated by various wires, and the green arrows are resulting magnetic induction vectors in various points. We observe that the resulting magnetic induction changes its module and direction across space, but has a general horizontal orientation. We are interested just in the horizontal component (parallel with the torus margins) because this component deflects charged particles. We consider a medium value induction, with the following formula (depending of the current's intensity):

$$B = \frac{\mu I}{\pi d};$$

$$I = \frac{\pi B d}{\mu},$$

I is the intensity and d the AMSSWAS's width (1.5 m), B the previously calculated necessary magnetic induction (0.0059 T) and μ the magnetic permittivity (4 π 10⁻⁷ N/A²).



Using the last formula, we find out that the required intensity to sustain magnetic field of given induction would be much higher then possible. We decided to conceive a new AMSSWAS, but with the same basic shape, only that it is repeated many times horizontally, and a few times vertically. In order to calculate the new required intensity, we used again an approximated formula for magnetic induction, based on the formula for the first conceived shape of AMSSWAS and the number of times it is repeated (n) and the number of time it is repeated vertically (m):

$$B_{nec} = nm \frac{\mu_{nec}}{\pi d};$$
$$I_{nec} = \frac{\pi B_{nec} d}{nm\mu},$$

In order to ensure the fact that at the given required intensity can be achieved at relative low temperatures, where Cu wires can be used in a state close to super conduction, we also used other equations regarding heating and thermal equilibrium of wires, which are described below. After taking all the factors into consideration and making many tries, we decided to give n the value of n = 467 (wires in 7 meters), and m the value of m = 5 (layers), so a total of 2333 wires in 7 meters length, and 2356194 wires for one AMSSWAS. The wires have the radius of 0.005 m, and 0.005 distance between their margins. The required intensity obtained from the last formula is $I_{nec} = 44.6A$.

In order to verify that the wires can be sustained at low temperature, we used energetic estimations.

The power transferred to the exterior through radiate by one cylindrical wire is given by the Stephan-Boltzman law: $P_{tr} = \sigma \cdot T^4 S_{ext} = \sigma \cdot T^4 2\pi r \cdot l$ where T is the absolute temperature, S_{ext} the exterior surface, $\sigma = 5.669 \cdot 10^{-8} \frac{kg}{K^4 s^3}$ is Stephan-Boltzman Constant, r=0.02 m is the wire radius and l=785 m.

The power absorbed by the wire through Joule effect due to electric current has the formula $P_{abs} = I^2 \cdot R = I^2 \cdot \rho \frac{l}{S_{sec}} = I^2 \cdot \rho \frac{l}{\pi r^2}$ where I is the electric intensity, ρ the electric

resistivity and S_{sec} the section area of the wire. When the wire reaches thermal equilibrium, the absorbed power equals the exterior-transferred power. The wires are kept between the super adobe layer, between the super adobe and the exterior Fe-Ti layer, so they are thermal isolated from the interior settlement, with void exposure. We neglect the heat absorbed through radiation from other components of the settlement, or from one wire to another. The condition stated above imposes the following equation:

$$P_{abs} = P_{tr};$$

$$I^{2} \rho \frac{l}{\pi r^{2}} = \sigma T^{4} 2\pi r l;$$

$$I = \pi T^{2} r \sqrt{\frac{2\sigma r}{\rho}};$$

From the last relation, with the given values for σ , r, we introduced different pairs of values (T, ρ) for discrete absolute temperatures lower than 250 K, with the corresponding resistivity value, until we obtained an electrical intensity enough to maintain the magnetic shield, also keeping an eye on the consumed power. We find out that for T = 60 K and $\rho = 0.872 \cdot 10^{-8} \Omega \cdot m$ the obtained intensity is I=43.2A which is close than $I_{nec} = 44.6 A$.



The power required to maintain one AMMSWAS can be calculated using the following formula:

$$P = I^2 \cdot R = I^2 \cdot 2 \cdot n \cdot m \cdot \rho \frac{l}{\pi \cdot r^2};$$

P = 42,718,497w;

So a total of approximately 42 Mw for each AMMSWAS, multiplied by 6 means 252

Mw for each torus segment, and multiplied by 24 means 6048 Mw for sustaining magnetic protection for the entire settlement. The magnetic field has a constant intensity, so it does not present any threats for human life, and the electrical wire arrangements determine very low magnetic induction outside the AMMSSWAS.



6.3 Interior protection

In DACIA'S interior there are sensors in houses and in public places which permanently show the parameters of the air: composition, temperature, pressure and relative humidity. In this way accidents are avoided through means of protection, back-up systems and gates that stop for example the lowering of the pressure; alarms and robots that detect toxic chemicals, gases and send this information to all the residents. They all have a Dacian bracelet that looks like a watch with a screen, that informs them about the daily news, dangers, what daily diet the resident must have in order to provide to his body the necessary amount of food and fruits.

These are all means of protection that DACIA'S offers to its residents for a peaceful and secure living.



7. ENVIRONMENT CONTROL





7. ENVIRONMENT CONTROL

7.1 Atmosphere

a) Composition

On the settlement the atmosphere must have the same concentration as on the Earth in order to offer proper conditions for living to residents, animals and plants. That means that the atmosphere is made of:

Nitrogen	78.0842%
Oxygen	20.9463%
Argon	0.93422%
Carbon dioxide	0.03811%
Water vapor	About 1%
Other	0.002%



Fig. 7.1.a

The relative humidity is about 50%, while the temperature is 22 degrees C. At the level of the residential area, the atmospheric pressure is $p_0=101325$ Pa. The human and animal body need a balanced atmosphere composition and pressure, in order to be healthy and survive. The atmosphere of the space habitat must contain a partial pressure of oxygen (pO2) to provide high enough partial pressure within the alveoli of the lungs (~13.4 kPa or ~100 mm Hg) for good respiration yet low enough to avert losses in blood cell mass and large changes in the number and distribution of micro-organisms, such as the growth of some bacteria . The level of carbon dioxide should be less than 0.4 kPa (3 mm Hg). At the same time the CO₂ levels have to be high enough to permit maximum rates of photosynthesis by crop plants.



b) Air pressure variation

Inside each a pressurized volume, kept in rotation, the air pressure varies with high respecting a different law then on Earth.

From the equilibrium of mass dm: $pS - (p + dp)S = (dm)\omega^2(r - y);$ $pS - pS + dpS = (dm)\omega^2(r - y);(1)$ But mass dm is given by the following expression: $dm = \rho dV;$ And dV: dS = Sdy;So it results that: $dm = \rho Sdy;(2)$ From the general law of ideal gas: $pV = \frac{mR_gT}{\mu};$ $p = \frac{\rho R_g T}{\mu}; \Longrightarrow \rho = \mu \frac{p}{R_g T}; (3)$ Introducing relations (2) and (3) in (1): $-Sdp = \rho Sdy\omega^2 (R - y);$ $-dp = \mu \frac{p}{R_z T} S \omega^2 (R - y) dy;$ $-\frac{R_gT}{\mu\omega^2}\frac{dp}{p}=(R-y)dy;$ $-\int_{n_0}^{p} \frac{R_g T}{\mu \omega^2} \frac{dp}{p} = \int_{n_0}^{y} (R-y) dy;$ $-\frac{R_g T}{u \omega^2} \ln p \Big|_{\rho_0}^{\rho} = (Ry - \frac{y^2}{2}) \Big|_{0}^{\gamma};$ $-\frac{R_g T}{\mu \omega^2} \ln \frac{p}{p_0} = (Ry - \frac{y^2}{2});$ $\frac{p}{p0} = e^{-\frac{\mu\omega^2}{R_g T}(Ry - \frac{y^2}{2})};$ $p(y) = p_0 e^{-\frac{\mu\omega^2}{R_g T}(R-\frac{y}{2})y};$



Fig. 7.1.b.1

The final equation is the law describing the law of air pressure dropping with height. For y = r we calculate the pressure inside the center of the settlement (R = 4800 is the distance from the "ground level", where the pressure is the normal atmospherical pressure, to the center of the settlement). We obtain:



$$p(R) = p_0 e^{-\frac{\mu\omega^2}{R_g T}(R - \frac{R}{2})R} = p_0 e^{-\frac{\mu\omega^2 R^2}{2R_g T}};$$

p(R) = 71640Pa;

for p0=100000Pa, t = 21°C, meaning that T=294K, Rg = 8.31 J/(mol K), μ = 28.9 kg/mol and ω =0.045 rad/s.

The conclusion is that the pressurized parts of the spokes leading to the center of the settlement, even when they communicate with the torus segment, the pressure would only drop to approximately 70%, so there is no need to fragment the tube into isolated multiple parts to maintain the same pressure

c) Filtrating, sterilization methods

On the space settlements the odors represent a really major problem. In order to escape from it, on DACIA'S we use "Large fans"(2 per each segment of torus). In this way the air is permanently filtered, sterilized (in this way the bacteria that provide the unpleasant odors can't spread anymore) and odoriferous (a filter imbued in aromatic oils of rosemary, mint, lavender, depending on the resident's preference; they can also buy different aromas for their personal use, at home).

The atmosphere filtering process has an extra "natural" UV treatment, through a special structure "Quartz module" situated on the central axis as seen in picture 7.1.c.1. The benefits of this method are that bacteria and other microorganisms are killed, because of the sterilizing effect of the UV. The windows are made of quartz glass that is penetrated by the UV radiation at high concentration and therefore the process develops really fast.



Fig. 7.1.c.1

The air is constantly filtered through pumps and filters with active carbon. In houses and in public spaces there are sensors that permanently show the parameters of the air: composition, temperature, pressure and relative humidity.



In the agricultural areas that have plants with prosperous green mass, the water resulted from the perspiration process is collected by special filters and used for drinking because it has a high level of purity.

To avoid the atmosphere contamination of the residential area, people that work in the industrial area or people that come from outside the station use a sterilizing, decontamination system.

This is a very important protection method, because asteroid, Moon workers, as well as engineers from the industrial areas, researchers can pollute the residential environment with different substances. On the other hand DACIA'S has an active tourist activity and Earth tourist, or from other space settlement can bring epidemic, contagious diseases. That's why all people that arrive through space port are scanned by a "disease computer" that tells you the present activity of tour body and are given the Dacian bracelet that is communicates with this computer by Bluetooth connection.

"DACIA'S Decontamination system" see picture number 7.1.c.2 is adapted to both ways of human direction transport and have hermetic doors, air filters that stop the air exchange between residential area and people that come from industrial, space ports etc.

When people want to: - leave the residential area, they enter the hermetic door, pass through a sterile air room that permanently filters its atmosphere (air decontamination system).

- get in the residential area, they have to pass through changing room number 1, where they have to get off the working uniform, costume, or the unsterilized cloths. The next room that they have to visit is the shower. This water decontamination technique is very useful and practical as well as the next room changing room number 2, where people get new cleaned cloths, that don't represent any danger for DACIA'S community.

The rules on the settlement are very rigorous concerning the hygiene, health and comfort of the residents, but it is not difficult to adapt to this high evolved civilization.







7.2 Light:

On DACIA'S we use artificial light in the residential torus, in spite of the fact that natural sunlight seemed beneficial for human health. In order to be healthy it must be provided through quartz glass windows, but the UV radiations are too concentrated in the outer space and many health problems may appear if measures of protection are not taken. For health reasons we offer the possibility for each resident to spend ten minutes daily in the "Sun bath &Stars room" described at 13.0ther facilities.

That's why the residential areas' walls are covered in "which is in fact a white dye that reflects the colors of the projection. The residents feel that they have a natural Earth sky above their heads, clouds that move on the sky, starry nights, which are in fact natural images, live taken from Earth.

The light during the torus day, the residents use, is obtained from the "smart dye screen" reflection. The environmental sound of the residential area is natural, live recorded from Earth's woods, lakes, rivers. We don't use the weather and climate simulator because we think it is a waste of money and water.

Inside the agricultural area we use artificial light for animal rising and for plants filtered in red or blue glass, because they are more productive and grow faster if they receive light in this spectrum.

7.3 Water management

Each resident has a quantity of 251 of water at his/her disposal daily. Besides this, the industry, research activities, agriculture animals' rising and growing of plants also need this vital element. A water cycle must be created in order to simulate the conditions on Earth The total quantity of water that DACIA'S needs for life maintenance activities is 24 000 000 liters.

Its quality is very important for the resident's health and that's why we have proposed means of providing it as pure as possible. The water is provided through pipes from the light industry area, where it is filtrated in several ways: multifiltration, sand filters (made of lunar



regolith), that transform raw water into potable water. This method does not require chemical substances or electricity. A hypogeal layer is created at the top of the sand layer. It contains bacteria, fungi, protozoa, rotifera and other microorganisms. After water passes this layer it does not contain any particles of foreign matter. Species of algae, water filtrating plants (ex: water lilly that loves zootehnic polluted waters and has important economic uses in obtaining furniture) have an important role in the filtration process, as well as the UV radiation, that sterilizes. The Sun emits ultraviolet radiation in the UVA, UVB, and UVC bands, but on Earth, because of absorption in the atmosphere's ozone layer, only 98.7% of the ultraviolet radiation that reaches its surface is the UVA. Here, on DACIA'S we have avoided to use artificial ultraviolet radiation, because we can naturally benefit from it. Therefore we have designed an "UV water belt" of 1.5 m wide, embedded in the solar panels layer at the exterior of each torus (see picture 7.3.1). It is made of a transparent material to vacuum UV wavelengths, preferable Silica or quartz glass. Ordinary glass is easily to obtain on the Moon factories, but it is partially transparent to UVA and opaque to shorter wavelengths.



Fig. 7.3.1



There are two reservoirs of water storage and distribution on each light industry area, under the residential area. The first type of filtration is done here, the primary one, previous described, and the second one, through UV radiation. These reservoirs are disposed 2/each segment of torus (see picture 7.3.2) and communicate with the "UV water belt" by water pipes, that penetrate the settlement's wall structure. This system is carefully protected by robots and microbots, because water is one of the most important substances that we use.



Residential water recycling map



7.4 Waste management:

Everything on our space settlement DACIA'S must be used rational. The main condition is to use the reduce-reuse-recycle cycle. People must use only what they need in everything that they do, without any excess. When something is not needed, people have to think at another way to use that object or material, and only in the end, when it has not got any use, it can be recycled. With the help of microorganisms, some materials decompose. Organic materials can be recycled with the help of composting. Compost can be used as fertilizer in agriculture. For zootehnic solid waste we use bacteria and worm, together with inorganic substances, to obtain again soil and nutriments that were used in the process of growing and rising.

Materials as plastic, aluminum and glass must be deposit in special places, collected and melted. One of the recycling methods combines non-incineration plastic disposal technology using TiO2 high grade materials recovery to recycle old home appliances. The method uses unique mixing and carrier systems that allow plastics to contact the catalyst efficiently for gasification, leaving the valuable metals. As the catalytic reaction of TiO2 generates heat to promote gasification, an additional heating source is not required in the process. The method uses cooling water to maintain temperature (500 C) for optimal catalytic reaction. The subsequent heated water from the process can be used for other purposes.

A bacteria used in our waste management can breathe TCA (1,1,1-trichloroethane), making it a cleaner substance. TCA is used as solvent in glue, paint, sprays and industrial degreasers. It is found in water and in the ground. It evaporates and appears in the atmosphere. It can also appear when different substances decompose and interact. This bacteria removes chlorines from TCA and produces chloroethane, a not so toxic substance that can be absorbed by land. The bacteria uses TCA as people breathe oxygen.

There are also experiments that are done on DACIA'S as research activities that study the invention of a reactor which transforms waste into energy. It utilizes bacteria that feed with wastewater also studied in the "Cylindrical bio lab" at the GMO section. See section 9. Scientific Laboratories. For a population of 600 000 the DACIA'S health protection bracelet that supervises their medical parameters, knows also when a human is dying. The settlement's rules state that he must be used as a soil fertilizer (this is done by bacteria), his bones for bone glue, his fat must be used as a soap prime material, and his organs and tissues for transplantation. This is the only compromise that the residents should assume for reintegrating in the DACIA'S natural cycle.

 $\begin{array}{ccc} & bacteria \\ C_2H_3Cl_3 & & & \\ \hline & & \\ Organic matter that remains in soil after decomposition \end{array}$

Putresceina H₂N-CH₂-CH₂-CH₂-CH₂-NH₂

Cadaverina H2N-CH2-CH2-CH2-CH2-CH2-NH2

 $C_6H_{12}O_6$ Sacharomyces Cerevisae $2C_2H_5OH + 2CO_2$ (fermentation)



The hydrolysis for soap obtained from human or animal fat can be done in alkaline or acidic medium:



8. INDUSTRY:





8. INDUSTRY:

DACIA'S is the most important industrial center in Earth orbit. It is the first outpost and serves as a primary construction site for future colonization of space. When the settlement construction is finished, it can immediately begin construction of new settlements and spaceships. This way further colonization of space will be faster and cheaper because DACIA'S provides all necessary facilities for the constructions, at a lower price than importing the components from Earth.

Heavy industry is located on the central axis so that heavy masses do not influence the settlement's rotation or will be easy to correct using smaller masses in the torus sectors. Here, people also work, study and perform research in a OG environment because of the close position relative to the rotation axis. This improves maneuverability of heavy objects and some technological processes are easier to perform in OG. Another advantage that could be used is that outside each industry chamber is vacuum, which is useful for some technological processes. For example, rather than pumping all the air out from the inside of a given volume, we use the vacuum outside; we obtain fast and cheap vacuum inside bags for better conservation or for best thermal isolation.

8.1 Industry layout

DACIA'S has a modular organization of industry, so each factory can attach itself to the lattice, positioning itself close to resources, storage areas, spaceports and other factories which depend on its production. The shape of the industrial lattice resembles different radius cylinders, as presented in picture 8.1. Depending on future businesses and contracts, these can easily be expanded to enable the construction of larger spaceships, settlements, or just to increase the number of industry module. Each industry module is an individual room, or just an empty space defined by beams, separated from the other ones and from the torus sectors, so vibrations, noise and any possible pollution caused by accidents will not reach any of the inhabitable areas.

The activities performed in the Industrial area are mainly mechanized and robotized, and the human role consists of supervising operations or, when needed, conducting special operations (such as custom making of new components that would require a lot of input data to produce a unique part). People will still need to perform research, test new



Fig. 8.1 Heavy industry center layout

concepts and designs, explore the outer space and maneuver machines and program robots. This way, the inhabitants will have work places to keep them busy and assure their wages.



8.2 Heavy industry factories

DACIA'S is a powerful industrial center in Earth's orbit, capable of processing minerals extracted from extraterrestrial sources, mainly the Moon and nearby asteroids. The main income comes from building complete, new, orbiting settlements, mining bases on the Moon or other celestial bodies, construction of spaceships and selling of material, fuel and other goods to other settlements or spaceships. The most important industry modules are those that manufacture cargo and passenger spaceships, robots, spare parts for different vehicles and standard settlement components. The assembly of different components is done by mobile industrial mechanical arms which are also assisted by small industrial robots that were also used in settlement's construction (Bee Builder and Ant Builder – see section Construction Stages – construction devices).

Other modules are mass-producing solar panels using silicates extracted from the Moon base, or assemble future settlements, taking advantage of its position relative to the Earth's (thus a low price when importing elements from Earth) and all robots available in the industry. There are some modules specialized in manufacturing fuel cells, which are needed for most robots and spaceships, others in hydrolysis of water into oxygen and hydrogen, both needed for spaceship propulsion; the last one also compresses the gases and transforms them into liquid oxygen (LOX) and liquid hydrogen (LH₂) - thus the volume needed for fuel storage is minimal. Other important industry chambers are those that manufacture and perform maintenance for the Cargo Ships, Transport Ships, Earth-to-Orbit and Orbit-to-earth spaceship, spaceships that provide the active protection of the settlement, along with spare parts for easy and quick reparations.

Component name	Radius (m)	Height (m)	Number of components	Volume (m ³)
Major cylindrical lattice	600	517	3	1753250400
Medium cylindrical lattice	400	260	4	522496000
Minor cylindrical lattice	200	380	2	95456000

8.3 Light industry

All the technology, machinery and systems required to maintain autonomy and sustain optimal conditions are located under the residential area (see torus section at 10. Agriculture). This includes the factories which produce all the necessary daily items for the 25 000 inhabitants inside each torus sector. Light industry also produces and maintains robots that construct, repair or perform surveillance of the neighborhoods.

Storage areas are available for storing raw materials for the factories (these were transported in large quantities from the central zone) or goods resulted from processing of these materials; DACIA'S will always produce more than the required amount, so if anything gets broken there is no risk in running out of important goods. These can also be traded with other ships, thus increasing the settlements income.

Systems and robots that assure plant growing in agriculture, the air-filtering systems, waste management and recycling units, and all that is necessary to maintain a safe and pleasant environment are also located inside the light industry area.



8.4 Resources

The main resource sources are the Moon-mining base and other celestial bodies captured by spaceships, but most of the resources are obtained from recycling all the waste products. Any non-degradable materials are used to reconsolidate the settlements shield that, inevitably, is damaged by space debris.

The Moon base is an important part of DACIA'S industry because it provides us with all the resources need for maintaining optimal life conditions and performing industrial activities. This base will prospect and mine MINERALS/ORES from the Moon, using its robots and facilities. The main ore extracted from the moon are silicates, the raw material for fabricating solar panels. This mineral will be transported to the settlement with Cargo Ships and the heavy industry will manufacture solar panel first for the construction of the colony and then for selling these to ships and future settlements. For more details, see section 4.1 Lunar facilities.

Industry has an important role in DACIA'S future because is the main income source by manufacturing spare parts, solar panels, robots, spaceships and new settlements for expanding human exploration in space and space colonization, by providing sources of materials and robots for the colonization of the Moon.



9. SCIENTIFIC LABORATORIES





9. SCIENTIFIC LABORATORIES

One important aim of our space colony DACIA'S is research, therefore were build special biology laboratories. Their aim is to adapt plants and animals easily, in order to earn money from their trade with future colonies. We have to discover the reaction of bodies (of human, animal, plant) health in time, the reason is to help the next space settlements and our residents that supervise the mining on Moon and asteroids.

There are three types of biology laboratories on the settlement. The first one is situated on each of the 45 floors of the agricultural area, it has permanent 1 g gravitation and its aim is to check the health of plants, animals, as well as food safety. The second type of laboratory takes advantage of variable pseudo-gravity levels from ~0 to 1g with approximation. This is possible due to its movement system. There are 4 "Cylindrical bio lab". Two of them are situated on the 2 of the 8 spokes from the first level of torus named Dacia and the other 2 on the spokes of the second level of torus named Daciab, all of them disposed symmetrically to avoid the consumption of more fuel. There are also 2 "Cylindrical industrial laboratories" on the 3 rd level of torus named Daciac where important industrial research is done. Biology and industrial laboratories were also refered as "Moving cylinders" in construction sequence.

Important researches for the evolution of the human beings are made in these laboratories. There are planets like Mars that can be inhabited and even terraformed, but one of the crucial problems is the lower gravity and the fact that we cannot adapt to it yet. For this reason we study the human, animal and plant breeding, health, quality of life, raising/growing in the "Cylindrical bio lab". We also want to see if we manage to obtain genetically modified organisms (GMO) between 0.2-0.5-0.7g. Genetically engineered organism (GEO) is an organism whose genetic material has been altered using genetic engineering techniques. These techniques are generally known as recombinant DNA technology. With recombinant DNA technology, DNA molecules from different sources are combined in vitro into one molecule to create a new gene. This DNA is then transferred into an organism and causes the expression of modified or novel traits. But is this possible in microgravity?!

A number of 400 specialists work permanently in shifts on the 4 "Cylindrical bio lab", 100 workers/each (see picture 9.a). Their aim is to supervise the evolution of plants, animals, microorganisms, bacteria in special conditions of life. Important attention is accorded to the water species like fish, jellyfish and shells. Their life development, health condition in lower gravity is a strong point that we have to study, as well as its effect on living organisms, including cellular and tissue development, metabolism, biological functions and growth. We may discover something innovative, in order to adapt them. Some of the experiments refer to different species that can survive in lower pressure areas (example: species of bacteria and animals that live in caves). Some of the water species like fish, jellyfish, and shells are grown in water sphere pools and studied. Another question comes... do they really need water in lower gravity in order to survive?! Maybe an atmosphere with 85%-90% humidity is enough for their survival, since the water is used only for swimming, although the fish breeding through spawn and milt may seem impossible without water...

It is also interesting to study the reaction of frogs and their jumps in 0g. One of the most important properties that frogs have is the "Super glue", obtained if their skin is slowly electrocuted. Some of the flying birds need a magnetic field in order to organize their migration and survive, but it is still interesting to see how they can adapt in lower gravity, and how does our artificial magnetic field against radiation affect them.



Important medical researches have been made between approx. 0-1g. Some of the human health problems that need the physician's intervention through operation develop, better between 0-0.2-0.5g, because the bleeding is reduced and the blood can be recollected if the atmosphere is sterile. There are still experiments that try to discover the hidden points of this innovative technique. Until now important achievements have been obtained. The humans' sexual relationships in lower gravity are also a studied theme and an entertainment activity that the Dacians benefit of. Researchers try to find out how does the human embryo react and develop and if it possible to beget a healthy children in these life conditions. It is obvious that the first experiments will be done on animals and if they prove safety the first 0g Dacian will be born.



Fig. 9.1

The two "Cylindrical industrial laboratories" on the 3rd level of torus (Daciac) allow important industrial research and the development of the technique used for mining. There are 200 engineers and specialists that work in shifts and survive the activity permanently. Some of the processes require almost 1g for the process of sedimentation, others do not. In this way we discover practical means of labour done through robots and automated systems and new building materials. There are also physics, chemistry, engineering and automation laboratories. Their workers are experts and science men that collaborate between departments and have great technological achievements. The 3 rd type of laboratories are the "Og spherical labs", located in the industrial cylinders from the centre of the settlement. Its host different experimental activities (chemistry, physics, engineering) and processes that need 0g



gravitation. The most important fields of research are the studies of : the solar radiation; the cosmic rays; phases change of the substances in 0g environment; the solar energy storage; the usage of the solar energy for the interplanetary transport; the vacuum "energy"; alternative new energy Helium-3 from Moon; combustion phenomena; solar sail see picture 9.2.



Fig. 9.2



10. AGRICULTURE





10. AGRICULTURE

In order to create a well-balanced ecosystem for an unlimited term, DACIA'S life support system needs a stabilized and optimal life-support system that would be based on a combination of physical, biological and regenerative processes that are well integrated, this is exactly what happens on Earth but at a large scale. The Dacians need a safety and comfortable life, so this is what the settlement offers them. A great variety of food, good hygiene, multifiltrated plus UV irradiated potable water, waste management, breathable (ultra ventilate) air and also permanent and automatic medical care for all the residents, using high-tech devices (bracelets).

Agriculture is the production of food, feed, fiber and other goods by the systematic growing/harvesting of plants, animals and other life forms. Agriculture has played one of the most important key roles in the development of humans, because it produces the O2 in the air through plants, the food from animals or plants, and also the medicine, chemistry research is done through them. Correct nourishment is an essential condition for a healthy population and being healthy does not mean only "not being ill", but also a physical and mental mood of well-being. In order to create the proper conditions for them to develop, we have proposed special automated systems.

10.1 Chemical properties of soil and chemical reactions:

The weathering of the parent material by water determines, to a large extent, the chemical composition of the soil which has ultimately been produced. Some chemicals are leached into the lower soil layers where they accumulate. Other chemicals, more insoluble, are left in the upper layers of the soil. The most rapid removed chemicals are chlorides and sulphates, followed by calcium, sodium, magnesium and potassium. The silicates and oxides of iron and aluminium decompose very slowly and are rarely leached. When some of these products come into contact with the air in the soil, chemical reactions occur, such as oxidation in particular, which results in the formation of chemicals either soluble or insoluble.

Soils may have either an acid or an alkaline reaction, or may be neutral. The measure of the chemical reaction of the soil is expressed by its pH value. The pH value varies from 0 to 14, with pH = 7 indicating that the soil has a neutral reaction. Values smaller than 7 indicate acidity and values greater than 7 indicate alkalinity. The further from the neutral point, the greater the acidity or the alkalinity.

For good productive conditions, the pH value of pond soil should be neither too acid nor too alkaline. Preferably, it should be in the range of pH 6.5 to 8.5. Soils with a pH value lower than 5.5 are too acid and soils with a pH value greater than 9.5 are too alkaline. They will both require special management techniques which will considerably increase the costs of fish production. If the soil pH is either lower than 4 or higher than 11, it should be considered unsuitable for the construction of pond dikes or for use as pond bottom. On DACIA'S's we have an artificial soil regolith, obtained through weathering, it has a neutral acidity and alkalinity.



10.2 Base saturation:

Closely related to cation exchange capacity is the base saturation, which is the fraction of exchangeable cations that are base cations (Ca, Mg, K and Na). The higher the amount of exchangeable base cations, the more acidity can be neutralised in the short time perspective. Thus, a site with high cation exchange capacity takes longer time to acidify (as well as to recover from an acidified status) than a site with a low cation exchange capacity (assuming similar base saturations). The long term resistance to acidification, however, is determined by the weathering rate.

In soil science, cation exchange capacity (CEC) is the capacity of a soil for ion exchange of positively charged ions between the soil and the soil solution. (A positively-charged ion, which has fewer electrons than protons, is known as a cation.) Cation exchange capacity is used as a measure of fertility, nutrient retention capacity, and the capacity to protect groundwater from cation contamination.

The quantity of positively charged ions (cations) that a clay mineral or similar material can accommodate on its negatively charged surface, expressed as milli-ion equivalent per 100 g, or more commonly as milliequivalent (meq) per 100 g. Clays are aluminosilicates in which some of the aluminium and silicon ions have been replaced by elements with different valence, or charge. For example, aluminium (Al³⁺) may be replaced by iron (Fe²⁺) or magnesium (Mg²⁺), leading to a net negative charge. This charge attracts cations when the clay is immersed in an electrolyte such as salty water and causes an electrical double layer. The cation-exchange capacity is often expressed in terms of its contribution per unit pore volume, Qv.

Regardless of your perspective, redox reactions are important aspects of soil chemistry. Redox reactions change the speciation and solubility of many elements, create new compounds and alter the biochemistry of soils.

In a complex mixture such as soils the interpretation of redox relationships is difficult. Since the dynamics of soil oxygen which drives the changes in redox potential are rapid, equilibrium may not be attained. From a thermochemistry view point redox is not at equilibrium, because all of the energy yielding compounds by definition contain excess free energy and are unstable with respect to carbon dioxide and water. Processes which reduce oxygen levels and decrease redox potentials are driven by microbial consumption of oxygen.

Conditions necessary for lowering redox potentials include, a source of decomposable organic materials (energy source), a population of microbes capable of utilizing this energy source for metabolism, and a restriction on the resupply of oxygen. These requirements are not uniformly distributed in soils and sediments. Thus, redox reactions and redox potentials are not uniform throughout the soil matrix. In fact, redox potentials are highly variable and therefore are best used as an indication or relative status of the soil.

 $Fe^{3+} + e- \qquad \qquad Fe^{2+}$ $Fe (OH)3(S) \qquad Fe^{3+} + 3(OH) -$ $Fe(OH)2(s) \qquad Fe^{2+}+2(OH) -$ Photosynthesis



10.3 In plants:

Most plants are photoautotrophs, which means that they are able to synthesize food directly from inorganic compounds using light energy - for example from the sun, instead of eating other organisms or relying on nutrients derived from them. This is distinct from chemoautotrophs that do not depend on light energy, but use energy from inorganic compounds.

 $6 \text{ CO}_2 + 12 \text{ H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2 + 6 \text{ H}_2\text{O}$

The energy for photosynthesis ultimately comes from absorbed photons and involves a reducing agent, which is water in the case of plants, releasing oxygen as a waste product. The light energy is converted to chemical energy (known as light-dependent reactions), in the form of ATP and NADPH, which are used for synthetic reactions in photoautotrophs. The overall equation for the light-dependent reactions under the conditions of non-cyclic electron flow in green plants is:

 $2 H_2O + 2 NADP + 2 ADP + 2 Pi + light \rightarrow 2 NADPH + 2 H + 2 ATP + O_2$

Most notably, plants use the chemical energy to fix carbon dioxide into carbohydrates and other organic compounds through light-independent reactions. The overall equation for carbon fixation (sometimes referred to as carbon reduction) in green plants is:

3 CO₂ + 9 ATP + 6 NADPH + 6 H+ \rightarrow C3H6O3-phosphate + 9 ADP + 8 Pi + 6 NADP+ + 3 H₂O

Plants absorb light primarily using the pigment chlorophyll, which is the reason that most plants have a green color. The function of chlorophyll is often supported by other accessory pigments such as carotenes and xanthophylls. Both chlorophyll and accessory pigments are contained in organelles (compartments within the cell) called Chloroplasts. Although all cells in the green parts of a plant have chloroplasts, most of the energy is captured in the leaves. Plants use up to 90% of the light that strikes them, whereas commercial solar panels use less than 30 %.

10.4 Plant growing

The life of plants is as important as the life of people that inhabit DACIA'S, because it produces O_2 and nourishment from simple compounds such as CO_2 , H_2O . To the maintenance of the balance of life on the settlement plants are essential if they receive optimal conditions. The most important factors that influence their growth are the nutrients (minerals, C, H, N₂, O₂, P,S), the soil and the climatic conditions (temperature, light, atmospheric composition) so that the processes of photosynthesis, circulation and respiration are more efficient The Dacic soil is very important to plants, because it offers both support and almost all nutrients. It is impossible to use natural Earth soil because it takes millions of years of development making manufacturing almost impossible, and its transportation from Earth would be very expensive. The conclusion is that we use artificial soil that has similar properties as the natural one. It resembles to a solution, which contains both organic and



inorganic molecules. The artificial soil will have two main components: a biotic one (plant roots, solid organic waste and other organisms, like bacteria, worms, needed to maintain the soil balance) and an abiotic component. The abiotic component like the natural soilproviding support and space for water and other dissolved compounds -like nutrients, sand (silica)-small quantities, calcar (CaCO₃)-small quantities, nutrients, lunar/ asteroid regolith and organic detritus (in small quantities). An average depth of 1-2 even 3 meters will be sufficient for all type of plants grown on the station. The soil will stay on an impenetrable bed for all substances solved in earth. Special designed systems establish the quantity of water and amount nutrients each plant needs (by their attraction to the negative charged membrane of the root absorbing cells) depending on the age and type. Nutrients are absorbed by plants in their ionized form (K+, Cl-, Mn₂+, Mg₂+, Fe₂+, Fe₃+, Cu₂+, Ca₂+, (NO₃)-, (SO₄)₂- or as gases (CO₂,O₂) or liquids (H₂O) through osmosis. There are two major groups of nutrients: macronutrients (which are required in large amounts - approx. 1 mg per gram of dry mass: C, H, O, N, P, S, K, Ca) and micronutrients (100 microg per gram of dry mass: Cl, Fe, Mn, B, Zn, Cu, Ni), obtained from the Moon and asteroid mining. Plant roots manifest a certain degree of selectivity. However, the mineral composition of plants often reflects the composition of the soil and water in which they grow, meaning that some minerals that are not necessary for plants can accumulate in their body. For example the nutritional value of fruits and vegetables may vary depending on the composition of soil.

We have proposed a system named hydroponics for some species of plants is growing crops in nutrient enriched water. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel or mineral wool. In natural conditions, soil acts as a mineral nutrient reservoir, but the soil itself is not essential to plant growth. When the mineral nutrients in the soil dissolve in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant's water supply artificially, soil is no longer required for the plant to thrive. Almost any terrestrial plant will grow with hydroponics, but some will do better than others.

Aeroponics is another process of growing plants, but in an air or mist environment without the use of soil or an aggregate media. Aeroponic culture differs from both hydroponics and in-vitro (Plant tissue culture) growing. Unlike hydroponics, which uses water as growing medium and essential minerals to sustain plant growth, aeroponics is conducted without a growing medium. The word aeroponic is derived from the Latin meanings of 'aero' (air) and 'ponic' (work). Aeroponic growth refers to growth achieved in an air culture. In an aeroponic system the plant's root zone is suspended into an environment where the roots protrude into an atomized nutrient solution; the leaves and crown, often called the "canopy", extending above. The roots of the plant are separated by the plant support structure. The lowest stem and root system are sprayed or misted for short durations with a hydro-atomized pure water/nutrient solution. Plants t are the basis of the station's food, air and water self-sufficiency and the only way of DACIA'S survival overtime. It is suggested that plant growth must be organized in plant chambers using artificial light in the specific spectrum (red and, or blue). Light is essential for plants and they cannot live without it. It influences circulation and its absence prevents photosynthesis and the plants die. Light is one type of electromagnetic radiation, a form of energy that behaves like both a particle and an oscillating wave, straining the human ability to represent natural phenomena realistically.



The advantages that these techniques present over the traditional agriculture are the fact that most plants produce more in less time and sometimes of higher quality than using the soil, it uses less water and we don't need the crop rotation anymore (see fig 10.4.1).



The nutritive substances are divided after their function in: nutrients with catalytic role (vitamins, minerals, which influence metabolic reactions), nutrients with energetic role (glucids and proteins, which provide the vital energy), nutrients with plastic role (proteins, used to repair cellular structures). The table of plants cultivated on the settlement shows that the diversity is required, in order to avoid the psychological problem of appetency for an "Earth product", or the counter effects that a long term diet may cause with the lack of some minerals and/or substances. Medicinal plants are very important for the Dacians' health and industry. The settlement offers the possibility to the residents to order and buy from Earth whatever plant they wish, with some exceptions (tobacco and drugs) because DACIA'S must be inhabited by healthy people, since their medical assurances are very high.



Table of plants cultivated on the station

	Name		Energy		Carbo	
<u>Category</u>	ENGLISH	LATIN	Value (Kcal)/100g	Protein(G)	Hydrate(G)	Fat(G)
reals	Wheat	Triticum	338	13.50	72.28	2
	Maze	Zea mays	89	3	18	1.10
	Barley	Hordeum vulgare	354	12.48	73.48	2.30
	Oats	Avena sativa	389	16.89	66.27	6.90
	Soybean	Glycine max	30	3.04	5.94	0.18
Ŭ	Rice	Oryza sativa	130	2.38	28.59	0.21
	Rye	Secale cereale	335	14.76	69.76	2.50
	Sunflower	Helianthus annuus	570	32	18.75	1
	Tomato	Solanum lycopersicum	20	1	4	0.20
	Cucumber	Cucumis sativus	20	0.65	3.63	0.11
	Pepper	Capsicum annuum	20	0.86	4.64	0.17
	Cabbage	Brassica oleracea	20	1.4	0.10	5.60
	Lettuce	Lactuca sativa	10	1.4	2.2	0.20
	Carrots	Daucus carota	40	1	9	0.20
	Potato	Solanum tuberosum	80	2	19	0.10
	Beans	Phaselous vulgaris	330	24	60	1
es	Pea	Pisum sativum	80	5.40	14.50	0.40
able	Cauliflower	Brassica oleracea	20	2	5	0
Vgeta	Mushroom	Agaricus bisporus	35	5	2.30	0.50
	Spinach	Spinacia oleracea	25	3.50	2	0.30
	Nettle	Urtica dioica	68	7.90	7.11	0.70
	Onion	Allium cepa	40	1.40	8	0.20
	Garlic	Allium sativum	137	7.20	26	0.20
	Dill	Anethum graveolens				
	Parsley	Petroselinum arvense				
	Savory	Satureia hortensis				
	Laurel	Laurel nobilis				
	Sugar cane	Saccharum officinarum				

The fruits are also integral aliments to our health and therefore a few species were proposed, with the possibility of enlargement the menu if the Dacians request it.



Name (fruits) English	Latin
Lemon tree	Citrus limon
Apple tree	Pyrus Malus
Orange tree	Citrus sinensis
Watermelon	Citrullus lanatus
Hazelnut tree	Corylus avellana
Pistachio tree	Pistacia vera
Strawberry	Fragaria ×ananassa
Fig	Ficus Carica
Grape-Vine	Vitis Vinifera
Coffee	Coffea canephora
Cocoa tree	Theobroma cacao
Apricot	Prunus Armeniaca
Sweet cherry	Prunus avium
Pomelo	Citrus maxima
Tangerine	Citrus reticulata

There are also species that are grown on DACIA'S because of their economic multiple purpose: health, confort, odour, textile industry etc. On DACIA'S we encourage the use of natural products and a healthy diet. The mother nature offered us all that we need on Earth in order to have a beautiful and healthy life, we have just to redecover and understand their purpose.

Name		Ttility	
English	Latin	Ounty	
Luffa	Luffa cylindrica	The interior contains white flesh as well as a fibrous structure that is dried and used as a sponge. Seeds are used for oils, fruits can be eaten, very fast growing vine to 10-15ft; luffas are used for making slippers, table mats, and pillow stuffings; Young fruits (less	
		than 12" long) known as vine okra, are cooked like squash.	
White underbrush	Hypophae Rhammnoides	essential role in ensuring the daily necessary doses of minerals and vitamins. It is also rich in vitamin C (4000-8000 mg/100 g juice), A, B1, B3, B6, B9, E, K, P, celluloses, beta-carotene, phosphorous. it is such a complex product almost the same with ginseng.	
Lavender	Lavandula	For aromatic therapies and for the unpleasant odours	
Mint	Mentha longifolia	Culinary as a spice, as a medicinal herb to treat stomach ache and chest pains, menthol used in cosmetics and perfumes industry.	
Rosemary	Rosmarinus	Culinary as a spice, used in cosmetics, perfumes,	


	officinalis	and aromatic therapy industry.	
	Vaccinium	The fruits and leaves (tea) for eye problems,	
Bilberry bush	myrtillus	digestion, circulatory system	
Dandelion	Asteraceae	Body lotion, antiseptic	
Danuenon	Taraxacum		
Aloe	Aloe arborescens	75 nutrients, 200 activ substances, 20 minerals, 18 amino-acid ,12 vitamins	
Camomile	Matricaria chamomilla	Aromotherapy, disinfectant, bactericide	
Dog Rose	Rosa Canina -	high vitamin C level, used for: tea,syrup,marmelade	
Flax	linum usitatissimum	For the clothing industry, the seeds produce a vegetable oil known as flaxseed(used in painting and varnishing); flaxseed taken in the diet may benefit individuals with certain types of breast and prostate cancers. Flax may also lessen the severity of diabetes by stabilizing blood-sugar levels. There is some support for the use of flax seed as a laxative due to its dietary fiber content.	
Hemp		Clothing and nutritional products, omega fatty acids, amino acids, and minerals oil containing 80% essential fatty acids (EFAs), linoleic acid (LA, 50- 70%), alpha-linolenic acid (ALA, 15–25%) and Gamma-Linolenic acid (GLA, 1–6%). The proportions of linoleic acid and alpha-linolenic acid in hempseed oil meet human requirements for EFAs.	
cotton	Gossypium hirsutum	Clothing industry	
Water hyacinth	Eichhornia crassipes	It filtrates water, it loves polluted waters(zootenic and from waste management area water) and can be used to produce furniture.	
Dandelion	Asteraceae Taraxacum	Antioxidant properties;	
Bee	Anthophila	honey as sweetener, while the propolis is used as preservative; pollinate flowering plants.	
Cactus - Prickly Pears	Cactaceae Opuntieae -> Opuntia ficus- indica ,fruits: prickly pears	fruits of most prickly pears are edible; Both fruits and pads of the prickly pear cactus are rich in slowly absorbed soluble fibers that may help keep blood sugar stable.	
Cactus - Hylocereus	Cactaceae Hylocereus -	their fruits are known as pitaya or dragonfruits, ornamental, a water reserve;	
Spirulina	Spirulina	that is incredibly rich containing a balance of nutrients that make it virtually a 'whole food' capable of sustaining life without the need for other food and other species; have photosynthetic machinery and so produce oxygen	



We offer the possibility to our residents to enjoy the beutiful surroundings in beautiful parks with flowers and fruit trees.

10.5 Animal rising

In order to satisfy all the tastes and human necessities, on DACIA'S there are also raised animals, even if our studies have showed that meat is unhealthy (cancerous because it contains deuterium that contributes to the ageing process of the organism). For psychological reasons we ignored the option of a perfectly useful and beneficial vegetarian diet in order to attain a rapid adaptation of the Dacians. So we use a diet based not only on vegetable but also on animal protein. The residents must have an adequate diet, the food must be nutritious, sufficiently abundant, and attractive. It should consist of 2000 g of water, between 500 g - 600 g dry weight of various carbohydrates and fats, 60 to 70 g dry weight of proteins, and adequate quantities of various minerals and vitamins. The importance of the psychological aspects of food should not be neglected. The variety and types of food should reflect the cultural background and preferences of the colonists.

Fish is also available because it has high essential Vitamins and nutrients and it tastes wonderful. Seafood can be an important part of a balanced diet for pregnant women and those of childbearing age who may become pregnant.

Breed	A dvantages	Amount(g)	Calories (kcal)
Anchovies	Avoid the suffering from high blood pressure	100	42
Bluefish	Vitamin B12 and niacin	100	105
Carp	Body builder; excellent source B12	100	138
Croaker	Source of magnesium and iron	100	112
E el	Excellent source; plentiful in niacin, thiamine, Zn	100	145
Mackerel	Among the healthiest choices of finfish; may lower triglycerides and breast cancer risk.	100	223
Octopus	Excellent source of Vitamin B -12, iron, Vitamin B - 6.	100	170
Pompano	Vitamin B -1 2 rich	100	179
Roe	Vitamin B -12 rich also great source of Vitamin C , folate, omega-3's and riboflavin.	100	119

	SHELLFISH		
Abalone	Protein rich.	100	161
Clams	Rich in sodium	100	121
Crab	Excellent source of Vitamin B -12.	100	87
Mussels	Source of iron and vitamin A	100	146
	Source of iron, magnesium and Vitamin B-12. One		
Whelks	of the lowest in fat marine foods	100	234
	Total fat 1 g ,saturated fat 0,2 g, cholesterol 113 mg,	100	79
	sodium 80 mg, carbohydrates 0,0 g, protein 14,7 g,		
Crayfish	vitamin A 1%,vitamin C 1%,iron 1%,calcium 5%		
Oysters	Source of iron ,zinc and magnesium	100	150
Scallops	all B complex vitamins	100	76



COMMON AN IMALS AND THEIR PRODUCTS					
Rabbit	Reproduce quickly, and their fur has industrial uses	40	б4		
Sheep	Wool for clothes and source of milk and meat	100	234		
G oat	Source of milk rich in proteins and source of meat	100	143		
Chicken	Their feathers are used for pillows	40	49		
Omit quail (coturnix coturnix)	Their feathers are used for pillows	100	234		
Duck (Cairina Moschata)	Their feathers are used for pillows	140	182		
Chicken eggs	Good source of proteins	24	39		
Omit quail eggs	Are economical and their eggs don't have counter indications	9	14		
Duck eggs	Source of proteins	70	1 2 9		
Sheep milk	Source of milk and dairy products	100	108		
G oat milk	Source for dairy products	100	69		

The animals are raised on 15 floors of the agricultural area from each of the three residential torus (see fig. 10.5.2) and also on the "Cylindrical bio lab" (see fig 10.5.1). Automated systems that use necklaces and/or bracelets calculate the necessary food and water, needed by the animal during the day. Through water and feed pipes the food comes in the animal's cage. The same system checks their health, hygiene, and selects the ones that should be sent to the light industry, to transform them in food.







Agricultural area from the residential torus:

Fig. 10.5.2

10.6 Processing and stocking

Each floor has harvesting and storing facilities for the food products, done by the agricultural robots or by the automated systems, both supervised by the human residents. There are factories on each floor that pack, and deliver the products to their storage areas or to the light industry area (through the infrastructure corridors and lifts) for being cooked for immediate consumption. There are also packages that are sent to the spaceport area for the Dacic ships or for trade.



11. RESIDENTIAL ORGANISATION



11 Residential organization:

Our residential design proposes equal distribution of population and residential areas in all three torus' eight sections. We considered that the original population is represented in this way:

- Married adults: 30% (average age 38, median age 35)
- Single Men: 37% (average age 35, median age 36)
- Single Women: 30% (average age 40, median age 35)
- Children: 3% (average age 11, median age 9)

Thus, the population is divided this way:

	Total	One torus	One torus section
Total population	600000	200000	25000
Married adults	180000	60000	7500
Single men	222000	74000	9250
Single women	180000	60000	7500
children	18000	6000	750

In order to satisfy human needs, we created a meantime zone (see fig.11.1), especially for people who work in shifts. For example, for jobs that require 24 hours presence, there would be necessary three shifts of eight hours each. It is uncomfortable and unhealthy to work over night. If between the three torus is an eight hours difference, then in each torus is an individual who can complete the shift during the day. In this way, all the shifts are completed by people living in different torus, each person working during his own day.



Fig. 11.1



Furthermore, people must go once a day in the "Sun bath &Stars" room, for their own health. All people can go there during the day, due to the meantime zone.

Instead of a government, DACIA'S has an auto administration system, based on ability criterions. Each department, such as industry, agriculture, culture, etc, works on this system and has some wise man to supervise all the actions. It is the best way to avoid political fights.

Because of the big number of religions, we didn't build churches. It is impossible to build for everyone exactly the type of place where it would normally pray, so it is better that everyone has its own place of meditation.

Before getting on DACIA'S, people were carefully selected, depending on their physical and psychical particularities. Not only them, but also their close relatives were genetically tested, in order not to have predisposition to diseases. Even more, during years, they were psychically tested and registered, so that the population on the settlement would be peaceful and healthy.



12. HUMAN COMFORT





12. Human comfort

12.1 Buildings:

In Feng Shui, round shapes facilitate energy flow. Also, the Dacian spiral is the most characteristic and tight symbol of the Dacian people. Simple, double or triple, the spiral represents eternal life. Furthermore, the circle means the Universe without limits and its circumference means mental tranquility.

The circle is the shape that covers the biggest area having the smallest perimeter, and the sphere is the body that has the biggest volume having the least lateral surface.

Taking these into consideration, we created round shaped buildings for our settlement's residents. The architectural theme is the circle, so we made variations using this shape. The sphere is the most resistant body at implosion, explosion and big pressure because it has no corners, no fins that could diminish its resistance, so all buildings meant for residents are round shaped.

12.2 Internal arrangement:

Due to the large number of people living in one torus' segment, each of the 24th settlement's segments must be as independent as possible. Thus, each section includes the following:

• Education:

- One school including: kindergarten, primary school, secondary school and high school. They are all at the same place, but have different entrances and schoolyards, so that pupils learn in the same campus. Still they are divided, taking into consideration their different ages.

- A museum or an exhibition place for tourists who visit DACIA'S.

- Entertainment:
- One stadium for contests, concerts or spectacles that require a large space.
- Theaters for performances.

- Sport halls for different trainings. They are polyvalent, so that they can be used in multiple purposes.

- Auditoriums for concerts or different activities such as school feasts.
- Cinemas to show movies.
- Relaxation centers, including SPA, massage, etc, for people psychological comfort.
 - Medical:

- One hospital including different sections such as maternity, infant care, surgery, and contagious disease, separately from the other ones.

- Each house has its own dressing case, for minor accidents.

• Parks and recreation

- Parks and open places with benches, flowers, shrubs and small trees, all for increasing psychological comfort.



• Housing

	Number of	Number of houses in	
Number of people	houses	each segment	Note
1 (house type 1)	378000	15750	
			12000 houses where people
			live together + 78000
2 (house type 2)	90000	3750	houses where live couples
			6000 families having one
3 (house type 3)	6000	250	child
			6000 families having two or
4-5 (house type 4)	6000	250	more children
Block of flats (house type 5)	800	33	

All houses are spherical or cylindrical with arched roof.

A spherical house is meant for one or two persons (see fig. 12.2.2 and fig. 12.2.3). It has two floors: the first one is lowered with 1.5m from the center, so that on the lateral sides the opening angle is bigger than 90° . Thus, at the second floor, the opening angle is slightly smaller than 90° and the spacious impression is created (see fig. 12.2.1).

Houses: type 1: x=1.5 m type 2: x=2m



Fig. 12.2.1









The blocks of flats are also made of spheres (see fig. 12.2.4 and fig. 12.2.5). It is well known that the sphere is the only body which can be surrounded by twelve identical bodies. The central sphere is the lobby and the other twelve are the flats, all being in contact with the lobby. We avoided having too many floors and too high buildings because of the effects of the Coriolis force.



Fig. 12.2.5





Houses	Radius	First floor radius	Second floor radius	Terrain surface	First floor area	Second floor area	Total area	Opening angle	Garden surface
(1 pers)	4	3.87	3.7	100	47.03	42.99	90.01	104.5°	52.97
Type 2		3,07	5,7	100	17,05	12,99	,0,01	101,5	52,97
(2 pers)	5	4,9	4,77	170	75,39	71,44	146,84	101,5°	94,61
Type 3								_	
(3 pers)	7,5	7,5	0	300	176,63	0	176,63	90°	123,38
Type 4 (4-									
5 pers)	6	6	6	320	113,04	113,04	226,08	90°	206,96
Type 5 (1-									
2 pers)	5	4,9	4,77	0	75,39	71,44	146,84	101,5°	0

Examples of interior floor plans for spherical houses (fig 12.2.6 and fig. 12.2.7)







A cylindrical with arched roof house is meant for four or five persons. It can have one or two floors, depending on preferences (see fig. 12.2.8 for interior plan and fig. 12.2.9 for exterior view of the house).







All houses have a surrounding garden where people can plant flowers or even some consumables, or they can just use it in esthetical purpose.

The triangle is the most resistant structure and can form various shapes. All houses are made of many triangles interconnected because they can be easily connected and disconnected, which offers modularity possibilities. People can add or remove walls, can change the doors places, and can move walls, so they can change room sizes, depending on their preferences.

Furniture is mainly represented by water hyacinth furniture, because it is easy to grow and it is ecological. It can also be product in basic shapes, such as parallelepiped, which can be joined in different ways, so it is also modular.



13. ENERGY PRODUCTION AND DISTRIBUTION



13. ENERGY PRODUCTION AND DISTRIBUTION

In space, few sources of energy may be converted into electricity in order to sustain the settlement. These sources are solar energy, and nuclear energy, from nuclear fission or fusion. The latter requires complex technologies and also a continuous supply of materials. Nuclear fission requires fissionable materials, like uranium and plutonium, but also heavy water which is used as moderator. Nuclear fission requires hydrogen and the process itself is very unstable. Taking these reasons into consideration, we have decided to use the sun as a primary source of energy for DACIA'S space settlement. However, we decided to use smaller nuclear fusion reactors to provide energy for ships traveling long distances through space (cargo and human transport ships).

Solar energy is much more easily to obtain, after placing all the required solar panels. In order to acquire as much energy as possible, we have decided to cover with small modular photovoltaic cells all the exterior of the settlement. Photovoltaic cells are made of semi-conductive materials and use the photovoltaic effect to transform electro-magnetic energy (waves) into electric energy. Each photon is absorbed by a valence electron, increasing its energy so that the electron passes in the conduction energy band, generating electric current. However, according to quantum physics, only photons of certain energy levels can be absorbed in this way, so the efficiency decreases. In order to increase the efficiency, multiple layers made of different materials with different band gaps are used. The technology is still in progress, but we assume that the solar cells used for DACIA'S settlement will have a efficiency of 40%.

In order to calculate the total electric power obtained from all the cells, we must multiply the solar radiation intensity with the total projected area covered with solar cells. The total projected area can be approximated, as can be seen in the figure below, by a rectangle with 6 additional semicircles.





Symbol	Significance	Value
Н	Vertical dimension $(= 4t + 2r)$	4328.427125 m
R	Torus small radius	750 m
R	Torus big radius	4500 m
S	Total surface	$4425700 m^2$
E	Solar radiation intensity	1380 w/m^2
η	Solar cell efficiency	40%
Р	Total electrical power	24,430,019,000 w (24,430 Mw)

The values and significations of symbols can be found in the following table:

For each of the 3 torus, inside each of the 8 segments, in the exterior light-industry area, there is an electrical power plant, which collects energy from the solar cells disposed on the exterior of the respective torus segment. There are 24 power plants, and for each, the effective power is 1017 Mw (P/24). Because the settlement is rotating, the instantaneous power varies for each power plant. For this reason, all power plants in one torus are connected to another main electrical facility, which gathers all the power, providing a constant power current as output (direct current).

The DC output is partially converted into sinusoidal AC at the main electrical facility, and the sent to distribution facilities around the torus and to the central AC distribution facility placed on the corresponding central platform. There are 8 AC distribution facilities in each torus (one for each segment) placed inside interior light-industry area, responsible with the residential area above the respective light industry area and with the agricultural area beneath. AC is preferred for interior usage because it has fewer losses through Joule effect.

The rest of the DC output resulted from the main electrical facility in each torus is partially directed towards other DC distribution facilities inside robot maintenance areas and inside exterior light industry area – for each segment, one facility for exterior robots, one for interior robots and one for exterior light-industry area – and towards the DC distribution facility on the corresponding central platform. Robots work with fuel cells, which require DC for loading. Also, the exterior light industry area and exterior robots area are held depressurized, at a temperature close to absolute 0, where metals have small resistivity (close to 0), so there are few loses due to Joule effect.





The remaining DC output is directed to the magnetic field generators, through a series shield sustaining power plants. There is one shield sustaining power plant inside each torus segment, also placed inside the exterior light industry area, and it sustains 6 AMSSWAS (Active Magnetic Shield Spatial Wire Arrangement System) disposed around the torus segments. The electro-magnetic field has the purpose of protecting the settlement against high energy protons, electrons and other charged particles that form certain types of radiation. The AMSSWAS are powered from inside the light industry area and are kept between the Fe-Ti 70 layer and the superadobe layer, at low temperature (60 K), in order to decrease the energy consumption.

For more details, see section 6.2 - Settlement protection – Magnetic field generation.

Some power is also stored in the exterior light industry area through superconducting coils and capacitors. The coils are kept in superconducting because they are kept in void, so all absorbed power through joule effect is radiated to the exterior. Some high power capacitors are combined with electromagnetic coils to form LC circuits, inside which alternative current can be "stored". The reason for which we store energy is represented by eclipses that from time to time block the solar light shutting down the power. During eclipses, all heavy industrial and spaceport activities are shut down, and magnetic shields are reduced, allowing all stored energy to be used for life-maintenance functions and transportation. Solar eclipses last for short time, they are rare and can be predicted long before, so they do not significantly affect the settlement's operations. For more details about solar eclipses see settlement's dynamics – solar eclipses.

The table below describes the quantities of electric power directed towards each part of the settlement.



Power (Mw)	Туре	Destination	Purpose
900	AC	Residential areas +	Illumination
		infrastructure area 1	household,
			transportation
800	AC	Int. Light-Industry	Support of different
		areas +	facilities,
		infrastructure area 2	illumination
			transportation
900	AC	Agricultural areas +	Support of
		infrastructure area 3	plant/animals
			processing and
			maintenance
			systems,
			illumination,
			transportation
500	DC	Interior robots area	Fuel cells refilling,
			robot maintenance
			systems
500	DC	Exterior robots area	Fuel cells refilling,
			robot maintenance
			systems
7000	DC	Ext. Light Industry	Support of Electro-
		area	magnetic shield,
			thrusters &
			superconducting
			coils and capacitors
10400	AC + DC	Central Industrial	Support of systems
		area	and robots,
			transportation
3000	AC + DC	Spaceports	Ships clamping
			system, ships
			moving and
			maintenance
			systems



14. OTHER FACILITIES





14. OTHER FACILITIES

People on our settlement enjoy a special park called "Sarmisegetusa" (fig. 14.1), as the town of the old country Dacia. It has big stones that form three circles, which represented the calendar of the autochthon people.



Fig.14.1

Beside normal facilities that people have on Earth, DACIA'S inhabitants also enjoy OG particularities. One of the most important structural components of the settlement is the "Sun bath & Stars" room. In one half of the room people must go once a day and in the other half they can go whenever they want, in order to have beautiful views from the outer space.

14.1 "Sun Bath & Stars" room:

DACIA'S offers to its residents and tourists the possibility of naturally observing the Earth, Moon, asteroids, and stars. This facility is provided by the "Sun Bath & Stars" system, a pressurized room that has an opposite rotation movement to the settlement's, through magnetic levitation system. it has also telescopes, that record the images, live broadcasted on the entire settlement and even on Earth, as news. Besides this, it has another purpose: it offers the possibility for people to sun bath, because the UV radiation is very important for the human metabolism. A positive effect of UVB exposure is that it induces the production of vitamin D in the skin. It has been estimated that tens of thousands of premature deaths occur on Earth annually from a range of cancers due to vitamin D deficiency. Another effect of vitamin D deficiency is osteomalacia (the adult equivalent of rickets), which can result in bone pain, difficulty in weight bearing and sometimes fractures. Other studies show most people get adequate Vitamin D through food (fortified foods or taking a dietary supplement pill) and incidental exposure. For a long term living on DACIA'S we strongly recommend this remedy. There are the two special designed rooms situated on the central axis, at its poles (north and south with respect to the Polar Star), under the space port (see fig. 14.1.1).





Fig. 14.1.1

It has windows made of transparent material to vacuum UV wavelengths, preferable Silica or quartz glass and adaptive filters. Also, a high concentration causes health problems: cancers, DNA damage and sunburn. The UV concentration may be too high, for this reason people have to wear special UV protection suits that cover the entire body except head and hands (it is enough for your body to induce the production of vitamin D and avoid skin cancers), body lotions with sunscreens, eyeglasses (protection against eye cataract).

Each Dacian has the possibility to spend 10 minutes daily in this room to get "sunburned" or watch the beautiful surroundings. They have a capacity of 4200 people, which means \sim 2100/ each of the two "Sun Bath & Stars" and a number of 48 rotating shifts in 8 hours time for each torus (the 3 torus have different time zones delayed with 8 hours). The residents enter this area through the central axis with the help of some accommodation platforms that have an anchoring system (ex: belts). It has an opposite speed to the settlement's of: 1,5m/s.

The same anchoring system is used for the internal "Sun Bath & Stars" transport, due to the ~0g gravitation.

The room is naturally divided in two areas: half 1 is permanently exposed to solar radiation, where people both benefit of UV rays and observe the outer space and half 2 that only offers the possibility of admiring the amazing structure of DACIA'S and the beautiful space views (see fig. 14.1.2).





In "first half" people enjoy sunbathing in 0g and have the possibility to anchor themselves in the "wall chairs", or "swim" in this pressurized room. The way the chairs are disposed is on 15 rows and 8 corridors between them, with a horizontal amphitheatre design as you can see in fig. 14.1.3.

In "second half" people get dressed in the special UV protection suits, use the sunscreen lotions and eyeglasses. It has a great importance in research, study, education, health, entertainment of Dacians, their children and tourists.

The exterior protection of this structure from debris penetration and glass for no becoming opaque is done through robots and automated system that brush the window and calculate the collision with pebbles smaller than a grapefruit to install a catching system depending on the size of the danger.







14.2 Human transportation

For human transportation, electrical cars (fig. 14.2.2), tricycles and roller skates are available. Inside the torus, these are the safest means of transportation, due to the Coriolis force. If you move with high speed in the opposite to the settlement rotation direction, the effect of the artificial gravity is lowered. Elevators are used to move from the torus to the central axis, through the spokes, or to move from the residential to the lower levels. To save energy, elevators work on a counterweight system, antagonistic (fig.14.2.1). They are very efficient because the settlement has a lot of residents that have to work in different places, on shifts, so they will function all the time.



People can also use a railway system placed in the "transport and plumbing" area, in infrastructure. There are three stations corresponding to each torus segment and it is the fastest mean of transport between the segments. Even though, there is a speed limit because of the Coriolis force.

A resembling system is used for food and other consumables transportation – the "DLS" delivers these types of products from the light industry area, restaurants and shops directly to the house. It is also used to collect garbage.

Tourism is an important domain. Visitors have a lot of places to go to, including 0G areas. They have a lot of hotels to stay to and a series of touristic programs. These include museums, commercial places, entertainment, including climbing on "Daciassus". Tourists also have special options such as trips on moon or just in outer space.

As a DACIA'S souvenir, there are available trinkets made of recycled materials, unusable anymore. People can also buy different things, DACIA'S genuine, such as t-shirts and perfumes made of materials and aromas produced on the settlement.



Space ships

DACIA'S space settlement will benefit from a variety of space ships, for transportation, construction sequence and protection against asteroids.

Cargo ships (fig. 14.2.3) are used for transportation of materials and from lunar facilities during construction sequence, but also afterwards, for industrial activities. They are propelled by VASIMR engines but also use LOX-LH2 thrusters for direction and positioning. Cargo ships are described in detail at Construction Sequence – Construction Devices. Cargo ships have an interior small fusion reactor fo



have an interior small fusion reactor for energy.

Construction ships (fig. 14.2.4 and fig. 14.2.5) are used in construction of major settlement components. These ships also use both VASIMR and LOX-LH2 engines. They also use an interior small fusion reactor for energy.



Fig. 14.2.4

Orbit-to-Earth ships (fig.

14.2.6, fig. 14.2.7 and fig. 14.2.8) are the ships used for transportation of both people and materials from the settlement to Earth. These ships use only LOX-LH2 thrusters. In order to land on Earth, they use their engines to leave Libration point L5 and enter a close elliptical trajectory around Earth. When it reaches the closest position to Earth, the ships are reoriented against its moving direction. It uses the thrusters to lose







speed, and then gradually changes direction, while entering the atmosphere in entering state (the exterior endings of the wings are turned upwards with 90 degrees). It stops rotating when it reaches an optimal angle, afterwards using only its large wings and air friction to loose velocity (the entering procedure is similar to the space shuttle). After it reaches a certain



lower speed, and friction stops heating the wings, the ship enters the landing state (the exterior endings of the wing are reoriented horizontally) in order to ensure maximum lift. The ship uses conventional landing gear to land in a similar manner with the space shuttle.



Earth-to-Orbit ships are actually the same ships as the previous, only that they use additional fuel canisters in order to leave Earth. After reaching the settlement, the ship can be reused as an **Orbit-to-Earth ship** and vice versa.



Interceptors (fig. 14.2.9 and fig. 14.2.10) are smaller ships used only on orbit, using 3 VASIMR engines for movement and also 6 LOX-LH2 thrusters for orientation. They have 3 lateral "arms" where special outer-space rockets are deposited. Some rockets use chemical explosives, for smaller asteroids, and other rockets use plutonium nuclear fission in order to give larger quantities of energy to larger asteroids. All rockets are conceived to first penetrate and then explode inside the asteroid, in order to make it disintegrate. Three identical rockets are usually launched from the exterior of the three arms, and they are all guided with a triple point laser guiding system that "points" the asteroid. Interceptors are powered by high capacity fuel cells.



Fig. 14.2.9

On-Orbit-Small-Transport ships

A type of ship used for transportation of people or important components that require safer conditions of transportation then those provide by Cargo Ships. It is used for transportation between the main settlement and lunar facilities, and it also uses VASIMR combined with LOX-LH2 thrusters.

Space Drone

A small, automated ship, using an ionic thruster, sent for reconnaissance and research missions in both interior and exterior solar system. The ionic thruster technology uses very little fuel, and is powered by electricity provided by two solar panels. It provides a small but constant acceleration. This is the reason for which it is used in deep space missions.

The VASIMR engine (fig 14.2.11)

VASIMR is a new type of propulsion system special conceived for outer-space missions. It uses hydrogen and electric energy. It can be considered a new and improved version of ion propulsion. Hydrogen is injected through a superconducting electromagnet and a Plasma Source Antenna, which uses electromagnetic waves to ionize the hydrogen, transforming it into plasma. The new plasma jet passes through another, shorter superconducting magnet, used to make the fascicle thinner. This Fascicle then passes to another longer superconducting electromagnet that makes it again parallel, and through another RF Booster Antenna, that uses electromagnetic waves to energize the particles to higher levels, as can be seen in the picture below. When the energized plasma reaches the exterior, the last electromagnet becomes a magnetic nozzle, because it transforms particle energy into mechanical energy, accelerating the particles backwards, as can also be seen in the picture below.

The physical phenomena involved by this revolutionary engine are very interesting, and we chose to write more about them.





www.adastrarocket.com/vasimr.html Fig. 14.2.11

In the first place, plasma is the fourth state of matter, and it's very abundant in our universe, because it's the main ingredient of stars and other hot bodies. Plasma forms when a gas is entirely ionized, so ions and electrons move free inside, interacting with each other. For the VASIMR engine, plasma forms inside the first Antenna, which uses electro-magnetic waves to rip electrons away from their atoms.

In the second place, the way that plasma responds to electro-magnetic fields is also very interesting. While Electric fields accelerate the particles, magnetic fields guide them. The problem with electric fields is that it accelerates particles with different charges in opposite directions, making plasma rip apart. Because the engines purpose is to accelerate all particles in one direction, to generate thrust, electric fields can not be used. Magnetic field works as a direction marker for charged particles. Inside a partially parallel jet of particles, for each particle, the speed can be projected on two directions: one parallel with the main particle flow (horizontal) and one perpendicular (in the vertical plane). If the magnetic field is parallel with the main jet, the second component determines a Lorentz electromagnetic force perpendicular on both speed and magnetic induction vectors. This force gives the particle a uniform helicoidally shaped trajectory (fig. 14.2.12), around a magnetic field line. The positive charged ions rotate in an opposite way than the negatively charged electrons, but all particles are held together on close parallel, helicoidally shaped trajectories. This is why inside the first and third superconducting electromagnets the particle jet is parallel. Even when magnetic field is not parallel, particles' trajectories follow the field lines. So if the field is converging, the particles are also converging (between magnets 1 and 2) and vice versa (between magnets 2 and 3, and at the end of magnet 3).





Fig. 14.2.12

$$\vec{F_L} = q\vec{v}_{yz} \times \vec{B};$$

$$\vec{F_{cf}} = \frac{mv_{yz}}{R^2} \vec{R};$$

$$F_{cf} = F_L;$$

$$= R = \frac{mv_{yz}}{qB}; (trajectory radius)$$

Now, what happens actually when plasma is energized by the RF Booster Antenna? The particles gain energy, and consequently speed in the vertical plane, so they are forced to spin with increased velocities on trajectories with increased radius (the Lorentz force remains constant, so the Centrifugal force must also remain constant).

But why does the particles' horizontal speed increase when leaving the third electromagnet? There is no electric field, only guiding magnetic field. This is the most interesting phenomena involved by VASIMR thruster. While the particle passes through the magnetic nozzle, the field begins diverging. But at the same time, the field loses intensity (the module of the induction vector drops). As the induction vector drops, the Lorentz force drops in the same way, so particles tend to spin around trajectories with increased radius. However, the particles are held together by interaction forces between them, so radius can not increase very much. Due to this reason particle begin to lose speed in the vertical plane, in order to make the centrifugal force decrease in the same way as the Lorentz force. However, the total kinetic energy must remain constant, so horizontal velocity increases, and according to the



first mechanical principle (an action implies reaction), the ship accelerates in the opposite direction. Because the particle flow is permanent, the ship acceleration is constant. This is how particle energy is converted into thrust.

$$B \downarrow;$$

$$F_{cf} = F_{L;}$$

$$R = ct;$$

$$\Rightarrow v_{yz} \downarrow;$$

$$m(v_{yz}^{2} + v_{x}^{2}) = ct;$$

$$\Rightarrow v_{x} \uparrow;$$

By increasing or decreasing the density of the particle flow, the specific impulse can be varied from 3000 to 30000 s, meaning that thrust is varied. This is another advantage of the Variable Specific Impulse Magnetoplasma thruster against the conventional LOX-LH2 thruster.

VASIMR technology also requires much less fuel than LOX-LH2 technology, which is why the first is used over long distances, while the second is used more for maneuvers and short distances.

14.3 Importance of hydrogen

All ships described above use hydrogen in one form of another, as it is an element very spread and easy to find across the universe. Cargo ships, construction ships, and interceptors use it for VASIMR and LOX-LH2 thrusters, while Earth-to-Orbit and Orbit-to-Earth ships only use it for LOX-LH2. In addition, Cargo Ships use hydrogen also for fusion reactors.



15. ENTERTAINMENT:





15. ENTERTAINMENT:

In order to attract more tourists, DACIA'S offers a large variety of 0g games in the central area and a unique sport called "Daciassus" that means DACIA'S up or above. It is a mountain sport, where residents escalade a lunar and asteroid regolith mountain, situated in the middle of each residential torus. It starts from the residential area and it goes to the central zone of the settlement. It has a total altitude of 4700m and its particularities are the facts that the gravitation varies between 1g to 0g, which means that as people escalade it, they feel lighter, and the ascension is easier and enjoyable (fig. 15.1). Each year "Daciassus" competitions take place and encourage the residents and tourist to participate, win special prizes and conquer the "top" of DACIA'S situated in 0g. Trainings can be a form of encouraging the residents to get fit, because they have a sedentary life.





Rules:

From the base of the mountain more people start climbing. At the beginning, there is more difficult, because they have to face the same difficulties that a normal alpinist has on Earth: the (pseudo) gravitation force. After that, it becomes easier because the gravitation force lowers. "Daciassus" climbers have to catch handles (fig. 15.2) which record the time when it was touched, meaning that one level was achieved. When the gravity is low enough, alpinists can just pass over levels, going directly to the upper ones. The climber who reaches first the last handle wins. Due to the fact that the time is recorded, people can set records at each level.





To come back, people must climb down on bars or ropes (fig. 15.3). The whole mountain is divided in floors (from 5 to 5 meters) between which there are bars, so that people descend gradually and safely. If an individual gets exhausted of climbing, there are gates at each floor where he can enter inside the mountain and come down.





16. COMMUNICATIONS




16. COMMUNICATIONS

Interior residential communications are possible through wireless access points that cover the entire area. Eight such access points are enough on each torus, because more can interfere and produce electromagnetic resonance (fig.16.1).

r = 750m;

R = 4500m;

d – maximum distance of optimum reception $d = \sqrt{(R+r)^2 - (R-r)^2} = \sqrt{R^2 + r^2 + 2Rr - R^2 + 2Rr - r^2} = 2\sqrt{Rr} = 2\sqrt{4500 \cdot 750} = 3.674m;$



Fig. 16.1

Internal communication is between:

- a) Residents for their private life;
- b) Residents and officials for the settlement's facilities (work, rest);
- c) Officials and community (ambiental music, secure alarms);
- d) Devices, automated systems that supervise the utilities control, robots;

The communication system is wireless in the tori areas but in the axis consist of fiber optic, because the electromagnetic rays can't pass through metal. The private communication between residents is provided by Dacian bracelet. It looks like a watch with an attached



screen, that also informs about daily news, dangers, what diet the resident must have in order to provide to his body the necessary amount of food and fruits (fig. 16.2).



Fig. 16.2

There are also communication systems available in each resident house, public, in tube station and in the streets for emergencies, in case if the resident's Dacian bracelet breaks off, or if an accidents happen (in 3 minutes time a doctor, a fireman and a policeman are there to solve the problem).

External communications (fig. 16.3):

There are special allocated frequencies for: commercial communication (ex: for Terra we use the Internet, Earth satellites), transport systems between Earth-DACIA'S-Moon-Mars, scientific communication and settlement's exterior protection systems. These are relays satellites situated in the settlement's neighborhood or on an orbit further than Pluto that describe the outer space, the cosmic non electromagnetic radiation, solar flare density. They are on orbit with a speed of 11.2 km/s and act as planets. The distance between them is chosen by the science men and engineers from DACIA'S, which is in fact the revolution period.

The human transportation ships have complex communication devices for safety, as well as the factories from Moon and exploration ships.





X - Sattelites

Fig. 16.3



17. COSTS



17. COSTS

Name	Medium price/unit	Quantity	Total
Employees salaries	\$350000 (28 years)	60000	\$588,000,000,000.00
Settlement material	\$25	150000000000.00	\$37,500,000,000,000.00
Solar cells	\$13	148365000	\$1,928,745,000.00
Infrastructure	\$4744383600	1	\$4,744,383,600.00
Buildings	\$50000	472200	\$23,610,000,000.00
Space ships	\$1000000	1500	\$1,500,000,000.00
Laboratories	\$1750000	20	\$35,000,000.00
Robots	\$10000	50000	\$500,000,000.00
People transportation from Earth	\$10000	600000	\$6,000,000,000.00
Other			\$2,000,000,000,000.00
Total			\$40,126,318,128,600.00

All the Earth countries managed to earn the huge amount of money needed in DACIA'S construction. This was possible through a common agreement that stopped wars and saved money.



18. RELATIONAL PERSPECTIVES



18. RELATIONAL PERSPECTIVES

DACIA'S' main purpose is to be an "Earth's extension", a starting point for communication and cooperation. It is the base of other space settlements' construction, an important step on the way to the Red Planet. It represents the first phase in the process of Mars terraformation due to the fact that it facilitates the transport to this planet.

Being an independent settlement, it develops a new culture, but at the same time it adopts something from each culture from Earth because of the large number of inhabitants. Basically, here take place cultural interchanges and are developed cooperation relationships, starting from communication between individuals to communication between states or different human settlements.

In order to assure its independence and to develop continuously, DACIA'S also has a commercial side. It is not only a starting point for the construction of other settlements, but it is also a manufacturing centre: sells solar cells, fuel, prime materials.

Thus, DACIA'S is the most important Earth's spaceport through which we are closer to discover whether there is life on other planets or not. The humanity will be able to explore further and further the solar system with its advanced high technology.



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