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The Colonization of Space
An Anthropological Outlook

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Abstract. *The colonization of space implies an adaptation of both physical and cultural type. The human species is characterized by a great adaptive capacity that, in a basically extreme environment, reveals all its plasticity. However, this capacity must be aided by appropriate technological solutions that identify the problems related to long stays in space, and to long space voyages. Anthropology could aid future colonizers rethinking the environment of the spacecrafts, and the habitats of future colonies. Last but not least, anthropology can prepare them to a possible encounter with alien intelligences very different from human way of thinking.*

Keyword. Space Anthropology, physical and cultural adaptation, colonization, interstellar travels, alien communication

Even though this isn't well known, anthropologists have been studying problems and opportunities connected with space flights and colonization for several years.

Conceiving the occupation of other planets in our solar system and later on of other planetary systems, does not exempt us from solving the problems on Earth, at least because we'd export the mentality that caused the same problems here.

It means conceiving well organized, self-sufficient space colonies, socially harmonious, as the result of man's new attitude towards the environment. Which is to say, colonies which are evidence of the fact that the existing social conflicts and environmental dangers have been overcome.

Is this science fiction? Many of the current scientific, technological and social achievements were considered as such, in the past. Anthropology deals with this particular field of research proposing some practical applications implying a new conception of what was the "space race" until a couple of decades ago, providing its knowledge about nutrition, evolution, environmental impact, human behaviour and conflict resolution (Tiziani, 2011).

Space antropology deals with the elements of adaptability, posture and proxemics of subjects in a limited environment with microgravity, in order to support a project centered on wellness, to improve the efficiency and the habitability of space missions and the possible future settlements (Masali *et al.*, 2005). The results do not only apply to the aerospace context, but also, and especially to the solution of present social and environmental problems, conceiving on a larger scale what has been assumed for small groups of space travellers.

The need for conquering the terrestrial orbital space was brought up by the requirements imposed by the Cold War. The military and propagandistic implications were clear, but they have been fading out in time. Only in recent years we are considering the colonization of the Moon and a trip towards Mars, for what now looks like a scientific and human demand rather than a political need.

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It so happens that the approach to human presence in space has changed: it is no longer a matter of "conquering The Space", but of allowing mankind to occupy "a space".

The assumption of anthropological research is that the current general design rules favour the machine rather than man: in a space trip, this would be detrimental to the physical and mental health of passengers, which is already being considered for what concerns long stays on the International Space Station and the first pleasure trips in space. It is easy to understand that, if space colonies have to be self-sufficient, they also have to be comfortable for human beings.

The political need has not completely disappeared, but what described above is becoming the main mental approach. The idea of the importance of human experience rather than results is spreading among engineers and technicians, who are now conceiving that launching a space shuttle is a great effort and it has to be useful to man, rather than to a political and technological opportunity.

The pioneer of such an outlook was probably Krafft Ehricke (1917-1984), also known as the "ambassador of space".

His thought has greatly influenced astronautics in the second half of the Twentieth Century, laying the basis for a more humane, and not only political "space race". Ehricke's view depended on thoughts which were not so taken for granted, at that time. He was the first one to formulate the three Laws of Aeronautics (Ehricke, 1957):

> *First Law: Nobody and nothing under the natural laws of this universe imposes any limitations on man, except man himself.*
> *Second Law: Not only the Earth, but the entire Solar System, and as much of the universe as he can reach under the laws of nature, are man's rightful domain of activity.*
> *Third Law: By expanding throughout the universe, man fulfills his destiny as an element of life, endowed with the power of reason and the wisdom of the moral law within himself.*

The Three Laws were the ground for his definition of "Extraterrestrial Imperative" (Ehricke, 1972), where he expresses his historical view about human species:

> *Man, the cutting edge of terrestrial life, has no rational alternative but to expand the environmental and resource base beyond Earth. Global development, therefore, must be based on an open world concept and include both the development of extraterrestrial resources and the wiser management of our terrestrial resources. This is the extraterrestrial imperative. Its central goal is the preservation of civilization.*

Ehricke had realized that human beings couldn't possibly go on demographically growing and developing their civilization within the limits of a closed ecosystem such as the Earth, without ruling themselves.

So he conceived the Extraterrestrial Imperative, comparing it to European Renaissance, where the centrality of human creativity gave way to the age of great geographical explorations and scientific discoveries which were the roots of the modern era (Freeman, 2010). Nevertheless, it's only at the beginning of this century that we see the conditions to apply Ehricke's thought and improve his ideas at the light of new scientific and social knowledges.

His Imperative should be the prime mover to colonize space, to reflect upon our existence as a species and on the biosphere in which we have evolved: as much Ehricke's formulation considers man as the "cutting edge of terrestrial life", new discoveries in the field of paleoanthropology and anthropogenetics have remarked that *Homo sapiens* is just one of the other animal species, its success depending especially on the environmental surroundings which allowed its evolution.

These remarks are the basis of the anthropologist's work in this context. About which aspects of a space voyage does the anthropologist work? It mainly concerns everything dealing at first with the space flight, and later with the colonization, these being the variables regarding the astronaut/colonist.

It has to do with biological, physiological, cognitive and biomechanic factors which influence the design of equipments, interiors and tools. But, in a larger conception, there are also political, sociological and economic factors which lead to the planning of the mission and reflect in the choices taken for its success.

Therefore it's not easy to plan and run a space mission, as different fields overlap and their interactions aren't often intelligible. If we add the personal bent, the needs, the social abilities and the cultural background of the individuals, the picture comes out even more diverse and complex. So it is not surprising that the companies entitled to run the space flights consider very carefully the probabilities of success in a mission mostly weighing statistic factors, overlooking the unreliability of the human factors (Harrison, 2002).

From an anthropological point of view, studying the space flight and its implications means to reconsider what we know about the interaction between man and environment, re-gauging the weight of culture as a mean of mediation and modeling of a human unfriendly environment. Which is to say, generally speaking, an "extreme" environment. Usually this adjective implies everything related to a limit: a conceptual place, rather than physical, where the best human values such as courage, sincerity, resoluteness, sense of duty come out. In other words, what may represent a particular range of human beings, as the astronauts are perceived and consider themselves (Olson, 2011).

The activity of anthropologists aims to neutralize this conceptual place, cancelling the separation between the idea of space as a border and as an environment and considering the human beings a whole, rather than specific categories of persons.

So we are not speaking about specifically trained people, nor genetically modified, nor using particular drugs easing adaptability. We are speaking of common people, which cannot be listed among nowadays astronauts, at least with reference to the hard and peculiar training they are submitted to. From this point of view, science-fiction writer Sylvia Engdahl (1980) points some interesting assumptions to limit the hypothesis on which she was to base one of her University works (non completed):

> *1) Expansion beyond the biosphere of a single planet is adaptive for a culture-bearing species and should be seen as occupation of a new environmental niche.*
> *2) Once the above hypothesis is taken as a premise, the controversies in anthropological theory concerning cultural evolution appear in a new light. If development of technology and social structure prerequisite to extraterrestrial expansion is adaptive for the species* Homo sapiens*, then the belief that such development constitutes "progress" is not mere ethnocentricism; thus cultural advancement can be objectively defined and cultural relativism becomes untenable as an overall view of human history, however valid it may be for comparing aspects of particular cultures. (This is not to say that cultures conducive to progressive evolution of the species are "better" than others, since it is not necessary for all cultures to adapt to new niches in order for the species to do so, and since diversity is important to a species' adaptability.)*
> *3) Neither of the above hypotheses implies that any specific socioeconomic system is more advanced than all others; on the contrary, the importance of space colonization is currently defended with equal vigor by adherents of diametrically opposed ideologies. Furthermore, an argument often advanced in favor of space colonies is that they will foster cultural diversification. Therefore, in the present era at least, a space-oriented perspective has no effect on theories of social evolution, as distinguished from theories of cultural evolution in the sense of exosomatic evolution.*
> *4) However, since it is self-evident that occupation of extraterrestrial environments requires a high level of technology, the premise that expansion into space is adaptive does have significant effect on views of the role of technology in evolution. It leads to the conclusion that continued technological advance is an essential and integral part of exosomatic evolution, and that there is no distinction between "natural" and "unnatural" environments in the case of a species that evolves by exosomatic as well as by genetic means.*

Basically, space habitats are artificial ecosystems, conceived to be self sufficient and to ensure the astronauts' survival. For what mentioned above, it is therefore necessary to consider human needs before technological necessities. Especially in case of long lasting missions, the human being is submitted to microgravity and to peculiar environmental stress, which aren't the same in any terrestrial environment. They are conditions which man can resist thanks to training, but in time they can affect the astronauts' psycho-physical health.

The accelerations during the take-off wear down a human body's endurance. And the body fluids, when not subdued to gravity, reallocate themselves causing congestion in the tissues; the sense of balance is altered, the bone and muscular tissues tend to grow thinner and loose mass (Banks *et al.,* 2008).

These are some of the alterations which happen in microgravity conditions, which study is important both from a physiological and an anthropological point of view, in order to keep astronauts in good health. In fact we don't have to forget that at present the most technologically advanced extraterrestrial habitat is the International Space Station (ISS): the age is still far away, when we'll be able to see space crossed by interstellar ships such as the Enterprise of the televisions series Star Trek, where artificial gravity and food replicators are considered as normal.

The space shuttle is to be reconsidered at the light of the alterations of biorhythms and perceptions, and of a higher ergonomic output, not only in order to place the higher number of tools in the smallest room possible (Schlacht, 2010). Speaking of which, it is useful to reflect about the current anthropometric standards used to design interiors, especially if aimed to a military use as space shuttles are nowadays.

Designing the interiors of shuttles means considering the variability of the individuals' mass and height. The huge variability found considering these factors has often caused several problems: to assign a shuttle to a person who wouldn't find it comfortable would mean to slow down her activities and even to risk the flight itself. Even though only a few accidents have been ascribed to a poor ratio between body proportions and cabin, there were several inconveniences caused by the underestimation of body measures during the design stage of the project (Rathjen *et al.*, 2008).

Hence the necessity of a more exact anthropometric measurement system, based upon the selection of staff within a certain range of measures, excluding those who don't fit in. On this basis they have developed standards procedures matching the selectioned sample.

In order to outline anthropometric (and therefore ergonomic) profiles to be used in the realization of interiors suitable to the human being and at the same time to the variability of the considered sample, it is necessary to divide properly a population or, when needed, to create under-sets of it from samples relatively similar to each other.

Until a few years ago, such measures were taken on military staff or persons which were to be selectioned for a military life period (e.g. during army medical examinations). Since these measurements are no longer taken, many designers have started basing their projects on samples composed of civilians applying statistic-like adjustments to match the demographic profiles and the fitness for military life (Rathjen *et al.,* 2008).

In the past, measurements were taken by analogic tools, such as straight and curved compasses, while nowadays scanning technologies have more and more improved allowing the surface mapping of the human body in a precise and functional way.

Probably the most known project using such technologies has been CAESAR (*Civilian American and European Surface Anthropometry Resource*), run by a group of research workers of the Institute for Information Technology, Ottawa, led by Jacques Domey, of the National Research Council of Canada. The scanner has been used to map the body surface of about 6000 Dutch, Italian and North-American individuals, aged between 18 and 65 (Tiziani, 2011).

An artificial and limited interior can alter not only sense perceptions, but also the feelings about needs, both physical and psychological. Because of its being artificial, it is not possible to re-create the terrestrial environment there. This is often compared with the creation of aquariums and terrariums, where animals can find a comfortable environment suitable to their exigencies. But these are neither closed systems nor easily reachable, like the orbital space or the moon surface (Schlacht, 2010). Anyway, even conceiving such environments, which would be the result in the human experience? Especially, would that be a satisfying experience?

To answer this question we have to consider the physical and psychological problems which astronauts and settlers may meet, analyzing the biological and cultural devices which allow man to adapt in different and non common contexts as space could be. At the same time we have to analyze the factors which may affect safety, relating to the length of the stay in space. An environment apt to maintain human life must also protect DNA from alterations due to cosmic rays; must resist to the impact with floating objects and be able to grant a normal life at the return on the Earth, if this is expected.

Gravity is probably the most important factor, as it contributes to the definition of distances and the balance keeping, as a matter of fact its absence is not even conceived in our motion, which has evolved for million years. We couldn't possibly imagine to adapt to the lack of gravity in a few years (Masali *et al.,* 2010). Nevertheless, in order to get used to this new condition, we could be helped by some evolutionary adjustments appeared during evolution to absolve a function other than permitting survival in a different environmental context, or attributes appeared without a specific aim, showing their utility later on.

Evolutionists call this characteristic "exaptation". To be precise, when we speak about physical characteristic with the aim of an evolutionary adaptation, we don't mean such alterations as bone calcium or muscular tone decrease, as these are physiological and don't necessarily concern the whole species; they are rather linked to the current stress and in the long run may lead to pathological conditions.

How can exaptation help in the case of human beings in space? Sight becomes the main sense to understand one's own position in space, with other senses if adequately used (Masali *et al.* 2010). The vestibular system, which rules the perception of balance, becomes useless, because it doesn't respond suitably in microgravity conditions. When designing interiors aimed to foster human beings in microgravity conditions it is necessary to consider this detail, focusing on sight as a movement and distance perception modulator. In fact we know that the perception of space is influenced by light and colours, by the presence of curved surfaces, by the layout of

the main axis of the rooms and by the presence and number of portholes or windows. Even the sense of sight is subject to environmental conditions: on the terrestrial surface the body's neutral posture is characterized by the straight spine (like when laying on one's back, or standing). In lack of gravity the spine tends to bend forward and the legs and the head look like they were pointing to the thorax.

The sight angle changes consequently: if on Earth the skull at rest point the eyes to the horizon, in microgravity conditions its sighting is towards the body (Schlacht, Birke, 2010).

In the μgOrienting project, a group of international research workers (Schlacht *et al.,*2009c) has made experiments on visual stimuluses in order to improve the abilities of crews in space missions. At first they considered the inner ear biomechanics and the function of the balance organ with reference to gravity.

As a second step, other experiments were carried out in order to understand the relationship between sight, microgravity and body structure. The experiment ZEROgYM focused on the connection between movement and sight in gravity *g* (the gravity at ground level) and in neutral set; WIUD (*Where is Up and Down*) was an experiment aimed to the analysis of instinctive reactions to colours and symbols to find the Up and Down (Schlacht *et al.,* 2009b, 2009d). With reference to the subject we are interested in, CROMOS is the most interesting one, conceived to analyze the colour perception in microgravity conditions.

The experiment was carried out in 2007 during the parabolic flights set up by ESA (*European Space Agency*).

In CROMOS, coordinated by Melchiorre Masali and carried out by the designer Irene Lia Schlacht and by aerospace engineers Stefano Brambillasca, Henrik Birke and Gabriele Rotondi (Schlacht *et al.*, 2009a) they analysed the parameters of tone, saturation and luminosity of colour, which perception changes in lack of gravity, by an especially devised software.

The participants were wearing a sort of viewer connected to a computer by which they could see two coloured squares. One of the two squares could be modified, by shades, thanks to a joystick. When the modified colour was perceived exactly like the one in the other square, not altered, they had to push a button. Hence the possibility to compare the sight of the same colours in terrestrial gravity and in microgravity conditions. As a matter of fact, the perception of colours in lack of gravity can be remarkably altered, which affects the perception of one's body in the space, and therefore, the performance of the operator. Because of the monotone environment in which they are compelled to live, astronauts can't enjoy the same variety of forms, colours and distances as one can find on Earth.

From this point of view it is interesting to remark the difference in the patterns of space shuttles (Schlacht *et al.*, 2009b): the US/European pattern prefers modular structures, formal interiors, white or blue light; the Russian pattern presents more familiar interiors which form a unitary structure where brown is the colour used for what is meant to be recognized as the floor, white for the ceiling and green for the walls.

In the US/European pattern, orientation is provided by written notice and directions; in the Russian pattern on the contrary they prefer lines and colours.

Astronauts preferred the Russian pattern, where they also showed a better psycho-physical condition.

The altered perception of colours is due to the minor oxygen supply towards tissues and to the myopia caused by the shape eyes assume in microgravity conditions. So colours are perceived as faded, and designers recommend the maximum saturation (Schlacht, Birke, 2010) .

For what mentioned above, it is easily understandable how, at the current state of space exploration, it is necessary to employ selected and well trained personnel, which members, if they were to settle permanent colonies, may become the subject of particular studies about the genetic drift and the natural/artificial selection of the personnel. (Masali *et al.*, 2005). But as we said at the beginning, anthropology has to consider spacefaring as feasible by the largest range of human beings. This is particularly true if we consider the settlement of colonies. In this case we have to consider also the fulfillment of the secondary needs of individuals, such as satisfying the sense of aesthetics and feeding their culture. Which means to create life conditions beyond the mere survival.

Anyone involved in the project of space flights or the founding of permanent colonies must consider all the aspects connected with the physiological and psychological needs of the mission participants. And to succeed they must focus on the daily activities, both mental and physical, based on the biological rhythms developed during the evolution of our species on the Earth.

A great part of the physiology of terrestrial living beings is based on the day-night cycle. The circadian rhythm deeply affects our behaviour. The alteration of this rhythm produces tiredness, somnolence, decrease of the performing time, memory and attention difficulties, as well as cognitive diseases due to the chronic lack of sleep (Rathjen *et al.*, 2008).

In the simple module buildings of the International Space Station, designed to accomplish particular functions, there isn't the possibility to imitate the day-night alternation. Houses in future colonies should consider this factor, at least to increase the wellness of settlers and their productivity.

This doesn't necessarily mean to recreate terrestrial environments in or out of the colony. Consider the Moon, for instance. It is difficult to turn it into another Earth, wrapping her up in a kind of atmosphere to plant beautiful gardens, at least at the light of the current technological knowledge.

A lunar colony submits remarkable problems if we want to contribute to a satisfying wellness of the settlers, and we can easily understand that it isn't a mere technological problem. In this aim, designing a space colony, but also a space vessel, we should consider the contribution of experts in different fields. So, not only engineers, but also anthropologists, designers and artists.

The aim is to build an artificial ecosystem able to grant variability and variation, the two characteristics of the environments in which the human species has evolved. Which is to say, to provide all the stimuluses able to grant the life quality in space. To this purpose, the Japanese artist Ayako Ono (2010) suggested a solution about a possible permanent base on Moon. It is a zen garden *karesansui* (literally "dry garden"), on the lunar surface. Actually the garden would be part of the colony, enveloping the module buildings, if not taking them into its structure.

The principal elements of this kind of zen garden are rocks and pebbles, while the sea is represented by lines of the same pebbles, wavy or straight, at choice. Every element is considered as living, despite its composition.

The stones are a fundamental aspect of *karesansui*. As they represent landscape elements, such as mountains and hills, they shouldn't be carved by man or smoothed by water, they are to be of different colours and the garden is to be developed around them. From a symbolic point of view, stones also represent interior force and steadiness.

The gravel, composed both of white and black pebbles to represent the imperfection of reality, is the basis for the stones and makes them catch the eye. More, it represents water, as said above, but also the void, which this kind of garden brings out. We are not speaking of the "void" with a western meaning. In *karesansui* the void becomes an object of contemplation, so it represents a "full" for the mind who is living it (Berthier, Parkes, 2005). The job of building and maintaining the garden would be committed to robotic units able to redefine the garden design from time to time, granting a certain visual variability to settlers.

The use of robots for the garden care means to leave the settlers free to carry out other tasks: as a matter of fact, a zen garden demands a lot of time and care. What's more, the programming of robots is a creative task, often cooperative, which can be used as an occupational therapy where needed.

The rules set for a *karesansui* garden clearly need a derogation, considering the place where it will be planted. The material in use is the regolith from the moon soil, almost without colour variations. Ayako Ono (2010) devised another change, some solar panels which in shape and colour recall big flowers sprouting from the regolith, as a memento of the planet the moon settlers have left behind.

The landscape definition as devised by Ono makes part of a larger project which considers art as a therapy and a psychological comfort for the settlers, able to make up for the lack of certain environmental stimuluses and the length of communication gaps with Earth. This solution would exploit all the materials available *in loco*, in other words the local "nature", in opposition to the method by which one would recreate totally or partially the original terrestrial environment.

These two views are far from each other both from the pragmatic and the ideological side: using the local resources would mean to remarkably cut the costs, but also means to encourage the evolution of an autochthonous culture based on the environment in which the colony is rising.

If this implies a more difficult adaptation at least at the beginning of the stay, it means that the following generations will less and less depend on the mother planet, both from the technological an psychological point of view.

Ono's proposition (2010) implies some interesting consequences:

- the "natural" design as devised by the artist, which is to say the use of local materials, will become a well-established rule in the case of colonies on other planets, for instance on Mars;
- the zen garden shows strong implications for what concerns space tourism, as it could become an attraction for tourists;
- art and design will be more and more integrated in the planning of space exploration in order to make space occupation complete and efficient.

Ono's zen garden is one of the optimum solutions for the necessary anthropization of a hostile environment, and at the same time allows the emotional stimulation of the settlers.

In its own way, such realization could originate a new kind of aesthetics, a new philosophy, and what's most important, a new way of conceiving environmental ecology. In other words, a new culture could rise up.

And in the far future? The vision of science fiction writers and of futurologists present several different scenarios: some think that for long space trips only robots or conscious cybernetic beings should be used, others would rather conceive great arks as home for generations of settlers (the "generational space vessels" represent a peculiar science fiction case) some others wish the human species turned to genetic engineering.

Anyway, will man himself have to evolve and adapt to a new planet, or will the planet, by turning itself into an Earth-like environment? Science fiction writers and scientists support one or the other solution.

In Hyperion saga, Dan Simmons (1989) introduces the Ousters, a semi-nomadic people which preferred to genetically adapt to the different planet environments rather than transform them, unlike what Egemonia did, composed only by *Homo sapiens* representatives.

The Ousters can be massive to adapt to planets with strong gravity, or very thin for gravities below the terrestrial standard; or they can have different temperatures depending on climate. Differently, Kim Stanley Robinson, in his Mars Trilogy (issued since 1993, starting with *Red Mars*) imagines that the planet is deeply Earth-like transformed, at the beginning only by a hundred settlers.

The narrative time going on, Mars gets the physiognomy of a cosmopolitan culture, similar to the terrestrial culture, but with its own peculiarities.

One of the interesting aspects of Robinson's trilogy is that the basis of the narration is founded on the studies carried out by the NASA (National Aeronautics and Space Administration, the US space institute) to explore and colonize Mars. So might the Earth–like transformation be the most probable solution? Actually we can't be sure of that, we can only take a cue from the experiments carried out on the Earth to recreate self-sufficient terrestrial environments. Among these, Biosphere 2 was probably the most impressive. It is not the second try of the project, actually. The number is due to the fact that the Earth itself is number 1.

Within the enclosed structures of Biosphere 2 they recreated several terrestrial ecosystems, in order to get useful information in case they had to repeat the experiment on space shuttles or colonies on other planets. Biosphere 2 was built in Arizona between 1987 and 1991 by the Space Biosphere Ventures (Nelson, Dempster, 1995) as a totally isolated environment spread on 12700 square meters (Cohn, 2007), where even the water and air recycle was to be totally separated from the exterior. Nevertheless the missions which have taken turns there haven't led to encouraging results: in the first stay experiment the carbon dioxide rate increased exorbitantly beyond any expectation, and made it necessary to purify air by the installation of a filter, even though the experiment didn't conceive any help from the outer world (Watson, 1993).

In the second shorter experiment, within the group of "settlers" different alliances developed after a furious fight, which led to the sabotage of the biosphere itself opening panels and doors towards the exterior (Seedhouse, 2012).

What did Biosphere 2 teach to us? First of all that the running variables and, most important, the interaction among the elements of an ecosystem are much more complex than we thought, and that an isolated human group must be selected, in order to grant a certain balance in it, using the techniques of conflict solution, reconciliation and cooperation.

Interpreting the philosopher of science Telmo Pievani (2002), the unexpected results produced by the experiment and its failure represent the proof the ecosystems evolve and adapt notwithstanding human intentions. Life goes on reorganizing itself independently from our will. Even though we tried to recreate the terrestrial environments on new planets, they may be never identical, or totally different.

Later on there have been, and are going on at present, other experiments and projects trying to simulate life in space or its exploration. We're quoting two of them, mostly important for the results they obtained both from the project and the behaviour side.

The NEEMO project (*Extreme Environment Mission Operations*), a programme devised by NASA to prepare future space missions, took place in a submarine base in Florida, by Key Largo, run by the National Undersea Research Center (NURC) of North-CarolinaWilmington University. Initially conceived for marine biology research works, the base has sheltered, in the course of 2001, several missions of astronauts, in that occasion renamed aquanauts, who carried out extravehicle activities (EVA) under water (Olson, 2011).

The CAVES project (*Cooperative Adventure for Valuing and Exercising human behaviour and performance Skills*), an ESA project recently reactivated (European Space Agency, 2012), allows a selection of astronauts from different countries to prepare for space missions not only living for a certain time in caves on the Mediterranean sea, but also exploring them using the procedures established in the case of landing on another planet. Its aim is to

promote the cooperation in a difficult working environment, in a context devised to be the simulation of a long length space mission.

A mission conceived on a long period, especially if aimed to colonize an extrasolar planet, must be planned expecting a several years' travel (at least by the current technological knowledge) and a minimum number of people to be able to found a permanent colony.

It's not easy to decide which this number should be and one often drifts towards inconceivable suppositions. Certainly, the higher the number, the more probably the colony will settle permanently. The factors that can interact in this case concern the demographic structure and its stochastic fluctuations, the environmental characteristics, the likelihoods of natural disasters and the random variations in the gene frequency. The importance of these factors decreases as the population increases.

These variables are always included in the calculation of the minimum number of individuals of a species, even though the methodologies may be different. In fact, one can draw the data from direct experiments, from the mapping of the biogeographic distribution, from theoretical models, or from simulations and theoretical genetic studies. Every method presents advantages and disadvantages to be considered carefully according to the study context, the time period, the shortage of available data or to statistic variables particularly difficult to control (Shaffer, 1981).

A permanent colony must be considered as an enclosed system, in which immigration and emigration are not possible. More, it must be composed of a number of individuals higher enough to avoid crossbreed, but low enough to be able to travel in space.

The anthropologist John Moore (2003) calculated the minimum number devising a multigenerational journey (leaving out technological solutions previously devised, such as cryostasis, sperm banks, or frozen embryos on board of the space shuttle) by the software Ethnopop, especially created to analyze the migrations of the first human groups by taking into account its demographic trend. Assuming a 200 years' travel which is to say from eight to ten generations, the minimum number of individuals able to autosupport a colony is, according to Moore, between 150 e 180. This number would grant ten potential partners per person, in a monogamic system, and could lower down to 80 or 90 by social engineering techniques.

For instance, wishing the decrease of the number of persons leaving for economic or logistic reasons, Moore has taken his starting point from island colonization among the Polynesians, thinking of couples embarking at a very young age; or asking the crew to postpone reproduction creating long intervals between one generation and the other (Moore, 2003).

According to Harrison (2002), the minimum number should be 500, even though they shouldn't necessarily travel together, but separated, when needed in groups of 25 which would gather just in order to select each others' partner.

These are theoretical results, which fluctuate depending on the variables considered at the beginning of the study planning. For instance, in these scenarios, they considered neither any incidental harmful mutations, nor the reduction of the genetic variability, nor the potential conflicts which may come out within the group or among the groups (as it happened in the case of Biosphere 2), risking to raise a cultural barrier which wouldn't favour the casual coupling. Moreover, the multigenerational space shuttle should provide artificial gravity devices o at least physical exercise programmes aimed to stimulate the bone and muscular mass, to avoid the migrants, and especially the newborn, not to be active in the colonization of a planet because they wouldn't be used to gravity any longer.

There's one more aspect to consider while dealing with colonization of space from an anthropological point of view: the possible encounter with other intelligent forms of life. The human beings have been wondering about the presence of other intelligent beings in the Universe. Out of scientific curiosity, but also because the thought of being alone in the cosmos frightens them. What if, during an interplanetary journey, we really met the Other? This is not a secondary aspect in the field of space colonization. Anthropologists are interested in it, too: the main aim is of course to get ready to a possible encounter with intelligent aliens; but there's also the opportunity to draw useful instruments for the reciprocal comprehension among the peoples on Earth.

Many of the debates about this subject have focused on the possibility of using a "universal language", understandable by other intelligent species. In the process of building this language they tried to bring out the knowledges which could be shared both by human beings and by aliens. The plates set on the two Pioneer probes and the Golden Records on the two Voyagers in the Seventies are an example of this possible shared knowledge. But are we sure of that?

The message sent out by the Pioneer and Voyager probes was addressed to cultures mainly keen on the

technical aspect, rather than the social one, even though the way in which it was expressed allowed to understand both our scientific knowledge and some aspects of our culture. But only some aspects, as it was about the scientific description of the species who sent the message and the planet it lives on, and about some aspect our species is proud of. As a matter of fact, there isn't any mention of war, illness, poverty (Vakoch, 2011).
So the problem brings out other possibilities of intervention for anthropologists.
Anthropology deals with the interpretation of different cultures by comparisons and analogies, with a methodology improved in time in order to understand the Others. This very methodology can be used in first contact simulations based on anthropological models. There could be a double advantage: on one side we could understand how to transmit a broader idea of our culture, on the other side we could verify if the protocols drawn up in the case of extraterrestrial signal records are really adequate.

There is a detail that could be difficult to deal with: because of the interplanetary distances the dialogue between the two culture wouldn't certainly be prompt. It would be necessary to plan message exchanges knowing that the answers may arrive to next generations. In this scenario, the correction of a possible initial misunderstanding would be expensive, in terms of time. More, we have to be prepared to the plausible hypothesis that the extraterrestrial intelligence which we are trying to start a connection with has a different psychology, given by different physiology, whereas the interpretation of cultures provided by anthropology is often based on the fact that the representatives of the different cultures belong to the same species. However there are studies aimed to understand how to connect with different species, by the paleoanthropological and archaeological reconstruction of the life and relationships of the hominid species which came before us. In particular, however difficult it may be to consider in all its aspects, a precious help can come from the encounter between the *Homo sapiens* and the *Homo neanderthalensis*, which anatomical and cultural differences would have caused remarkable difficulties to both species, even though they both belonged to the *Homo* family. These differences come out, for instance, in the organization of the Mousterian sites, much simpler than the sites occupied by the *Homo sapiens*, which in general look more structured and divided by areas of utilization (Wason, 2011).

Moreover, the method of maya and egyptian hieroglyphic analysis, apparently so different from other writings, can help to understand the writings adopted by other intelligent species. These are research works which can draw some guidelines in the recognition of those signs, materials and behaviours connoting an extraterrestrial culture (Olson, 2006; Vakoch, 2010).

A connection by messages sent through space is of course different form a direct and physical contact. This is why the efforts of scientists are concentrating on the speculations about the structure and values of a possible alien society, also from the basis of what we know about terrestrial cultures. These efforts have produced another question: what can be considered universal, in cultural terms, admitting that something universal does exist? Anthropologists don't share the same idea for what concerns the word "culture". But it is true that the discussions about this subject have led to general established principles. For instance, we know that the cultural customs generated by empirical needs are the real basis of the behavioural plasticity typical of our inheritance of adaptation and evolution. Why should it be different for an alien intelligent species? The variability of cultural customs may be at least similar to ours, even though a different context of evolution implies a serious reflection about the meaning of such customs. For instance our species has worked out a perceptive interface aimed to interpret and simplify the outer world to make it useful, in order to adapt to it, rather than just objectify it.

If, as we may suppose, evolution has worked in the same way wherever life has developed in the Universe, we should also admit that every species has devised a perceptive interface based on the particular environmental conditions in which it has evolved.

We can see that also in the culture of a species: mathematics, ever considered a universal language able to allow communication between different intelligent species, thanks to cognitive anthropology studies, has come out as a cultural construction deriving from a peculiar biological and cultural evolution. Therefore, we can't be sure that on other planets they have evolved the same ways of expressing the mathematical laws of the cosmos. (Vakoch, 2010).

The language used by the Amazonian people of Munduruku to works out mathematical notions, could be a good example of the different representation of abstract concepts. According to the linguist Pierre Pica, the Munduruku count up to five in an arithmetic sense, and refer to major quantities using qualitative expressions, such as "some", "many", or "a small quantity".
This doesn't certainly derive from lower intellectual faculties, but rather from an adaptation to an environmental context in which certain mathematical knowledge are of no help in daily life. As a consequence, the number of

words referring to numbers and mathematical concepts is very small. (Pica *et al.*, 2004).
Nevertheless, the Munduruku can easily place numbers on a line at regular intervals, but they accord to a logarithmic function in which smaller numbers are placed at longer distances. There's a proof that the representation of numbers in a linear form is spontaneous, but the use of regular intervals between numbers has got a cultural origin (Dehaene *et al.*, 2008).

So the anthropologists are in privileged position to contribute to the debate using their knowledges about cultural evolution and about which of those can be considered as universal.

What's more important, the anthropological studies about the possible connection with alien cultures and about adaptation in space are demonstrating that the extraterrestrial activity, which we are already carrying out, is slowly reshaping the human societies, in a way which isn't completely clear to scholars yet (Olson, 2006). From this point of view, we are in the best position to assume an "extraterrestrial outlook" and analyze our species from a new and different angle. The dichotomy between "terrestrial" and "extraterrestrial" as well as the division between space as a frontier and an environment, can be the subject for analysis and study.

Maybe the truth is that nowadays we are aliens for ourselves, we still have to realize it.

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