Architecture and the exploration of Mars

A different approach for colonizing the Red Planet

Final

Edwin Vermeer
E.C.F.Vermeer-1@student.tudelft.nl
4026705

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Architecture, Urbanism and Building Sciences
Faculty of Architecture
Delft University of Technology

Course
AR2AT030
Tutor
Andrej Radman
A.Radman@tudelft.nl

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Preface

Humans have always been looking up to the sky and for a long time they could not tell what it was they were looking at. We might have felt safer, having some light shine in the pits black of the night. We might not have felt lost, since the stars would always guide us on our journeys. We probably told stories sitting by a fire, keeping us warm, surviving as best we could and we might have used the stars to conquer the hearts of our loved ones. Stars were a mystery, but they were always there, throughout our common history and they will be there, long into the future.

Stars were long the subject of mythology and even formed the basis of many modern day religions and belief systems. Furthermore, it is of importance to realize that many of the technologies we take for granted today also have their origin in our fascination of the night sky. Stars sparked our belief, philosophy, as well as our technological capabilities, defining both our physical and metaphysical world.

To elaborate, mankind long believed that the earth was in the center of the universe. Everyone who questioned that the universe was unknowable was at great risk. Some were imprisoned, other were burned alive like Giordano Bruno who wrote that the universe was infinite. Churches and rulers were afraid that the entire intellectual frame of Western civilization, and therefore power, would collapse (Zubrin & Wagner, The Case For Mars, 2011). Brave astronomers prevailed and things changed when Nicolaus Copernicus published his book "*On the revolutions of the heavenly spheres*", depicting the sun at the center of the universe in 1543, which was later proven by Johannes Kepler. Kepler's famous quote: *"Geometry is one and eternal, a reflection out of the mind of God. That mankind shares in it is one of the reasons to call man an image of God."* States that the human mind is of the same order as the divine mind means that whatever appears to be rational to God can be made to appear rational

to the human understanding and this is the fundamental proposition of science (Zubrin & Wagner, The Case For Mars, 2011). He proved Copernicus theory by determining the elliptical orbit of Mars in contrary to circular or epicycles orbits which were assumed by many others. He discovered the three Laws of Planetary Motion. His findings marked the end of the Dark Ages and the beginning of the scientific revolution to which, among others, many great thinkers like Galileo Galilei, René Descartes, Christiaan Huygens, Isaac Newton, Albert Einstein contributed. The works of Kepler resulted in the modern laws of motion, universal gravitation and the theory of relativity, which also laid the foundation of space exploration in general. We started to wonder if we could finally understand what it was we were looking at.

Mars, the planet, the dream, the ambition, has had one of the greatest impacts on our existence compared to anything else. We owe to it our everyday lives and understanding of the universe.

The Right Approach

We have once again set our aim to go to Mars, not just to explore, but to stay and inhabit the planet permanently. This brings forth new design opportunities and challenges. From an architectural perspective it is interesting to see our historic development in space exploration, and the meaning of both exploration in general and our existential presence in the universe. The approach can be categorized into technical challenges, environmental challenges or context specificity and above all social challenges. This thesis will investigate what we have already done and know based on the different categories and exactly why a different approach might be better to help extend our existential presence in the universe.

Research Methodology

The first part will describe our presence on *Earth* and the effect of our presence on the planet to understand what we have done here, if we can repeat a similar approach for Mars or that this might not be the best strategy and why. This topic is introduced by a literature analysis of the famous work of Felix Guattari, called "*The Three Ecologies*," which will be explained in more detail. Then, going gradually further from earth, the space exploration approach of *The Moon* and *The International Space Station* will be discussed to generate an understanding of the evolution of space exploration in general. This is done by a literary analysis and topic investigation which includes an issue of Architectural Design (AD) called "*Space Architecture, The New Frontier For Design Research*," edited by Neil Leach, which has multiple articles on different aspects of space exploration. And the book: "*Mars Direct*", written by Robert Zubrin, astronautical engineer and President of the Mars Society. Then we go further from home, to *Mars*, and this part will also be described based on the literature above and additional research papers, which describe new design challenges when comparing short

term space exploration versus long term space exploration. The investigation will also include a small case study for Mars habitation proposals and design proposals for analogs in regard of the Mars mission. Finally the scope is summarized and referred back to the work of Felix Guattari, after which a different approach will be emphasized.

Earth

Before we go into space we should first look at Earth. This chapter will describe the current state of Earth and the impact of humans on the planet. Furthermore, it will discuss the effect of capitalism and globalization and what this means for Earth as it is today.

We live on "The Blue Marble," a water rich rocky planet which is the third from the sun in our solar system. The distance from the sun is just right for life to emerge, because, we live in the so called "Goldilocks Zone," or habitable zone, of our solar system. Apart from Earth, Mars is the only other planet that is within this zone, already pointing out why a mission to Mars might be so interesting. Our planet formed 4.5 billion years ago and has gradually evolved the sensitive biosphere that we all live in today.

Unfortunately we know that human presence can have a very negative impact on the environment. Felix Guattari describes this impact by summarizing some of the more severe problems that are occurring. Pollution, global warming, deforestation, depletion of valuable materials and the usage of unrenewable fossil fuels all add up to the distortion of the environment in the most harmful sense. Thousands of species have already gone extinct, insect populations are decreasing and even many large mammals are at great risk. He argues that the feedback that we get from nature is often

interrelated, unpredictable and impossible to control. "We have upset the delicate symbiosis between ourselves and nature, with largely unforeseeable results (Guattari, 2000)."

In Guattari's eyes the capitalistic system is largely to blame. Ever since the industrial revolution things got out of control and market competition generated mass extraction of natural resources. The market globalized and large corporations exploited, not only the resources, but also cheap labor which created a lot of poverty. Even if we stop polluting right now it would take hundreds of years for the ecological equilibrium to be restored. One of the bigger realizations on how bad the situation really was came from The Club Of Rome in their report called: "The Limits to Growth (Meadows, Meadows, Randers, & Behrens, 1972)," published in 1972. It gave a rough estimation on how long the current rate of production could be maintained before society would collapse. This report created awareness, but it wasn't until the Brundtland commission gave a clear definition of sustainable development in 1987 that actual sustainability strategies were developed to deal with the environmental problems. The definition: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1987), was especially strong because it emphasized that we do this for our future generations, our children. Current day practices are adopting more and more sustainable business strategies to help reduce our negative impact on the environment. However, things are going slow and large capitalistic companies still care more about economical profit than the environment and they will exploit natural resources as long as they can. This is perhaps the biggest problem, where globalization has lead to the point where individuals can't seem to fight the large constitutional powers in the world.

This *current state* of our planet is important because either we seem to want to escape it, or Mars could be an opportunity to get valuable insight into new opportunities for humanity as a whole. More important, *if we go to Mars we should not make the same mistakes as we made on Earth*.

The Moon, Mars and The International Space Station

If we look at the history of space exploration we could understand how this has evolved over time, what our objectives were, and what we should take into account once we venture to Mars. In this chapter both the mission to the Moon and the mission to Mars are discussed to clarify what we did in the past, and why we should go to Mars right now.

To answer the question: why Mars and not the moon? There are two answers. First of all Mars might have traces of life, because we know for sure that it was once a warm and wet planet, so we could find answers regarding that life is a natural phenomenon or not. This would be the biggest breakthrough in history and our general understanding of the universe. Secondly, Mars has water stored in ice and mud and other important minerals for life and it could thus host a sustainable environment for humans, where the moon does not. The moon would be very depended from earth.

Robert Zubrin, astronautical engineer and President of the Mars Society poses an important question when he compared the Apollo space program and our current space program to get humans to Mars: "What did NASA have then that is does not have now?" His answer is Resolution, by which he means determining what it is you want to accomplish and committing to that objective (Zubrin & Wagner, The Case For Mars, 2011). We landed people on the moon and the Apollo space

program was in itself a success, it brought forth one of the most memorable moments in human history, when Neil Armstrong set the first step on the moon and said: *"One small step for men, one giant leap for mankind."* They were sure of their objective and did everything they could to make it happen. Unfortunately that does not go the same for the missions to Mars. Multiple proposals were run through different administrations and all were replaced by insignificant proposals that only repeated that which we already were quite capable of. Resolution, determining what you want and committing to it, seems to be the opposite of what is actually happening. Many people say that the mission is too complex, too expensive or that we do not have sufficient technologies. Without going into details it is important to know that we are about as ready as we will every be and that the only challenge that we face are the same as any pioneering adventure in history, *the-risks-of-the-first*. The first is always risky, because there will always be things that can not be planned, but this should not be an argument to postpone, in contrary, the sooner we start the better. The information and knowledge of actually going would surpass any calculation, simulation or robotic exploration that we could do right here on or from earth, therefor accelerating the process. The objective approach that we have today is keen on predesigning every step of the way, taking into account everything that could go wrong and having the answers ready. This should not be interpreted wrongly, it is of vital essence to have a general understanding of the conditions on Mars and to create a safe environment for our astronauts. One of the biggest reasons why is that space exploration is strongly dependent on public opinion. If something went wrong and astronauts would be injured or worse, then the entire program could be cancelled. The problem with this argument, like stated above, is that we are as ready as we will ever be. The journey will only be marginally safer when we wait a couple years longer and this small gain of safety is nothing compared to the unpredictable dangers that cannot be planned upfront. There are however more aspects to take into consideration.

After the first Moon landing in 1969 the attention shifted from space exploration to space research and funding was reserved to build The International Space Station (from now on ISS). On itself, again, this was a breakthrough for science and a lot of technical development came forth from this proposal. One of the most interesting concepts of the ISS is modularity, which allowed different components to be send to space individually and put together. They could be replaced, repaired or relocated. The notion of modularity became a popular design methodology for modernist architects and especially for Bauhaus (Leach, 2014). Bauhaus nowadays also has a focus on robotic production methods and 3D printing, which is a very promising technique to create habitation modules on Mars. This will be discussed further ahead.

Buzz Aldrin, the second man on the moon after Neil Armstrong also thinks that Mars should be the next space destination to explore. In his book "Mission to Mars" Aldrin explicitly states that a second race to the moon is a waste of resources, that it doesn't hold national glory and that there is no commercial or scientific payoff (Leach, 2014). And he is right, the moon would just be a rerun, with little to gain from it. Aldrin also mentions an important difference between the original Apollo mission to the moon and a future mission to Mars, he mentions we would go there to have a permanent presence on the red planet. His vision is about everything it would entail, both from an architectural and engineering perspective. He also thinks that humans should go instead of robots as they are faster and more efficient and can evaluate any situation in real time. In the end Aldrin hopes that the 50th anniversary of the Apollo 11's landing on the moon will be the start of new ambitions of going to Mars, but he wonders if it will be the Americans that will be there first (Leach, 2014).

The first moon landing was accelerated by what is known as "the space race," which is best described by Neil Leach in the issue of Architectural Design covering Space Architecture: "During

the cold war it was clear that the space race served as a vicarious displacement for other concerns, fueled as it was by rivalry and national pride. The question that remains is which nation now needs to explore space most (Leach, 2014)." The space race might be the thing that gave NASA their resolution, pressure can accelerate most processes. Apart from NASA the private space sector has made considerable progress and with great entrepreneurs like Elon Musk we are able to shoot thinks into space more efficiently and effectively as ever before. His company Space Exploration Technologies Corporation (SpaceX) also wants to send humans to Mars in 2024 (Mission to Mars, 2017). The current day space race might be between different countries, but it might be even more between the public sector and the private sector. For which it could be argued that the private sector has more resolution, and this could be the main ingredient for space exploration like Robert Zubrin mentioned, even though NASA has more experience, funding and capacity to deal with the challenges at hand.

Robert Zubrin's strategy for colonizing the Red Planet is a "travel light and live of the land" strategy and it means that we do not need giant space ships, futuristic propulsion technologies, lunar bases or bigger space stations. Mars has a lot to offer, so it would be more than just scientific research. It possesses carbon, nitrogen, hydrogen and oxygen, all which are the fundamental elements to sustain life. "The Moon on the other hand is so dry that if concrete were to be found there, lunar colonists would mine it to get the water out (Zubrin, Space Architecture The New Frontier For Design Research, 2014)." Colonizing the Moon means we need to produce food there, but this can only be achieved once we import enough biomass to do so, which is economically not very logical. The geological history of Mars has been compared to Africa, which means it possesses mineral wealth, as Zubrin states. Solar panels will be used for power and Mars has a lot of carbon and hydrogen which is needed to produce pure silicon required for photovoltaic panels. This means that we could

produce our own energy producing facilities on Mars, although photovoltaic panels on its own is not enough. Large dust storms can cover the planet for months, so additional energy sources need to be found. Panels can be imported to the Moon, but the 28-day light/dark cycle makes it equally important to have large energy storage capacities. The biggest problem for the Moon is that it has no atmosphere, or better said, it is an airless body and thus sunlight is not available in a form useful for growing crops. The domes that would have to be created, would create indoor temperatures that are unbearable. Altogether, the day/night cycle, no atmosphere, the extra expenses and additional resources needed make it an hopeless proposition. On Mars smaller, lightweight plastic domes could be made from local materials and the greenhouse effect would even create a perfect indoor temperature. On Mars global warming could actually be used to create a thicker atmosphere. We would be able to live on the surface eventually. (Zubrin, Space Architecture The New Frontier For Design Research, 2014) His approach describes a very Earth-like society, and it would even become more Earth-like in the process.

Globalization might be another reason why we have not gone to Mars. Globalization is the idea that everything and everyone gets connected, creating an international society. During the Apollo space program NASA was focused, determining their goals and ways of obtaining them, but currently a lot more stakeholders are part of the NASA space program due to globalization, thus making it hard to determine exactly what it is *we* want. A multitude of demands from different institutions, companies and people, make it hard to make progress on something like a mission to Mars. It is, however, understandable that NASA's field of expertise has broadened due to globalization. NASA has to shift focus between: the ISS, satellites, communication, asteroid surveys, military applications, research and many other things, apart from a mission to Mars. It means that there can hardly be any resolution. The resolution that we need to go to Mars. On the other hand globalization is opening

up opportunities as well, because progress can now, more than ever, be achieved by multidisciplinary and interdisciplinary collaboration. Space exploration might even be one of the first fields where these kinds of collaboration were established on a large scale and thus the field is now represented by engineers, astrophysicists, mathematicians, chemists, biologists and others, just to talk about the technical professions. However, architects have almost not been included and this opportunity has been left open. The field of architecture could contribute significant, especially because we will not only just build on Mars, but also *live*. Architects themselves see this opportunity and it is the reason why many of them design proposals for the colonization of the red planet. Accepting this collaboration is important because it would be a waste of time, energy and finance if the technical development has to be redesigned based on the input of the architectural field.

Mars is perhaps the most context specific design challenge so far. Conditions on Mars might be more consistent across the planet, but the extreme conditions are nothing like the conditions here on earth. We will have to create a context specific design on Mars. Technical challenges can be dealt with by engineers already working at NASA, but architects could have valuable input for spatial quality, psychological wellbeing, form, materialization and meaning. To justify this statement past and present space exploration need to be compared.

What are the biggest differences between space exploration in the past and the ambition to go to Mars? The biggest differences are that most space missions are short-term, crews are all males with a similar national background and have the same professional background (Kanas, et al., 2009). If we aim for Mars then we have to take into account long-duration space missions. Our crews will be multinational, heterogeneous in terms of gender, cultural background and professional training (Kanas, et al., 2009). Along with this the severity of the environment, work and personal factors

increases and so does the risk of psychological issues (Sandal, 2001). Psychological well-being of astronauts is becoming the focus of attention for many researches. Simulations have been done on different terrestrial locations to investigate the psychological effects of possible long-duration space missions, but these missions represent only marginally what we can expect in space. Different terrestrial locations might, however, capture different aspects of living in space (Sandal, 2001). Simulations have taken place on the North Pole, Antarctica, within submarines, on mount Mauna Kea and in Lower Earth Orbit. There are important similarities between these different simulations, one of them above all, living in an isolated and confined (extreme) environment. Understanding what this does to the human mind is perhaps at the core of this research, but it is currently very difficult to see the cumulative effect of living in space for longer periods of time (Sandal, 2001). This confirms that we have to go to obtain the exact understanding of what will happen during these missions.

The psychological well-being of astronauts is affected by more than just living together with other astronauts in an isolated and confined space. We know very little of the effects of deep space on the human body, let alone the effect on the human mind. The "Earth-out-of-view-phenomenon" is one of these questions. Being able to look down to the Earth from space has a positive effect for astronaut well-being, so not being able to will almost certainly have a negative psychological impact (Kanas, et al., 2009). Other challenges are the sheer distance from earth in relation to communication and not having the option of being rescued when something goes wrong. Crew self-sufficiency is therefore very important (Sandal, 2001). These things come on top of the already known dangers of the extreme environment itself, like: radiation, weightlessness, equipment failure and so on. It becomes evident that we have to design something not only to deal with the physical extreme environment, but also for the psychological well-being of the astronauts. Psychological well-

being can be translated to the notion of identity. Being able to maintain your identity is arguably good for your psychological well-being. Relating identity to the psychological well-being of astronauts means that there needs to be a way to achieve autonomy to a certain extend. This can have massive implications for mission success as it can result in a dysfunctional crew when tension and problems are not dealt with in the right way. This means that there is a big challenge to be solved. How can the psychological well-being be sustained without the missions success being compromised? During short-duration space exploration we would send military trained males to space who would be trained not the let emotional factors compromise the mission. Right now, as is described, emotional factors will become increasingly important as long-duration space missions will become standard. Space architecture, the design of space exploration capsules and habitats should help sustain the psychological well-being of astronauts.

Mars Proposals

Current space architectural design focusses on robotic production of habitations and deal with the physical conditions of Mars. They take into account the weight of transportation and the economic aspects. In most cases they try to work with the resources on Mars, with the aim to have habitations ready before humans even arrive. This is the reason to reference to generic buildings on Mars. We will use robotic production processes to generate similar architectural habitats on Mars. Like mentioned before these robotic production techniques and 3D printing capabilities open up new opportunities for the settlement on Mars, which is very different from the traditionally "shoot-a-prefabricated-habitational-module-from-earth" kind of approach. Two famous examples are the Mars Habitat by Foster & Partners, and the ICE House proposal by Space Exploration Architecture and Clouds Architecture. The project by Foster & Partners will use an array of pre-programmed, semi-autonomous robots to 3D-print a Mars habitation module for four astronauts using

regolith, the loose rock on the surface of Mars (Foster & Partners, 2015). This approach aims to have the habitats ready before humans arrive. The semi-autonomous robots will select a good location and built it. The habitats will basically be bunkers, to shield the astronauts from exposure to radiation. The concept for ICE House was to "follow the water", and since its predicted abundance on Mars they used it to their advantage to 3D-print the ICE House. Because the shell is semi-transparent light can still get in, but not the radiation due to the ability of the water to filtrate the light. Furthermore, the façade creates an interior-exterior effect, something that most Mars design proposals deem impossible (Ciardullo, 2015). These design proposals really deal with some of the challenges that we face, for instance: The extreme environment, using the resources that are available on Mars and building before humans will actually go there. Some of them even include a high level of comfort and take into account psychological well-being. In the ICE House for instance, it is possible to look outside, which is good for your well-being. However, there is one analog in particular that has a similar approach but which does not always work.

A habitation on Mars would not be much different from a refugee shelter. First of all the habitats are very small in size, because resources are limited and hard to transport. The habitats will be generic, because they are made based on a system, effective and easy to repeat. In both situations you will live in a confined and isolated space. There are not a lot of things to do recreational, and the things that can be done are described in detail, mostly for security reasons. The conditions are extreme and both Refugee Shelters and Martian habitats have to deal with occasional extreme weather. Apart from the obvious technical differences and mission goals and so on there is one particular difference that I would like to mention. Refugees, to some degree, can walk outside, under a blue sky enjoying fresh air. Astronauts cannot. It would almost seem that being an astronaut is

worse than being a refugee. And maybe it is, apart from the fact that astronauts have global support, and being able to explore is probably the most exciting job in the world. But when astronauts do live on Mars, wouldn't this motivation decay over time, as they adapt to Martian life and are exposed to the extreme conditions and challenges every single day. It is currently impossible to predict how events will unfold, which actually means that apart from integrating the psychological well-being to a higher degree also resilience needs to be addressed. Resilience is the capacity adapt and overcome. We are at risk at making the same mistakes as we are making in refugee camps. Leonora Oppenheim who designs improved refugee shelter states that humans are resistant to homogeneous designs, they much prefer to build their own house (Oppenheim, 2006). Emily Underwood also describes why many proposals for humanitarian aid in refugee camps fail. To her many proposals fail because they effectively prevent people from using their own skills and tools to come up with a solution that suits them much better (Underwood, 2016). Finally Kilian Kleinschmidt former United Nations High Commissioner for Refugees (UNHCR) emphasized an approach which was based on "beyond-survival", by which he means that people need basic needs, but that they also need self-esteem and identity (Kleinschmidt, 2015). Placing a person at the core of the approach, instead of trying to predefine every aspect of the mission seems to be important.

The technical challenges for colonizing the Red Planet are far to big to leave everything up to the astronauts themselves, but taking away autonomy entirely might have a negative impact on the psychological well-being. To deal with this problem a balance needs to be found between overall safety of the mission and the degree of autonomy that can be integrated into the design. Furthermore Resilience is an important theme which allows astronauts to adapt and overcome unforeseen conditions, problems and events. This concept of autonomy and resilience can be translated back to The Three Ecologies of Felix Guattari.

The Three Ecologies

Human activities have a negative impact on the environment of Earth and we should not make the same mistakes once we go to Mars. It should not be our escape plan. It should be our opportunity to extend our existential presence in the universe and we should save our home planet in the process by discovering new technologies and ideologies. The history of space exploration has brought many advances in every day life and it expanded our general understanding of the universe. Still the process for space exploration didn't accelerate much in the past 50 years and this might be because we don't have the same resolution. A second space race could facilitate this process, but we should be very careful that this would not be a race for national pride. Furthermore, globalization has made it hard to diverge from current ideologies, but this could be an essential aspect of going to Mars. We need a different ideology, a different approach towards colonizing Mars. Secondly, many Mars proposals include context specific designs, which work with local resources and which will include sustainability. We probably realize well enough that we should take care of the planet and not let something similar happen to Mars as what has happened to Earth. The real challenges are about human psychology, social aspects of living together in confined and isolated environments for longer periods of time and the need for autonomy and identity. Felix Guattari calls this the inseparability of the three ecologies: social ecology (collective), mental ecology (identity) and environmental ecology (context).

The historic and current day approach seem to be very objective, maintained and controlled. If we go to Mars then maybe this could be the right strategy for the mission itself, but not for the society that we are going to create on Mars.

Colonizing the Red planet has been a popular theme in science fiction. Conceptual art, artist impressions and detailed plans reveal how diverse our vision is. The objective approach is about exactly measuring what we need to go to Mars, what we need to take with us to live there, and what we should do to maintain it. Science fiction writing is opening a lot more doors that are probably more interesting in terms of opportunities. Does the Mars society need to be equal to the society on Earth? Will we live the same way, do the same things and eventually go back and forth the same way as we would go to a different country? Will Mars be an extension from Earth, eventually have borders and its own earthly population? When something like this is described in the high-road-low-road way then the result would be that the high-road is the utopian we all want. The planet would be colonized in the right way, and the boundaries of earth would have expanded to Mars. A new society would be established, made sustainable and life would continue more or less the same way as it did on Earth. The low-road would in fact be about unforeseen events that radically change this utopian world. The society would change differently from Earth and have different values and beliefs, to the extent that, our world leaders choose to be at war with Mars. It would be ironic, since Mars is named after the Roman God of War. This perspective reflects most of what has happened time and time again here on Earth. The belief that some values and beliefs stand above others and that actions should be taken if some society chooses to be different. Will history repeat itself? Mars should not be tamed like a beast. Mars is an opportunity to leave our mistakes behind and finally start something new. We should not go to Mars to plant another flag, we should not draw borders on its surface, there should be no debate about who it belongs to, because this will also mark the beginning of the end. If the first astronaut sets foot on Mars then he or she should say something like: *"One small step for men, one enormous opportunity for human evolution."*

The bigger question is actually do we want to create Earthlike condition on Mars or do we allow humans to develop differently from what we are used to on Earth. Eventually this could mean that humanity transcend into a whole new species since they will be living in vastly different conditions on Mars. It is a question of to preserve or to let go. Preservation would mean putting a lot of time, effort and resources into countering the differences between Earth and Mars as is this even justifiable? It is however important to think about the right strategy as it will have implications for space mission design as a whole. How could space architecture take this into account? We are accustomed to designing missions in every detail and even writing extensive protocols on how humans should behave, act and cope, but allowing evolution to take place it should be less about this control and more about letting go. There is a tension between these strategies and with little understanding of actual long-duration space exploration it is hard to pick a favorite. Evolution is not something that you can design but maybe, for the first time ever, venturing into space might be an important stimulus of evolution even if we don't know in what way it will come to be.

Conclusion

Many proposals for space architecture on Mars tend to only take into account the physical needs of our astronauts, and occasionally, like within the works of Robert Zubrin, the "life-of-the-land" approach and thus working with the environment. This context specific design proposal is perhaps the best that we have and although plenty of research is being done on the psychological well-being of astronauts it would still seem that we miss this translation into our current architectural perspective for Mars. As Félix Guattari argues in The Three Ecologies, we should take into account the social ecology, the mental ecology and the environmental ecology. The question is not to implement this strategy "eventually", or "when the time is right", but to do it right now. We have learned from the past, we have the technical capabilities, we just need to change some ideologies.

Mars doesn't need to be a copy of earth, it can be something totally new. Like mentioned above, the first man on Mars should say something like this: *"One small step for men, one enormous opportunity for human evolution."* Maybe human evolution will transcend the homo sapiens, into a new species, open up even more opportunities. Subjectification could be the right approach for a mission to Mars, not in a technical sense, but in a existential sense. We need new ideologies based on intelligence, social interaction, care and emotion to help transcend beyond our current barriers.

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