the space between aspiration & achievement:
an architectural exploration through an extreme environment

by Olia Punch
“We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.”

T.S Eliot. Little Gidding, 1942
introduction

The underlying question of this thesis is concerned with the place of architecture in extreme environments. It is about designing a typology for living in a destabilized and uncertain environment. It is about designing the capability of living somewhere else.

In its own right this thesis is an exploration in itself. An exploration of what is possible, and more so, what could be probable. It is a critical response to the question of how we might both construct and live in the near future.
In contemporary discourse we ordinarily use three words to describe our planet. The Geographer Denis Cosgrove has perceived that these three words exist as; Earth, World and Globe.

**Earth**: an organic notion – it ties itself to the land. It is deeply rooted in nature. It in fact epitomizes the power of nature. In its simplest meaning, it is the place where all living things dwell. The solid part of the Earth’s surface.

**World**: a manifestation of social meanings - It encompasses the social orders by which our society functions. World is both internally personal, and externally communal – each of us have our own world in which we live. In the same vein, we each have a distinct way of interacting with the world through what is commonly referred to as our human personality. It can be both reality, and imaginary. World shapes our individual and collective identity. World is inclusive of our beliefs, values, our traditions and customs.

**Globe**: a reference to space and shape – It is spatial, geometrical, communal, global! It is something that we all share, but from our line of sight we cannot see where it begins, or where it ends. It is dissimilar to earth; for globe cannot be touched. It is a conceptual visual image that we can imagine, but yet are distanced from. It is a conglomeration of both natural and un-natural systems. It is the formwork that holds earth and world together.

Earth, world and globe – Unequivocally, these three words are synonymous with the idea of home. Home exists as a fundamental human instinct - an instinct that is embedded in all human consciousness, and one that is firmly attached to architecture.
Architecture is the method in which we have learned to not only live, but to thrive in certain environments. Mankind has the ability to transform the natural obstacles in our world into assets. We do not submit to the intrinsic environment we find ourselves in. We adapt. We evolve. We learn, and we create a selective environment suitable to our human requirements. In a sense, throughout our human past, we have completely resisted our external environment, often detaching ourselves from the natural world. The method in which we have done this is through our buildings, our shelters - our homes.

Buildings manifest themselves as the transmitters of our lives. They project the life of time that has passed, into the lives of the future. The solid forms that surround us allow us to make, and pass judgment on our three dimensional perception. It is through architecture that we project our culture into the world. It is evident that there is a native genius that exists in primitive, and indigenous forms of architecture. In this case, primitive does not mean simple - but original.

The origins and evolvement of dwellings are fundamental to who we are. When a dwelling is pared down to its very basic function, it stands as a shelter. It exists as the separation of the human environment from the natural world. It is a deliberately planned environment. Dwellings offer us the basic requirements to shelter us from the physical threats of nature. The typologies of our shelter help define and explain who we are, and where in the world we are living.

Dwelling and exploration are too, in many ways, an evolution of one another. We traverse, and we dwell. It is when we do not submit to tradition upon exploring a new world, that new technology and knowledge is created. When the first immigrants moved to the New World, many of them based their cities on traditional ideas from the lands they originated from. They adapted the known to the unknown. However, some, particularly the land takers, planned their human and vegetative resources with the same attention, and consideration as our Neolithic ancestors. They became forged to the land. They used nature as an asset - and not as an obstacle to overcome.

The landscape and climatic environments of the Earth have shaped, and been the deciding factors of migration patterns taken by both animals and people. Ritual elements exist, and are also created within architecture. We have adaptive migrations within our homes. We create rhythms in life that alter with time, as do the passing seasons. Descending the stairs can mean joining family. Closing a door can mean creating privacy. Variety is important. As a species we search for bio-diversity. We adapt to different environments, we discover how to survive in an environment, and we dwell in a learned environment. We find the best features of a landscape in terms of its materiality and climate to serve our purpose. We do this through two methods – we become forged to a landscape, or we become detached from a landscape. We stay and transform. Or we migrate onwards. For nomads, place becomes irrelevant to home.

Throughout recorded history, humans have chosen to place themselves on the edge. To face extreme environments, all the while pushing their physical, psychological, and emotional capabilities to the extreme limit. Making an inhume landscape human is something that we have done for centuries. The risks we associate with today were undreamed of a hundred years ago. Earth is not static in any shape or form. This provides an unstable world both environmentally, and socially. It creates extreme places. It creates extreme situations.

Traditionally, we dwell on the solid part of the Earth’s surface. However, we have begun to look beyond this as the scale of our limitations. In the same light, we have begun to explore beyond the traditional constraints of architecture. Technology and science are informing architectural constructions on Earth in some of the harshest and most extreme landscapes. From Arctic environments, desert climates, high altitudes, flood plains, disaster mitigation zones, sub-aquatic landscapes, to outer space. The role of the architect in territories like these becomes more challenging and multi-disciplinary. Extreme environments must create a more resilient and sustainable typology of architecture. With the task of making the inhumane human; instead of becoming more generic, things should become more specific, and in the same vein, universal.
There is a difference between something being merely imagined, to being fully realized. Just as there is a distance between aspiration and achievement. The space between the measures of these distances is where exciting things happen, and new ideas emerge. This is the space where exploration begins.

The Age of Discovery in the fifteenth century marks the beginning of the period of global exploration. This was made possible through technological advances in sea voyaging, paired with the desire of finding a new world. An explorer can be defined as one who is willing to leave their community in search of perhaps a better one – it encompasses a utopian ideal – it also encompasses the human trait of a fierce restlessness. In contrast to this, is the human attribute of a burning desire to settle. We have a human passion to dwell in communities, to live amongst each other, and not in isolation. Although we transform our intrinsic environment – we also yearn to bring the outside in; to tame what is wild, to explore new landscapes, and to find an identity that is common to us all. Similar to the force of gravity, the human desire to live communally inevitably brings us back to ourselves, and to one another.

Many lessons and knowledge have been garnered from dwelling and traversing through harsh environments. As a consequence, there are different precedents that exist in the history of human discovery. There are different embodiments of exploratory conduct, and different strategies for exploration.

In 1914 the Antarctic South Pole was first discovered. Robert Falcon Scott, and Roald Amundsen found themselves on a polar voyage - both in the race to reach the South Pole first. Both of different nationalities, both hailing from different backgrounds – both subsequently exemplified very different methods of exploration and exploratory conduct. Amundsen, who went on to discover the South Pole, utilized the landscape around him to his benefit. He became forged to the land. He used the indigenous materials of his surrounding environment to his best advantage – he dug into the ice.

Scott's expedition conducted their exploration in the opposite manner – they detached themselves from the landscape, relying on only prerequisites and the constructs from their originating homeland. Scott described the glacial landscape as being featureless, and void of beauty. It displayed nothing of the picturesque or sublime – or at least in the way his eyes had been conditioned to see. The human senses search for familiar spatial idioms that give us comfort. As the explorer ventures into new worlds and unfamiliar lands, an outward-bound aspiration is to claim these unknown landscapes with names that will commemorate their personal heroism. Architecture will design a physical form to lay these claims and names upon. For voyaging ultimately, if nothing less; gives us an internal understanding of our identity – and - if nothing more; garners an intimated knowledge of somewhere else.

Buckminster Fuller viewed the Earth as one unit – a giant spaceship Earth. One that is so well designed, that life keeps generating and sustaining itself inside it's closed life support system. This life support is known as its biosphere. It is what keeps every living organism alive on this planet. It is the part of the globe where the zone of life exists. It houses the small-scale dwellings of everything living. Earth’s gravitational pull acts as the membrane, or the skin that holds in our atmosphere. The biosphere is made up of many different biomes – all of which work together naturally to create our self-sustained, and self-regulating environment. These are the ecological building blocks of our world.

Man first began designing human controlled eco-systems more than ten thousand years ago; this was the origin of agriculture. In contemporary discourse, designed eco-systems are more commonly known as farms. Man exploited, and still to this day exploits the surplus energy made available through farming the land. Through this, cities are created, and technology is developed. Our society has stemmed from agriculture, and farming has shaped our world. This transcends across all cultures and landscapes – in places where people do not farm, the resonance of designed eco-systems is apparent in their gardens – even in the banal simplicity of a window box. Continually, we yearn to bring the outside in.

The dawn of the space age created the view of Earth from space. Finally we saw Earth, our world, as the global unit it is – a spaceship Earth - an iconic image. What has perhaps most preoccupied many astronauts that have orbited our planet is not the moon, not the vastness of space - it is Earth. The biosphere of Earth is totally unique in our solar system. Without it, we will go nowhere off this planet without a similar life support. Perhaps it is through an architectural typology that we can begin to achieve this.

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By means of the exploration of our planet, we have learned the methods through which to live and construct our civilizations in certain environments. In harsh landscapes that without shelter are not humanly survivable. If the home can be deemed as much a physical place as it is a state of mind; how does that transcend to an extreme environment where conditions are completely inhumane? Typologies of dwelling help define who we are and where in the world we are living. But in the most extreme of places, there is no typology at all.

Space culture is often concentrated with fantasy - and within this there is perhaps little reality to encourage anything more. But what if we were to live somewhere else? What is the role of architecture in designing a method for human survival in the most extreme of all environments? How can sustainability influence the aesthetic of architecture? This idiosyncratic aesthetic—or even the lack of aesthetic for this typology—is non-existent in many senses. The Apollo Lunar missions projected the only image we know of humanity existing somewhere else.

Such thoughts begin to manifest themselves through the binary of dreamy armchair speculations, mixed with the scientific pragmatism of the possible. It is certainly possible. Even probable. We now live in every environment that exists on Earth. The landscape we see now is made up of a total human construct. It is difficult to find parts that have not been touched, or at the very least affected by humanity.

Space travel has re-opened the possibilities to fuel our primal desire for exploration and discovery.

The discourse of designing for space—traditionally—has been monopolized by mechanical and aerospace engineers. Architecture existed only on the margin. This thesis aims to explore how architectural design in extreme conditions demands the question of how to design and construct a long-term and viable typology in another place beyond our planet. And within this; it questions how to design for the human factor, in a place where humanity has never existed.

With the Apollo program an entire new, and unprecedented aesthetic was cast into the reality of our world. The spectacle of it all shocked the world. For a brief moment in time, it seemed we were capable of anything. The space race that brought about these extreme advances in technology—and humanity—was a product that sprang from the catalyst of a social and political change. And then, suddenly, much like the polar expeditions of the nineteenth century, the space race ended.

However, we continue to have outward-bound aspirations that are beyond ourselves. In reality, for all its material advantages, the sedentary lifestyle that we lead today has left us edgy. Even unfulfilled. As we become more aware over the last two decades of the instability of our world, we have started to look for solutions, and to other places—to new frontiers that are beyond the confines of our planet. A frontier—a noun that often has been associated with wonder and fiction—is a place that lies on the other side between what is known, and what is unknown. Existing on the boundary, an unfathomable place; consisting of a geography of material potential. Similar to the first Space Age in the nineteen sixties, when space faring seeped into our human conscious on a global scale, today—in 2015—space faring has been catapulted back into popular conscious, or so it seems.

Exploration has historically been driven by economic necessity. We search for profit at the margins of our world. Our goals keep shifting, as will the funding—for it is not as constant or stable as it was in the Apollo era. Nor is the political will as dominant. Regardless of these factors, the capability to send people beyond Earth orbit is coming into focus. There is a concept of moving forward. A concept of what might be the future. A new measure of modernity seems to be occurring. In times more recent than the Apollo landings; the Mars rovers Pathfinder, Opportunity, Phoenix and Curiosity created the first images of virtual space exploration. When these robotic explorers changed direction, we too changed orientation—when they picked up a rock sample from the Martian soil, we too were examining it with our own eyes.

Mars has played a role in our human culture, and is the most familiar planet in our solar system beyond Earth. That is because we have considered it as a world, and not just a celestial body. It has had a huge effect on pop culture, science fiction, and both myth and legend. It has been a major part of astronomy—the longest research program carried out by human kind. It has captured perhaps the longest focus of the ancient history of many civilizations.

As previously stated, this architectural thesis is an exploration of what is possible, and more so, what could be probable. Because of this, for now, pragmatism must leave science fiction behind.
“People are always asking what we discovered when we went to the moon: what we discovered was the Earth.”

Richard F. Gordon, Command Module Pilot, Apollo 12. 1969

Utopian ambitions often lead us back to where we first started. The issue with frontiers is tabula rasa will inevitably become terra incognita – in other words, exploration will inevitably return us back to where we first began. In the same train of thought, by designing the method in which to live on another planet, we are also designing a typology or method to exist on an unstable Earth.

If we begin to boil things down to their fundamental truths, this enables us to then deal with them in their purest form; and begin again from the virtue of first principles. A variation of existing knowns emerges. This points us to the very matter and origin from which something can be made; this points us to materials.

The origins of architecture first emerged when mankind had no other choice but to build dwellings and shelters from the materials and natural resources that surrounded him/her. This is the definition of vernacular architecture. The vernacular spans the origins of primitive architecture, evolving it to the architecture that exists today. As previously stated, primitive does not necessarily mean simple, but original. There is much to be learned from vernacular forms of architecture on Earth. Vernacular architecture is indigenous. Constructed of local materials. It is reflective of traditions that belong to a society. It tailors to the climatic and the material aspects of a given site. It is completely site specific. Subsequently, vernacular building styles and typologies differ and adapt, as much as to the climate, landscape and the local materials evident, depending on their location on the planet. Fundamentally, the vernacular submits to its surrounding landscape, and creates its construction and design from a first principles approach to architecture.

During the late nineteenth century the vernacular in itself became the subject of much exploration. Its study began to highlight and cast into the world the sheer technological and environmental intelligence that exists within the make up of these buildings. This is in contrast to the former dominance and focus occupied by only their aesthetic form.

There is a common misconception with vernacular forms of architecture. This is because the most common words in our language used to describe it are associated with stereotypical imagery; imagery that more often than not leaves little room for other associations to occur. Words such as indigenous, traditional and ancestral. Words like these imply strongly that the vernacular is something that hails from only the past or the exotic, and exists beyond ourselves; beyond our personal experience in the twenty first century. However, this is not the case – the majority of us have been raised in homes, or at the very least, our daily existence has been occupied at some point around buildings that speak of the vernacular to an extent. Vernacular architecture is an intelligence of itself, and an intelligence of first principles in materials and design. The vernacular continues to be the most viable method of sustainable, intelligent construction that has ever existed on this planet. Intelligence, sustainability, environment and materials – these are the words that the vernacular today should be epitomizing.

The common construction methods and alternatives to vernacular techniques that exist and that are in dominance today do not address the environmental issues that our planet faces. Modern construction methods for the most part do not address the environmental impact that our construction industry detriments further to the Earth, and as a cause of this; vernacular techniques are becoming obsolete.
Space architecture has a certain aesthetic. Similar to the lunar landings – it hasn’t evolved much in terms of its chosen materials or form. The International Space Station is one of the most expensive and intelligent pieces of architecture that humanity has ever created. Its scale spans the length of a football field. It has been in constant human occupation for over the last decade. Its inhabitants live there for six months at a time, working and living in weightlessness - inside 2.4 metre diameter aluminum module containers, that orbit our planet every ninety minutes. Its aesthetic exists in this way simply because it has to, in one rotation of its orbit it experiences an external four hundred degree temperature fluctuation. It acts as a vessel for sustaining life and replicating an Earth like environment. The space suit in itself is an abstraction of architecture. It too exists as a complete controlled and designed environment. Locked inside this hermetic environment – there is little relationship to what is happening externally. All of the senses, excluding vision – are cut off from external conditions – you do not exist in the outside world. Ultimately, there is certainly no space vernacular in existence. However, this thesis project is not located in space.

In the case for Mars, there is an extreme cost of importing materials and equipment from Earth in order to construct a habitat elsewhere. This greatly re-emphasizes the importance to use locally available materials that are indigenous on the planet. The notion alone of this upon first reading may appear like a reckless fantasy. However, pragmatically speculating what is possible moves the idea into reality - for we do know the composition of Martian soil – it is not that dissimilar to Earth. Just as it is a purely internal visual act to imagine the earth as a globe, it is one and the same to imagine Mars as a landscape. But it is a landscape, a desert one; and one where the most readily available materials are regolith and rocks.

The current state of play with space agencies outlines the deliverance of space habitats to be both constructed and sent from Earth. More often then not, these habitats are deployable structures that can fit inside the aerospace vehicles and cargo rockets that will transport them across our solar system – in some cases these habitats are the vehicles themselves. These habitats will become homes. And homes like these do not provide a sustainable, viable standard of life for the long-term habitation for our future explorers. Nor will they garner any new knowledge or ingenuity. Similar to Scott’s polar voyages in 1914; in a sense, these space habitats will completely resist, override and ignore their external environment – which in fact exists as a planetary landscape and not outer space - as which these habitats were originally designed for.

To counter this, there is another option. We can begin to focus on the elements that exist within the Martian soil. What is the material potential? In truth, a complete geography of material potential exists. On Earth we have a periodic table of all the elements in their compositional form that exist on our planet. What if we did the same for Mars? This information can be garnered from basing it on the existing facts that we have in our knowledge today. Curiosity rover has analyzed the Martian soil. For this thesis to move forward to uncover the potential that exists, a periodic table of Mars must first be created from the data that has been accumulated by NASA thus far.

This is a projection of the future that is based on the present – where gravity happens to be 62% less. This architecture thesis now aims to uncover the vernacular of Mars.
Sulfur Concrete Composite
Properties: Compressive and tensile
High freeze-thaw durability
Corrosion resistant
Mix: Regolith + Sulfates - No water required as a binder
Impermeable - hermetically sealed once structure is closed

Silicon:
Photovoltaic Cells manufacture: Energy Source
Solar Panels
At its essence, this material investigation reaches beyond normative endeavors. But limitations exist. To further the task of discovering the possible, parameters must be set. The only construct or prerequisites from Earth that can be relied upon in this investigation are its machinery and technology.

Under the laws of Martian gravity, the loads of a structure when compared with Earth standards will become lesser by approximately one third. This difference in gravity from our terrestrial home has been deemed as disadvantageous – as many differences often are classified. But in reality, on many levels, and certainly for architecture this is extremely opportune and desirable. It opens a whole new spectrum of possibilities; constructionally, spatially, and aesthetically.

There is of course already a speculative discourse emerging with regard to the development of materials in the areas of science and bioengineering. Some of these prospective developments are beyond even our current science fictions. The future of materials is that of material adaptability - materials that have the ability to respond to - and with - their surrounding environment. This will create an entire new construction process, and develop new forms.

For now however, the existence of sulfates and clay in the Martian soil already opens up a new realm of possibility in both material science and architecture. It creates an opening for a new generation of composite materials to emerge. The aim of discovering a Martian vernacular will provide a method for us to live in balance between the restrictions of our human bodies, and the planets given environment. This will create an entire new construction process, and develop new forms. A prospective development like this is the first stab at humankind constructing an architecture in another world. A large step-up perhaps from the lunar landings, but one that is far more fixed, attached and permanent; belonging to a certain place and with the purpose of naming an inhume landscape as something human. This raises the thought of what the cultural associations the architecture of Mars will convey.

Buildings while acting as transmitters also function because they incorporate the strict routines of professional practices of their time. Synonymously within this exists the expanse of cultural association. While architecture does act as a translator of our lives, buildings also too speak loudly of and belong to a certain culture. However, inclusive of this, there should be no desire to perpetuate a tradition that will have no true value. The ability to create a lasting structure on alien ground is based on proficiency. We can turn the deemed obstacles into assets. We can find the best features of Mars and turn them into resources. We can become forged to its landscape, and begin to transform it to serve our purpose.

To begin to speculate on choosing a site in the vastness of a planetary scale mixes the impossible with an arbitrary notion, although, there are certain critical parameters that must be met in order for this to become both feasible, and a possibility. The habitat should be sited in the vicinity of the in-situ resources required for its construction. Because of the higher level of atmospheric pressure on Mars, a low elevation is of fundamental importance. A site that has evidence of having thermal inertial qualities is also extremely desirable - if not extremely rare and difficult to find. The chosen site must be located on a suitable orbital trajectory in view of Earth; this is in order for clear communication and access to be possible. A site that exemplifies in fact all of these requirements is Gale Crater - existing on the equator - this site also provides the warmest and most temperate of the climates that the planet has to offer.

First principles will be the deciding factor of the architectures aesthetic – this involves two aspects – the construction method and the material ability. The prime virtue of materials is not aesthetics; it is perhaps their ability to alter the climatic elements of a given environment, thus creating a controlled intrinsic environment that exists within. This is an essential element in the case for Mars and human habitation. A return to first principles upon first speculation may appear as a step in reverse on such a forward thinking driven endeavor – but what if we combined our technological advances with the intelligence of local Martian materials in this same light? We can we apply the known to the unknown through our current Earth technologies. The construction method – for nothing less than complete proficiency in a hostile land - should be based upon this.
Choosing a site on a planetary scale
Specific parameters must be met and are required for this to become plausible.

Temperate climate exists along equator and within orbital trajectory of Earth for communication

Low elevation = higher atmospheric pressure
Site exists as Gale Crater

This site meets all criteria required for construction, landing access and will allow human occupancy and existence to be more feasible and comfortable.
3-D printing technology did not exist a decade ago. But within this decade alone, a NASA based engineer; Behrokh Khoshnevis, has been working on furthering the capability of technology like this in terms of building in another world.1 This could replace the demand for laborious human labor in extreme environments where normal construction methods may not be possible, or indeed extremely dangerous. Methods like this also can be used here on Earth in disaster mitigation zones. And with 3-D printing, the possibility of form is completely endless.

Khoshnevis has created robotic machines to be sent to another planet that can 3-D print pre-designed buildings using composite materials, one of which is similar to some of the properties of our Earth concrete. This is carried out through the science of extruding what exists indigenously in the given ground of a specific site. In the case for Mars, this composite material will exist as sulfur concrete, made only from Martian regolith and sulfates. The mix consists of twenty percent sulfur and eighty percent regolith. This material is particularly favorable as it requires no water, nor curing time as its Earth counterpart does. It is created by heating the components; therefore it can also be recycled by reheating the components – it has a zero carbon footprint. In terms of its material ability; it is impermeable due to the lack of water as a binder, henceforth it has the ability to create hermetically sealed environments. It has high freeze thaw attributes and is both compressive and tensile – these are advantageous material properties for weathering the Martian environment and its low temperatures. There is also a recent discourse that has emerged involving a similar idea for construction on the Moon by Foster and Partner Architects in conjunction with the European Space Agency. These once deemed reckless speculations and fictional ideas are now becoming a reality, and they will create a binary between modern technologies and first principles.

Due to the high level of clays that exist in the Martian soil, this then creates the opportunity for versions of brick or masonry construction to be produced. The ergonomics of brick manufacture and construction does not lend itself to the dexterity of a space suit. However, a brick on Mars will not look, nor does it have to look or be constructed like a brick on Earth. The form can differ as much as the scale due to the lesser loads applied by Martian gravity. Ceramics are also a construction possibility; any principle methods of adobe style construction can be applied to a Martian vernacular. The dominant difference and main advantage is; any type of masonry construction on Mars will be able to span much further.

Modern materials found in space architecture can portray a persona and image of timeless perfection, but in humanity this does not exist. This is the prime factor to why they do little to stimulate our human senses and therefore, where unnecessary, they do not belong in a long-term confined human habitat on another planet. Simply, we do not see ourselves reflected in them. Natural materials have a sense of authenticity and a virtue behind their origin. Over time they become weathered and aged, this aids to their character and sensuality. In a sense, they bring the outside in and reattach us to the natural world, from which we are sheltering ourselves. For this exploration this is where the human element in design begins to come into focus.

The architecture of Mars will be completely derived from what is possible, and more so, what is necessary. However, what is also necessary and perhaps of the most importance is the human factor.
“Every discovery must, at some time, have made use of the head, the eye, the hand of a person…”

Le Corbusier. The Modulor. 1966

As stated previously, there should certainly be no desire to perpetuate any traditions or constructs from Earth that will have no real value on another planet. However, this is humans in space – human exploration – and humans on Mars.

The human factor consists of the physiological position from which we experience, and interact with architecture - and with our entire world. With the prospect of colonizing Mars, some important questions are raised. There exists an extreme stress of an individual being in an environment that the human body is simply not adapted to. For Mars, social issues will be just as real as cosmic ones. How much space is required or enough for a human being to live in a prolonged contained environment? How much space is enough between a human and another human? How much space is enough between a human and another space?

The design challenge inescapably will look to universal design, and push it to its extreme limits – how does an architect design a building in a place where as a species we will have a complete lesser mobility; a place where our human form does not function in the way it does on Earth? There is a need for a new spatial typology that is not static to emerge, one that is transformative depending on the inhabitants needs or the required environment. One that perhaps may even - or more so – inevitably should, create an entire new way of living and interacting with buildings when compared to the constructs of our current societies on Earth. As well as satisfying the inhabitant’s physical needs, the architecture will need to ensure their mental well being while living in such an alien environment.

From the very beginning, we are born into an environment that begins to condition our notions and beliefs of beauty, aesthetics and comfort. From childhood we learn how to dwell, to seek comfort and to feel at home. All of this appears fairly relative. But there is no existing example or precedent of an eight-month journey to Mars in order for us to learn its effects on the human brain, and how it might be conditioned. Ambitious simulation projects are indicative of how important an understanding of this really is.

The European Space Agency carried out a pilot test mission – a psychological study. Could six humans live together to simulate a mission to Mars, a two week stay on the planet and a return mission – all of this encompassing five hundred and twenty days of living in extreme isolation and proximity to five other crew members, within in a hermetically sealed environment. This mission was called Mars 500, and its aim was to decipher what the effects both psychologically and physically exploration like this requires, and whether humankind could successfully achieve such aspirations.

Diego Urbina, a crewmember for this mission, highlights the personal difficulty of monotony in such an environment. The living quarters in the windowless habitation module equated to the scale of only seventy-two meters squared in totality. The complete lack of a spatial variety dominates his recount of the experience. Similar to personality traits, each crewmember found their own personal way of dealing with living in such close proximity. Urbina for example, instead of going to his personal bedroom for privacy, took refuge in a medical module in the evenings - unknowingly, the crew began to take ownership of certain spaces. Physically, sleeping patterns began to become disrupted. Due to the lack of natural sunlight, the absence of the blue light spectrum caused confusion to the brain – whereby a difference between day and night could not be determined. This resulted in some crewmembers experiencing twenty-five hour day sleep-wake cycles, which in turn caused them to be sleeping while they should have been awake and working. This created lethargic attitudes and forms of hypokinesia - For example; when faced with the task of living in a contained environment, ordinarily one would assume each space available to the inhabitant would be used, however, the crew began to stop using a specific module as it started to appear too difficult to get to - to enter the module required the act of crouching through a hatch door. Subsequently the module itself became abandoned for the most part – reducing even less the size of the Mars500 habitat, all as a cause of the crew beginning to simply move less.

This biological reaction supersedes a rational evaluation. The human brain gets bored easily, but it so too becomes passive and indifferent without lack of stimuli. This is where a variety of space becomes extremely important and imperative. The needs of an individual are not firmly fixed, however, nor are they infinitely varied. This creates a task for architects to design environments that will be more crucial, and more necessary to their users than anything that has ever been designed before.
If we look once more to what is known; the landscape and climatic environments of the Earth have shaped the migration patterns taken by both animals and people in search of bio-diversity. On Mars the same could apply not only on a macro scale, but more so on a micro level with the aim of creating spatial-diversity. Perhaps an architecture that looks to an adaptive migration within the home may be a solution. In the same vein, in light of first principles, this adaptive migration could be based on material properties. Different weather conditions will affect the buildings use, as will the ritual change between night and day. This will create a complete variety of spaces – each with their own spatial and environmental characteristics. These divisions and rhythms could be designed through the virtue of their purpose – thermal, visual, and comfort levels mixed with the pragmatics of functionality and use, all derived from a human scale. Fundamentally, the first and foremost step of such an architecture requires the design of an environment where the containment of a space suit is not required.

In reality, long-term or permanent habitation and settlement of Mars can only occur if a method can be found to enable the planet to be self-sustaining for our basic human needs. However, the exploration of this thesis has highlighted that there always exists a solution. One is emerging with regard to a genuine prospect for successful food growth and planting to occur on the planet. Similar to Earths biosphere, plant waste will create organic matter that could be composted and mixed with Martian soil, and thus allow the growth of effective crops. This process exists on Earth in a comparable soil type. For example; whereby a natural process occurs in lava fields when plant species colonize in a basaltic landscape, which subsequently lends their organic materials to it – activating it for life to begin.
Further pilot studies have been carried out by NASA with regard to the effects of planting in Martian soil simulant, of which the results were highly conclusive and successful. This potential farming off the Martian land will lead to a release of methane and other gases into the atmosphere, the effect of this, along with the added effects of humanity on Mars will eventually begin to alter the planet’s environment, and create a designed ecosystem. Could an architectural typology and a Mars vernacular help aid in the ability of making Mars naturally more Earth like, and therefore more hospitable for human life over the evolution of time and in the distant future? Essentially this could mean that the effects of the construction of a Martian architecture will one day lead to the terraforming of the planet. A prospect like this is a mixture of fantasy and hardheaded thinking, but it also is one that may very well become a reality.

A first construction on Mars will begin to catalyze further development and create an architectural precedent for other unknown places, places we class as frontiers. The technologies and knowledge developed will be used on Earth. We will develop forms influenced by those belonging to our former homelands, yet shaped and constructed by the characteristics of our new worlds. Life on Mars will not be like life on Earth. It will however demand an architecture of extremes, an architecture that will make all other projects in harsh landscapes on Earth seem almost straightforward. In designing a structure that is not only functionally effective against the extremities of the Martian environment, but also exists as structure - a home - that makes life possible to live under the mental constraints of containment. Such an architecture project will teach us as much about interplanetary science, as it will about human behavior – for perhaps the greatest thing we learn from exploration, is in fact, a deeper understanding of ourselves.
Far off places are invested with a certain romance. The appeal they emit appears to have been carefully designed within our human make-up by natural selection. This appeal has been, and will most certainly be, an essential element of our future survival. For within us we know, nothing will last forever. Amongst our species there has always existed a restless few. Originating from all epochs and meridians. Those who are drawn by a burning craving they cannot understand, or even begin to articulate. A desire hankers for undiscovered lands, new worlds, and above all else, improvement - for the future should be brighter than the present.

The truth of this matter is – the future of exploration can only exist with ingenuity, and the subsequent determination of willful action. For my own part, as a space age dreamer - who may just be forever confined to this planet – there is something conclusive if not repriming to know that as a species there is simply nowhere left for us to go, but upwards. It is the inescapable challenge. Those worlds promising unknown opportunities and material potential exist. And they will continue to beckon, inevitably, exploration will always give way to settlement. And the only expression of human settlement is architecture.

For now - however - the force of the desire to go battles ferociously with the necessity to be truly ready.
Brief:

Construct the first lasting structure on alien ground built from only the materials indigenous to the planet combined with Earth technology.

An exploration outpost housing research facility and living for 150 explorers. The architecture will be derived from what is possible. It will attach itself to the crater and be built from the material that exists in the crater. In order to span in one layer of sulfur concrete through the method of 3d printing, corbeling will occur. The architecture will therefore be a series of domes.

In light of climatic elements on site – mainly temperature fluxuation - the program will be arranged in series of layers to slow down the thermal bridging between day and night. The central layer will be the safe zone and the warmest - its function will be sleeping but also a place of refuge in case of solar flares or radiation storms.

The outer layer will house farming and water/soil extraction facilities. The intermediate layers will house research labs and living quarters.
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Wilter =xt • ct ioo lab

Water Siphon Lab

Fossil Fuel Planting Lab

Siphoned organics used in system as activated for growth through AD and composting
Programmatic Flexibility

Domes connected in a network form a system. The intersections between larger domes create smaller niche spaces for activities. Provisions are made at a personal scale.

Composition

Relative linear composition of multiple dome layouts in relation to one another.

Thermal Migration

Domes are transformed into one another to form a network of spaces that are able to interconnect. The temperature difference is controlled through a network of dome intersections at the inner face.

Input / Output

Farming and Fish Processing System

Farms are placed at various levels through a network of water channels. The environmental control is provided through an integrated system of water channels and air circulation.

Circulation Routes

Routes are created to connect to various levels.
3d prints
martian bricks
study of bubble connections
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