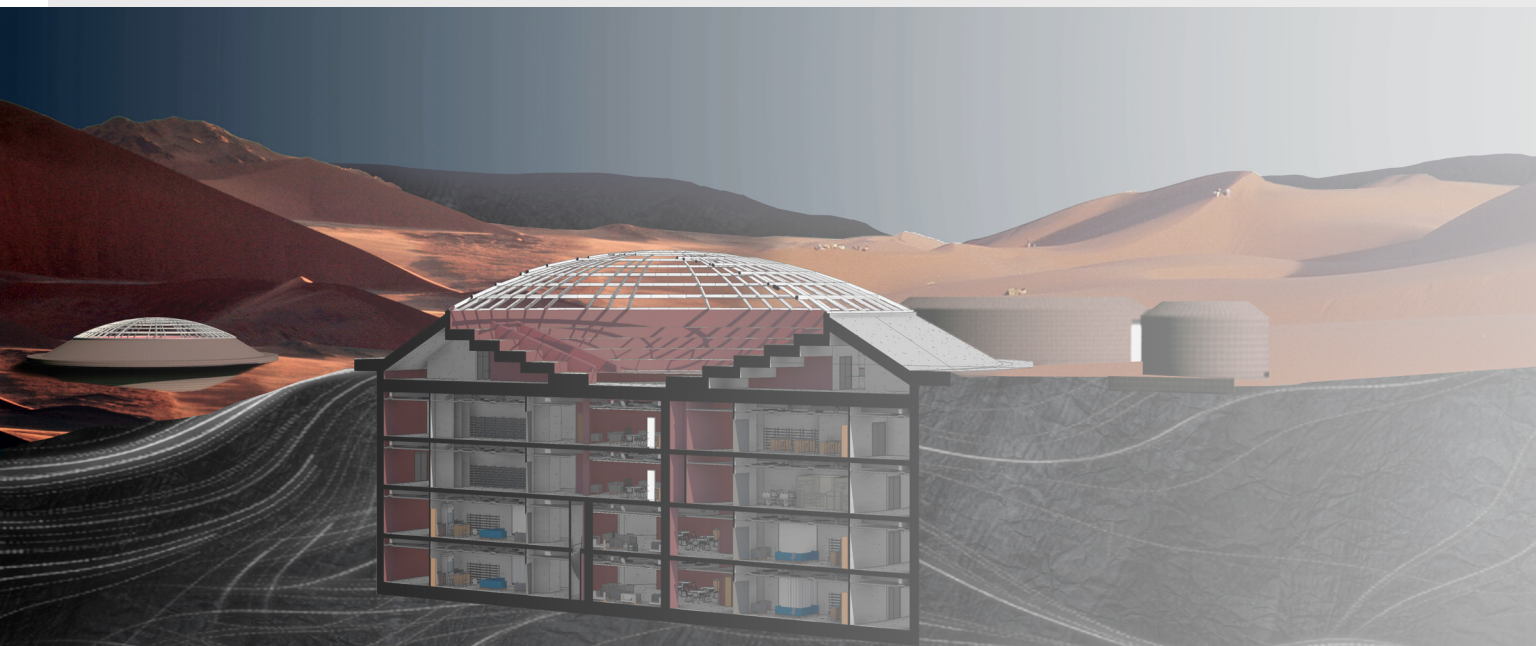




# INTERPLANETARY HABITATION

DESIGNING FOR LIFE ON MARS







# INTERPLANETARY HABITATION

DESIGNING FOR LIFE ON MARS



# SIGNATURE PAGE

Interplanetary Habitation  
Designing for Life on Mars

A Design Thesis Submitted to the  
Department of Architecture of North  
Dakota State University, By Landon  
Schoeneck, In partial fulfillment of the  
requirements for the degree of Mas-  
ters of Architecture.



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Primary Thesis Advisor



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Thesis Committee Chair

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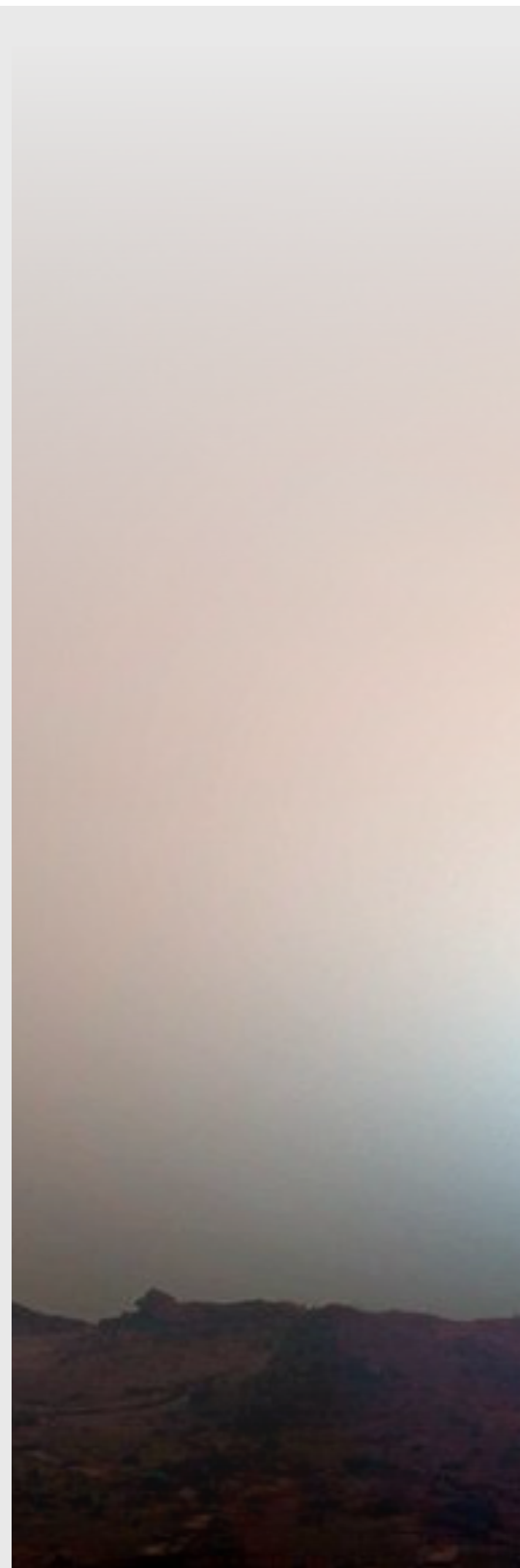
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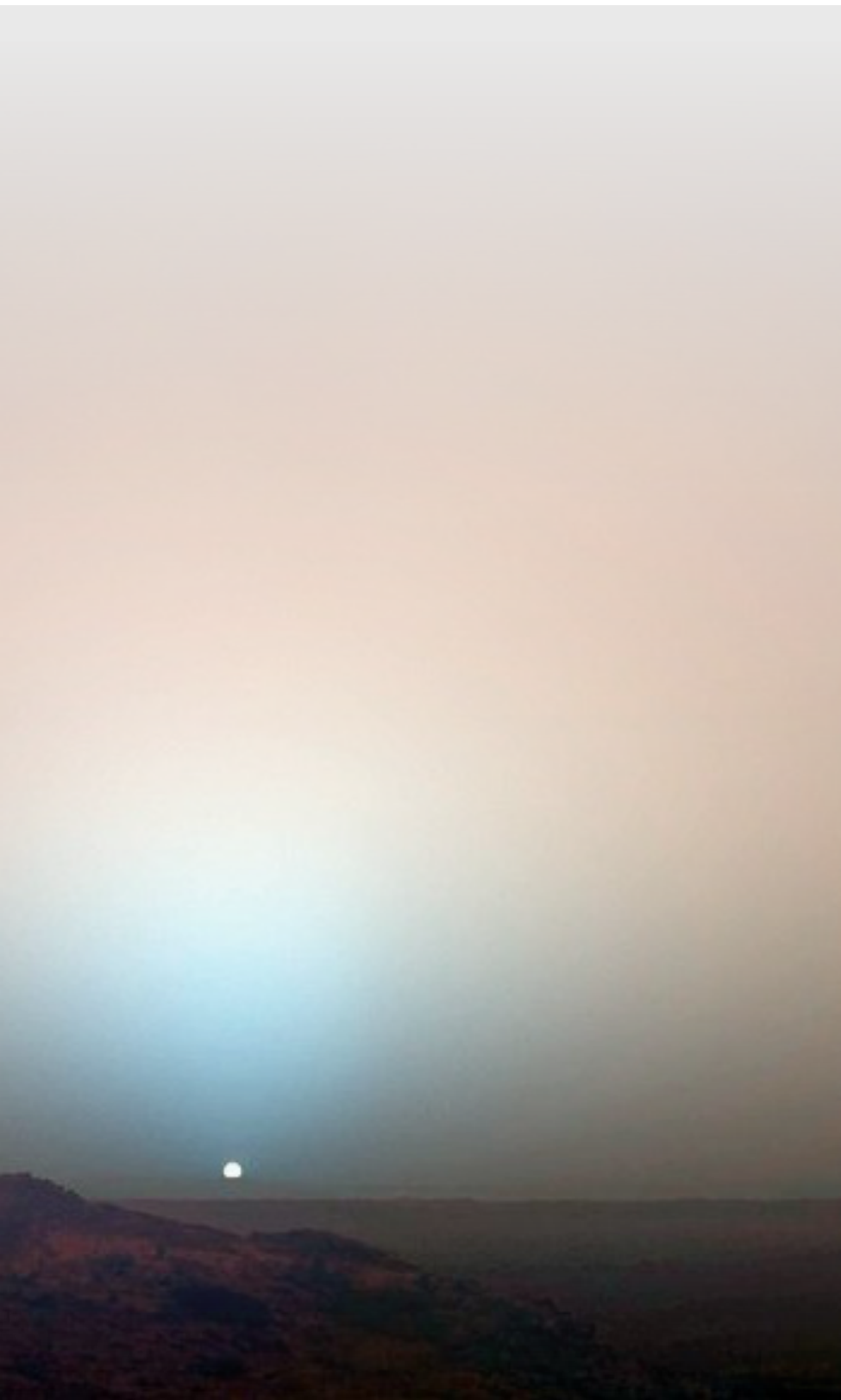
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# ABSTRACT

How can architecture adapt the complex engineering systems of a Mars colony to sustainable human life?

Migration and travel has evolved from the dawn of humanity to the automotive and flight industries of current times. Now interplanetary travel is on the forefront of technological innovation.

Innovation is created by those who dream farther forward than current society can understand, and it is necessary to push the boundaries of technology to make the impossible practical. thinking ahead to design for future interplanetary migration is a needed step to compel the world forward, as well as architecture and it's boundaries therein.

Building Title: Mars Station 1

Typology: Planetary Colonization

Site: Home Plate, Gusev Crater, Mars

The Primary goal of this Thesis is to practically design a Martian colony in which a building can combine the following requirements for sustainable life on the Martian surface.

Efficiency in Construction, Materiality, Transportation, Storage, & Functionality Systems

Aesthetics in Historical Connection, Design Hierarchy

Immediate Life Support in Radiation & Environmental Protection

Life Longevity in Medical, Physical, & Psychosomatic Health Systems

Comfortability in Residency, & Workspace

# NARRATIVE

## INDRODUCTION

How can architectural elements be adapted for sustainable human life on Mars? How can net zero energy production on earth be adapted to Mars? How will food production be adapted? How will basic resource production blend with scientific research? And the overlaying question is how can Architecture allow for all of this to become a possibility?

## THEORETICAL CONCEPT

I have always been fascinated in the concept of life in hostile environments, fallout survival, and taking current and future technology and adapting it to a basic survival instinct. This resulted in a curiosity of what life could look like for humans on Mars, which other than Earth has the highest chance of survival of a planet that is relatively close.

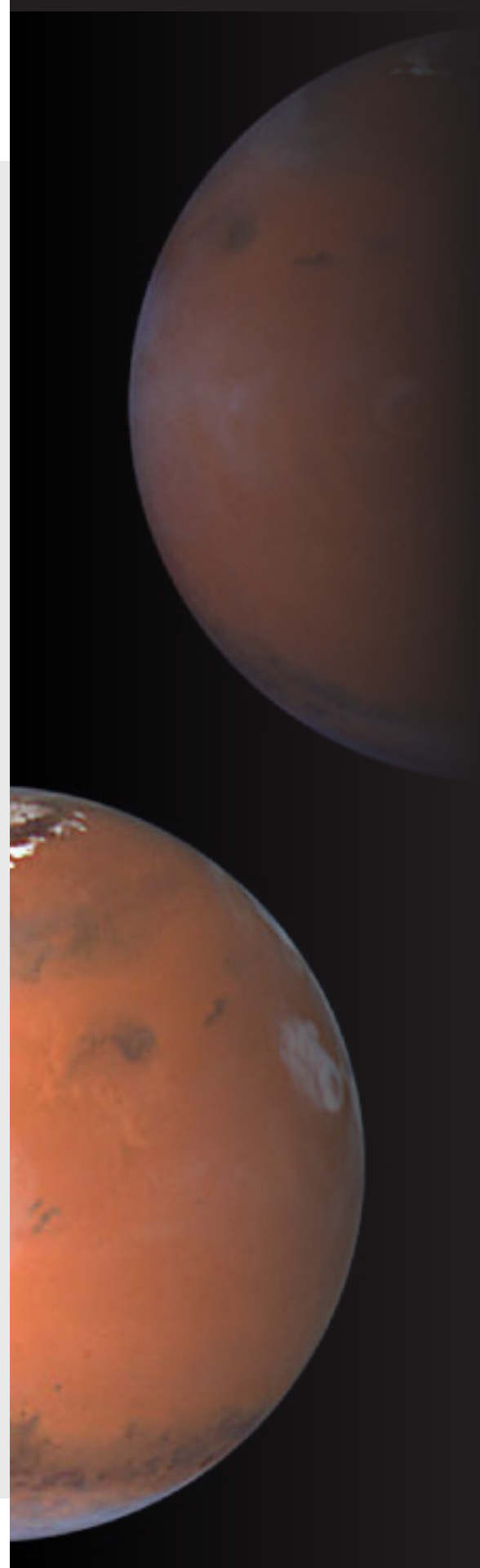
This concept will be an undertaking of programing for the necessities of a specific population.

I plan to research and produce a product of a theoretical colony station on Mars.

Points of reference and research include: personal design experience, desert climate architecture, current space station technologies, NASA research, SpaceX research, case studies on current mock up proposals, nuclear bunker programming and technologies, research on human sustainability and life support systems.

Site Location: Specific site on mars surface (ideally placed).

Context site in Southwest American deserts (meant to resemble specific site).



## NEED FOR PROGRESSION

When John F Kennedy told us we would put a human on the moon he excited a entire generation to dream

The surface area that you can stand on Mars is relatively similar to Earth's as most of the Earth is covered in water

He discusses time, seasons, years, etc...

Mars is by far the most livable place other than Earth in our solar system

We (Humans) Have sent 44 rockets to Marrs, but only about a third have been successful

The Saturn 5 was the last rocket that could have gotten us to Mars "It was the most magnificent machine ever built by humans"

"we are going to land on Mars in 2027", because Elon Musk is determined to make it happen

NASA has taken a huge responsibility to allow us to live on Mars

Perspective on Elon Musk and his potential to go to Mars soon:

In 2005 most of the automotive industry were saying there would not be a decent electric car for 50 years, Then Musk began mass producing Tesla electric cars that rival performance sports cars, and are transitioning into affordable consumer cars

Ten years ago Space X hadn't launched a single rocket and now they are launching the Falcon 9 with supplies to the International space station

What You need to live on earth: Food, Water, Shelter, Clothing

What you need to live on Mars is all the above & Oxygen: Food, Water, Shelter, Clothing, Oxygen

Of these water is the most important, "Water is the basis of all life"

# NARRATIVE

## PREMISE

Stephen Petranek had these things to say regarding the journey to Mars:

"We are incredibly vulnerable to the whims of our own galaxy" "to survive we have to reach beyond our home planet" "think of what a tragedy it would be if all that humans have accomplished were suddenly obliterated" "exploration is in our DNA" "Some of the greatest advances in civilization and technology came because we explored" "Think how inspired we will be to see a landing on Mars: Perhaps then we will look back at Earth and see that that is one people instead of many, and perhaps then we will look back at Earth as we struggle to survive on Mars and realize how precious the home planet is"

Mars soil contains 1 to 60% water

Lots of craters have water pools in them

Just below the surface there is water in the form of ice

There are huge pools of underground water as well as surface glaciers

If all the ice melted most of the planet would be under at least 30 ft of water

9:50 min in shows microwave emitter for humid atmosphere to generate water

10:20 min in shows Moxie to generate oxygen from Mars atmosphere.

96% of Mars atmosphere is CO<sub>2</sub>, and CO<sub>2</sub> is about 78% Oxygen and this gets converted by Moxie into Oxygen

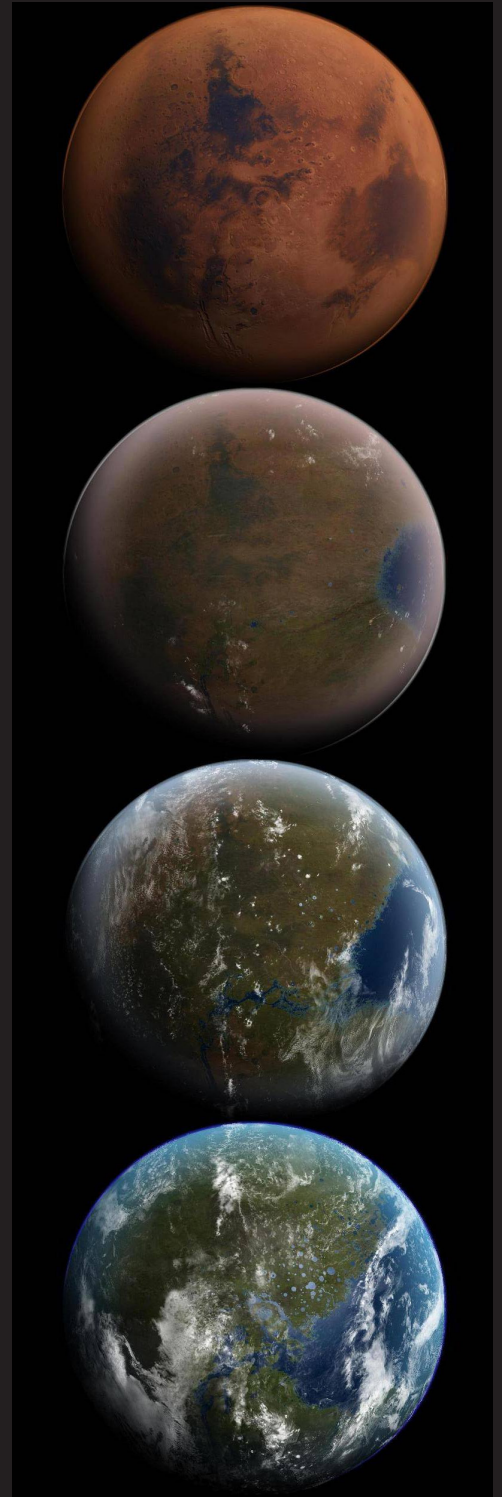
One Moxie will be on NASA's 2020 rover sent to Mars

To Start 80% Dried Earth food, 20% hypopnically grown food

To hide from radiation we need to go underground in caves or use soil to create bricks to build shelter

Clothing will mean specialized space suits

Terraforming and re-engineering will be necessary for long term survival: technology exists



Need to heat up south and north poles which are frozen CO<sub>2</sub>, to start warming planet> (projection to heat using solar mirror is less than 20 years)

Right now on a perfect day the equator reaches 70F, but go down to -100F at night.

By melting CO<sub>2</sub> it creates a greenhouse effect which will create pressure, constant temperature, and grow crops

Genetic engineering is considered to allow us to breath on Mars far before Terraforming would allow.

Otherwise it could take a thousand years to fully oxygenate, with current technology. Future tech could change this.





# PROJECT TYPOLOGY

Project Title

Project Sub-Title

## **Typology: Interplanetary Colonization Masterplan Structure & Design**

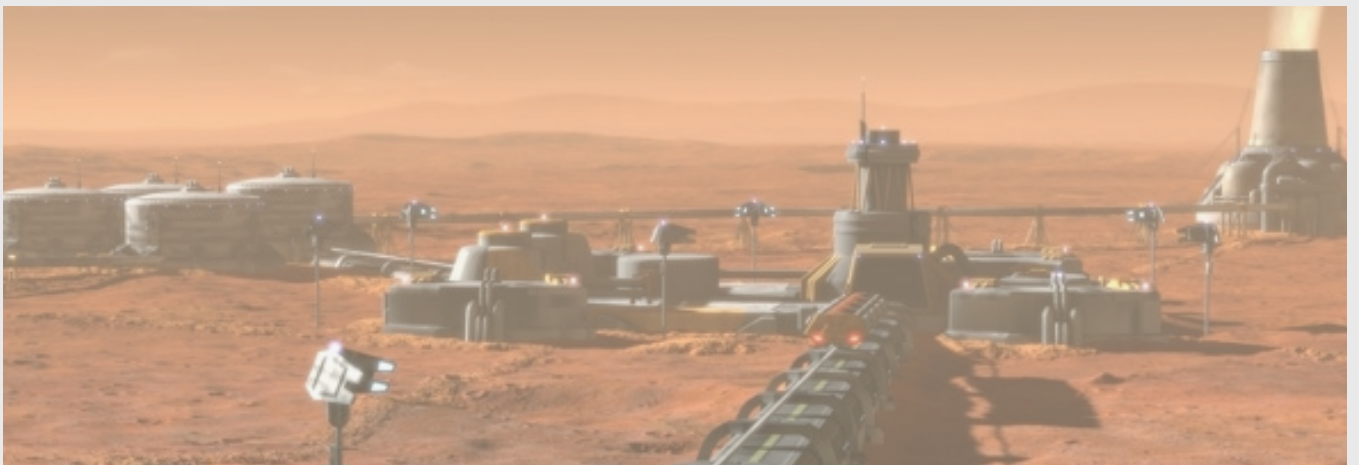
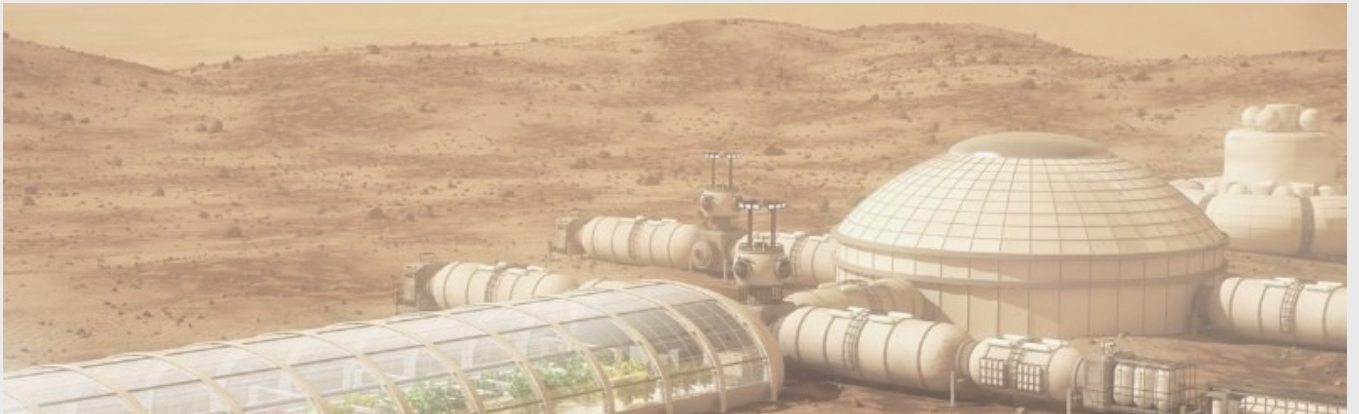
### **Urban Planning**

#### **Residential Development.**

There are several concepts in development for variations of Mars settlements from architects, and engineers alike. This includes SpaceX's masterplan for their base and launch site. The typology of a colonization takes multiple types into account. These are primarily Urban Planning, Residential Development, and various workspaces for researchers, and engineers. There are two different ways I can go about the typology of this project. One is to take a small scale population and fully design an initial base for the first migration. The second option is to schematically develop a distant future Mars city, with program development and massing concepts, and focus on a specific typology within the program. I have yet to figure out just what that specific building or section should be.

One of the primary premises of this project is to take a typology of interplanetary colonization and find a way to allow for something that is pure engineering and pragmatic to become architectural as well and appealing. How can we take a new world and the technology needed to create it and design as pleasing an environment as possible.





# TYPOLOGICAL RESEARCH

## MARS ONE

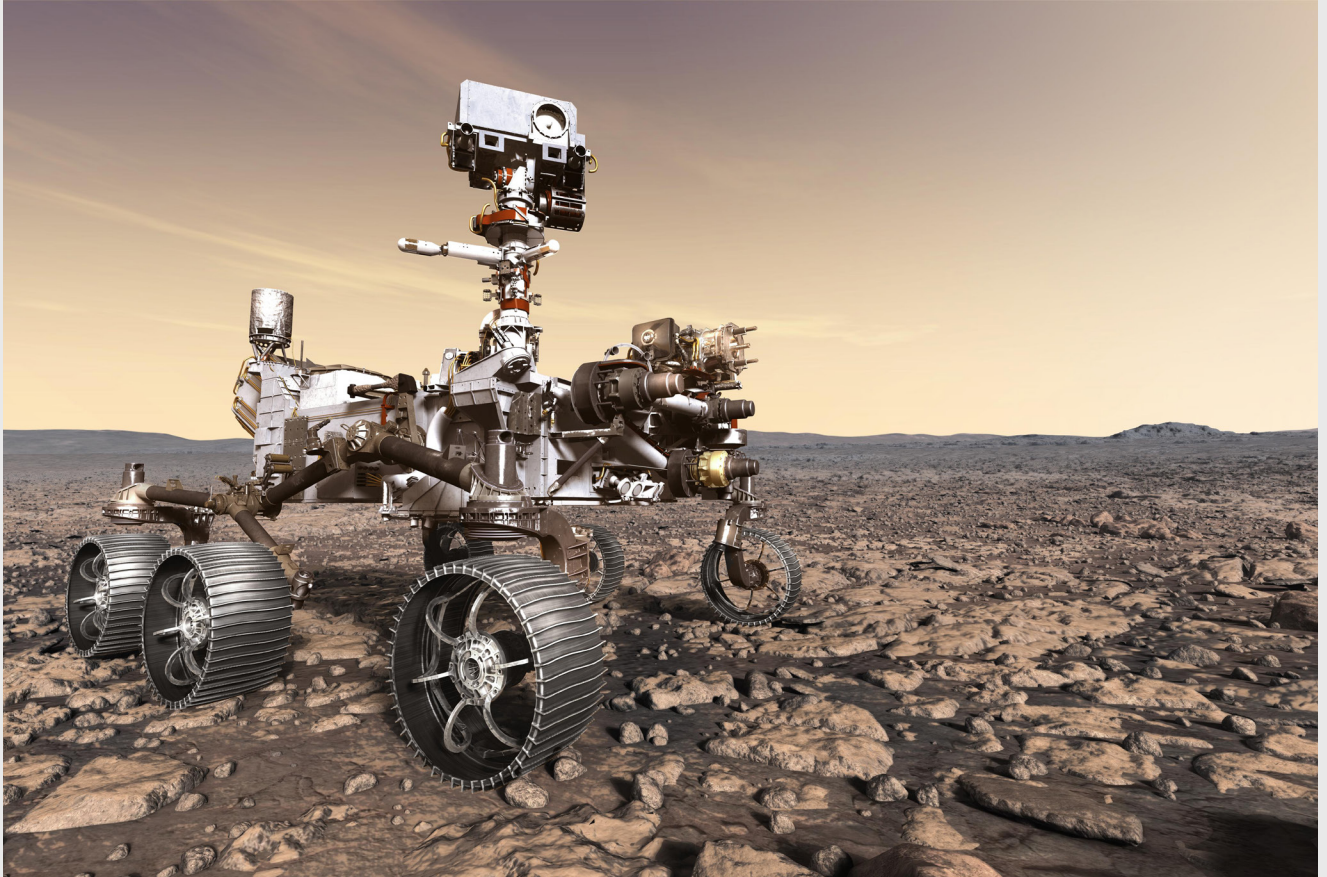


Mars One is a company that is currently generating funding as well as public interest into the creation of privatized Martian missions as well as temporary settlement designs.



# TYOPOLOGICAL RESEARCH

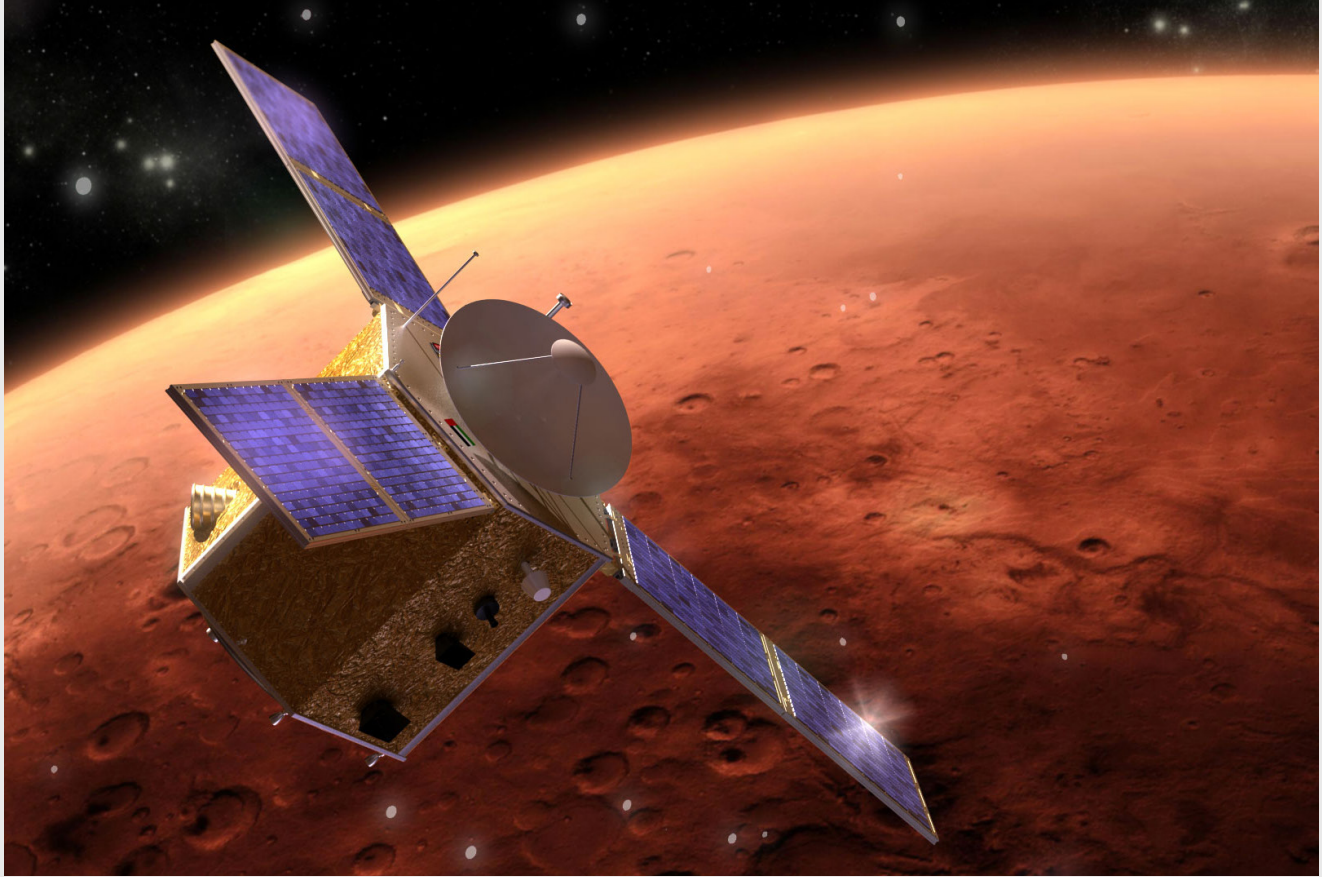
## NASA



NASA is and has been at the forefront of space travel research and discovery. This American governmental organization is the current leader of investigative development into the Martian surface as well as other potential habitable planets, such as one of Jupiters moons. The Martian rovers sent by NASA are currently operating in Gusev Crater, the site of this prospective project.

# TYOPOLOGICAL RESEARCH

## UAE



The UAE is a country in the middle-east that holds large sums of oil money and is investing into space travel and Martian development. They have a very slow timeline for space expansion, and is evidently planning to expand to Mars surface after companies such as SpaceX and Blue Origin are well established on the Martian surface. There is also a design by BIG Architects to simulate a Martian residence within the UAE.



# TYOPOLOGICAL RESEARCH

## RELATIVITY

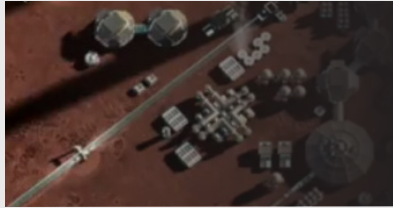


Relativity Space is a small startup space travel business, that is looking to print rockets and other space travel necessities in 3D at scale. So far they have produced various rocket parts, are quite successfully raising funds to expand. Ideally they look to design all the technology that will become a basis for rocket design factories at SpaceX, Blue Origin, and others.

# MAJOR PROJECT ELEMENTS

## ENGINEERING

Engineering systems include construction development, and system processes



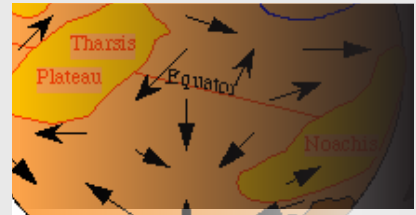
## CLIMATE & ATMOSPHERE

The climate of Mars is regulated mainly on temperature fluctuation.



## HUMAN ETHICS

Overall it is ethical to go to Mars as it will provide life to a new planet and humans alike.



## AGRICULTURE

Food production systems



## LIFE SUPPORT SYSTEMS

Water and oxygen production, Pressurization

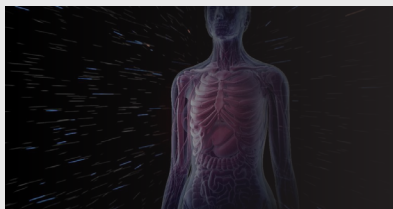


## MATERIALS

Materials will be delivered and derived from the planet. Also the possibility of 3D printing habitats.

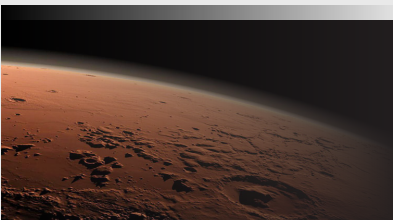
## THE HUMAN BODY IN SPACE

NASA has extensive research done to enable human function on Mars.



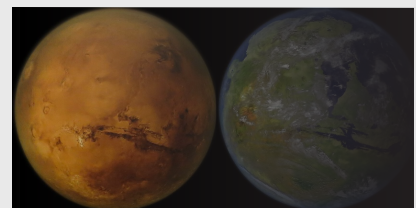
## POLITICAL ETHICS

Politically there will need to be consensus on a future on Mars and a separate government.



## TERRAFORMING

Planning & Preparation in strengthening the atmosphere and land transformation



# USER/CLIENT DESCRIPTION



Primary clients are SpaceX for conceptualization and production, in partnership with NASA.

The Colonization program will be governed by the U.N. (Further research needed)

At a set stage, a new Mars government will be founded that will govern all future interplanetary travel in conjunction with the U.N.

Users are first astronauts, scientists, advanced construction, and as colony expands will include: operators for O<sub>2</sub> and H<sub>2</sub>O production, farmers, etc. Upon full scale city colony the users will include people who are not necessary for colony survival, just as in major Earth cities.

In the first colony development the user base will be required to have an understanding that there is a possibility that they will not all go back to Earth. While this is a lot to ask, there is interest enough in these communities to fulfill this intention.

The project will be owned by a collective organization of major companies and governmental policies involved and invested into the colony. Of course this is only a temporary solution until the time when a specific Mars governmental body can be set in place.

The usage and requirements will be consistent as the primary function of the design is to support life with supplemental research, and engineering opportunities. By this there are very unique requirements within the user base.





# SITE

The site location is of course on the planet Mars, and there has been speculation on the best place to begin humanity on the planet.

One of the most likely to succeed is the Gusev Crater. This location has been thoroughly documented by the Spirit Rover, and is possibly one of the most survivable locations. In this location there is a potential for a hydrothermal environment that could help with shelter, and warmth.

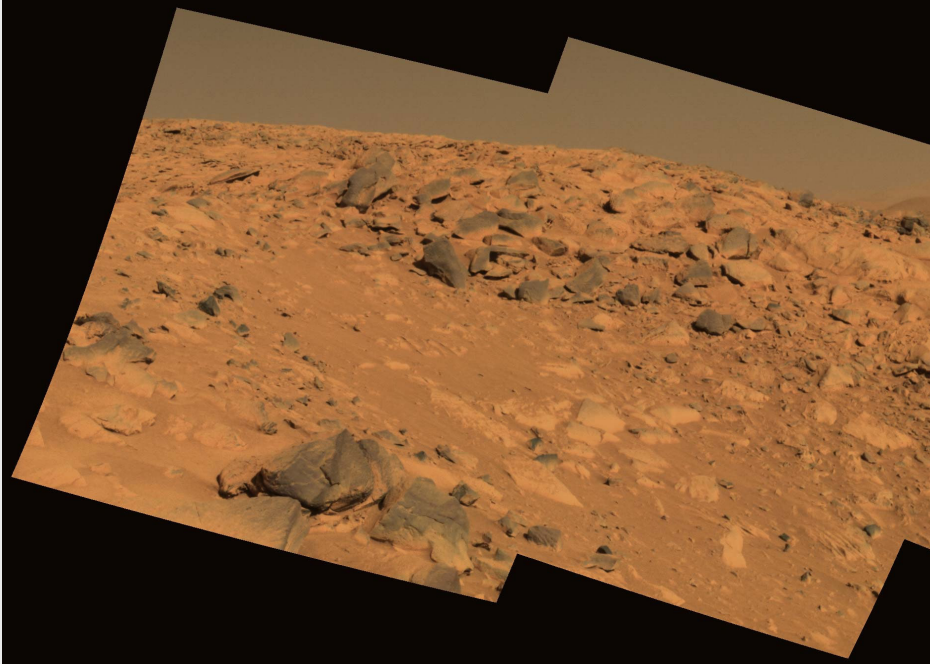
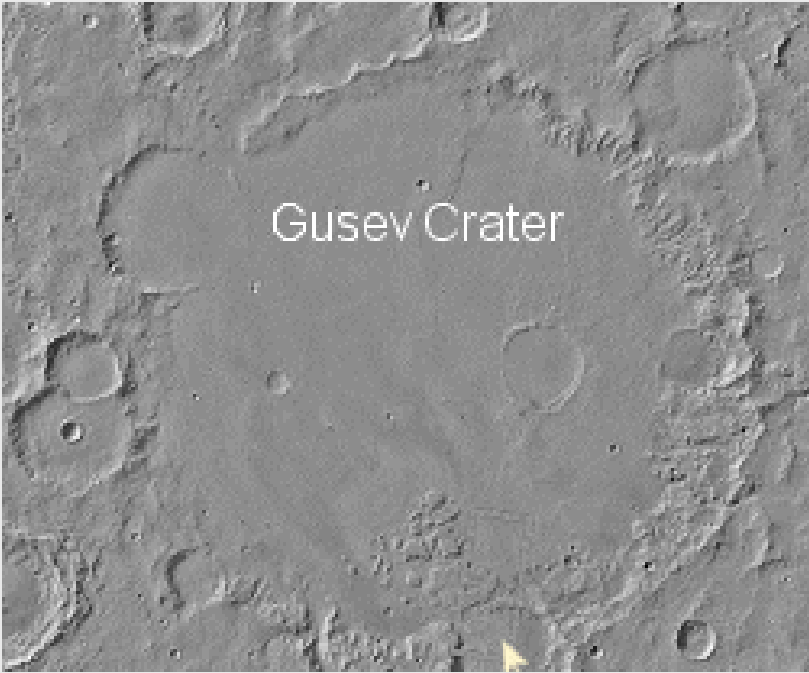
This is a site ideally suited for Mars thermal change, as it is on the Equator and will get up to 75F degrees during the summer season, and -80F during the winter nights.

This is one of the proposed landing sites already for NASA and corporations that are looking into this venture.

Current typological projects in different parts of the world are researching ongoing site design, and criteria. There is a testing facility in Hawaii that is currently undergoing research into human conditions, and what will be needed. They are testing how human isolating conditions are that resemble the current space station.

NASA discovered flowing water on Mars surface during the warmest months of the year with the Rover Curiosity, thus disproving that the atmosphere is too thin to allow for liquid water.

While global warming is bad on earth it is needed on Mars to increase surface temperature



Elon Musk on heating up Mars and Terraforming: "The fast way is dropping thermo-nuclear weapons over the poles"

The detonation wouldn't do much to initially change the climate, but vaporizing the carbon dioxide in Mars CO2 ice caps could jumpstart the planets global warming and greenhouse effect.

In a statement to the Los Angeles Times NASA states "We are also committed to promoting

exploration of the solar system in a way that protects explored environments as they exist in their natural state"

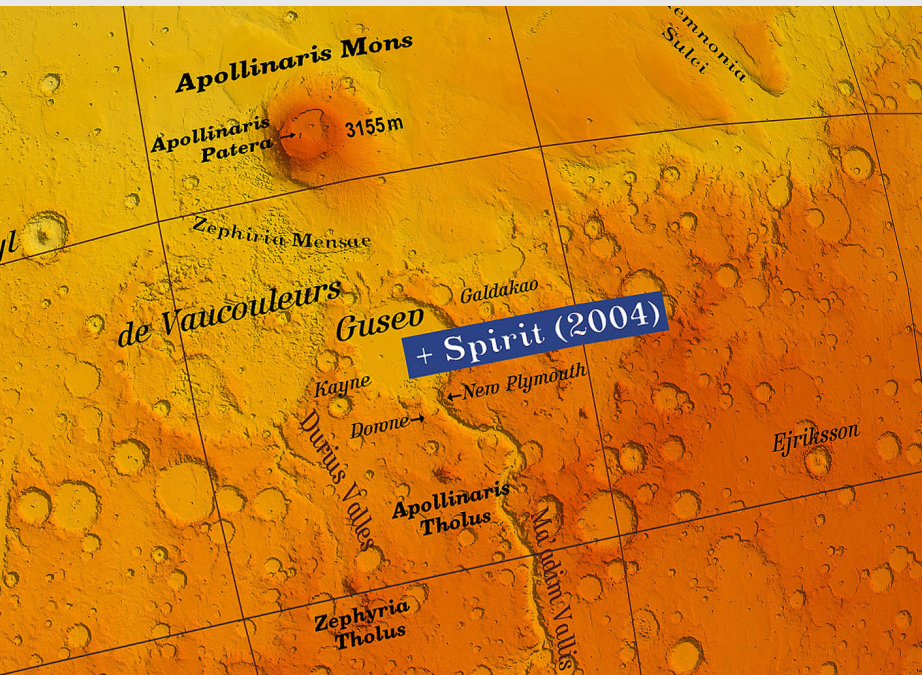
A rotation of Mars and therefore a day takes 2.7 percent longer than on earth. There is a need for Mars and earth clocks to keep time together.

Seasons and years will be displaced. Possible calendars are to keep Earth calendar arbitrarily to seasons, use Mars calendar such as Darian Calendar

There is a possibility of micro living organisms on Mars. Possible harmful for us or possible for us to be harmful to to "them"

8/7/1996 Bill Clinton talked about Rock ALH4001 (from Mars?) that possibly has organisms fossils in it. Possible extra-terrestrial life

It would be a good idea to create parts of Mars as preserved parks that are saved as they are so after terraforming there is still a part of the planet that is original.



# PROJECT EMPHASIS

This entails a combination of research and development that is too early in to define at this time.

Refer to Major Project elements

Architectural elements adapted for sustainable human life on Mars.

Net zero energy production on Mars. Food production. Basic resource production.

Architectural Possibilities in this environment.

Taking a typology that is based in engineering and making this machine a home, that is suitable, programmatically, scientifically, and aesthetically to human life.

## GOALS FOR THESIS PROJECT

The Major Goals for project: Interplanetary Habitation are:

The Primary goal of this Thesis is to practically design a Martian colony in which a building can combine the following requirements for sustainable life on the Martian surface.

**Efficiency** in Construction, Materiality, Transportation, Storage, & Functionality Systems

**Aesthetics** in Historical Connection, Design Hierarchy

**Immediate** Life Support in Radiation & Environmental Protection

**Life Longevity** in Medical, Physical, & Psychosomatic Health Systems

**Comfortability** in Residency, & Workspace



# PLAN FOR PROCEEDING

## Fall Semester:

Research into technologic aspects of design proposal, including means of construction, migration, etc.

Research into neccesities including, living systems, HVAC, presurization systems, etc.

Building a knowledge basis of which to expand into practical design.

## Spring Semester:

The first five weeks were spent in Wischer's thesis instructon, working on building presentations with a phylosophical basis for project proposals.

(Shown, further into the book is an example of this)

After this, there was a move to Ganapathy's studio, at which point theoretical concept design began, and preliminary design ideas.

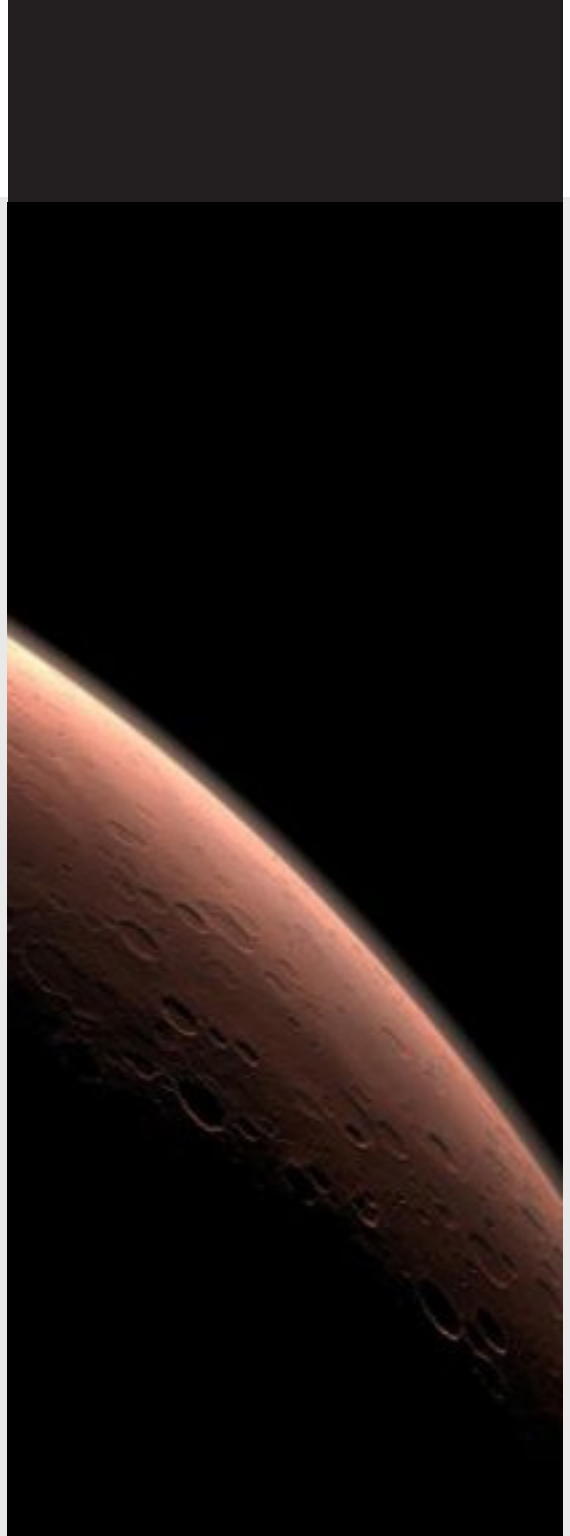
Midterm Presentation: At midterm the design concept was complete and began moving into development.

After this: development of core concepts, & floorplaning.

Final touches to 3D Design

Production of Visualization

Project presentations.



# RESULTS & RESEARCH

## Phylisosophical Research

### Cosmological Research:

Dalibor Vesely:

“The Christian Interpretation of the sun as Dies Solis or Sol Invictus gained new force in the seventeenth century, when supported by the spread of Heliocentrism, solar symbolism penetrated all domains of Baroque culture. It is against this background that we can appreciate Guarini’s contribution. His vision of Christ as sun was still governed by a geometrical structure of the cosmos in which what mattered was not the sun in the center and its relation to the periphery, but the sun situated on high and its relation to that below. This vision preserves the vertical hierarchy of the world and the possibility of differentiating between high and low, because the highest dignity belongs not to that which is most central but to that which is highest. The vertical organization of the chapel clearly reflects this hierarchy.”

“The meaning of the chapel and its enactment through liturgy and direct participation follow the vertical structure in a sequence that begins with the ascent of the steps and culminates in the contemplation of the upper dome. The tension between the terrestrial zone, where the shroud itself lies and the upper dome, dominated by the image of the sun, is mediated by the lower dome, consisting of three main arches and three pendentives.”

“In the Platonic tradition, the regular solids (Polyhedra) represent symbolically four elements--fire, air, water, and earth--all rooted in the fifth, celestial essence, from which they are generated in proportional relationships. The celestial essence is represented by a dodecahedron inscribed in a sphere: it consists of twelve pentagons, which Pacioli compares with the twelve articles of the creed and the twelve apostles.

“In the heliocentric system, the place of greatest dignity is the center of a perfect sphere. The sun and the sphere are in the static relationship of center and periphery, which together with the intervening space represent in a new manner the traditional mystery of the trinity.”

“The geometrization of cosmic space, which closely associated geometry with the divine, was an important step in the forming “absolute” space.”

## Cosmological Research:

Otinger:

“Pythagoras, the first to give the name “cosmos” to the universe around us, was the source of this singular idea, which poets would one day claim as their heritage. He invented the notion of the “music of the spheres”,<sup>2</sup> irrefutable proof of a harmony between musical intervals and the positions of the celestial bodies, with the planets in their orbits like notes on the staff.”

“The sphere, while a minimalist form, is also the form the occult tradition held to be the richest in meaning.”

“Newton’s discovery that the planets were subject to the laws of universal gravitation marked the end of a world. “Whatever is not deduced from the phenomena is to be called an hypothesis, and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy,””

“By displacing images from the observatory to the museum, the artists of the modern sublime identify the cosmos as a place that cannot be reduced to a useful function or a rational definition. In contrast to technical or political utilitarianism, there is space, as beautiful and useless as a work of art. “

# RESULTS & RESEARCH

## Philosophical Research

### Technological, Philosophical Research:

Dalibor Vesely:

Mies van der Rohe: "Some people are convinced that architecture will be outmoded and replaced by technology. Such a conviction is not based on clear thinking. The opposite happens. Whenever technology reaches its real fulfillment it transcends into architecture."

Me: New technology is thought of as a distraction within architecture by each generation. In reality technology allows architecture to expand and expand the thinking of designers to create. Technology is not inherently bad as a tool with which to use. The flaw in the system comes when designers allow for the new technology to produce work void of cultural meaning and thought. It becomes easy to design for nowhere and everywhere by using new design methods, and it is up to the architect to create something of relevance.

"The primary conditions for a new relationship between architecture and technology were first established in the seventeenth century when a gap opened up between the traditional symbolic and the new instrumental representation. ... The eighteenth century saw the foundation of engineering schools, which began to compete with the traditional architecture education"

Me: these centuries marked the emergence of modern aesthetics, sciences, and generalization. At this point traditional culture was less represented, leading up to today's culturally ambiguous architecture.

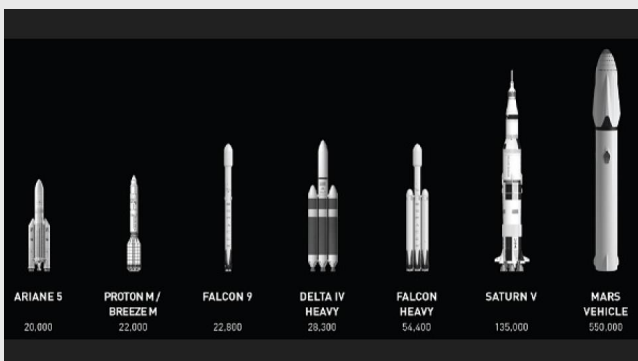
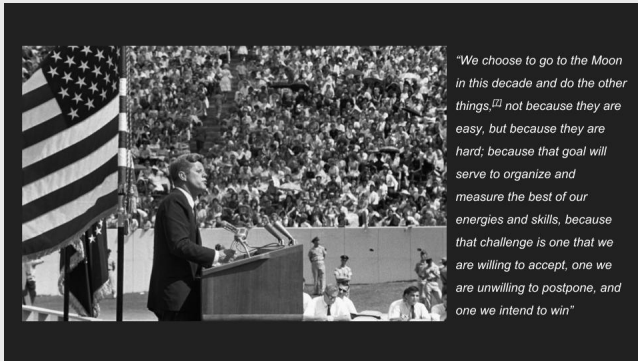
"The tense relationship between architecture and technology is a relatively new phenomenon."

Me: In modern times the discussion on technology has become a debate of architectural efficiency, and cultural and aesthetic relevance. A lot of this comes down to control. We as a species long for control over our environment. We have mastered that control with current technology and now seek to make it as efficient as possible. This is a good thing, but it can remove an architect's mind from intentional design. Culturally designs have been based primarily on a mission. The mission of those of the past was to design for their god, the cosmos, and historical culture representation. Today the main mission is efficiency, with a side of ego or competition. It is not the technology that removes the essence of architecture, but the will of the designer, and the client.



# PHILISOPHICAL PRESENTATION

From Wischer's Thesis Course, Before Switching Over to Ganapathy, Part Way Through Semester:



On September 12th, 1962 President John F Kennedy delivered a speech at Rice University, and within the heart of his address he said, "We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win" Now in 2018 I and many others believe the same about the mission to Mars.

My name is Landon Schoeneck and this is "Martialian Colony Nova Satus"  
This thesis project is an architectural installation on the Martian surface. This will be a colony designed for permanent habitation and work over long time periods, unlike any current propositions.

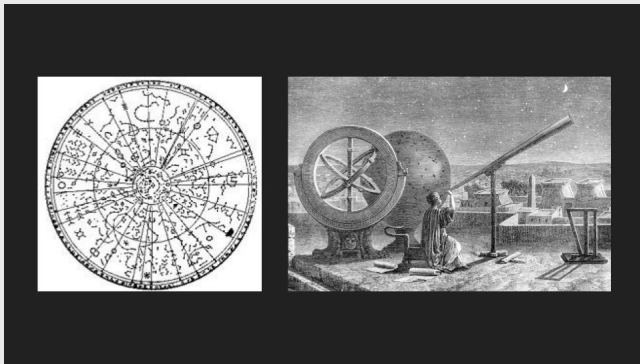
The design of a future martian station and colony may seem impractical, impossible, or unnecessary to some people but Migration and travel has evolved from the dawn of humanity to the automotive and flight industries of current times. Now interplanetary travel is on the forefront of technological innovation. Innovation is created by those who dream farther forward than current society can understand, and it is necessary to push the boundaries of technology to make the impossible, practical. Thinking ahead to design for a future interplanetary migration is a necessary step to compel the world forward, as well as architecture and its boundaries therein. Becoming a Multi-planetary species is not just a trajectory we are set upon, but a continuation of the celebration of creativity, design, culture, intellect, and drive that has allowed for the progression of humanity. The Saturn 5 Rocket, used during the Apollo Missions in the 1970s, was the greatest creation of engineering ever built by man and the superior of two machines that sent man to the moon.

# PHILISOPHICAL PRESENTATION

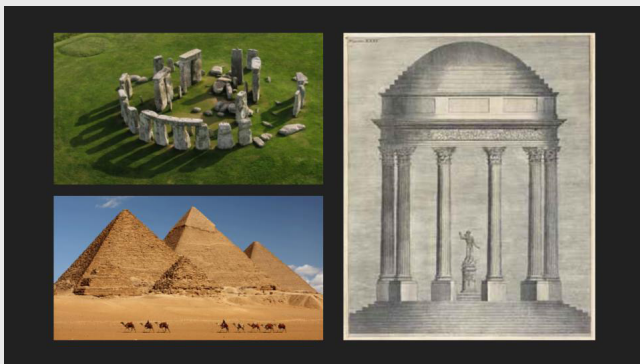
From Wischer's Thesis Course, Before Switching Over to Ganapathy, Part  
Way Through Semester:



Everything ever thought of was impossible before its creation, yet people doubt in the possibilities Mars has to offer. The Saturn 5 had the power to get us there in 1970, so now approaching on 2020 it's about time to expand our reach to the red rock. Today we are on the verge of developing a new vehicle that will also be the most affordable human space transportation ever: SpaceX's BFR Rocket.

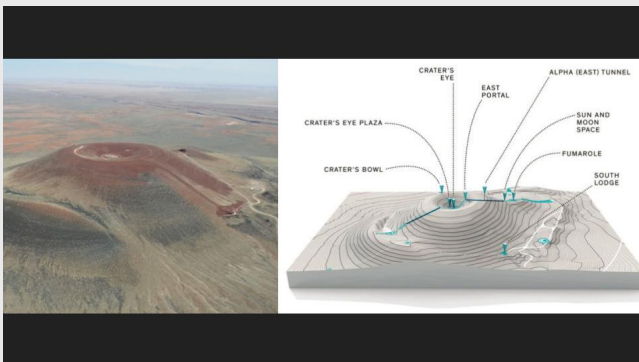
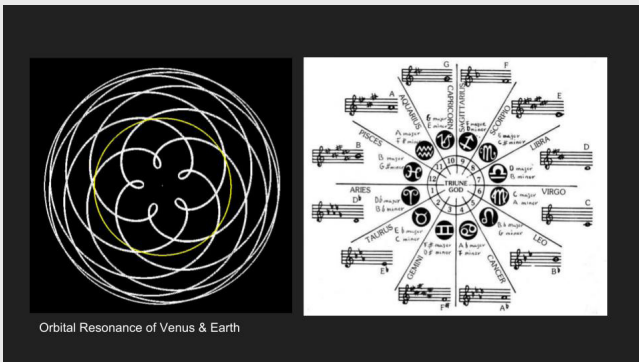
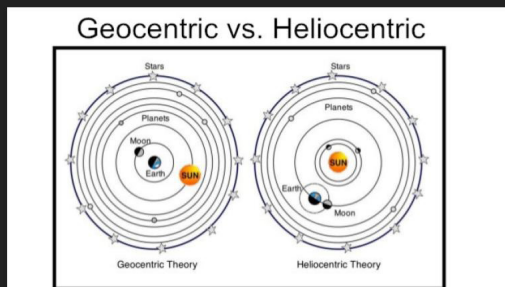
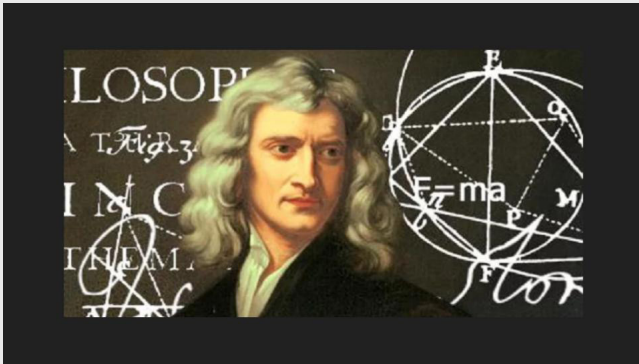


Sustainable life outside Earth's atmosphere has alluded humanity since man first looked up to the stars. Throughout history cultures around the world have been universally fascinated with the vast beyond. Previous to the last twenty five hundred years, man primarily used myth and legend to explain the sun, the moon, and the stars: How earth relates to it all. In architecture the cosmos were represented in religious buildings and cultural monuments to represent earth's relation to the universe, and pay homage to cultural myth and beliefs. As this world was marked the center of the universe many pieces of past architecture form a layout of the cosmos with a seat of importance at the center. "Newton's discovery that the planets were subject to the laws of universal gravitation marked the end of a world." Before this hypothesis was accepted the main belief was that the universe was situated around Earth, resulting in central and inclusive architectural design. "The sphere, while a minimalist form, is also the form the occult tradition held to be the richest in meaning." "In the heliocentric system, the place of greatest dignity is the center of a perfect sphere." Pythagoras "invented the notion of the "music of the spheres", irrefutable proof of a harmony between musical intervals and the positions of the celestial bodies, with the planets in their orbits like notes on the staff." This is referred to at Musica Universalis and in modern times is called orbital resonance. It is a dance of the planets.



# PHILISOPHICAL PRESENTATION

From Wischer's Thesis Course, Before Switching Over to Ganapathy, Part  
Way Through Semester:



A contemporary art piece by James Turrell captures this evocation well. Roden Crater has been a celestial lookout since 1975 when construction began to repurpose this dormant volcano. Turrell expressed his plan at the crater. "At Roden Crater I was interested in taking the cultural artifice of art out into the natural surround. I did not want the work to be a mark upon nature, but I wanted the work to be enfolded in nature in such a way that light from the sun, moon and stars empowered the spaces ... I wanted an area where you had a sense of standing on the planet. I wanted an area of exposed geology like the Grand Canyon or the Painted Desert, where you could feel geologic time. Then in this stage set of geologic time, I wanted to make spaces that engaged celestial events in light so that the spaces performed a "music of the spheres" in light." In Turrell's creation he aspires to create a Musica Universalis of light regarding the sun and the moon.

Now as a society we are looking toward inhabiting another planet, and expanding the inclusive society on Earth into a multiplanetary population.

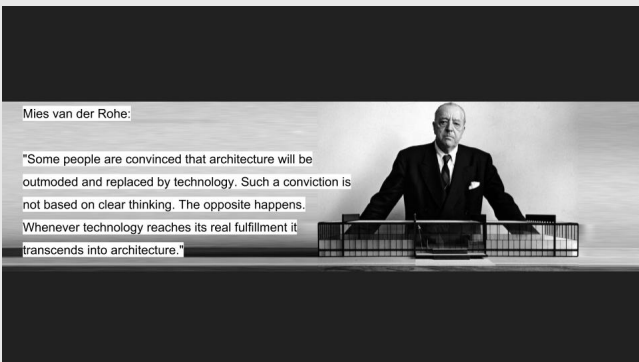
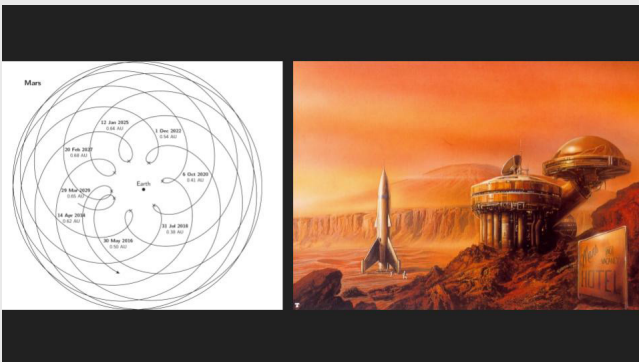
At Face value building a colony on Mars may seem an unnecessary prospect: the missions will be expensive and It is true that upfront costs are tremendous, as with any new venture, but the long term benefits vastly outway the initial expense. Developing a colony station on the red planet will require a vast amount of progressive technology.

Mies van der Rohe said that "Some people are convinced that architecture will be outmoded and replaced by technology. Such a conviction is not based on clear thinking. The opposite happens. Whenever technology reaches its real fulfillment it transcends into architecture."



# PHILISOPHICAL PRESENTATION

From Wischer's Thesis Course, Before Switching Over to Ganapathy, Part  
Way Through Semester:



Mies van der Rohe:

"Some people are convinced that architecture will be outmoded and replaced by technology. Such a conviction is not based on clear thinking. The opposite happens. Whenever technology reaches its real fulfillment it transcends into architecture."

ew technology is often thought of as a distraction within architecture by each generation. In reality technology allows architecture to expand and expand the thinking of designers to create. Technology is not inherently bad as a tool with which to use. The flaw in the system comes when designers allow for the new technology to produce work void of cultural meaning and thought. It becomes easy to design for nowhere and everywhere by using new design methods, and it is up to the architect to create something of relevance.

The technology to go to Mars as well as inhabit the surface is being created in todays time, but colonizing the new planet is not just about survival, but also a message to the world about how architecture of the future will value thoughtful design.

"The primary conditions for a new relationship between architecture and technology were first established in the seventeenth century when a gap opened up between the traditional symbolic and the new instrumental representation. ... The eighteenth century saw the foundation of engineering schools, which began to compete with the traditional architecture education"

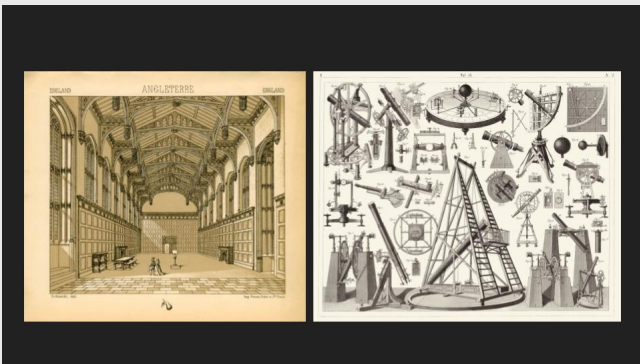
In "Architecture and The Crisis of Modern Science" the author discusses functionalism and its grasp on modern architecture. In the last few centuries architecture has lost essence to functionality and has been reduced to a rational theory. The 17th and 18th centuries marked this emergence of modern aesthetics, sciences, and generalization. At this point traditional history was less represented, leading up to today's culturally ambiguous architecture.

"The tense relationship between architecture and technology is a relatively new phenomenon."



# PHILISOPHICAL PRESENTATION

From Wischer's Thesis Course, Before Switching Over to Ganapathy, Part  
Way Through Semester:



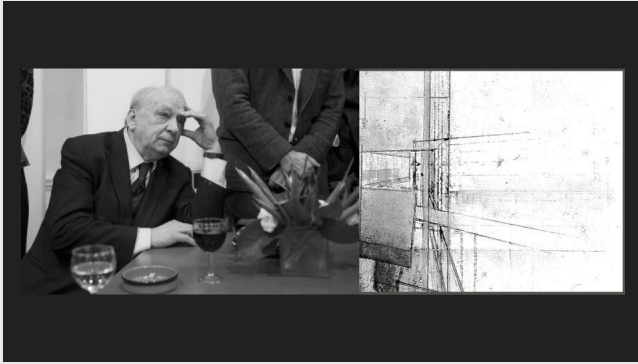
In modern times the discussion on technology has become a debate of architectural efficiency, and cultural and aesthetic relevance. A lot of this comes down to control. We as a species long for control over our environment. We have mastered that control with current technology and now seek to make it as efficient as possible. This is a good thing, but it can remove an architects mind from intentional design. Culturally designs have been based primarily on a mission. The mission of those of the past was to design for their god, the cosmos, and historical culture representation. Today the main mission is efficiency, with a side of ego or competition. It is not the technology that removes the essence of architecture, but the will of the designer, and the client.

As survival on Mars is the primary goal it seems easy and only natural to let pure engineering dictate efficiency without design context, and this is indeed what will occur at the beginning. However, there is a architectural duty to work to create meaningful designs that will be used for permanent colonization.

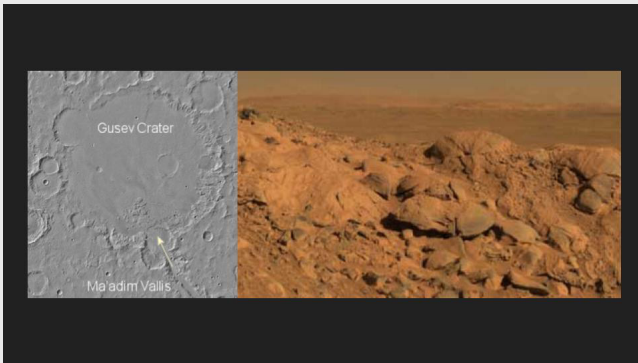
In her book "the Human Condition", modern day philosopher, Hannah Arendt describes life as an active process involving Labour, Work, and Action. Just as in the Mars project Labour entails accomplishing goals for basic necessities, such as the supply of food, water, shelter, and oxygen. Action she describes as a basis for which humans communicate and discuss to accomplish tasks. This is the innovative engineering taking place today. Work she describes as higher ideas, design, and creation and this is where the architecture lies. These three ideas of the human condition are ingrained into our nature: they push us forward to accomplish daily tasks and send men into space, and now push us forward to sights of settlement on a new planet.

# PHILISOPHICAL PRESENTATION

From Wischer's Thesis Course, Before Switching Over to Ganapathy, Part  
Way Through Semester:



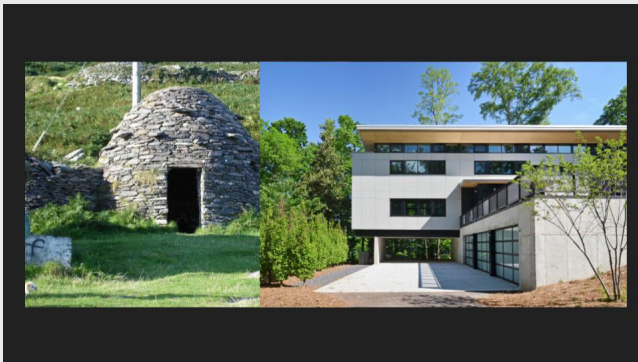
In "On the Relevance of Phenomenology", Dalibor Vesely states that :There are planners, economists and sociologists working on a large scale project and the architect is the middle". By this architect is also the bridge meant to bring together the pure engineering of our current technology and the narrative of a healthy dwelling place. It is not the engineers job to make their plan extravagant, but the architect's to make it humanly, and culturally personal.



The current site of "this project" is located in the Gusev Crater on Mars surface, However this design could be applied to any point along the Martian equator. This being where temperature fluctuation is survivable within shelter, and actually quite temperate during Mars summer.



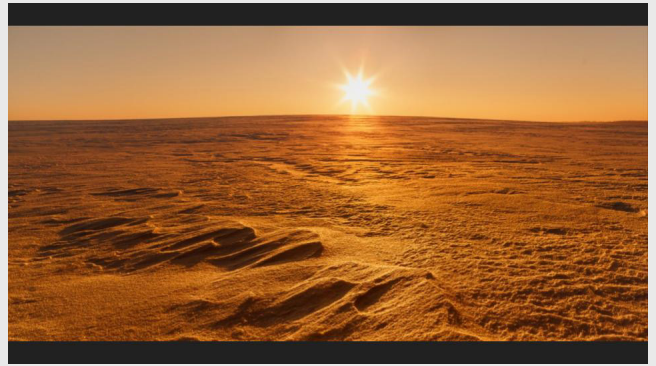
A major aspect of this project is the design of migration. Just as at the beginning of the migration to the Americas, or in any other major population migration there comes a discussion of how a community will shape their new world, and their architecture will influence that new life. Settling this new planet will be the first time in history that humanity is supplying new life to an area instead of destroying it.



Furthermore, the project is about dwelling. Dwelling as a living space as well as an example of how a narrative moves. In the Attunement Introduction it is said that "Vitruvius believed that the main purpose of a well designed city,.. Was to make possible a healthy life; that a balanced environment, the climate, or atmosphere, was fundamental to balance of the humors of the body, resulting in a wholesome psychosomatic existence". So the role of an architect in a dwelling is to allow for a residence, and in this case a interplanetary workspace as well to be psychosomatically healthy.

# PHILISOPHICAL PRESENTATION

From Wischer's Thesis Course, Before Switching Over to Ganapathy, Part  
Way Through Semester:



NASA has undergone research in Hawaii into how a crew living in close quarters for over a year can create a healthy life within a test Mars research facility. This has shown to be very functional within the given time, but for a long term use Martian facility there needs to be a thoroughly balanced environment. Further into this reading there is discussion on how the typical city environments today seem to alienate people in a urban sense, where in ancient times the functions of the city blended together. Today's society is associated with dwelling, transportation, and consumership in separate forms. The Mars project will be bringing the things of necessity to one stable location. During a discussion on technology in Attunement it is said that there are two statements concerning technology: "One says : Technology is a means to an end. The other says : Technology is a human activity". The means to an end is descriptive of necessary functionality to support life, and the transportation needed to get to Mars, However it as written is also a human activity. There is a need for technology to adhere to the human condition. The outcome allows not just for functionality but a relatability to us. (Slide) A colony design on the red planet could be entirely functional, but once we allow it to become a human activity, a human condition, it can flourish.

The nature of the prospect of a project like this is that it is highly technological and functional. An engineer could design in this typology and it would be efficient, purposeful, and functional: given SpaceX's recent example that's exactly what has been done.

At the start of this project I believed that it was to be conception of architecture and technology, but now I realise it, is more about bringing humanity, dwelling, and narrative into a functional structure.

Stephen Petranek, the author of the book "How We'll Live on Mars" had these things to say regarding the journey to Mars: "We are incredibly vulnerable to the whims of our own galaxy" "to survive we have to reach beyond our home planet" "think of what a tragedy it would be if all that humans have accomplished was suddenly obliterated" "exploration is in our DNA" "Some of the greatest advances in civilization and technology came because we explored" "Think how inspired we will be to see a landing on Mars: Perhaps then we will look back at Earth and see that there is one people instead of many, and perhaps then we will look back at Earth as we struggle to survive on Mars and realize how precious the home planet is"



# PROJECT JUSTIFICATION

There is a need to discuss how seeking out future technology is necessary for progress on earth as well as Mars. Technological innovation of Mars expansion has the potential to inform on new solutions to Earth's problems. This has always been the case throughout history as boats, ships, planes, trains, automobiles, and many other technologies are the result of expansionism, migration, and transportation. Even now SpaceX is developing rockets that will be as affordable as planes to commute around the globe in minutes instead of hours, and this is only happening because of the research to get to another Planet. Traveling to Mars is needed to expand technological innovation. Since we are currently in peace time throughout most first world countries technological development has been slow, compared to times of war and other hard parts of history. To dramatically advance technology there is either a need for nature to push us, for conflict to necessitate progress, or for humanity to push itself. As life in the countries that have the finances and resources to expand technology are in a state of easy life, nature and conflict cannot drive us forward, and thus we need to push ourselves.

React to NASA and SpaceX endeavors into progress toward Mars mean there will be a need for engineers and architects to work on building projects that will be on Mars surface. Regardless of if its right or wrong to go to Mars there are Public and Private companies investing everything into making it happen, and so there is a need for these types of designs. Just because a project won't get built tomorrow doesn't mean it will not happen and be needed in the near future. Progress isn't reactive to things that are here already, but expanding to develop things of new creation.

Need to be multiplanetary because of Potential catastrophic event on earth and saving



humanity, etc.

Space exploration is one of the only things in modern society that brings cultures together in a common goal. Despite the tension





between the US and Russia their space programs are working on the space station together and doing research together. Also they are not working on creating a new station together.

To allow everyone to dream bigger, have a common goal to move forward, and to always see a better world on the horizon. JFK and the Apollo project united the country to dream and in hope of a greater future like nothing before. In our culture today political oppression and capital control over society does not allow for many to see that brighter future on the horizon. This may not be a necessary part of life for survival, but it is a necessary part of having a happy or innovative and imaginative life.

#### Common Questions and Reservations:

Why is the project that you have defined important to you as a person (your personal reasons)?

Because the project I am doing brings together all my knowledge of design built up over the last five years and is presented in one work.

Why is it important for you to do at this stage of your academic development?

To show a representation of five years of architecture education.

Why is it important to do at this stage of your professional development? Refer above.

How is the project going to add to your knowledge base?

It brings together a research and design project which builds theoretical and practical knowledge.

How is the project going to add to your set of skills?

It will add skills through research, development, creativity, and design.

Why is doing the project important for the profession at this time?

Within the next decade there will be many design positions for creating a settlement on Mars, and so this field is soon to become very active.

Why is the project important as an academic exercise at this time?

Refer above. Also because it has been touched on very little to this point and needs to be explored.

How can you justify the project economically?

Missions to Mars is now becoming privatized and so this project will be part of an interplanetary economy soon in the future.

How can you justify expending the funds to implement the project?

All the reasons above. Also I have written a paper on this already but don't want to spend time adding that to this right now, so ya: You will see later.

Where might the funds come from for your project and are the sources justified?

Investments, and corporations, and a little from the government. Justified: yes because it's all by personal choice.

# HISTORY, SOCIETY, & CULTURE

The ISS is currently set to be abandoned by NASA in 2024.

NASA and Roscosmos(Russian Space program) announced they are working together on a moon orbiting space station. SpaceX also has plans for a moon station for refueling rockets and etc, on the way to Mars. NASA wants this to push its reach farther into the solar system.

The plan is unclear for now, but this could slow down NASA's plans to get to Mars. Thankfully SpaceX and other private companies are working on that as well.

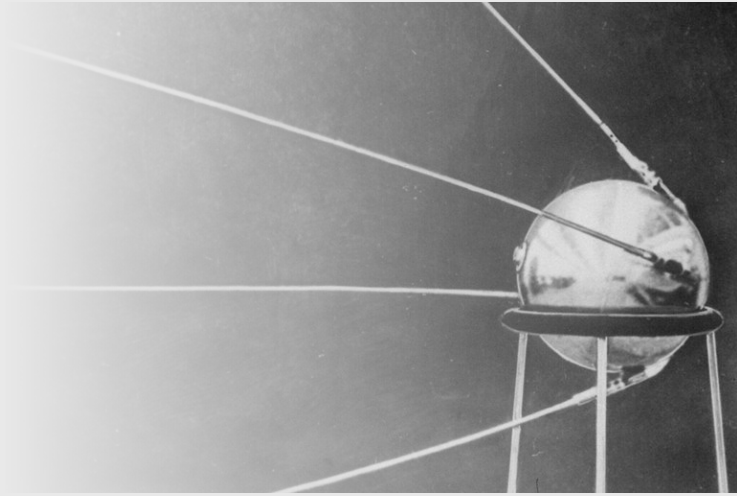
There is a proposal for a orbiting Gateway station for the moon by NASA, and SpaceX is working on plans for a surface station.

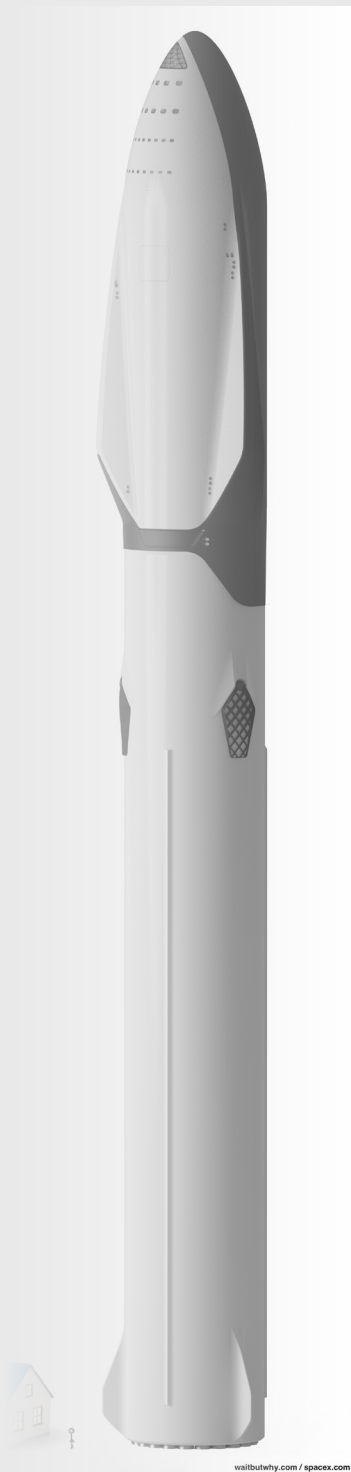
Unfortunately NASA and Roscosmos have not released any clear plans as to what their station would function as, just as the ISS did.

So while SpaceX has had endless innovations over the last decade NASA's plans for the moon seem mildly unnecessary to produce new technological research, at this time anyway.

We have spent \$65 Billion on the ISS, and the F35 jet project with the department of defense has spent over \$400 Billion. What could NASA do with some of that budget? This is one of the reasons private companies are necessary, to develop new technology and research.

One SpaceX launch costs more than NASA's entire budget. That's a problem.





They have raised \$10Million in funding and hope to fly their first rocket in 2021

One of their ultimate goals is to be able to 3D print rockets on Mars surface.

Relativity is working on designing and creating a fully functional rocket using 3D printing in order to lower rocket cost.

80 to 90 percent of rocket costs are labor, or peoples salaries, so to reduce these costs it will need to happen through machine building and 3D printing

SpaceX currently makes the most affordable rockets, and a launch costs about 60 million dollars

Their goal is to use autonomous manufacturing and 3D printing to provide rockets at 10 Million a piece

Both founders built rockets at USC. After Tim took a job at Blue Origin (jeff Besozs rocket company) working on 3D printing and Jordan worked at SpaceX working on engines.

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The money spent on Space travel is more helpful to us on earth than if we had spent it elsewhere.

Money spent on Space exploration research has given us Batteries, modern eyeglasses, GPS navigation, Weather satellites, global telecommunications, and many other necessities today.

NASA's research has given humanity a huge amount of current technological innovations.

An example is a solar plant that powers 75,000 homes in Nevada was created using NASA produced technology from the rocket designs. And now these plants are opening all over the world thanks to the innovation NASA started.







Their technology has been adapted by Nuclear power companies, video game industry among others, based on automated control technology produced in the 80's

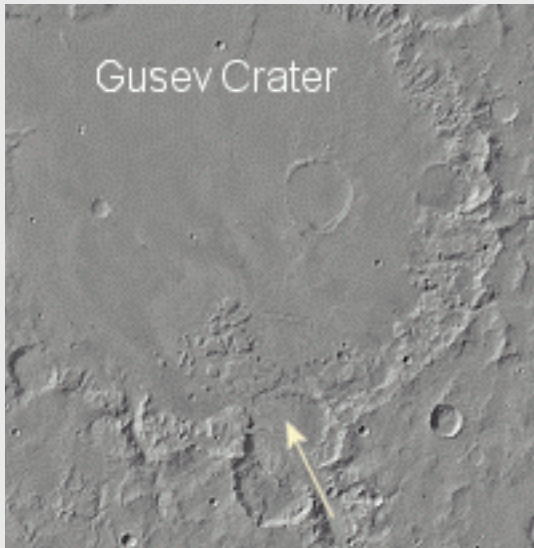
Giga pan technology (basically ability to take amazingly detailed panoramic pictures, was born out of Mars rover design technology. It works by taking hundreds of pictures and stitching them together. This software is even in Adobe Photoshop now.

NASA software has inspired bank fraud protection, aided in computer software design, video game production and many other software applications.

NASA tech has helped the medical field with MRI scans, and identifying Alzheimer's.

They invented LED lights to allow plants to grow without needing sunlight.

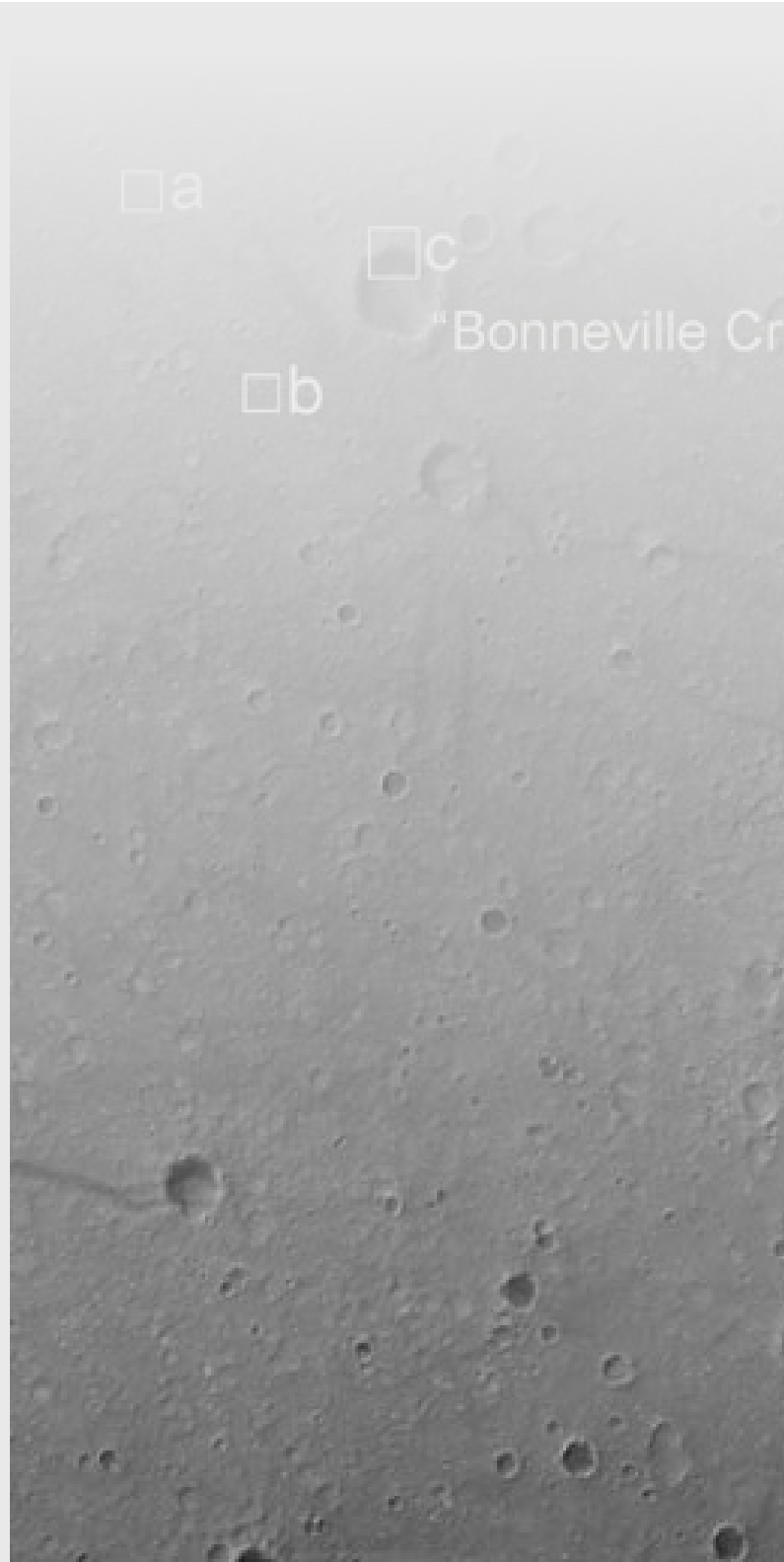
# SITE ANALYSIS



The Macro Site location is set at Gusev Crater which is a 90 mile wide crater that used to hold water, and has clear markings of flowing water. This is an ideal site as it sits at the equator with temperature fluctuation from -90F to 70F, winter nights, and summer days respectively. The NASA rover Spirit landed and explored part of the crater upon landing in 2004.

Because of the nature of this project and the open slate that is Mars, the project could be built anywhere along the equator on a roughly flat terrain.

The area that the Spirit rover has explored is the most likely to be settled upon, and specifically the "Home Plate" location as a completely flat plateau is an ideal area.





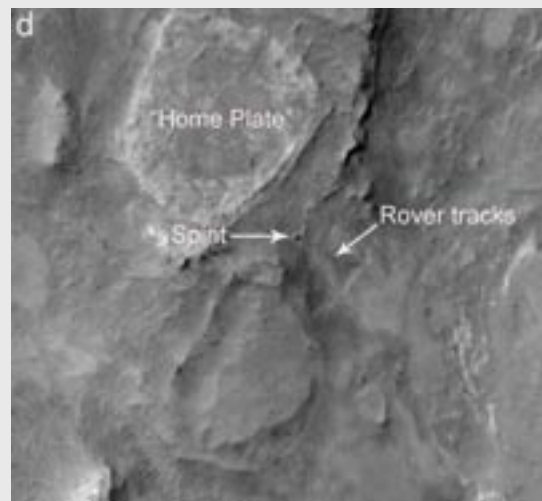
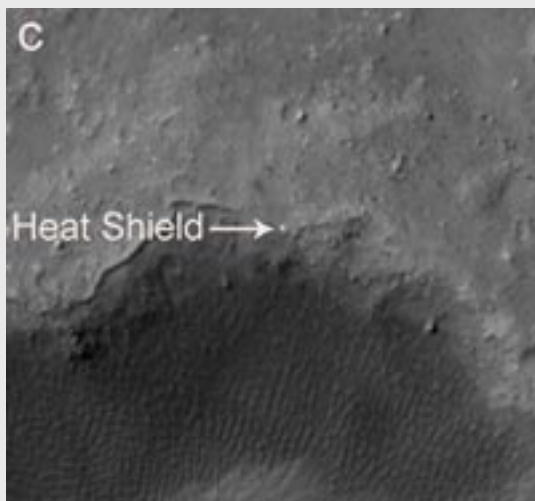
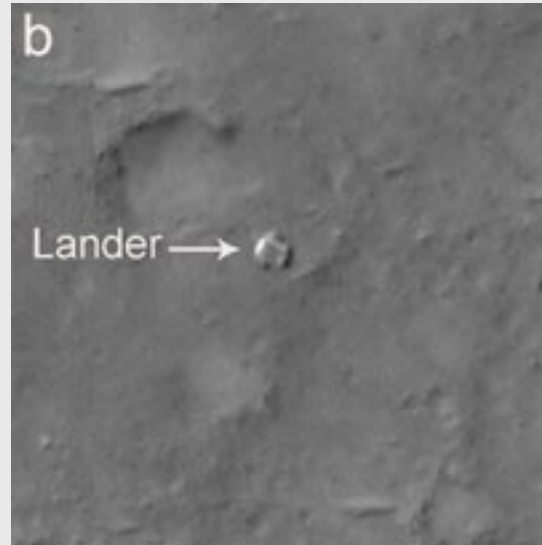
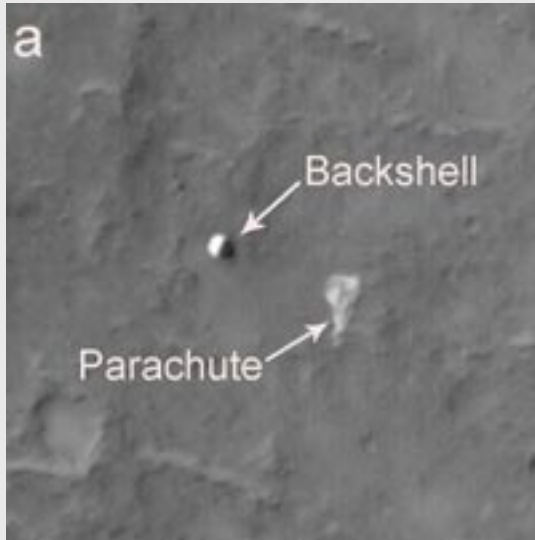
Martian soil is a mix of rocky terrain and very fine sand with significant iron deposits throughout. The actual soil particles are even finer than Earth's sand, and due to this any concrete or other soil based construction will be different in composition than anything similar on Earth.



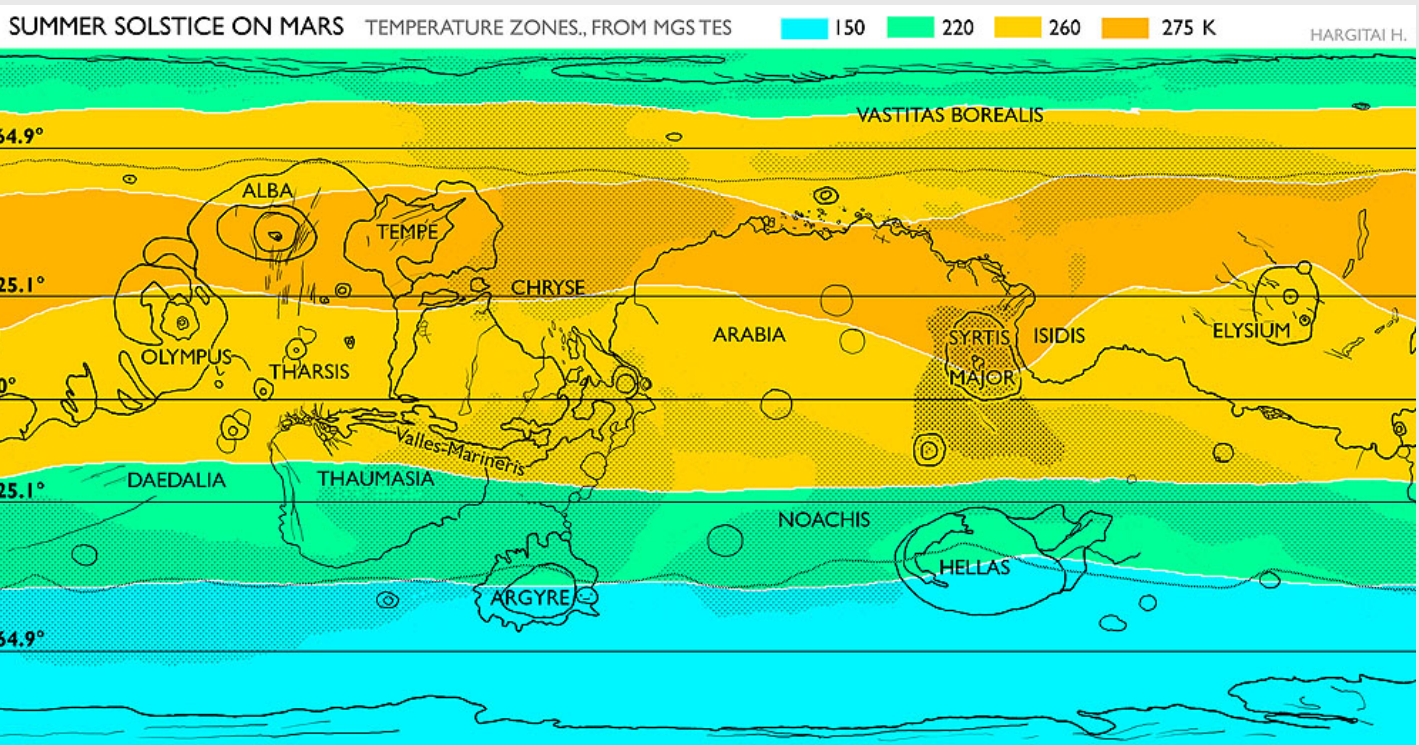
NASA has done thorough research into Martian farming and enabled reproduction of worms in simulated Martian soil as a test into farming capabilities, as well as soil nutrients. While most of the nutrients would come from excess organic waste, it is now possible to create life under these conditions.



# SITE ANALYSIS







The climate conditions of Mars are reflective of the long distance from the sun as well as the lacking magnetic field and thin atmosphere. Because of this there are very low temperatures and relatively little climatic variations. The atmosphere is thick enough to allow for small amounts of clouds. There are also occasional dust storms that can last quite long during warmer seasons. It also occasionally will snow on Mars in the form of carbon dioxide. The poles are mostly solid carbon that is frozen, and if this can be broken up and sent into the atmosphere there will be a potential to heat up the planet and allow for water flow. During the warmest times of the Martian year there has been flowing water seen on the surface.

# PERFORMANCE CRITERIA





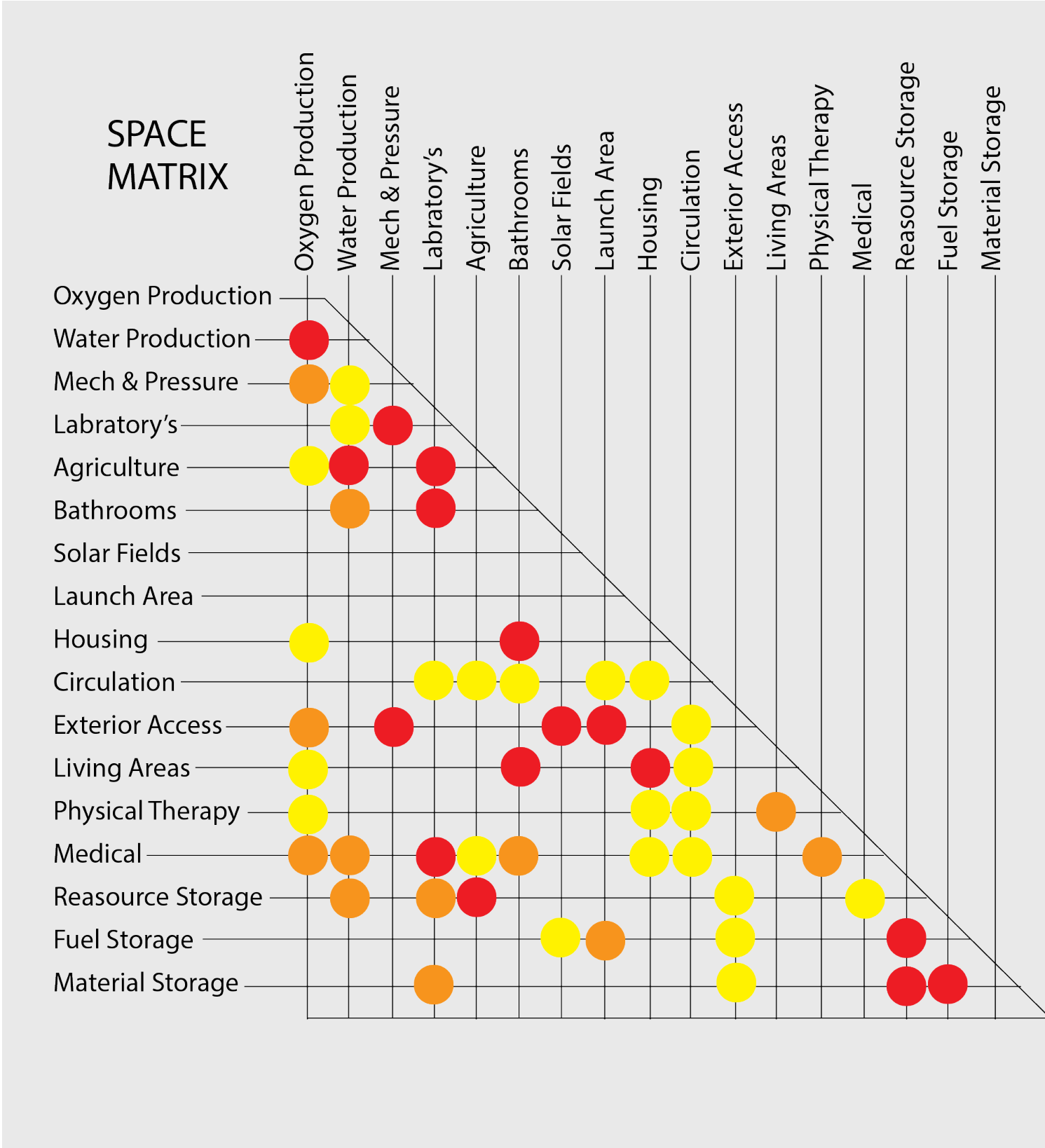
The performance criteria for the Mars colony is unique, because unlike on Earth there is actually a need for more carbon dioxide in the atmosphere so there is no need to create a sustainable structure. However, the problem here is that the easiest way to produce energy on Mars surface at least at the beginning of colonization is to actually use sustainable resources and imported systems from earth including solar power, and nuclear fission.

Performance criteria will be primarily based upon functionality of life support system integration and seamless transition within program functionality. There is a need for power allocations, life support, housing, and a reusable launchpad and docking base for transit back to Earth.

The performance criteria will be based upon the programming of the building design. This program includes oxygen production, agriculture, water production, housing, mech & pressure, lab area, solar fields, launch area, hygiene areas.



# PERFORMANCE CRITERIA



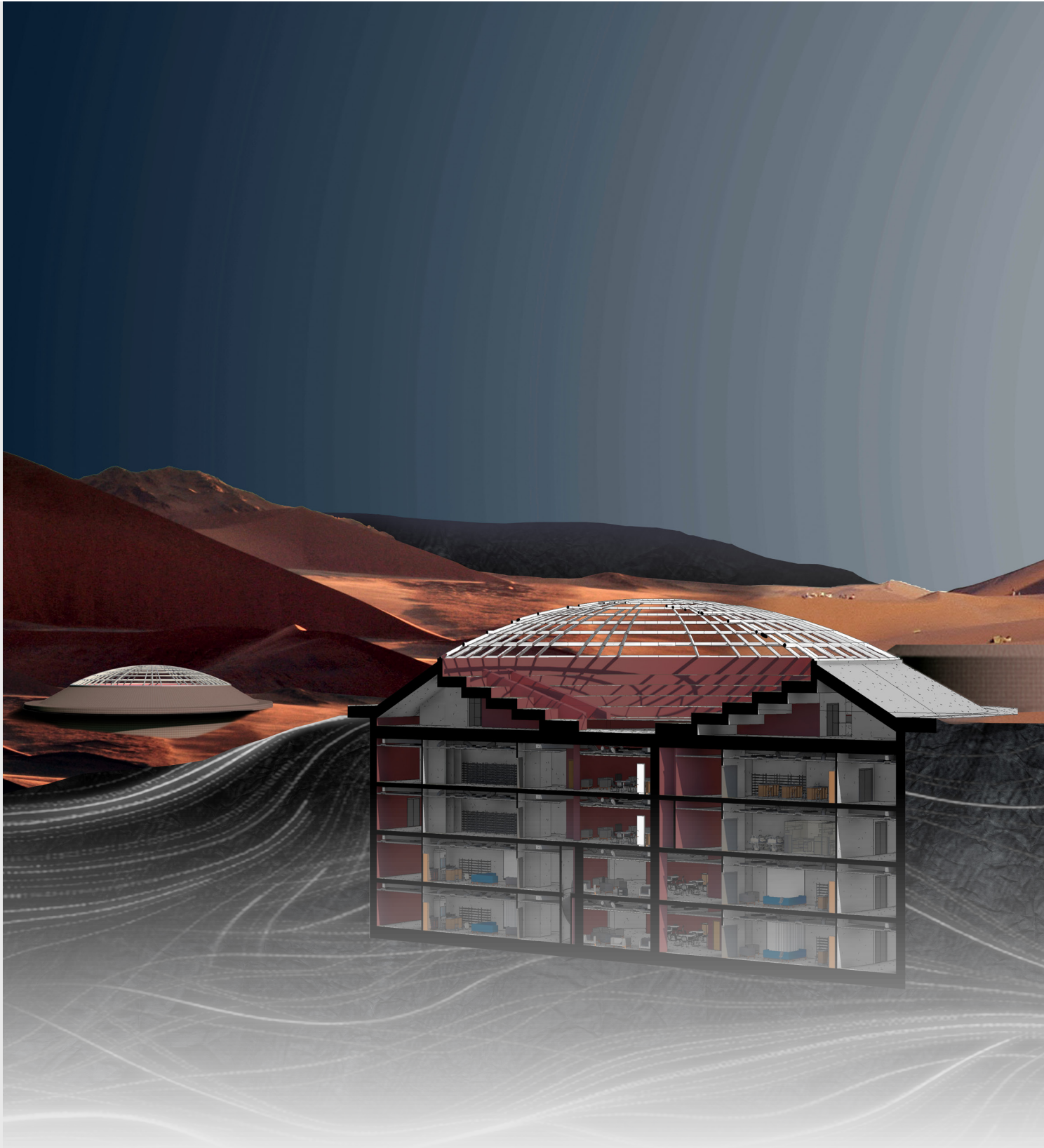


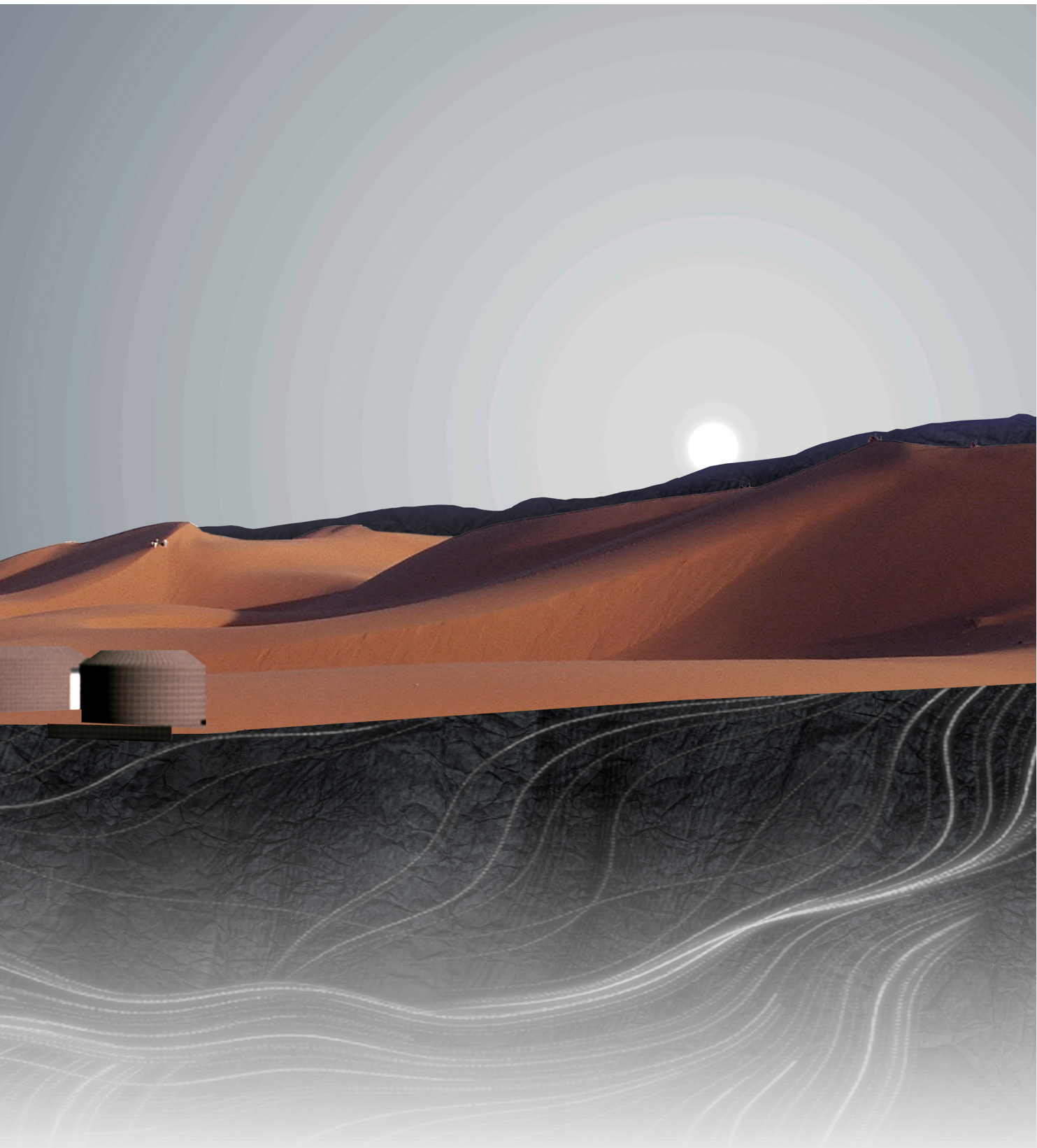
# PROGRAM APPENDIX

## REFERENCE LIST:

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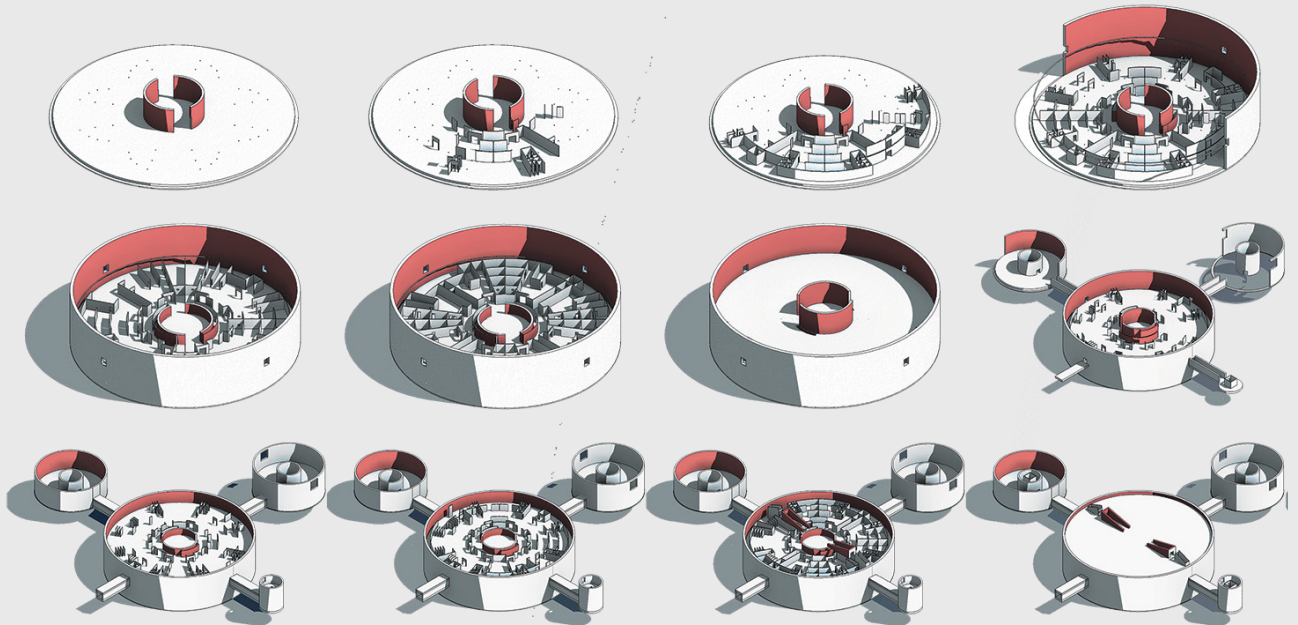
# DESIGN SOLUTION





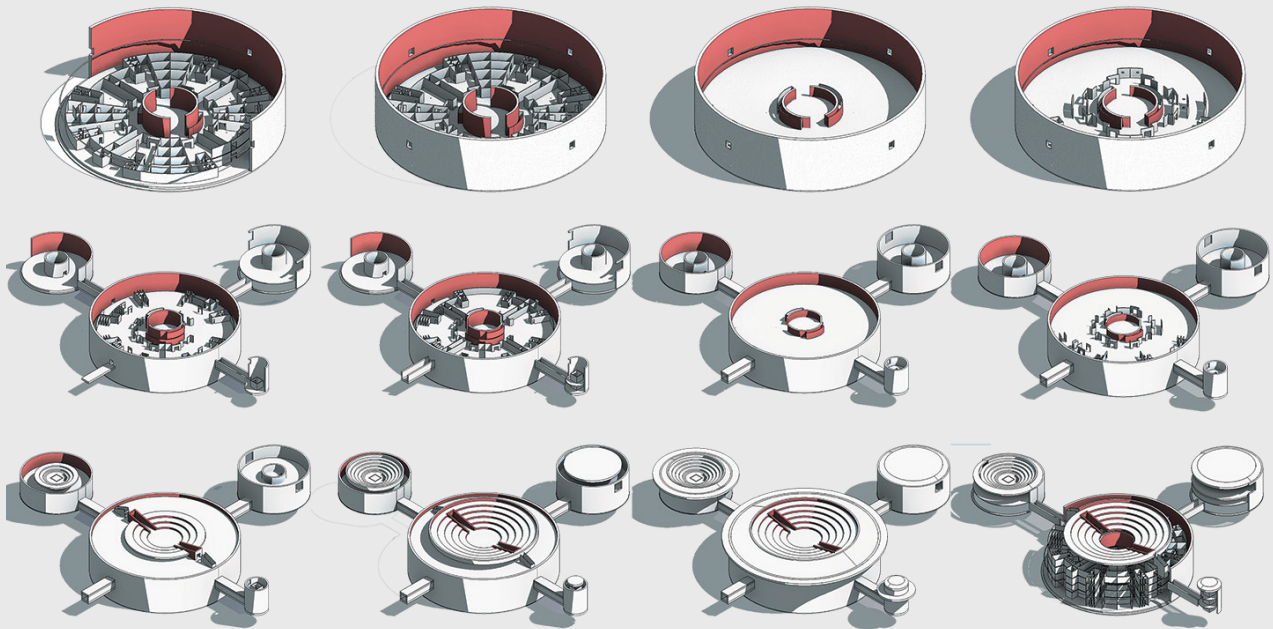


# PROCESS DOCUMENTATION



For the design process of this project, by the time I was able to begin designing, after transferring classes, the rough design was already planed out in my head. At this point the base design began, including a first level sunlight exposed deck, and a cylindrical depth into the terrain (predicated on circular borders to allow 3D concrete printing within Mars surface. The Main building is connected by tunnel to the greenhouse and food storage, the personal exit point, and the vehicular and material storehouse.





## Major Project Elements:

### Main Building:

Residence, Research Labs, Medical, Physical Therapy, Living, Storage

### Storehouse:

Materials Storage, Vehicular Storage and Garage, Exit Point

### Exit Building:

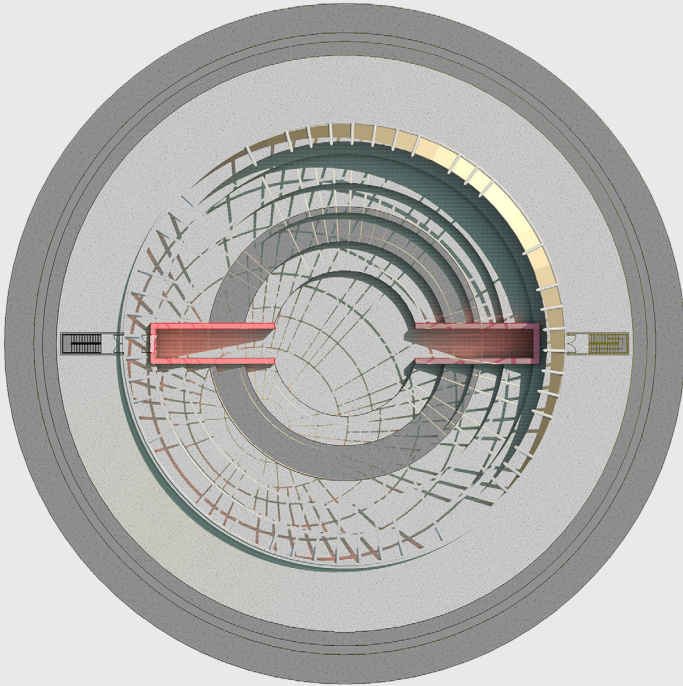
Personal exit point, tunnel access

### Greenhouse:

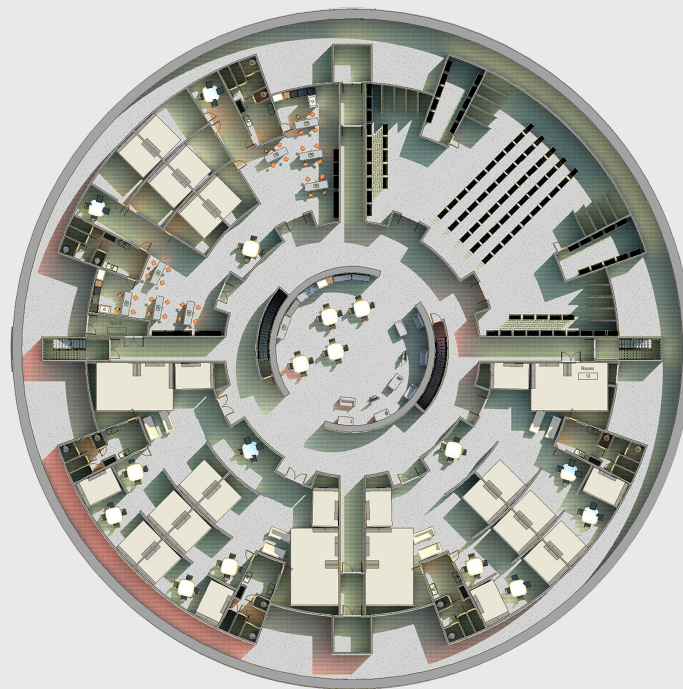
Greenhouse & Plant Food Production, Plant Storage frozen and chilled, Growing material and seed storage

# PROJECT SOLUTION DOCUMENTATION

## FLOOR PLANS

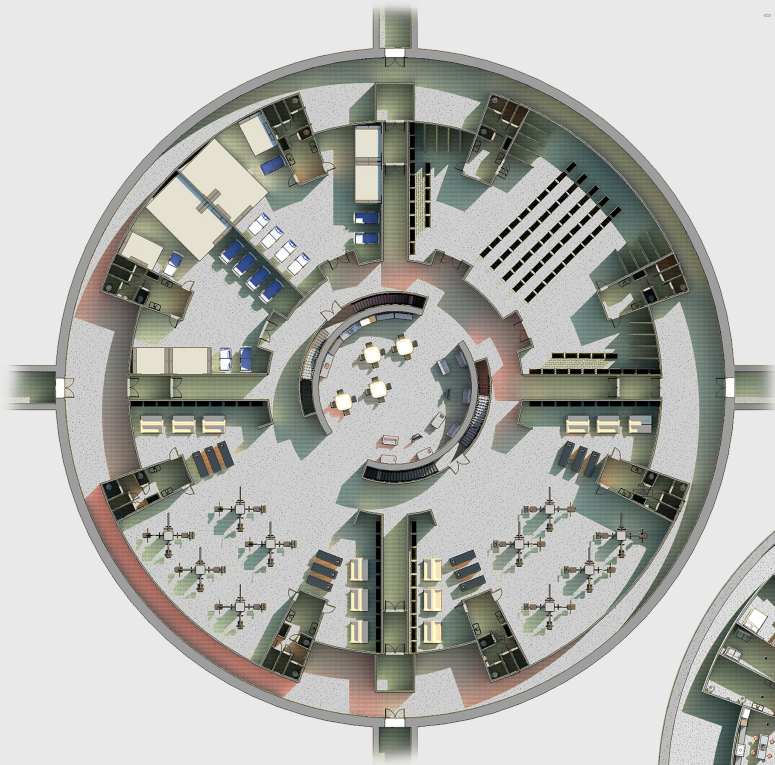


Level G  
G Level Access  
Ampitheatre Park design



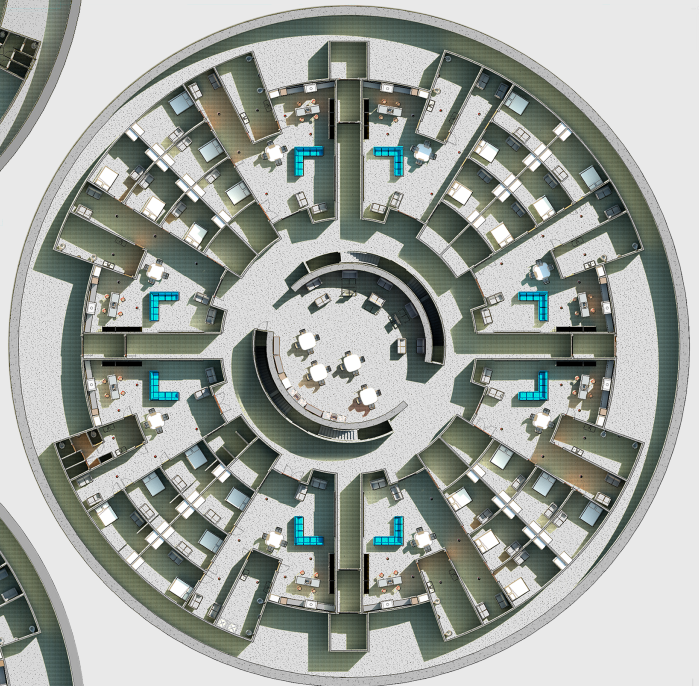
Level 1  
Level G & 2 Access  
Research Labs & Office  
Storage  
Lounge





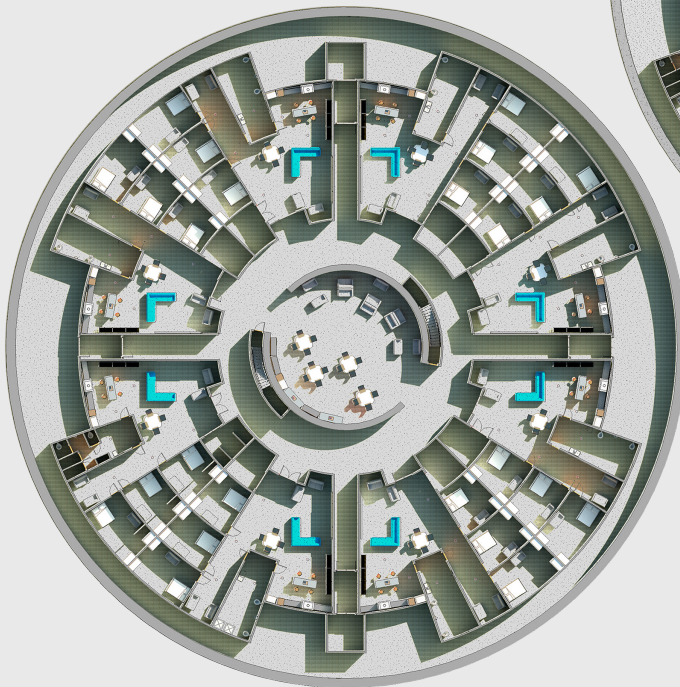
## Level 2

Level 1 & 3 Access  
Medical Labs  
Physical Therapy  
Storage  
Lounge



## Level 3 & 4

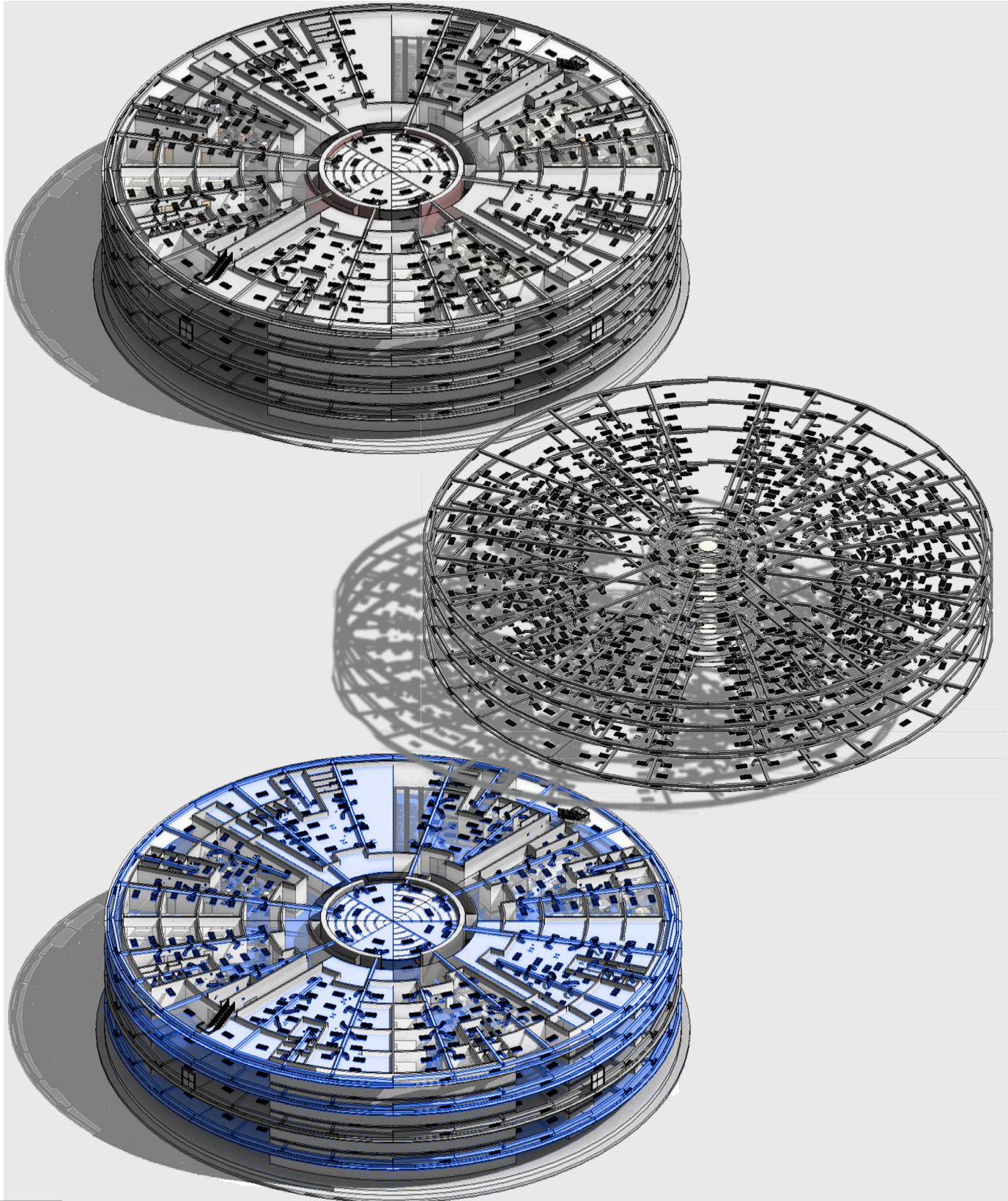
Level 2-4 Access  
Residences  
Bedrooms  
Bathrooms  
Storage  
Kitchen  
Living  
Lounge





# PROJECT SOLUTION DOCUMENTATION

## HVAC, OXYGEN, & PRESURIZATION

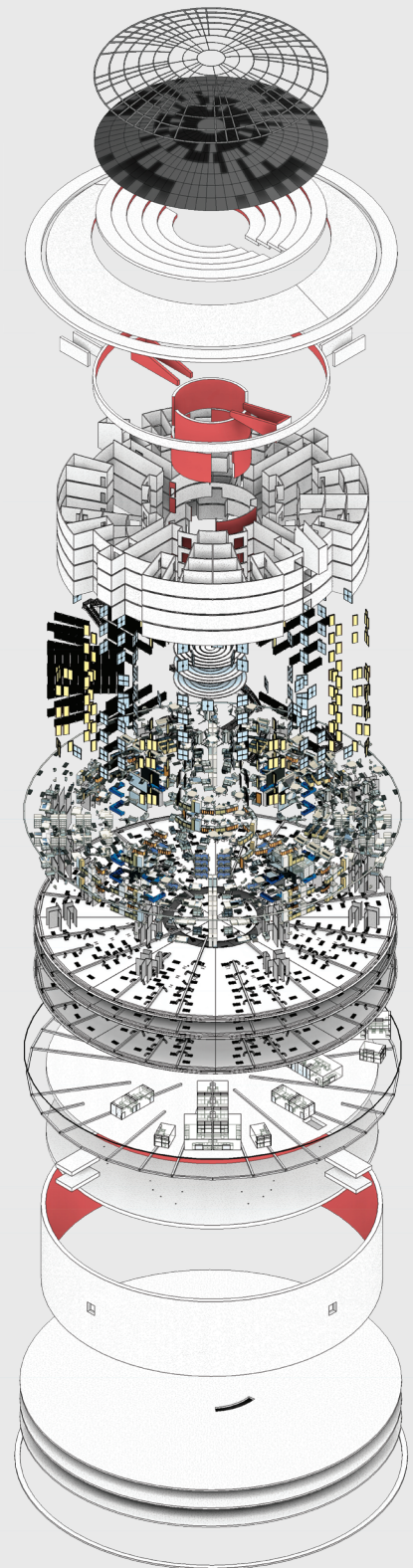




A primary feature of the whole design is the isolated HVAC rings surrounding the main programmatic elements of the building.

The HVAC, Oxygen, and pressurization life support systems are all designed to be functional independently based per level, all connected to the atmosphere above.

The Systems are all independent from the other buildings, but are functional together as a single system. This provides ease of use during regular use and provides security under compromising situations.



# PROJECT SOLUTION DOCUMENTATION

## INTERIORS



The Central Lounge is a feature on every interior Level of the main building to provide an escape at any point. The construction method uses the thick walls that create this space as vertical structure for the building. These three foot thick concrete walls contain the support for the lower floors as well as much of the shape of the building.

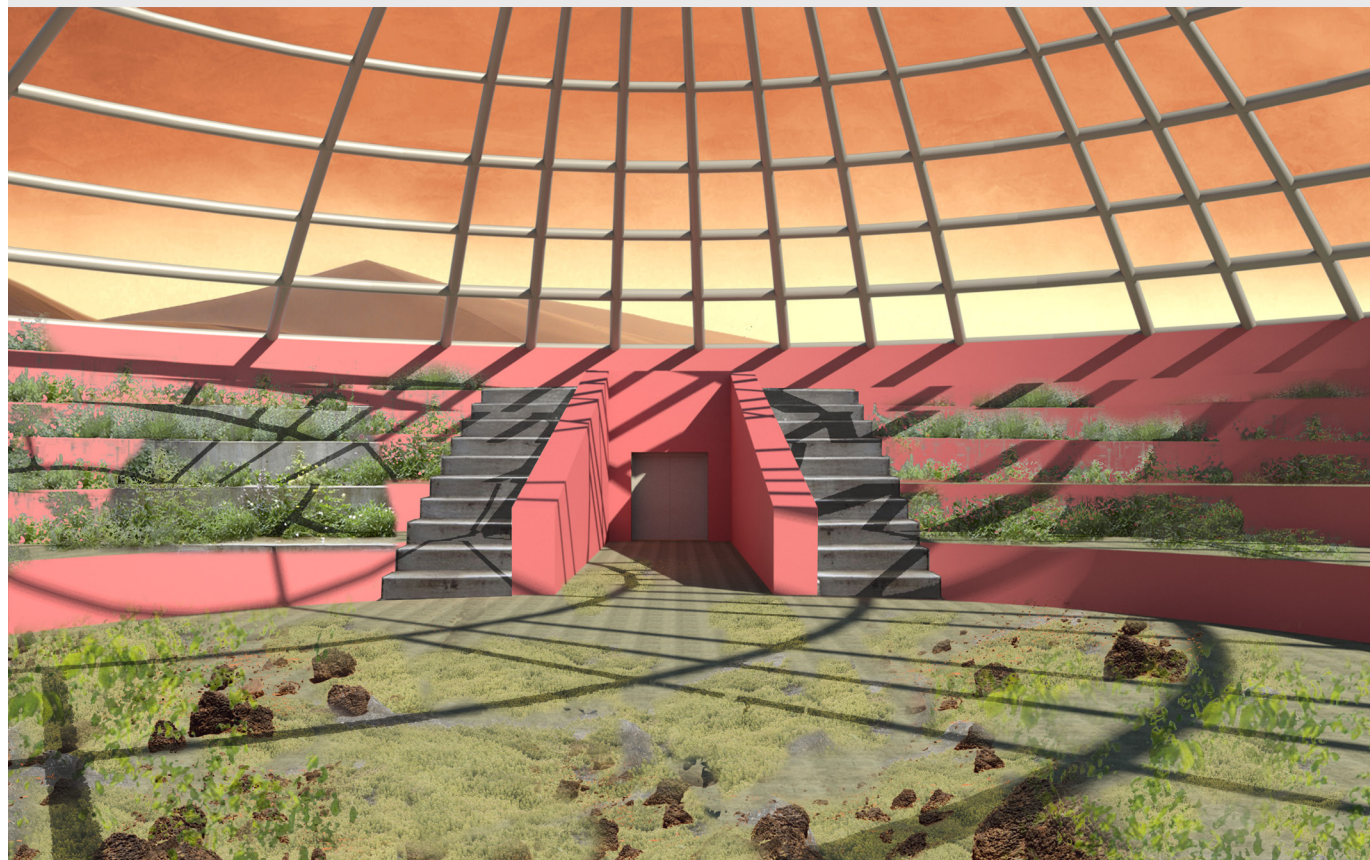


The residential interiors are meant to resemble apartments from Earth. Each has three full bedrooms to accommodate whatever expansion is necessary. The residences are on the lower levels as these are all that are necessary to support life in extreme circumstances.



# PROJECT SOLUTION DOCUMENTATION

## ATRIUM TOP LEVEL

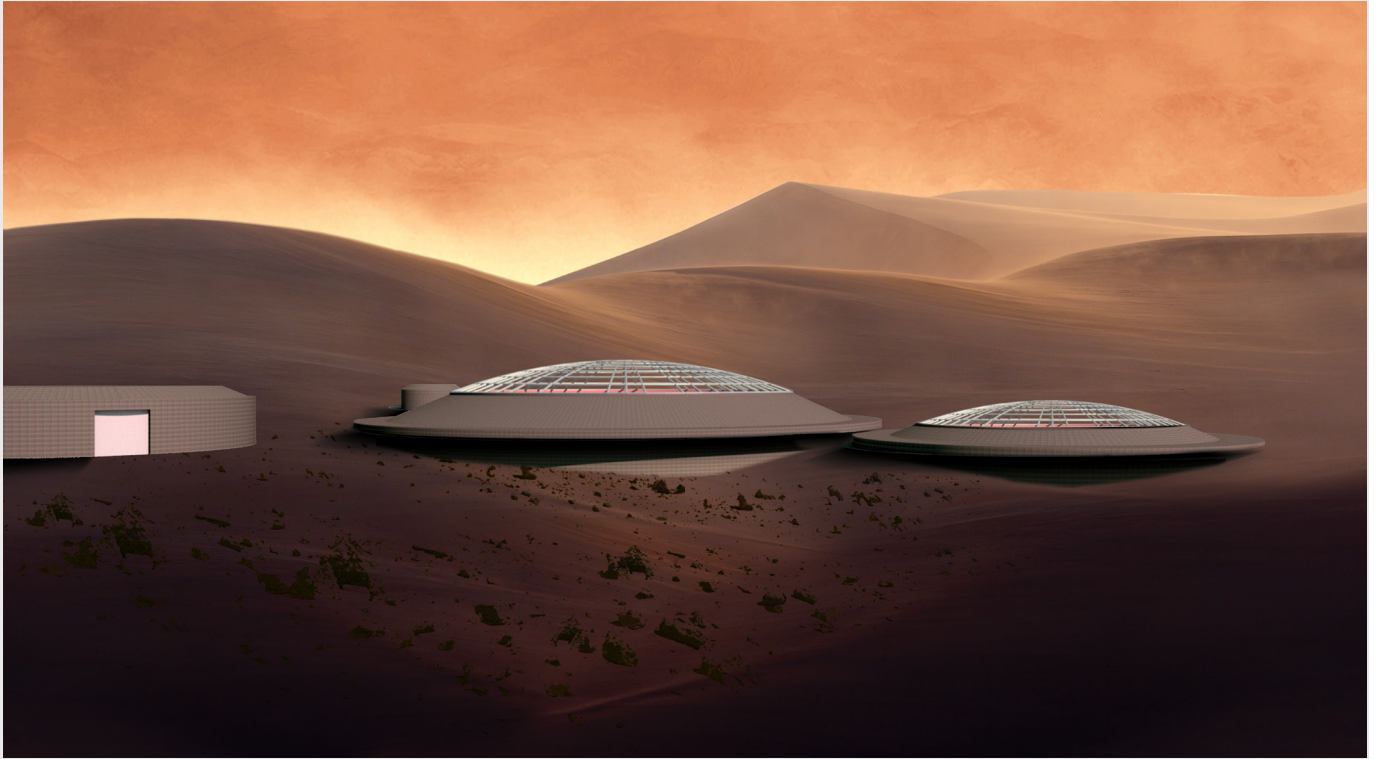


The ground level ampatheatre is used as a breakout space and a needed escape to the daylight. Most of the building is underground to protect from the advanced radiation Mars experiences. Residents are able to be on this level about 3 hours per day without any severe longterm side effects.



# PERFORMANCE ANALYSIS

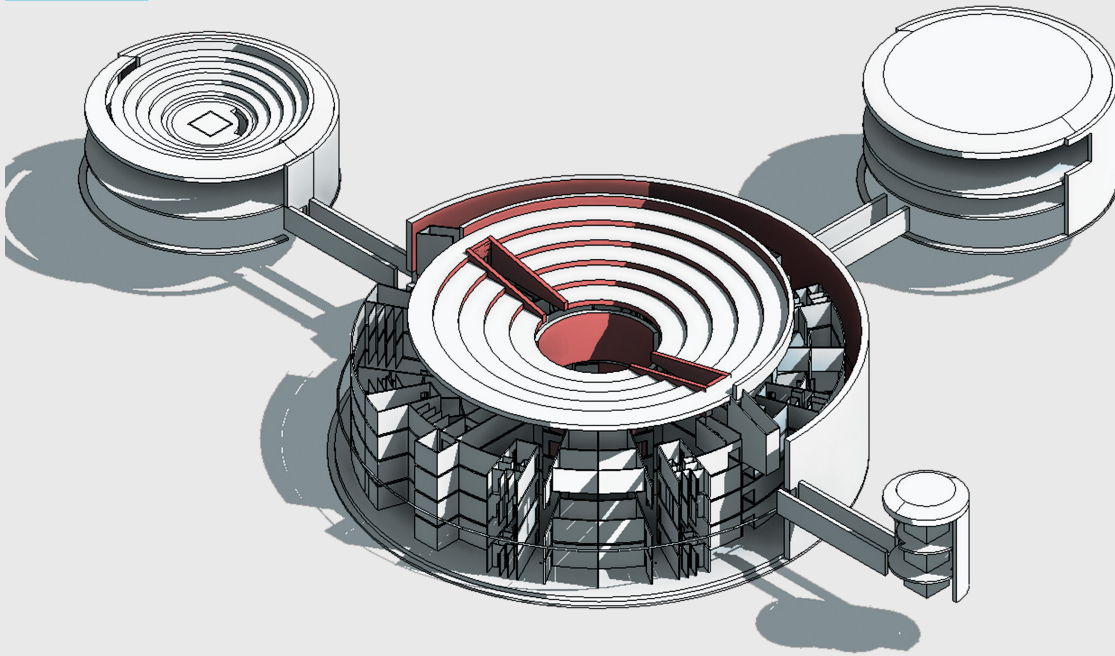
## RESPONSE TO THE SITE OR CONTEXT



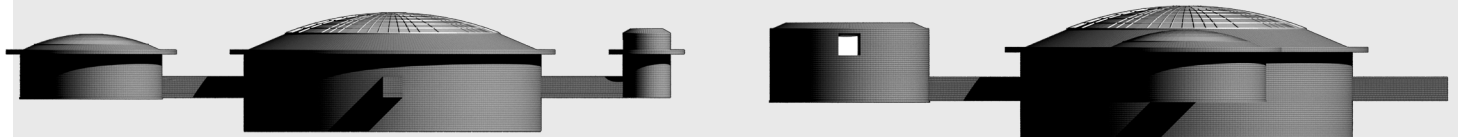
The exterior shows that although flat surface along the equatorial surface is ideal, most any site is feasible as the foundations of this design go 50 plus feet into the ground.

# PERFORMANCE ANALYSIS

## RESPONSE TO THE TYPOLOGICAL OR PRECEDENT RESEARCH

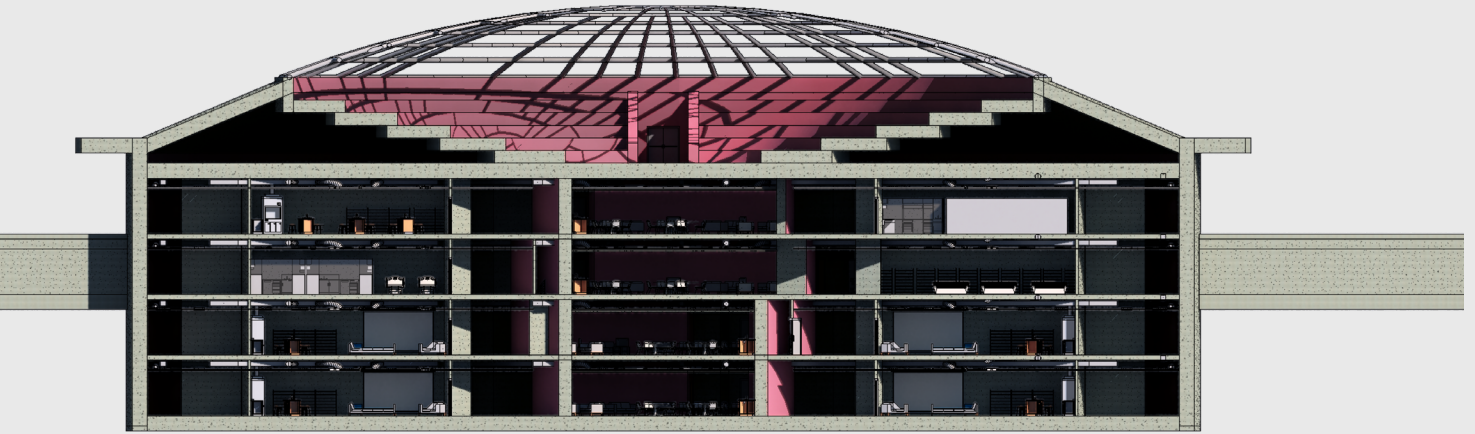


The performance of this design holds up well. all of the intigrated systems keep the building in a condition where human life is the priority. The residences are impenetratable and hold enough supply to keep all residents alive and well, while all integrated systems are able to function independently to support survival. That being said the buildings are fully sealed and radiation protected, allowing for healthy long term stays.

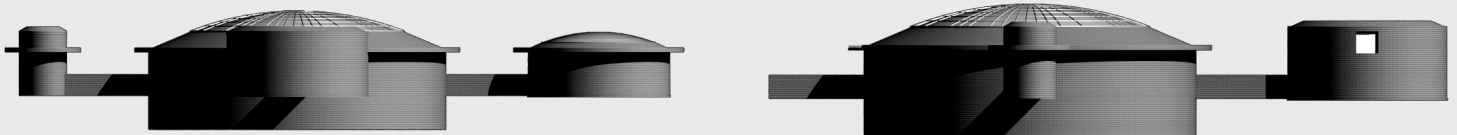


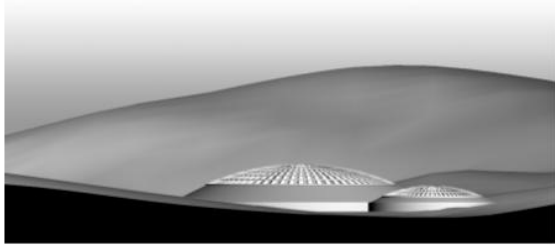
# PERFORMANCE ANALYSIS

## RESPONSE TO GOALS AND PROJECT EMPHASIS



The program is organized based on maximal life support, so that if somehow all the protective barriers were penetrated along the surface, and down into the building the primary needs to live remain contained. This is in an extreme case.





## INTERPLANETARY HABITATION

DESIGNING FOR LIFE ON MARS

Landon Schoeneck

### Abstract:

How can architecture adapt the complex engineering systems of a Mars colony to sustainable human life?

Migration and travel has evolved from the dawn of humanity to the automotive and flight industries of current times. Now interplanetary travel is on the forefront of technological innovation.

Innovation is created by those who dream farther forward than current society can understand, and it is necessary to push the boundaries of technology to make the impossible practical. Thinking ahead to design for future interplanetary migration is a needed step to compel the world forward, as well as architecture and its boundaries therein.

**Building Title:** Mars Station 1  
**Typology:** Planetary Colonization  
**Site:** Home Plate, Gusev Crater, Mars

The Primary goal of this Thesis is to practically design a Martian colony in which a building can combine the following requirements for sustainable life on the Martian surface.

**Efficiency** in Construction, Materiality, Transportation, Storage, & Functionality Systems

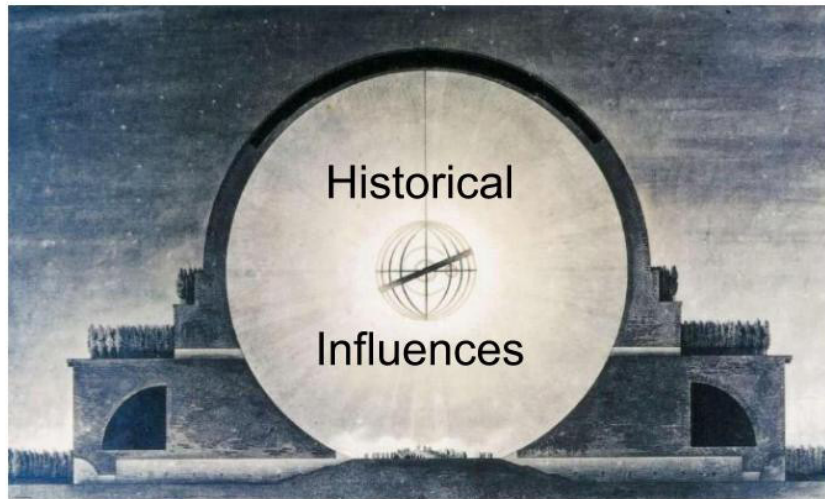
**Aesthetics** in Historical Connection, Design Hierarchy

**Immediate Life Support** in Radiation & Environmental Protection

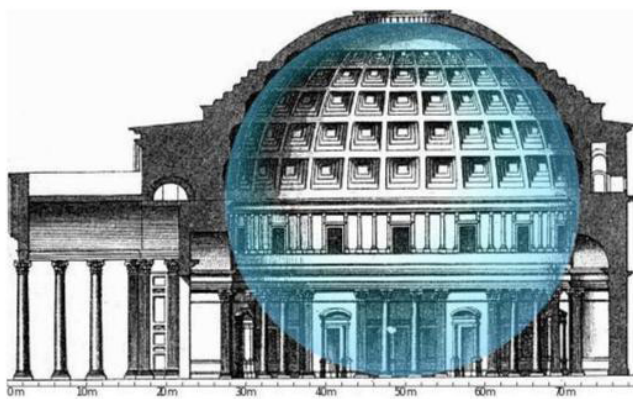
**Life Longevity** in Medical, Physical, & Psychosomatic Health Systems

**Comfortability** in Residency, & Workspace

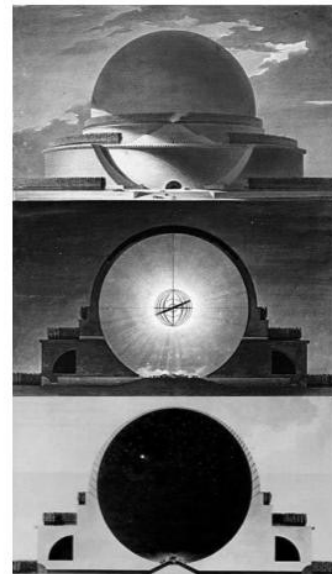




## Cosmology & The Sphere



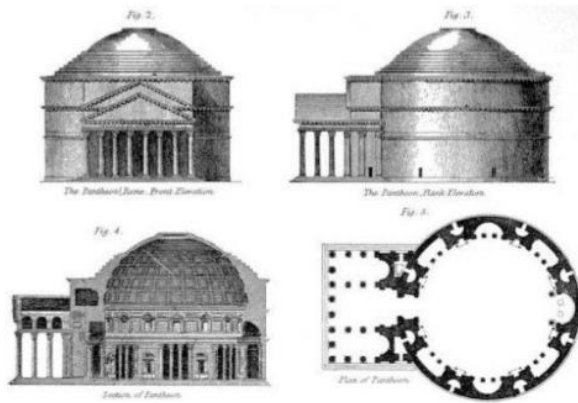
Pantheon of ancient Rome.



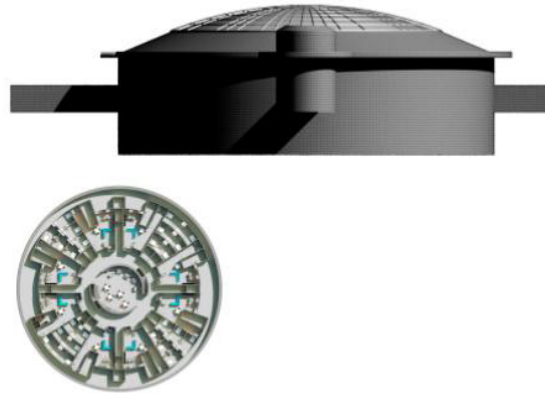
*Cénotaphe à Newton* Design By Étienne-Louis Boullée

# DIGITAL PRESENTATION

## Comparison to Pantheon aesthetic



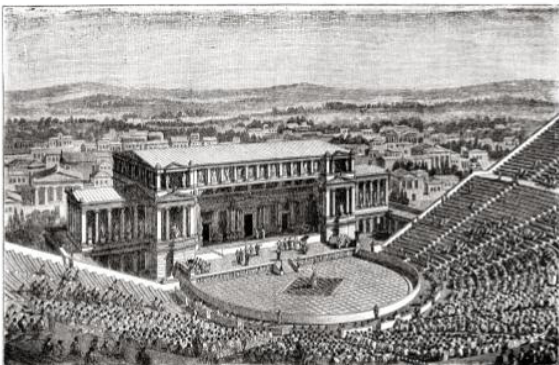
Pantheon Plan, Section, & Elevations



Mars Design Plan & Elevation

## Amphitheater Design Influence

Theatre of Dionysus in Athens



Conrad Prebys Amphitheater at Indiana University

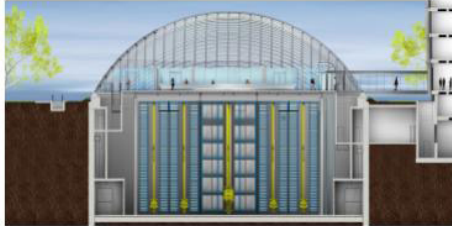


## Dome Design Influence

Reichstag, Berlin



Pantheon, Rome



Library, University of Chicago



1781, Project Design for The Paris Opera

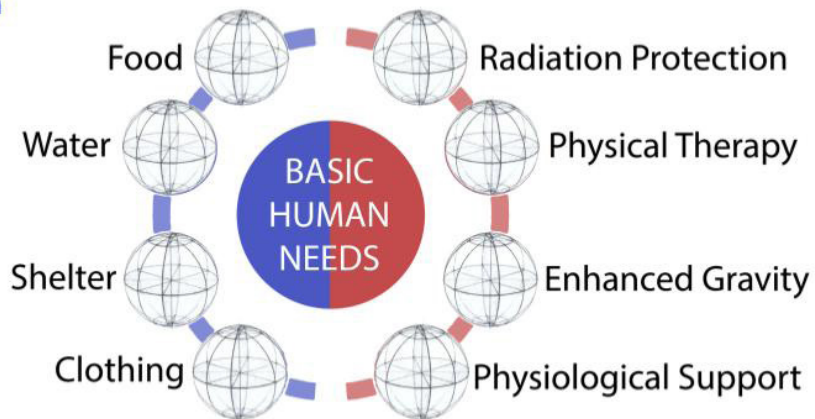
## Necessities for Life on Mars





# DIGITAL PRESENTATION

Necessities for longevity  
on Earth



Total necessities for longevity on Mars

Oxygen, Food, & Water



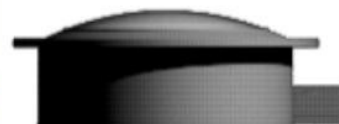
Electrolysis Oxygen Production



Water Purification



Food Production





## Environmental Shelter & Radiation Protection

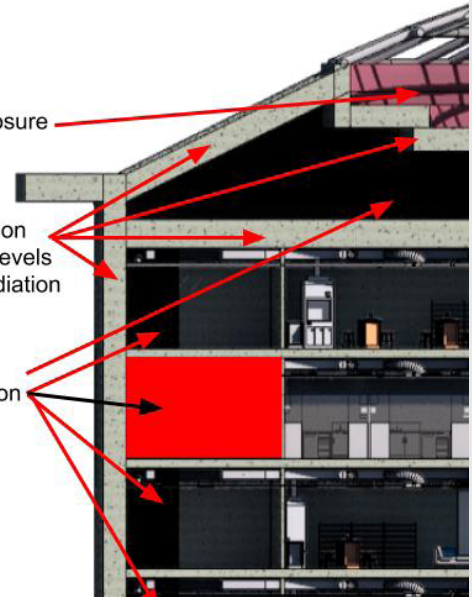
Earth's atmosphere protects life here organically, but on Mars we need to build protection.

Humans can allow for a maximum of 2 hours of exterior daylight radiation exposure, per day on Mars surface.

Level G: 3 Hour Exposure Daily Limit

3 Ft Concrete Radiation Protection Isolating Levels 1-4 for permanent radiation isolation

HVAC & Pressurization Isolation Ring



## Gravity & Pressurization

Gravity: 100%

1 Moon, & Many Satellites

Substantial Atmosphere

Mostly Oceanic Surface



Gravity: 38%

2 Moons, & 2 NASA Satellites

Weak Atmosphere

Little Flowing Water & Ice

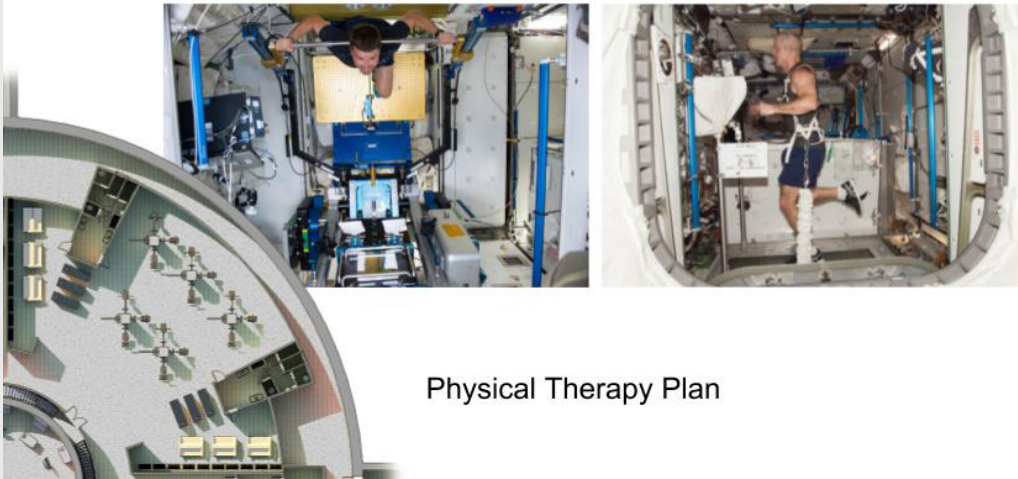
Avg Temp: -67 F

Temp High: 68 F



# DIGITAL PRESENTATION

## Physical Therapy & Tissue Regeneration



## Physiological & Psychological Support



## Construction Process



## 3D Printed Concrete Construction



# DIGITAL PRESENTATION

## Steel Alloys & Minimal Material Design

Steel Decking / Concrete Composite Flooring (3D Printed Concrete)



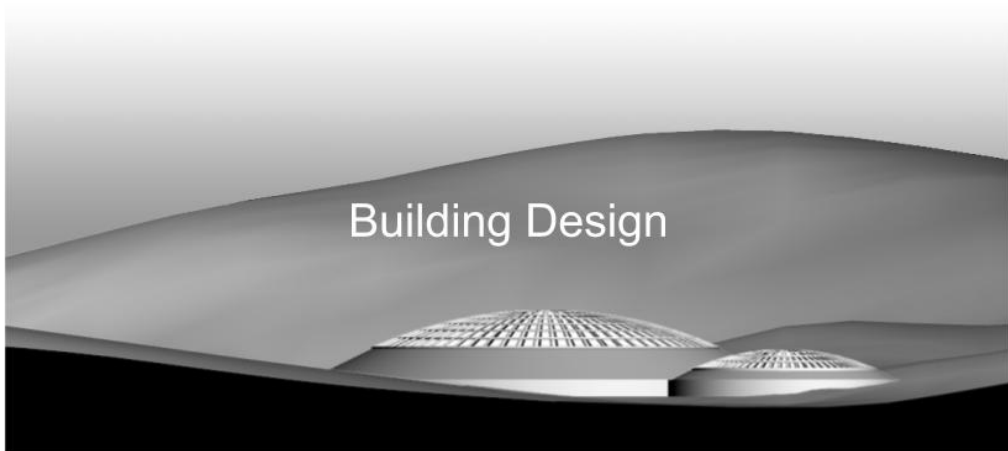
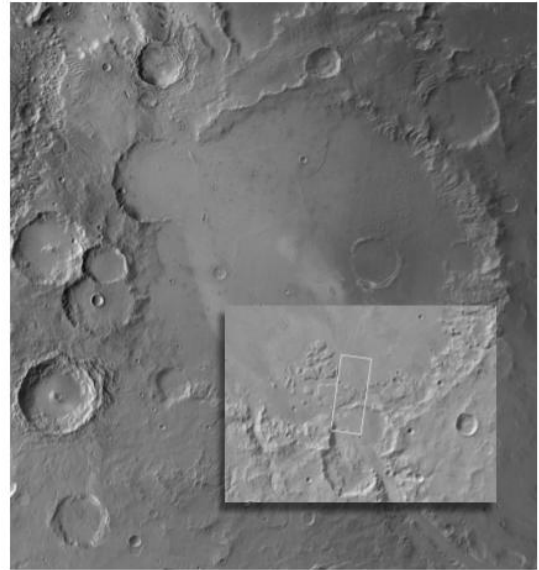
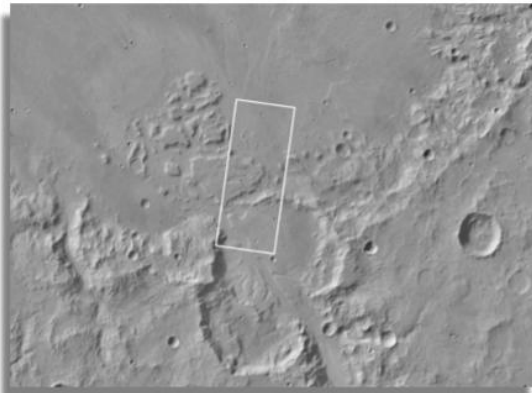
## Construction Diagramming



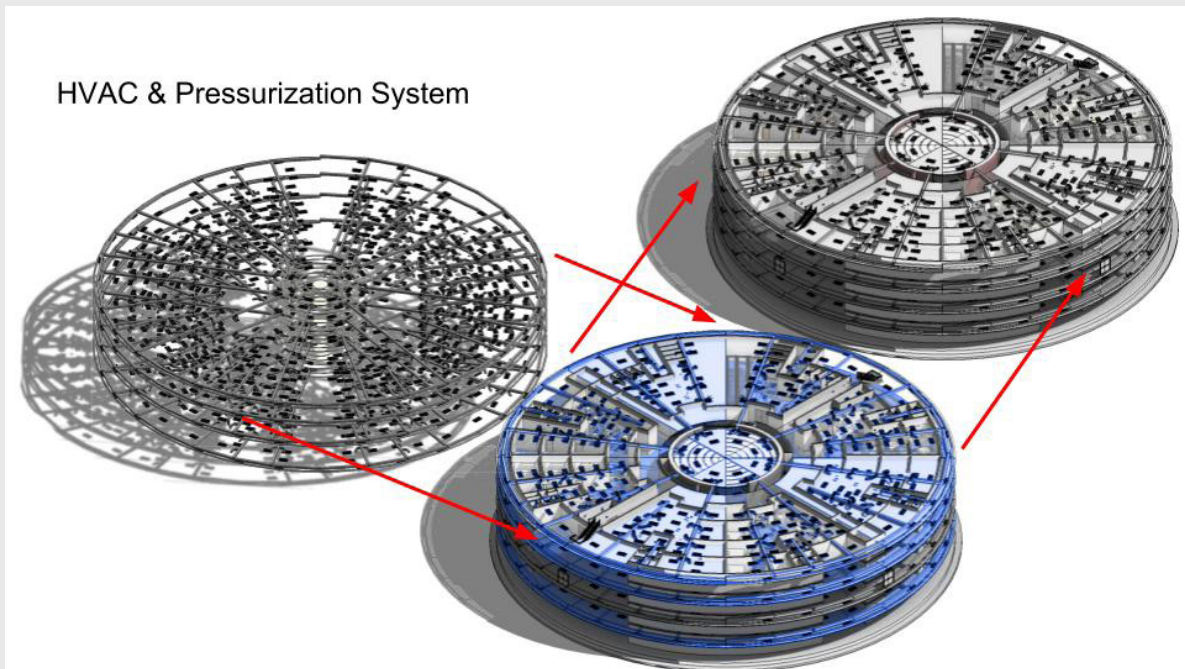
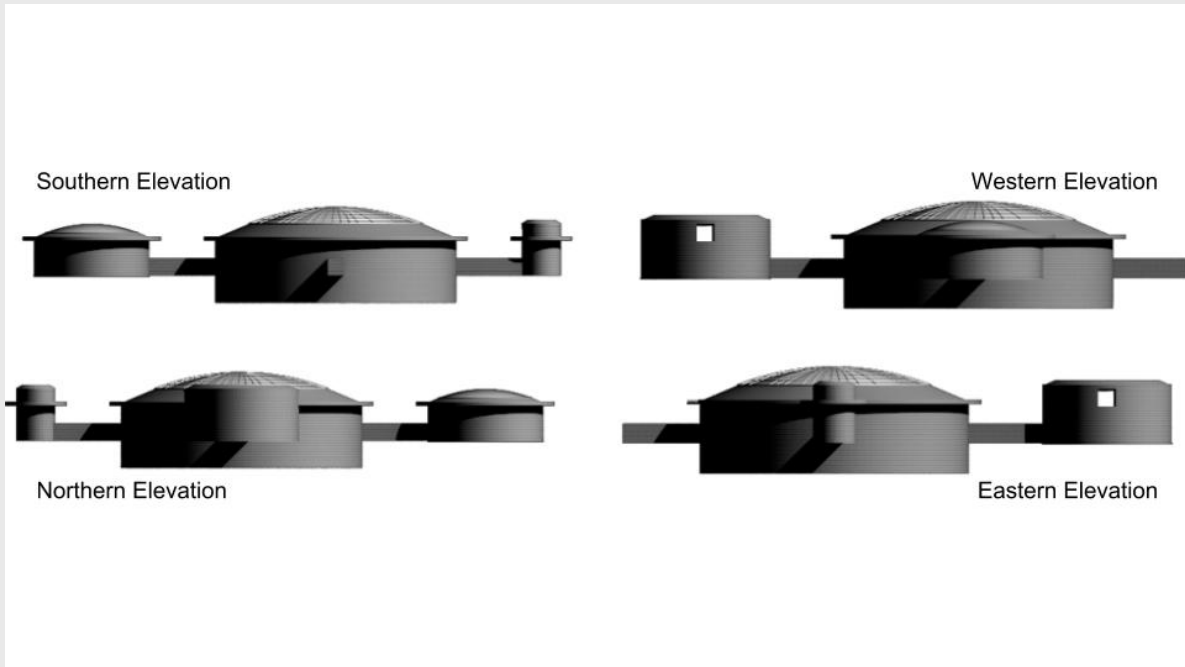


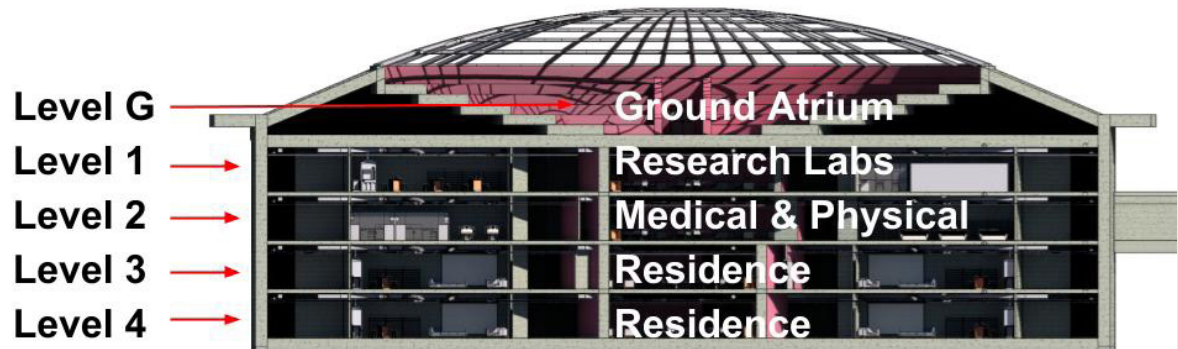
### Site: Gusev Crater

Site is replicable at any point along the Martian equatorial surface.

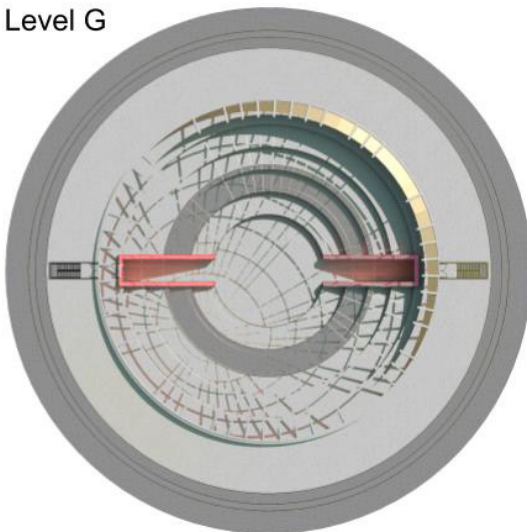


# DIGITAL PRESENTATION





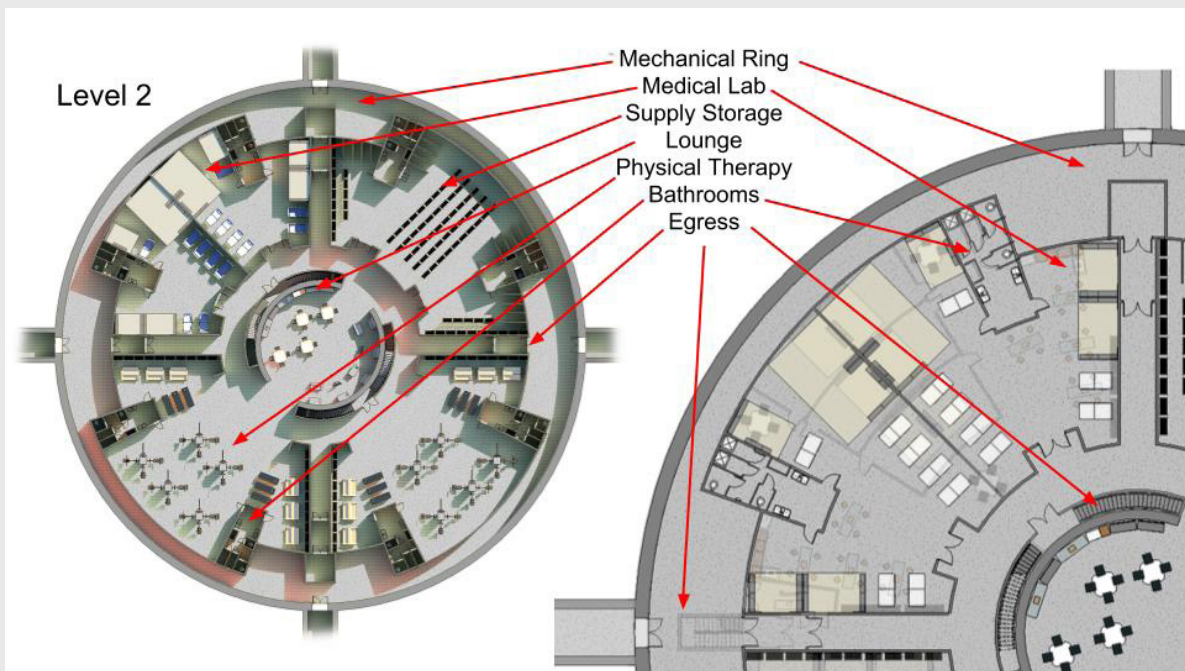
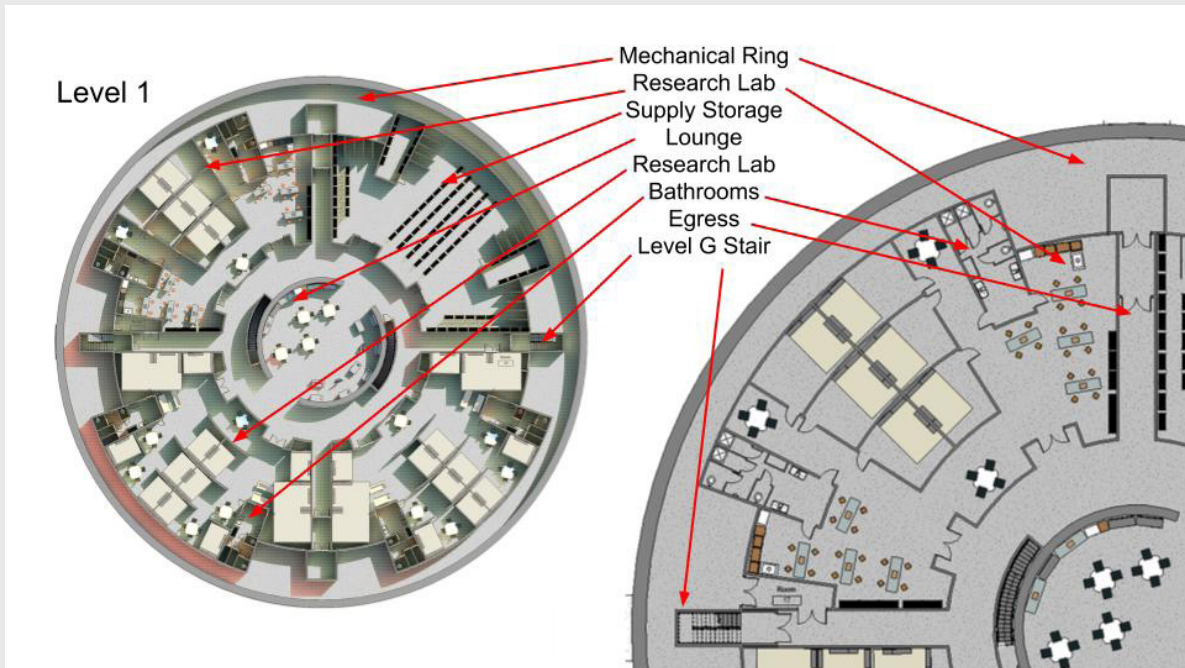
Level G



Ground Floor Atrium Space

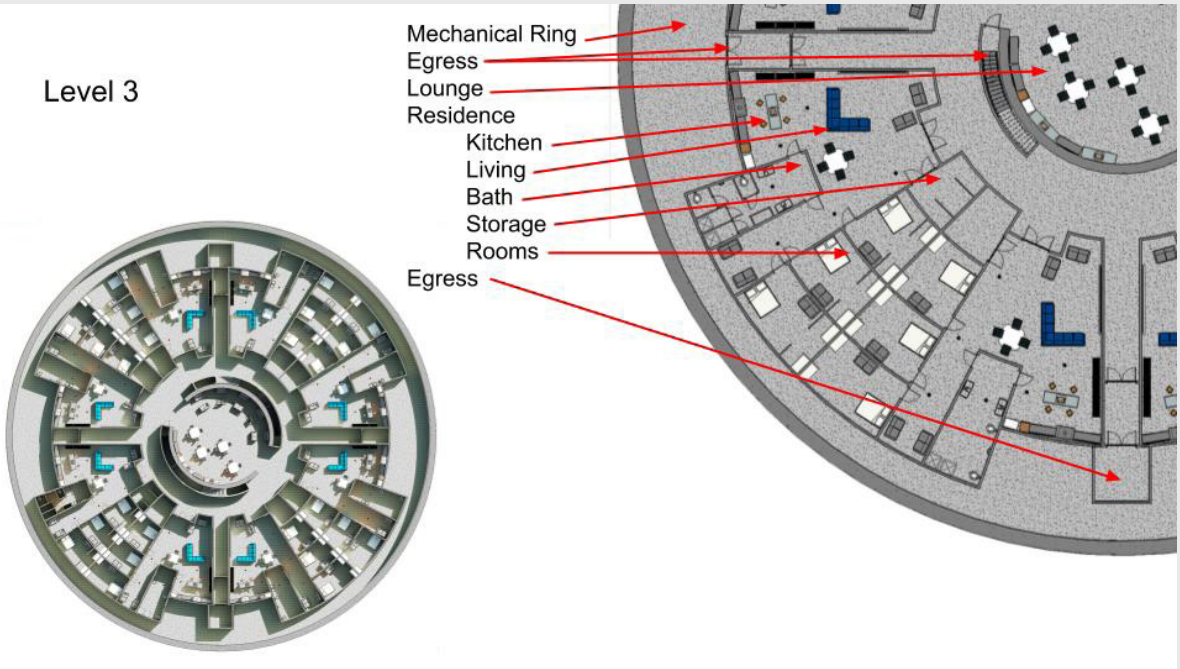


# DIGITAL PRESENTATION

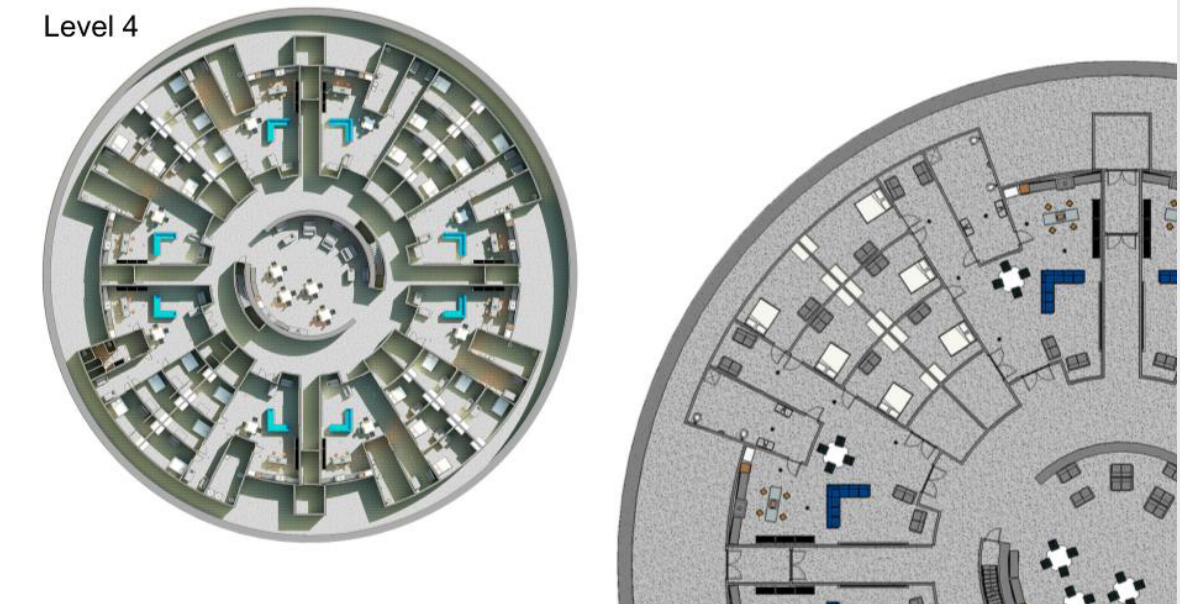




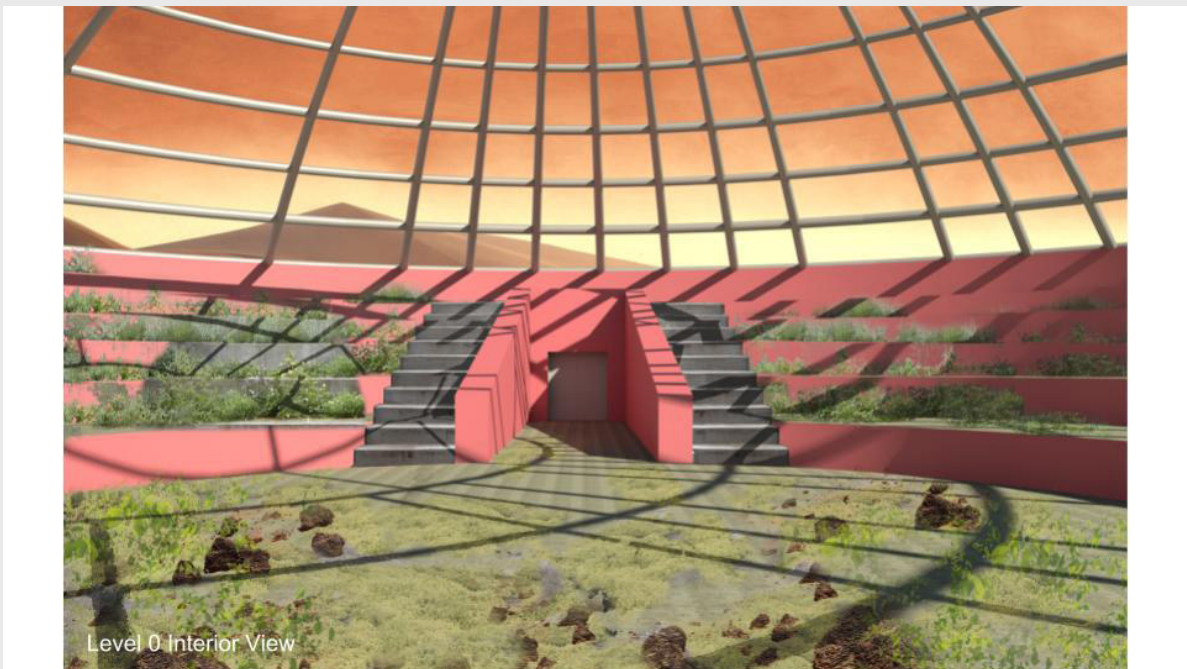
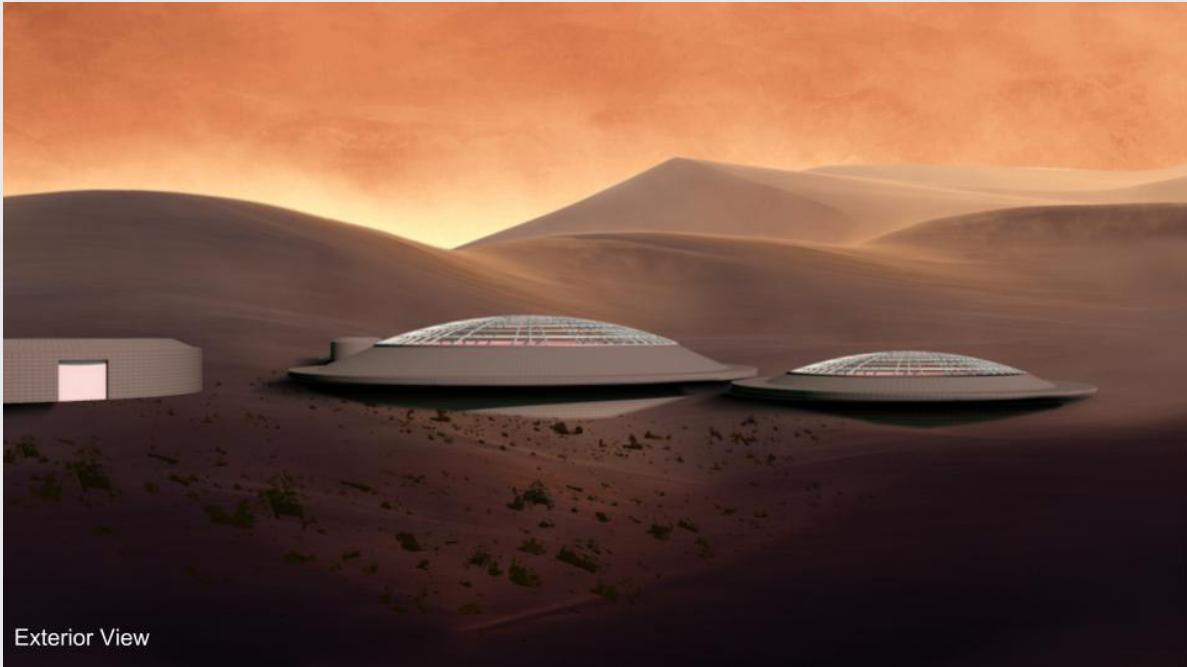
Level 3



Level 4



# DIGITAL PRESENTATION





Levels 3 & 4 Interior Residence



Levels 1-4 Interior Lounge

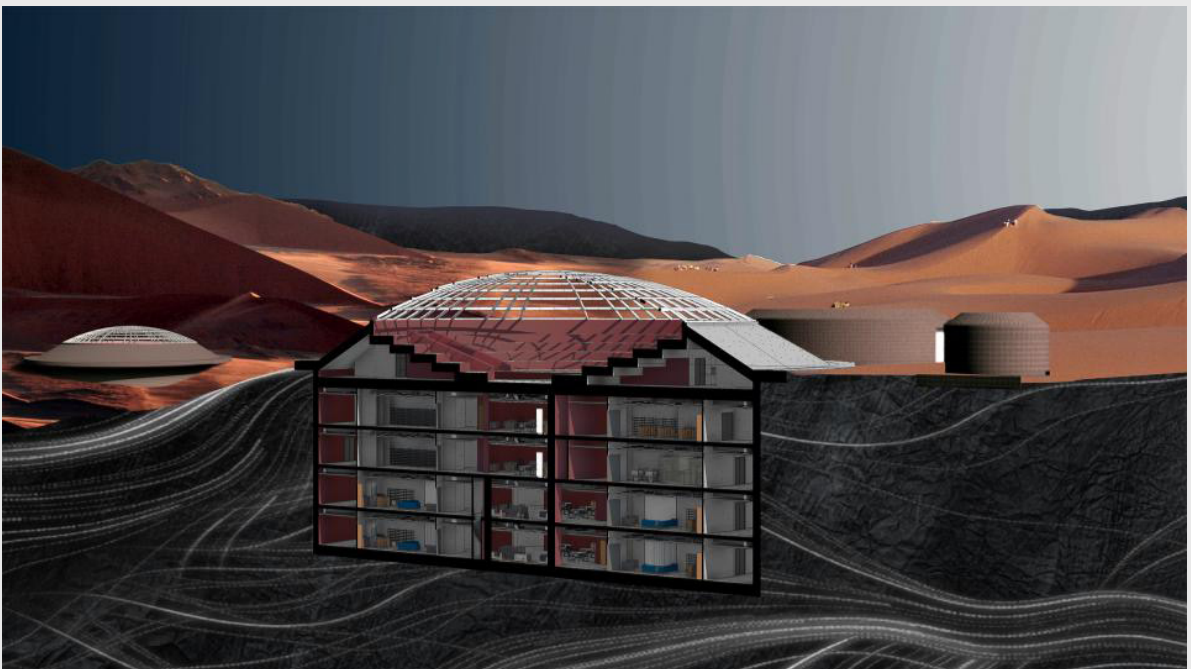


Figure 2.



# PHOTO OF PROJECT INSTALLATION



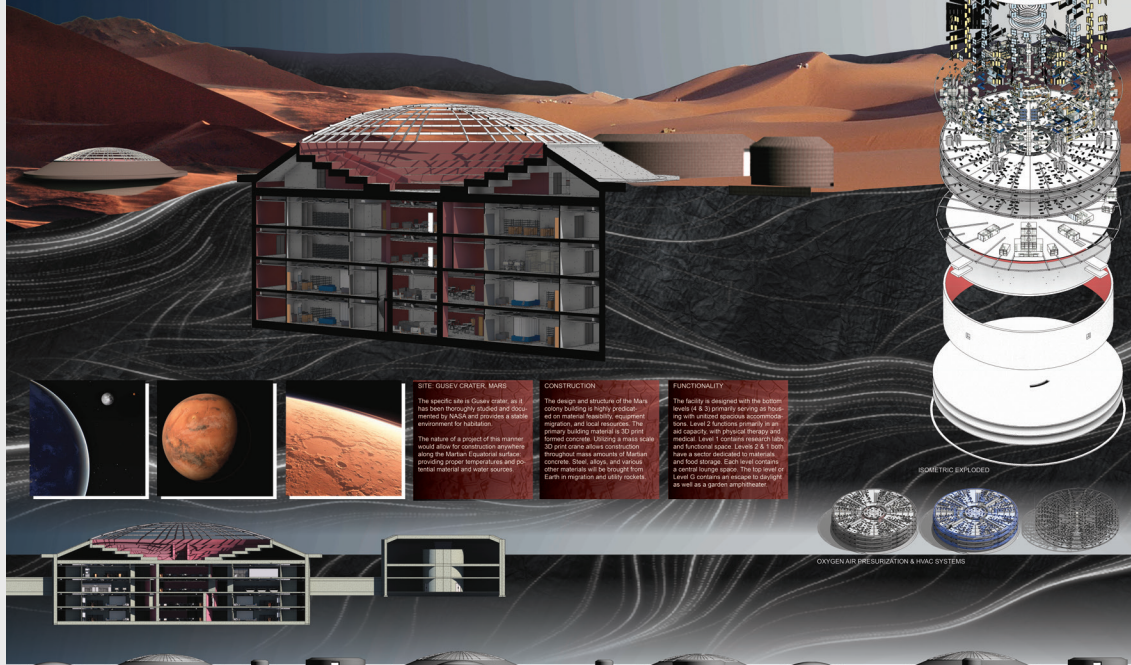


CONSTRUCTION DIAGRAMING



# INTERPLANETARY HABITATION

## DESIGNING FOR LIFE ON MARS



**SITE: DESERT CENTER, MARS**

The specific site is Desert Center, as it has been thoroughly studied and documented by NASA and provides a stable environment for habitation.

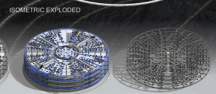
The nature of a project of this manner would allow for construction regardless of the Martian Equatorial surface providing proper temperatures and potential material and water sources.

**CONSTRUCTION**

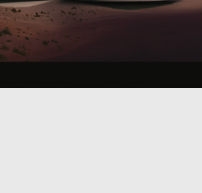
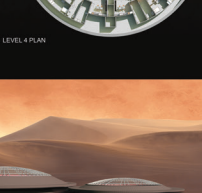
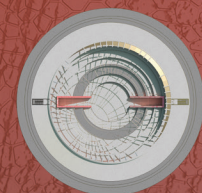
The design and structure of the Mars colony building is highly predicated on material resources, convenient migration, and local resources. The primary building material is 3D printed concrete. Utilizing a mass scale 3D print concrete allows construction throughout mass amounts of Martian concrete. Steel alloys, and various other materials will be brought from Earth in migration and utility rockets.

**FUNCTIONALITY**

The facility is designed with the bottom levels (4 & 5) primarily serving as housing with artificial gravity accommodations. Level 2 functions primarily in an aid capacity, with physical therapy and medical. Level 1 contains research labs and functional spaces. Levels 3 & 4 have a sector dedicated to materials and food storage. Each level contains a central lounge space. The top level of Level 6 contains an observatory as well as a garden amphitheater.



OXYGEN AIR PURIFICATION & HVAC SYSTEMS



# THESIS APPENDIX

## REFERENCE LIST:

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- Wilson, J. (2015, January 08). NASA's Journey to Mars. Retrieved from <https://www.nasa.gov/topics/journeytomars/index.html>

# THESIS APPENDIX

## PREVIOUS DESIGN STUDIO EXPERIENCE:

### 1ST YEAR:

2014 SPRING

HEATHER FISCHER

Design Studio: (Various Projects)

### 2ND YEAR:

2014 FALL

DARRYL BOOKER

Projects: Teahouse, Boathouse

2015 SPRING

CINDY URRNESS

Projects: Montessori School, Pritzker Project, Birdhouse, Dwelling

### 3RD YEAR:

2015 FALL

ADAM BECK

Projects: Art Museum (Wood), Midrise (Masonry)

2016 SPRING

REGIN SCHWAEN

Projects: Memorial (Concrete), Chicago Highrise (Steel)

### 4TH YEAR:

2016 FALL

ALY AHMED BAKR

Projects: High Rise (San Francisco)

2017 SPRING

PAUL GLEYE

Projects: Urban Redevelopment, Study Abroad

### 5TH YEAR:

2017 FALL

MARK BARNHOUSE

Projects: Wetlands Research Center

2018 SPRING

MAHALINGAM GANAPATHY (MAIN), STEPHEN WISCHER (TEMP)

Projects: Thesis: Interplanetary Habitation



# THESIS APPENDIX

## PERSONAL IDENTIFICATION:



## LANDON SCHOENECK

Architecture 5th year

My Name is Landon Schoeneck and I am a designer, a traveler, a creator, a hiker, a snowboarder, a rock climber, a son, a brother, a friend, a Christian, a photographer, a small video producer, and a student of life. In the past year I traveled all throughout Europe for three months until the end of April: all while taking classes in Brussels, Belgium, last year. I also designed a high-rise, an urban redevelopment, a natural resource center, and finished my bachelor's degree, along with working through my post-graduate education. I will be graduating with my master's degree May of 2018 in anticipation of potential full time work at a firm. I have many passions but the foremost is design.

