Reflections

Graduation Project (P4)
Master Track: Building Technology

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Graduation Studio

Name/Theme: Building on Mars
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Aspect 1 • the relationship between research and design

Building in a challenging environment such as on Mars, demands a high amount of research that can increase the reliability and actuality of the design. Throughout this graduation project, "Building on Mars", one of the main and personal objectives was to collect sufficient amount of data that can underpin and facilitate the construction of a habitat on Mars, which will be sheltering astronauts for 500 days on the surface of the planet.

Delving into Mars' environmental conditions puts numerous of question marks into heads. One may not tackle all of the challenges that have been faced, however may find where his/her interest lies in, thus run the research accordingly.

In the case of this graduation project, "Building on Mars", the research process has began with a similar approach as of an architect. The environmental conditions has been found and analysed:

Gravity varies from 3.758 m/s2 at pole to 3.711 m/s2 at equator.
Length of Day on Mars ("Sol") 24.66 hours
Length of Year 686.98 Earth days
Length of Seasons Northern: Spring: 199 Earth days, Summer: 183 Earth days, Fall: 147 Earth days, Winter: 158 Earth days
Pressure: 5-10 millibar (.0049-.0099 atm). Average of 8 millibar (.0079 atm)
Atmospheric Composition: 95.32% Carbon Dioxide, 2.7% Nitrogen, 1.6% Argon, 0.13% Oxygen
Temperature Daily Min/Max/Average -143 °C to 27 °C extremes across planet. -63°C average.

The scope of the project was then defined; construction of an habitat in an extreme condition where logistics are limited due to cost reasons and no processed material or ready to use power is present. This pushes the designer to come up with a creative thinking that can enable the construction constrained by set of challenges.

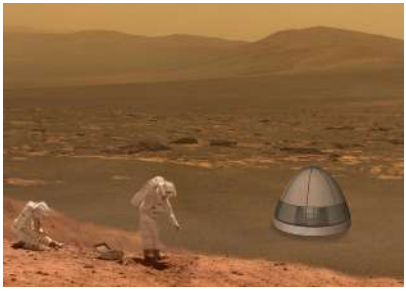
Thus, the following researches have been conducted to facilitate such a construction/design.

-Materials to be used
Resulting in: ETFE membrane, beta cloth, aerogel, kevlar and nextel, etc.

-Prevention from space radiation
Resulting in: using hydrogenated materials as the main construction material to reduce the space radiation's effect on human body

-How to generate energy that can facilitate construction and water production.
Resulting in: Decision making on solar powered energy systems operating for 10 hours or around the clock (UltraFlexTM arrays), or fission powered energy systems.

What are the possible sources of water on Mars and how to extract it. Resulting in: glacial ice, regolith, natural concentration of poly-hydrated sulfate minerals, natural concentration of phyllosilicate minerals. Production through microwave systems.



Aspect 2 • the relationship between the theme of the graduation lab and the subject/-case study chosen by the student within this framework (location/object)

Theme of this graduation project is mostly concentrated on the construction methodology and sequence in regards to its envelope. This envelope should withstand the martian conditions as well as shelter the astronauts from galactic cosmic rays and solar energetic particles.

The envelope is consisting of CO2 insulation bags on the inside and 2 layers of aerogel of 6cm thick. CO2 bags are the very first layer to stabilize the internal temperature while aerogel nearly blocks the heat transmission between the CO2 bag layer and the outer ice layer, which might be subjected to melting over the time if the outer layer of aerogel is above 0 T.The ETFE ice bags are 15 cm thick and they go layer by layer, lying on top of each other.

This can be very much related to the course offered within the Building Technology track, Extreme.

Aspect 3 • the relationship between the methodical line of approach of the graduation lab and the method chosen by the student in this framework.

In the earlier stages of this graduation project, the methodological line of approach of the graduation project was undefined due to topic's uncertainty. In the beginning, the conceptual idea of accommodating people on Mars was clear and set. However, due to the student's unfamiliarity to the space environment and the necessities to construct such accommodation spots on another planet, has pushed to seek to conducting substantial amount of research. In the on going phase of research, certain topics have arisen, defining the path of the methodology, such as; limitation in logistics, in-situ material utilization, space radiation, harsh environments.

From this point on, the work was mostly carried on by the means of setting clear require ments to be met, so that the habitation could be constructed. The creation of a mind map has taken place where durations of the transit to mars, the window period of construction has play an important role, leaving only 480 days to produce energy, extract water, inflate the structure and fill it with water. However, all of the aforementioned topics has certain constraints such as, limited amount of options to generate energy or extract water, as well as the TRL (technology readiness level) of the systems to be used and rely on.

Thus, the methodological line was to explore to the facts about Mars and coming up with a scenario of construction, keeping in mind the set of constraints and what is there to tackle.

Aspect 4 • the relationship between the project and the wider social context

The dream of exploration has been pushing humankind to seek new solutions, technologies and brought betterment to the world by the means of acquiring knowledge. Human learned a lot from arctic explorations that the world is undergoing a tremendous climate change and appropriate precautions should be taken, such as, the contribution in the built environment, sustainable buildings. In 1971 America's manned mission to Moon, to beyond low earth orbit (LEO), showed human that utilizing the near space successfully may meet the needs of contemporary human, such as satellites for international communication and worldwide forecasting.

On the other hand, landing on moon has also pushed human to seek the new destination in the near space environment, Mars. [Martian Outpost, Seedhouse, 2009] Practically next door to the Earth in our solar system is Mars. With its most Earth-like features among the other planets [Land Scapes of Mars, Gregory L. Vogt] the red planet is the most desirable land that human desires to explore. In order to do so, advancing the new technologies invented by scientist to build on a planet without human force may have tremendous contribution to built environment on earth.

Furthermore, the acquired knowledge in construction methods may well contribute to building such habitats. Thus in a wider social context, bridging number of professions to design on Mars, will add knowledge to the built environment that may potentially enable creation of technologies and solutions, helping to more further with the way we currently design and construct.