# Study Plan

## Personal information
<table>
<thead>
<tr>
<th>Name</th>
<th>Andrei Dan Muşetescu</th>
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<tbody>
<tr>
<td>Student number</td>
<td>4247396</td>
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## Studio
<table>
<thead>
<tr>
<th>Theme</th>
<th>Explore Lab 18</th>
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<tbody>
<tr>
<td>Teachers</td>
<td>Nimish Biloria, Karel Vollers</td>
</tr>
<tr>
<td>Argumentation of choice of the studio</td>
<td>The reason for enrolling to the Explore Lab studio is that you have the opportunity to engage into areas of design that are on the boundary of architecture, such as space colonization and space architecture. My specific interest lies into researching and understanding how to design a space colony using the latest architectural tools available today while maintaining a degree of feasibility for the final output.</td>
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## Title
| Title of the graduation project | RE_MOVE: A BIOMIMETICS INSPIRED MOVABLE HABITAT STRUCTURE FOR RESEARCH AND EXPLORATION PURPOSES |

## Product

### Problem Statement

The proposed problem, research questions and design assignment. This should be formulated in such a way that the project can answer these research questions. The definition of the problem has to be significant to a clearly defined area of research and design

Although the architectural community was rarely involved in Space Architecture during the Space Race, the last ten years show a renewed interest from some group of architects. The project aims to deal with the problems encountered in outer space and other planets, with harsh environment, such as planet Mars, using an architectural approach rather than a typical image of NASA’s “white cylinder with a NASA sticker on it” base. The main goal of the project is to develop new typologies of Space Architecture, which integrate current digital architectural approaches and technologies. The idea is to integrate a model of a self-sustainable base which is capable to produce an environment suitable for long term habitation. The strategy aims to investigate concepts directly inspired from biomimicry and computational design tools such as: self adaptation, growth, kinematics, minimal surface condition, topological continuity, recursive system, fabrication and material process. Having defined the problem, the main research questions are:

- What role should architecture play in the development of a Mars base?

- How can computation fabrication tools help the improvement of logistics and manufacture development?

- What is the relationship between human and its surrounding environment? - What is the importance and the necessity of movement for an exploration mission on Mars and what are the most efficient ways to do it?
Goal

The purpose of the study is to investigate concepts applicable to deployable structures, self-assembly systems, optimization and spatial perception inspired by natural phenomena and to interpret the findings for possible implementation into an architectural design. The following concepts will be investigated: computational tools, fabrication tools and biomimicry. Also the investigation will focus on material and structural development which takes into consideration detailing and fabrication, through means of spin-in and spin-off between technologies used on Earth and technologies used in space (technology transfer from space industry to products for Earth and vice versa).

- Develop parametric strategies that define a bottom up process from the form-finding generation to the architectural details. This process has to respond to the global requirements of the project's framework and also the various issues of the architectural scale.

- The translation will validate implementing concepts from nature and science into architecture and methodologies from one professional field into another.

Process

Method description

Description of the methods and techniques of research and design, which are going to be utilized.

At the beginning of the process various research on past and current project developed by space agencies such as NASA, ESA and private companies such as Mars One, Virgin Galactic and SpaceX were conducted to be able to define the main issues and understand not only technical issues, but also whether architecture plays a role at the moment.

Furthermore, research was conducted on technologies and materials that could facilitate such a mission today. Afterwards various studies on architectural practice have been made that uses computational design tools that took inspiration from natural phenomena. The choice for this kind of approaches was because of its efficiency in design, fabrication, logistics and the fact that has future possibilities and varieties of application. Also a study has been made on a comparison between Earth's condition and Mars, which will influence the project. Along with these factors derived from the surrounding other issues connected with the programs chosen were considered in order to develop a simulation for the optimal allocation of the functions within the base.

As the focus of the project lies on integrating adaptive environments and movable components for exploration purposes, scenarios in which movement is needed were developed. One important feature of the project is creating a system to create oxygen, water and helium using local resources. Research has focused on different movement mechanisms found in nature, analysing them and choosing a role model based on criteria that ensure both technical demands and possible architectural expressions.

Afterwards, various spatial configurations for the allocation of the functions are generated using graph analyses. This system is regulated by the negotiation between inner aggregation needs and external influences. This offers the possibility to define various spatial allocation of the functions depending on a selected set of influences that wants to be considered as relevant for the project: the main idea is to provide a framework for future missions. One other important aspect was to ensure compatibility and balance between the static and movable sections.

Using this bottom-up approach that provides a frame for functional and movement mechanism, the next step was form finding using Rhino. In order to develop a spatial concept, iterations based on cell
aggregation done on basic geometry followed some important aspects: degree of movement and connectivity, technical feasibility and further base development. Autodesk Vasari is used to run dynamic wind and shading simulations on the models to further restrict the choice. The selection of the 2 models to further develop takes 2 scenarios into consideration: one where there is a static base that has detachable self-similar structures and one where the entire base acts as a movable mechanism.

The next steps are defining one final model both morphologically and technical based on the most appropriate scenario and focus on fabrication processes.

Theoretical and practical references
Theoretical (historical, socio-political, scientific and technical research) and practical knowledge that will be consulted.

Research was conducted within several field of study. At the very first stage, focus was on understating current scientific and technical approaches for sending a long term human crew on Mars. For this, sources utilized consist mainly of web research, technical and scientific papers, movie documentaries and scientific conferences.

As the focus lies in movement and adaptive environments, the research was steered towards understating movement mechanism in biology and attempting a large-scale translation while considering climatic and environmental aspects. Various literature and web references were used. Also, examples of project from students or firms were investigated. For the form finding, a basic research on cellular aggregation was done to understand spatial quality and potential for large-scale structures. As for the resource production process, scientific papers and various web sources were used to develop the system.

The next step would represent a collaboration with various experts (such as ACT-ESA, Mars One, etc.) to develop the necessary technical and conceptual skill to obtain a consistent output. Various computational design tools will be used for morphological and fabrication optimization.

Reflection

Relevance and output
The value of the graduation project within the larger socio-cultural and scientific context. List of output with respect to conceptual and design development as well as materialization and construction documents.

The main output that the project aims to satisfy are:

- The development of an architectural form capable of accommodate the main requirements of the design statement and the integration of movement mechanisms.
- The development of an optimized topology in terms of structural and climatic issue capable of considering within the process various aspects connected with the digital.

Creating a large-scale functional prototype as a proof of concept.

Time planning Scheme of the division of the workload of the graduation project in the 42-week timeframe (P1-5). Compulsory in this scheme are the examinations at the middle and end of the semester, if required, the minors you intend taking and possible exams that have to be retaken. The submitted graduation contract might be rejected if the planning is unrealistic.

MSc3

1-7. Defining area of research.
8. MIDTERM PRESENTATION (P1)

12/11/2014
10. Define design brief.
11. Biomimicry and computational concepts research.
12. Analysis of specific biomimicry topics and relevance.
13. Functional layout research.
14. Functional layout research.
15. Cellular aggregation and form finding research.
16. First model development.
17. Development of models and draft conclusions + simulations.
18. Finalize presentation, 3D print prototypes.

19. FINAL REVIEW (P2)
Summer Holiday- Collaboration with ACT-ESA

MSc 4

20. Reflection on progress and future strategies
21. Refinements on the building form definition
22. Topology refinements and architectural considerations
23. Topology and skin system proposal
24. Structural considerations and skin system development
25. Architectural refinements
26. Structural and skin system developments
27. Final architectural refinements and reflection on possible architectural details
28. Structural and skin system refinements
29. Reflections on structure and skin details
30. Reflection on possible strategies for development of physical models and prototype
31. Structural and skin detailing and reflection for prototype development
32. Project visualizations and structural and skin detailing and physical model making
33. Presentation preparation and physical model making
34. Presentation preparation / GO/NO-GO ASSESSMENTS (P4)

35. GO/NO-GO ASSESSMENTS (P4)

Weeks 35-41 Finalizing presentation of the project, final physical model, renders and details

Week 42: PUBLIC FINAL PRESENTATION (P5)

Attention
Part of the graduation (especially in the MSc 4) is the technical implementation of the building design. Therefore a Building Technology teacher will be involved in the tutoring team from the P2 presentation on. This should be taken into account when writing the study plan / personal graduation contract, with respect to the time planning as well as in the relation to the content (e.g. statement, method and/or relevance).