INFLATE IN CASE OF EMERGENCY

Generative design of a lightweight mobile high performance emergency shelter via the use of a computational intelligent method.

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Name Gerardo Gonzalez Duarte
Student number 4520351
Place of residence Delft, Netherlands
E-mail address G.GonzalezDuarte@student.tudelft.nl
University Delft University of Technology
Faculty Faculty of Architecture
Department Architectural Engineering + Technology
Graduation track Building Technology
Graduation lab Sustainable Design Graduation Studio

Main mentor Dr. MSc.Arch Michela Turin
Chair of Design Informatics
Second mentor Dr.ing. M. Bilow
Chair of Architectural Engineering
External examiner Dr. ir. R. Binnekamp
Research Process and products.

This research project intends to address a complex problematic that embraces social, architectural and building technology aspects, each of these entail a vast number of variables that had to be taken into consideration. On every level, the configuration of a provisional settlement such as the one proposed brings a lot of particularities into its design. In a simple design case the combination of variables does not necessarily pose a problem for the designer as the process of decision making is relatively straightforward, trying a handful of possibilities and manually arriving to the best solution is still in reach, however the multidisciplinary nature of this project intends to contemplate variables that range from a purely technical field like the structural, with soft constraints like the ones that accommodate the needs of floating populations, In this situation it could be almost impossible to manually find a solution that embraces all of them. Instead the proposed methodology invites to establish a dialogue between the 3 parties involved; the architect, the building technology expert and the community.

The end result can be seen as a combination of two important products. First a set of parametric models brought together in a generative computer program. And second, a design exploration via the application in a case study as a method for validating the methodology. Utilizing a computer based method opens up the possibility of comparison, and furthermore, it provides a framework based in non-variable mathematical rules that can provide solutions out of the infinite design space. The aim of this project is not to arrive to an optimal design solution, but instead provide the designer with a range of possibilities based on informed decisions that could be further developed into an architectural project.

Although the aim of the tool is to be as intuitive and interactive as possible, it is still necessary to interpret the results given, and moreover be able to communicate with experts on various fields.

This multidisciplinary method of designing emulates the real conditions of a design of such magnitude, requiring coordination between the Architect, the building technology expert and most important, the community for which the settlement is intended. Replicating this interdisciplinarity has proven to be a challenging and time consuming task for one person. Firstly a thorough research into fields not previously known was needed to understand the complexity that the research entailed. Second a new set of computational tools with a steep learning curve was required to be able to materialize the research. The later proved to be of great impact to the research as it heavily relies on a set of solutions that require a high degree of experimentation, this tools can in most cases be seen as experimental, thus lacking the support and reliability of mainstream solutions.

In essence this research project embraced an atypical way of design. In the end the proposed research method was followed, but the sequential approach of literature study, followed by a design proved to be unrealistic as every step of the design required new additional knowledge. A broad starting point as well as a wide exploration phase led to unforeseen but welcomed discovery of a wide arrange of subjects that influenced the research in the end; A clear example of this is the integration of a computational tool that deals with the computer-designer interaction, in concrete a mathematical approach to architectural configuration called Space Syntax and a python written plug-in called
SYNTATCYC was used as means to produce a set of tools that would encourage the interaction between the designer and the intended final user. In parallel, an extensive research focused on the limitations and capabilities of pneumatic structures led to the development of a methodology that could harbour such constraints and produce a physically accurate set of design concepts to be interpreted by the designer. Last but not least a deep understanding of the problematic that led to the formulation of the research questions was crucial. A thorough research on temporary settlements, emergency deployment strategies, shipment and transportation methods and most important the dynamics and functional requirements of emergency camps.

![Image](image.png)

fig 1. force-directed graph-drawing algorithm produces a gamut of codesign configurations

Due to the extensive nature of the research some limitations have to be made in order to fulfill the proposed research questions, therefore the focus on multi-objective optimization shifted towards a comprehensive application of this method in order to understand and interpret the design solutions via a final exploratory phase.

Up to this point the last step of the research has not been fully completed as a brief exploration of the results was carried out using a connection between a newly developed link within grasshopper (an algorithm based design tool) and a multi-objective optimization engine, the second provides a set of tools that help understand the relation between the proposed design variables and their influence on each of the design objectives. Although the case study has provided a way to visualize the intended results from start to end, the number of design solutions obtained as of now is relatively small, this mainly caused by technical limitations as a substantial number of resources is required to produce a sizable population of design variants that could be used to analyze trends, compare the correlation between design variables and interpret a wider arrange of design objectives.

**Graduation Lab theme**

The theme “Sustainable Graduation Studio” covers an umbrella of Structural Design, Façade Design and Climate Design concepts with the support of research programs focused on Computation & Performance. Due to the expressed interest of correlating this concepts with a social engaging topic, the focus given to the research project also embraced concepts from participatory design and architecture. Although there is no explicit section of the work that deals with sustainability, this core axis was carried out throughout the development of the project.

The proposed exploratory design of an emergency pneumatic shelter in a disaster situation setting is not directly related to the graduation theme but it is used to verify the researched structural and computational methods. On an early conceptual phase the idea of designing a lightweight deployable structure with materials that could be easily reused, transported and refurbished was a decisive factor for choosing the case study presented. This core principles are embedded on every stage of the design process in the
form of hard constraints and parameters that dictate the final nature of the design, thus ensuring that the results always follow a set of pre-established guidelines drawn from the research phase. On the other hand the knowledge obtained throughout the Masters programme in fields of climatic design, structures and facade design played a substantial role on the final result, as they proved to be invaluable to the understanding of the concepts needed to materialize the research project.

The project and the wider social context.

The project focuses on the exploration of designs through the interaction of a wide range of participants.

[1] Architect / Designer which plays the role of an overseer, is in charge of the distribution decisions, as well as the masterplan and planning of the shelter, he is expected to be the link between the community and the humanitarian organization demands as well as being capable of interpreting the inputs and parameters of the tool.

[2] A Building Technology Expert is involved in the technical feasibility aspects of the design as his decisions have direct impact on the materiality, cost and effectiveness of the design.

and

[3] The Community, which as understood in this project acts as a voice communicating the functional requirements to the architect.

These three agents play an equal role on the use and interaction with the tool, and were always considered to be the drivers of the design. Although on there is still much more experimentation and refinement to be done, the outcome of this research project proves its value as a tool that intends to close the gap with this 3 actors, enabling a much more richer design process nourishing from the ideas and inputs of them all.

In conclusion, given the importance of lightweight deployable solutions that could be used as means to solve humanitarian and climatic crisis, it was crucial to push for solutions that incorporate new and innovative techniques found in Architecture and building technologies as they have undoubtedly staggered and have not yet benefited from the significant technological advances of the computational era.
The newly proposed tool allows architects, and building technology experts alike to search and identify useful structures with enriched architectural qualities, as well as providing the means for an interaction between community and designer. This project is embedded into a social context in which design often takes a back seat, relying on standard non catered solutions that only aim to fulfil basic spatial accommodation needs.

“well-planned settlements can have a positive impact which extends beyond the provision of basic shelter. They can help displaced populations in many ways: by strengthening their physical protection and supporting their livelihoods; by minimizing natural hazards and the spread of disease; and by managing natural resources in a sustainable way”. (Corsellis & Vitale, 2004)