MASTER THESIS – P4 FINAL REFLECTION
Faculty of Architecture and the Built Environment

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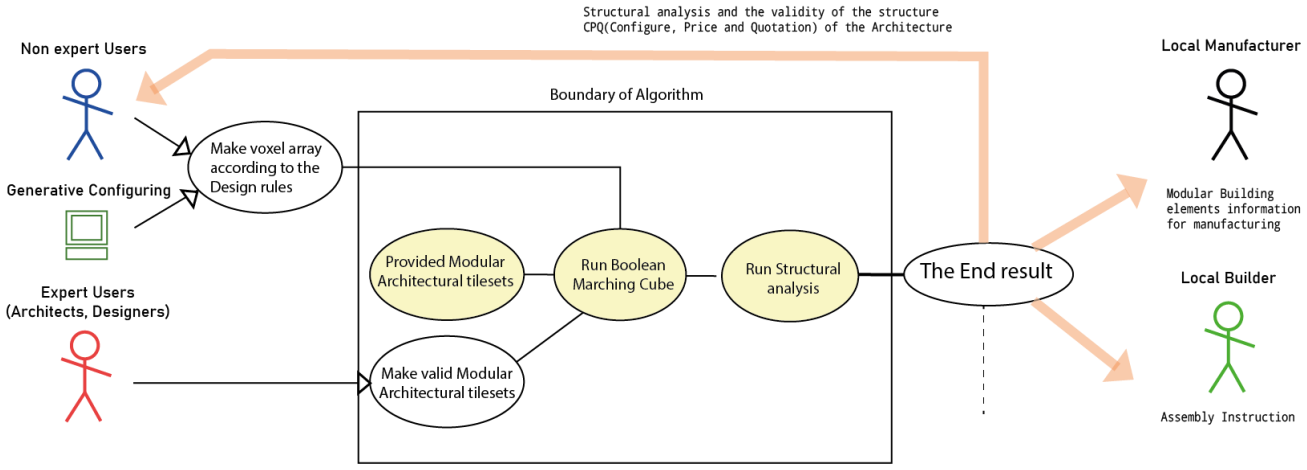
For the thesis project's overall refection, it was interesting to experience a project that evolves into the directions and plans as if the project was alive, with many changes even in the initial objective. P2 and even after P3, my lack of computational knowledge and understanding of the topic made me uncertain. Yet, the original idea of motivation stayed, and the design methodology was developed to meet the revised objectives of enabling mass customization of the architectural frame using the Boolean Marching cube algorithm. The resulting product has succeeded in achieving the basic expectation and objectives. the overall research objective is visualized in the figure below.



the objectives of the thesis are to design an interactive tool for normal users to customize their modular architecture from the input voxel array. Second, offering a structural validity check of the frame generated. Third, offering architectural tiles that incorporate mass customization enables expert users to develop the tileset using the framework.

the relationship between research and design.

In this project, the objective of the design is to develop a methodology of mass customization through participatory design. to reach the objectives, it was important for me to research relevant literature. the literature review is divided into three parts. The first part discusses the Modern method of construction, background research on previous modular architecture practices, categories, benefits, and case studies to get the most optimal types of modular construction used in the thesis. The second part discusses the modular participatory design of toys, gaming, and architecture that provides participatory creativeness. The research includes Lego, Mobaco, townscaper, and research of Savov from ETH Zurich. The third part is the research on algorithms. The two algorithms are discussed, the marching cube algorithm and the wave function collapse algorithm, and a comparison of the two algorithms. Through the research, conclusions are derived and suggested the fittest methodology of each part, and the design methodology has been developed based on the research.

the relationship between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS).

My graduation project aims to achieve mass customization of modular architecture using computation and participatory design to achieve combinatorial creativeness of modular construction. As technologies advance, the limits and boundaries of modular construction continue to expand. In today's digital world, where powerful computing power is easily accessible to designers in the built environment, mass design customization challenges provide the opportunity to develop digital solutions that can handle complex modularization. in the Genesis Lab of building technology, the GO_design framework aims to develop a modular generative design framework for mass customization and optimization in architectural design, which intersects with the topic chosen.

Elaboration on the research method and approach chosen by the student in relation to the graduation studio methodical line of inquiry, reflecting thereby upon the scientific relevance of the work.

The research methodology of the thesis is carried out as research by design. in the literature study, I focused on the theories and studies about modular construction and the modern construction method, from the definition, history, and types of modular construction to derive an answer of which element type of modular construction should be considered by adapting the boolean marching cube algorithm. the next part discusses the modular participatory design of toys, gaming, and architecture, providing participatory creativeness. The research includes the toy industry, Lego, Mobaco, the game industry, townscaper, and the research of Savov from ETH Zurich. the research was to derive and research the efforts and methods of participatory design use cases. what could be derived is that the efforts exist in small sizes such as toys or in environments where no physics is required to be considered (digital). The third literature study of procedural context generation algorithm involved studying the wave function algorithm, and the marching cube algorithm enabled me to derive from the results that the marching cube algorithm is more beneficial for the context of modular participatory design enabling trace and impact of users to the resulting design. the literature studies of such necessary information helped me develop a theoretical framework and provided the information required for the algorithm design and development.

In the design development stage, the preset of the algorithm and module components are designed. The terminology of modules, units, and methods to narrow down to 26 unique cube tilesets are developed, and more of the learning by doing process has occurred, but the trials have enhanced the understanding of the process even more. tutors were helpful in the process that I had never experienced, and the help was very effective. Even when I did not understand the consultation and the underlying meaning. they were always found out at later stages with great help. it is now understood the scirentic relevance of the work is in the study of translating the digital information into valid physical modular components. The potential benefit of the research can be a link between construction to computer generative or participatory design methods. Connecting the two can suggest a solution to an increase in productivity and the labor crisis that the industry is facing.

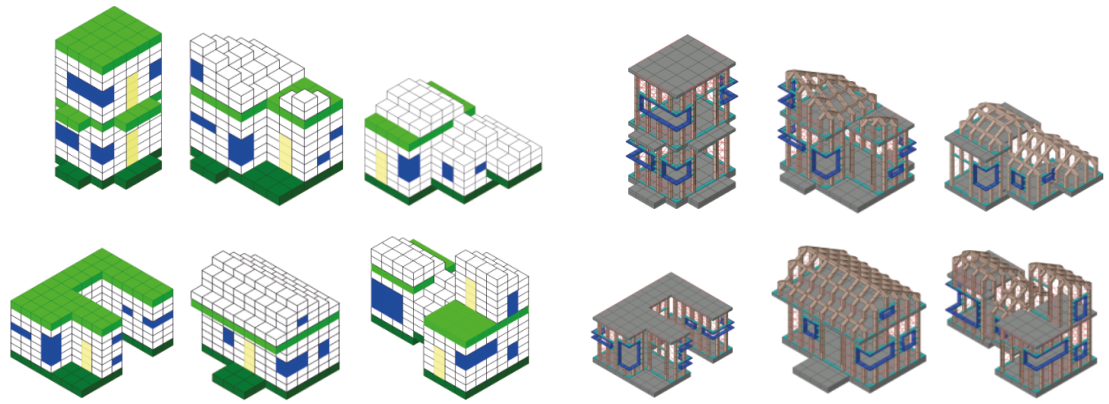
4. Elaboration on the relationship between the graduation project and the wider social, professional, and scientific framework, touching upon the transferability of the project results.

90% of the 200 cities around the globe are considered unaffordable to live in, and the prices of houses in cities and the cost of construction price increase as the material cost and labor wage increase, yet the construction industry's productivity remains low. Due to its complexity and high price, the process of architectural customization has only remained bespoke, available only to a few people. To break this convention, the project aims to develop a mass customization method of architecture through participatory design involving people in the design process and achieve a more transparent CPQ(configure price quotation) of the industry. Since the project is a study of translating the digital information into valid modular and connectable components, the potential benefit of the research can

be a link between construction to computer generative or participatory design methods. Connecting the two can suggest a solution to an increase in productivity and the labor crisis that the industry is facing.

5. Discuss the ethical issues and dilemmas you may have encountered in (i) doing the research, (ii, if applicable) elaborating the design, and (iii) potential applications of the results in practice.

The ethical issue I can think of for modularizing architecture and bringing a participatory design process to the mass is the issue of reducing the architect's work by automatizing. However, I do not think that the automation of the design process does not limit or bring constraints to the architects but only enhances their creativity by bringing more combinatorial possibilities and enabling architects to focus on a more creative design process rather than the works that can be automatized. in the design process developed, such a possibility can be observed from block stacking of voxels. As shown on the left endless combinations of voxels can be established. just like two by six lego blocks creating millions of combinations.



the potential application of such combinatorial creativeness can be further developed. The tool can achieve the CPQ of structure to productize architecture. A web version can be developed to enable more access to the mass and experts. a generative design method can be applied to the tool for further automatization and optimization of the design process.