TIM SCHUMANN

COMPUTATIONAL DESIGN

PORT FOLIO

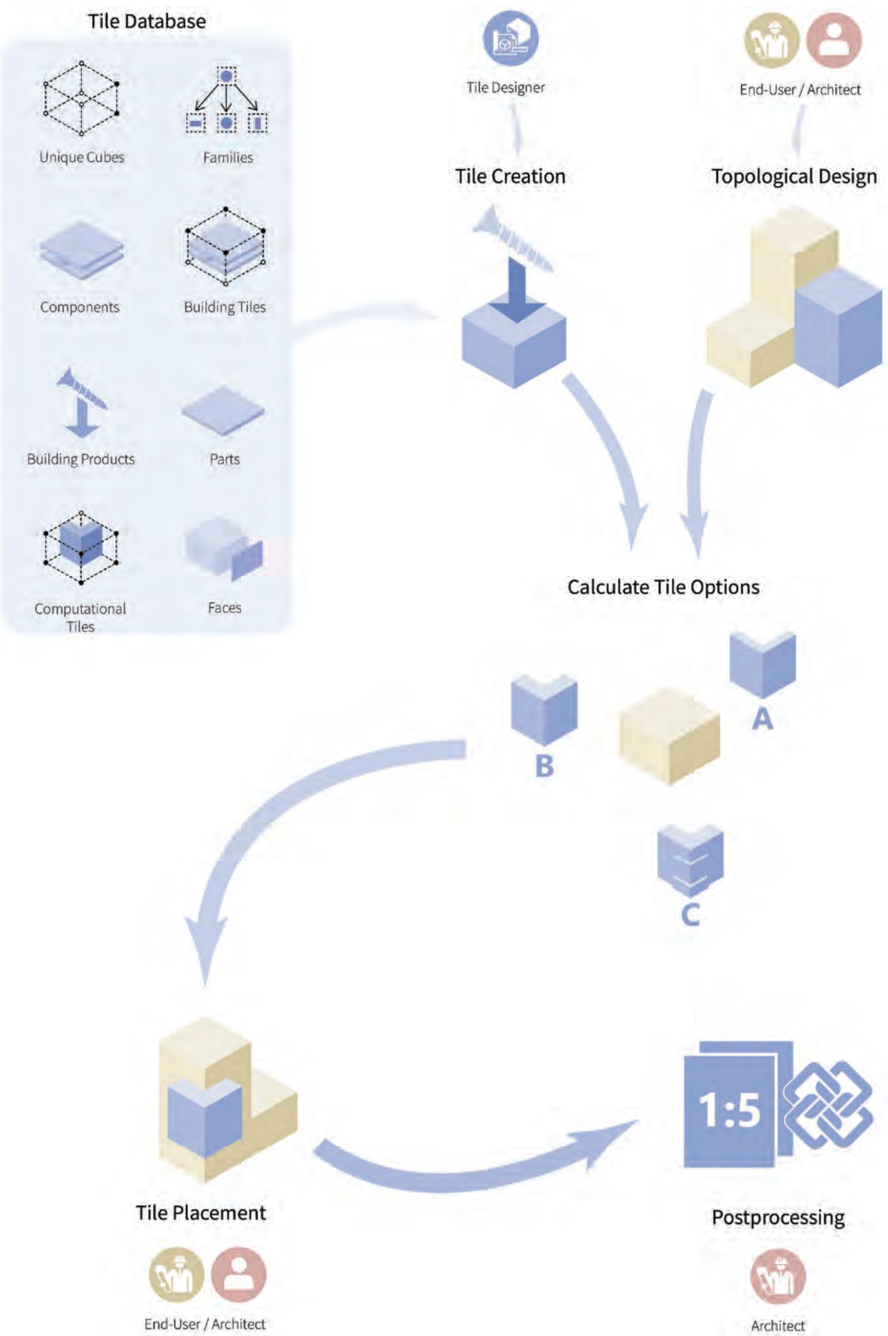
TWOTHOUSAND TWENTY THREE

ENCODING BUILDING PRODUCTS

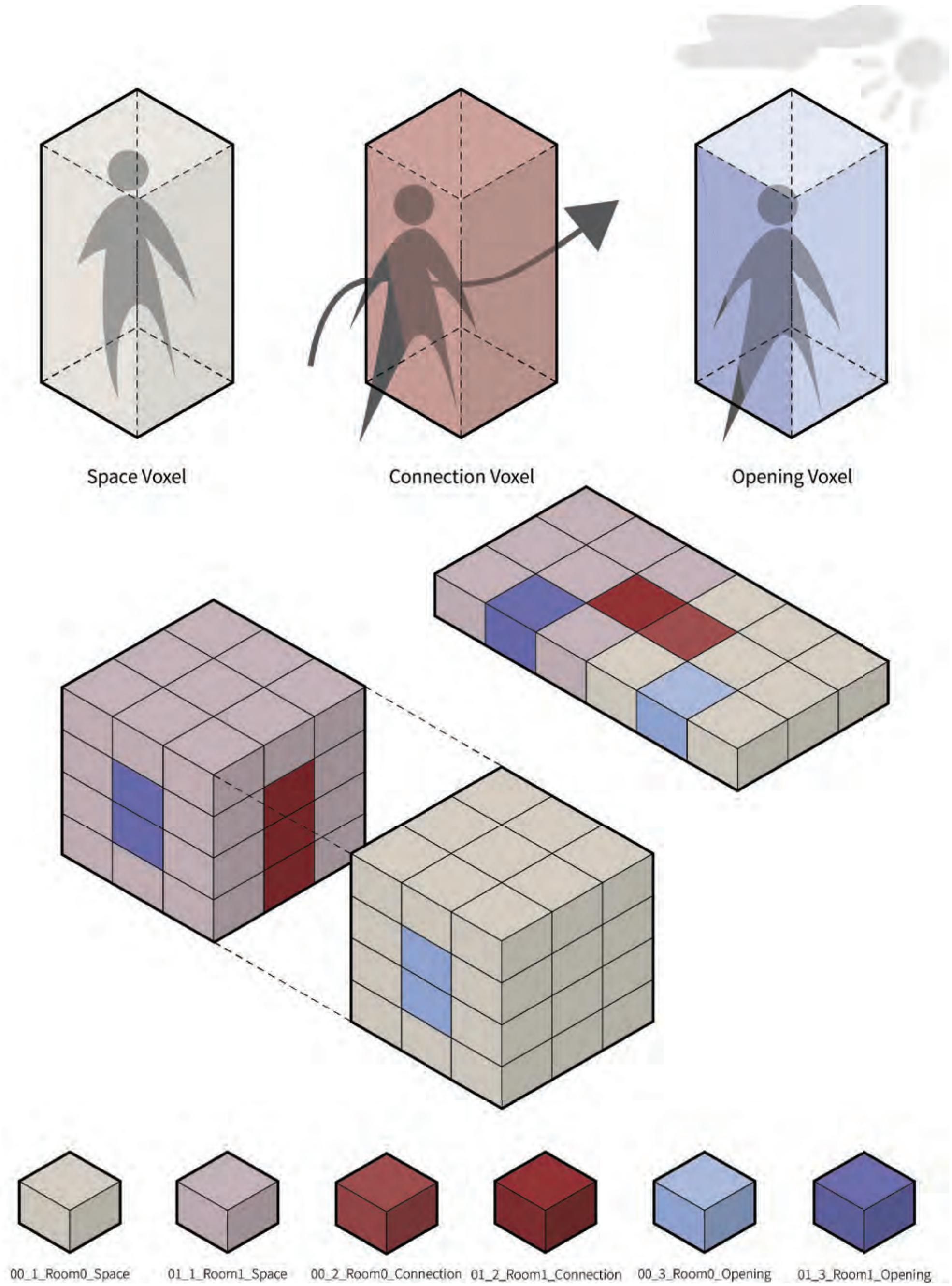
Type: Msc Thesis Project at TU Delft
Date: 11.2021 - 01.2023
Location:Delft, Netherlands
Supervisors: Dr. P. Nourian,
Prof. Dr.-Ing. T. Klein, H. Hoogenboom, Shervin Azadi

One million homes will be needed in the Netherlands by 2030. Prefabrication in the construction industry can contribute to construct affordable houses, but that results often in standardized and not customized designs. These repetitive designs can be overcome through the introduction of mass-customization in architecture. Computational Architectural Design offers the possibility to tackle mass-customization through developing tools to let the user easily customize a design while providing guidelines and feedback towards a successful building design. This can be done by discretising a building into building blocks that can be controlled through a computational workflow.
This project elaborates on the potential of developing a design tool that allows the customization of houses through discrete building information modelling. Since the housing design process is a complex and multi-layered problem, the process is broken down into the sub-problems of topological design, building product development, configuration, and data export. For these steps, algorithms from the gaming industry are tested to improve the participation of the end user trough a simplification of the design process. Through design grammars, a relational data structure is created that is compatible to the BIM environment of the industry.

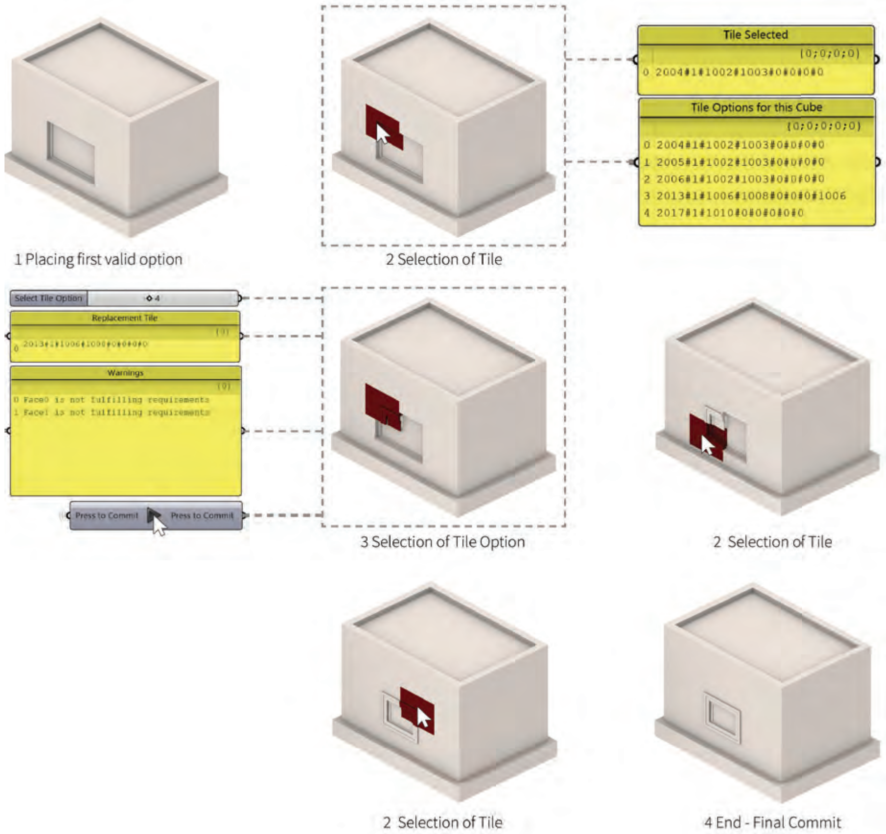
The evolved methods are applied to the test case of a rowhouse design in Delft to predict the possible impact of the design tool. The results of this are set in the context of the AEC industry.



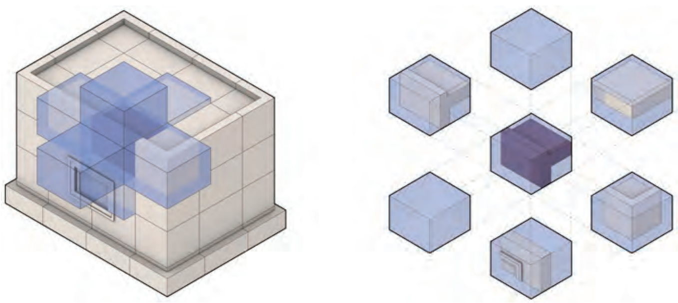
WORKFLOW OVERVIEW



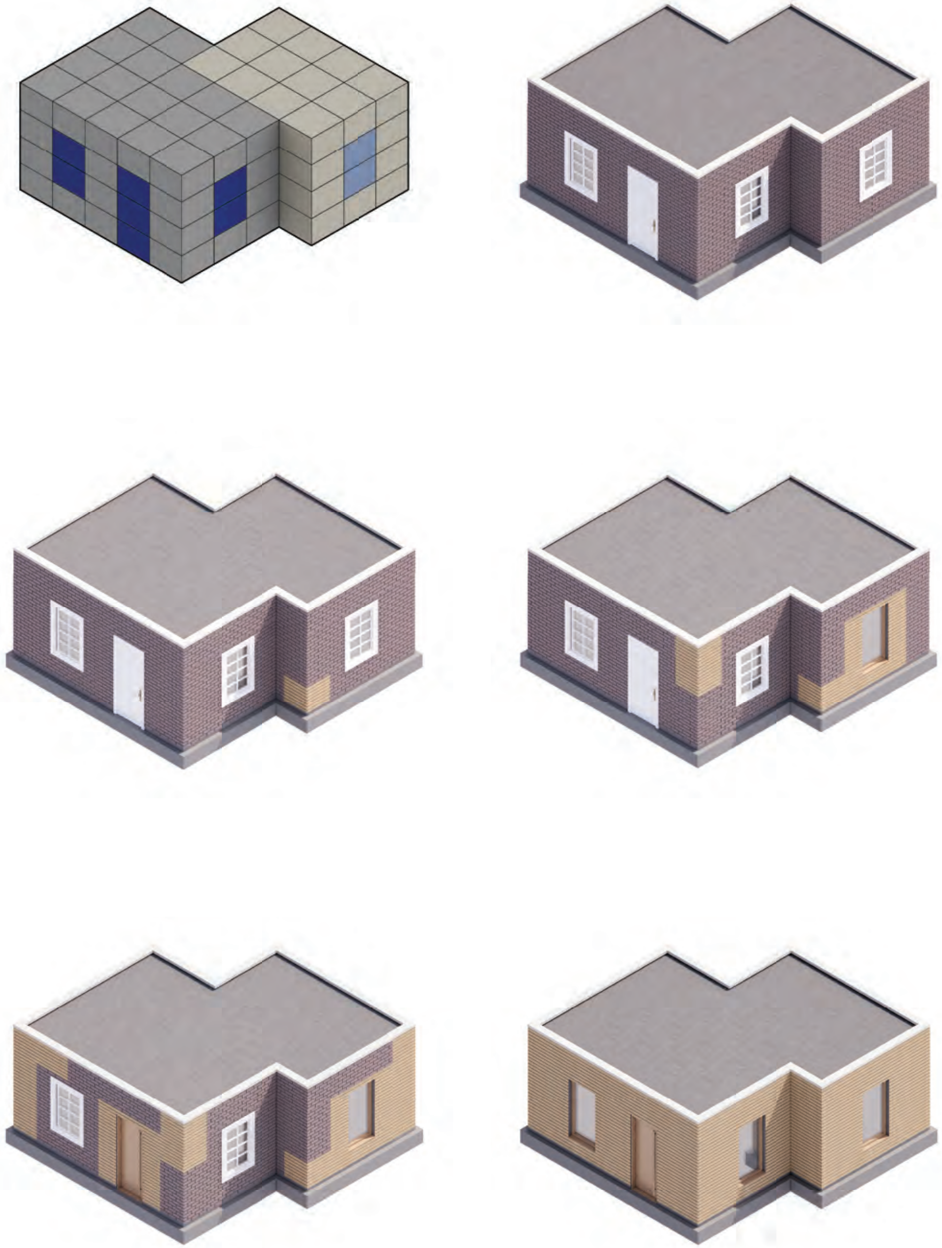
TOPOLOGICAL DESIGN



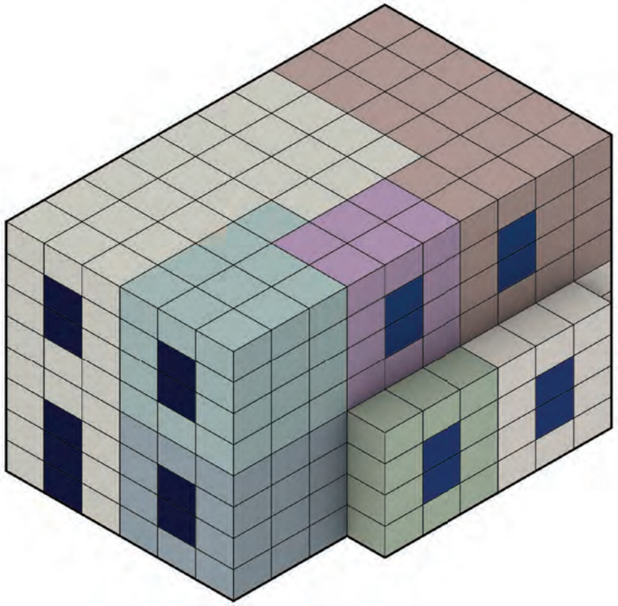
INTERACTIVE TILE PLACEMENT

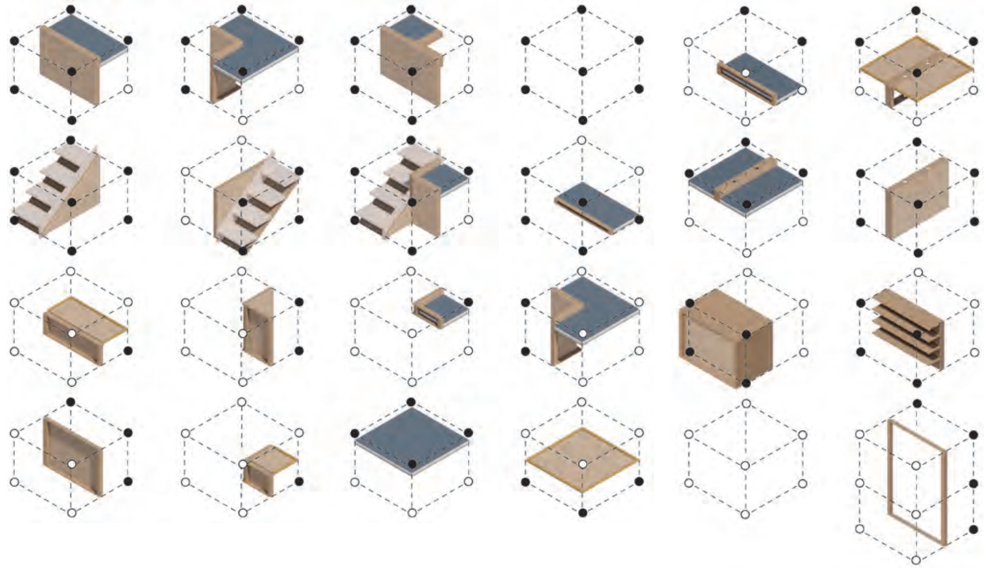


STENCIL APPLICATION TO DETECT FITTING FACES

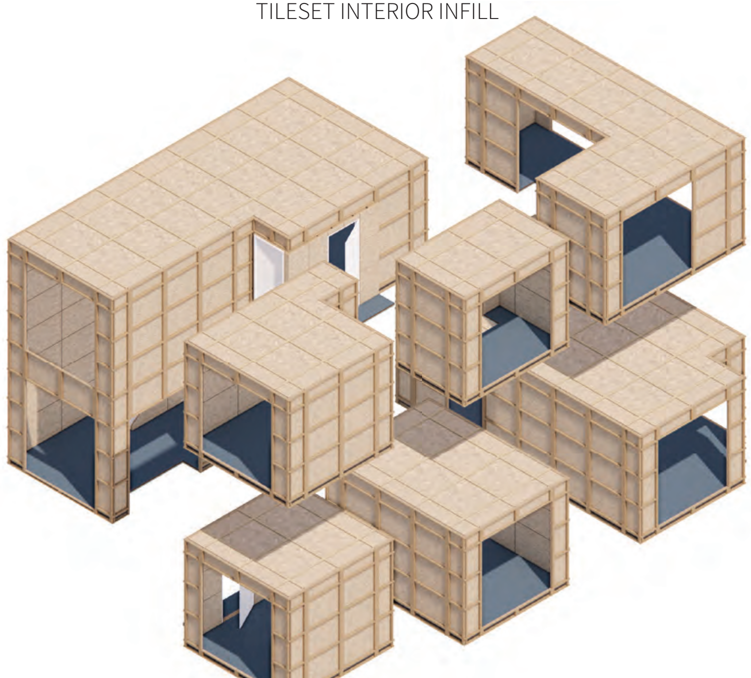


APPLYING DIFFERENT TILESETS ON ONE TOPOLOGICAL DESIIGN


TOPOLOGICAL DESIGN BUILDING


TILESET INTERIOR INFILL


APPLYING TILESETS FACADE

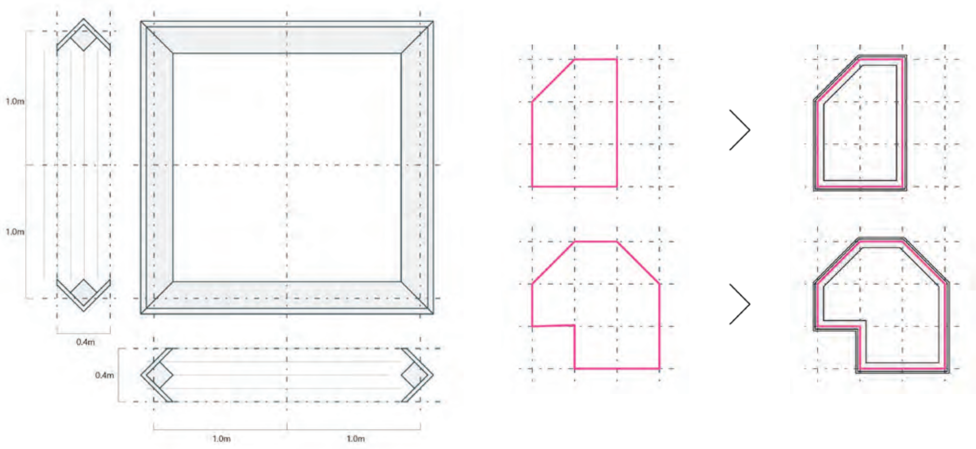

APPLYING TILESETSINTERIOR INFILL

TETRIS LIVING

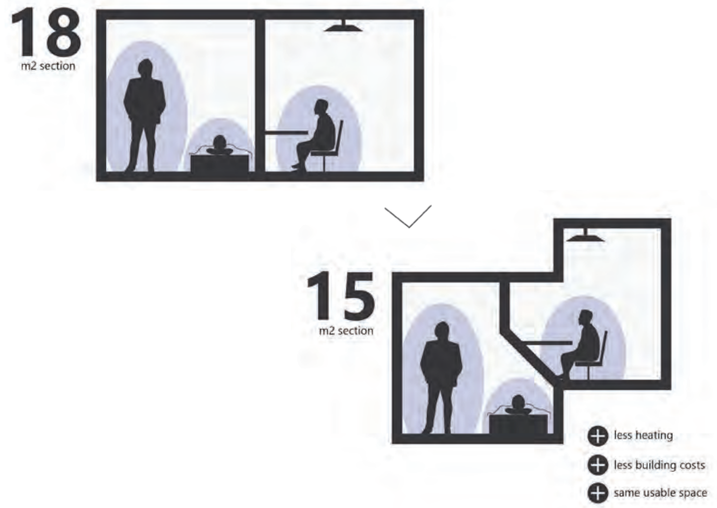
Type: Design Studio at University of Melbourne
Date: 02.2022 - 06.2022
Location: Melbourne, Australia
Team: Taichen Li
Supervisors: Darcy Zelenko - Danny Ngo

Tetris Living tackles the inefficiency in the current building industry with a proposal for architecture. Buildings should respond to the changed needs of the inhabitants, and allow the individualization and reconfigura¬tion of their living spaces. This can be done with the discretization of architecture. Specifically, this means that buildings are assembled out of a set of few components, allowing a huge range of possible configurations. The first step is the development of a part, suitable for the built environment. The part is then aggregated to shape a building following a certain logic. The aggregation and the concept of discrete architecture as a participatory platform is tested in an architectural project, located in the Fishermen's Bend, a new urban development area in Melbourne.

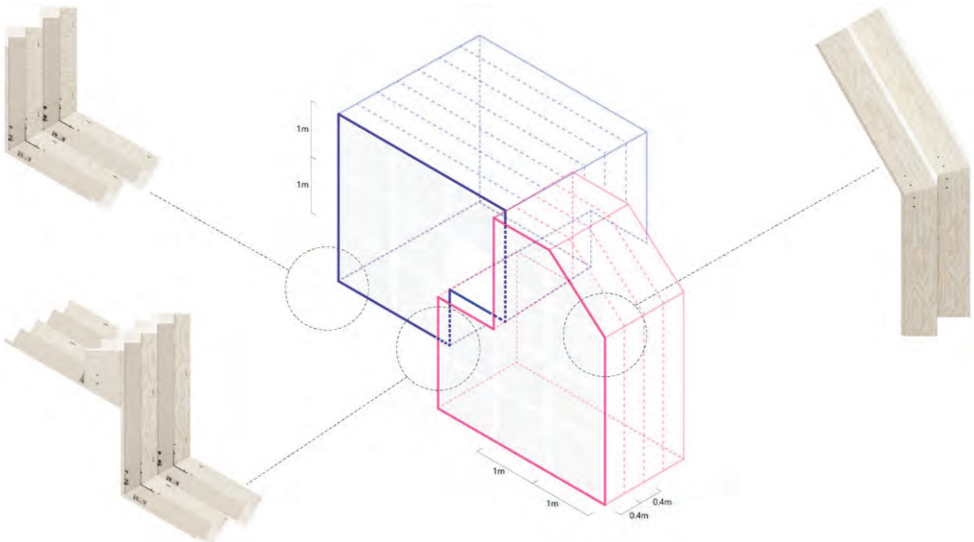
As a discrete part, a timber beam with triangular section was developed. These parts can be assembled to frames. A row of frames can be assembled to rooms, and rooms can be stacked uppon each other thanks to the triangular section of the parts. Through an interactive platform, inhabitants can choose their preferred room configuration. Following that, the appartments are stacked with the goal of maximum space efficiency.



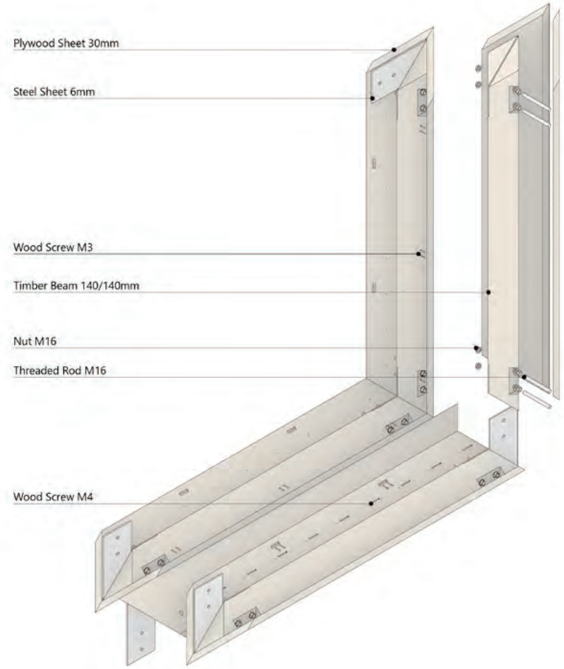
CREATING A DISCRETE BUILDING PART



SPACE OPTIMIZATION

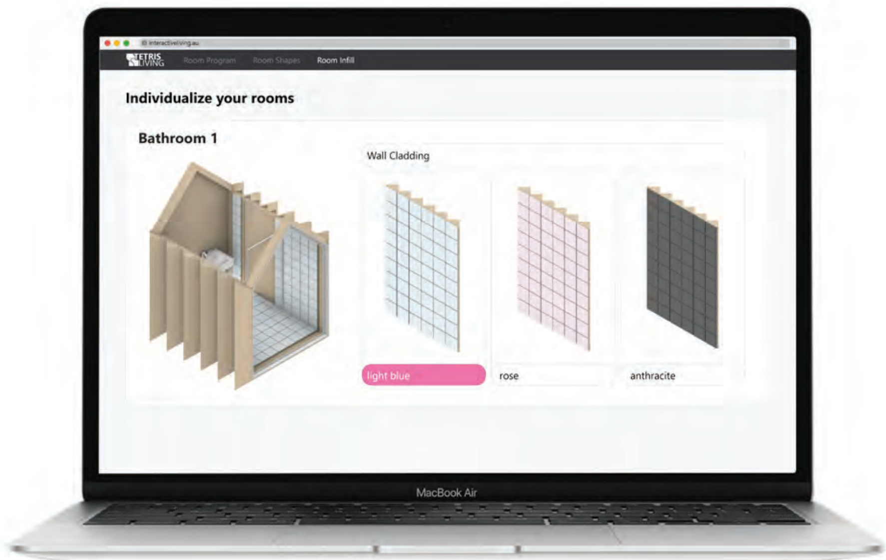


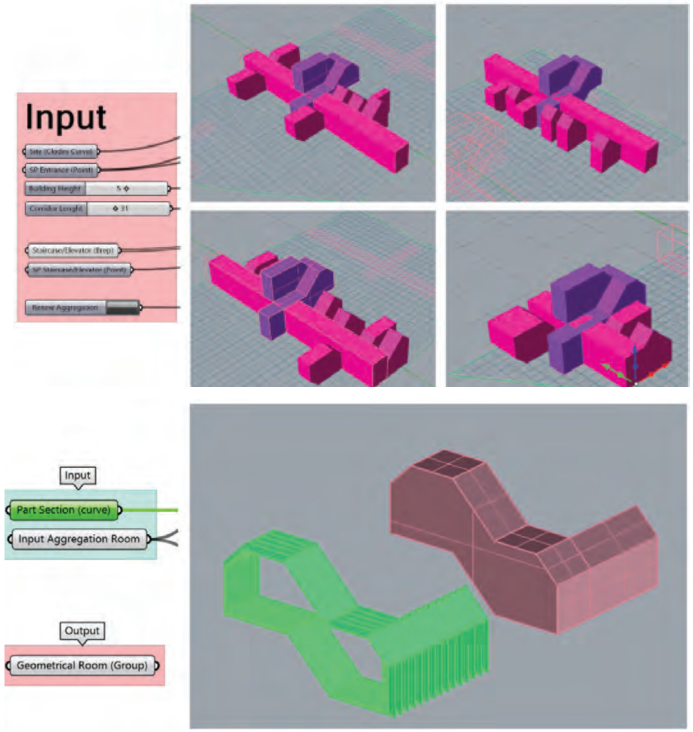
MATERIALIZING THE PART



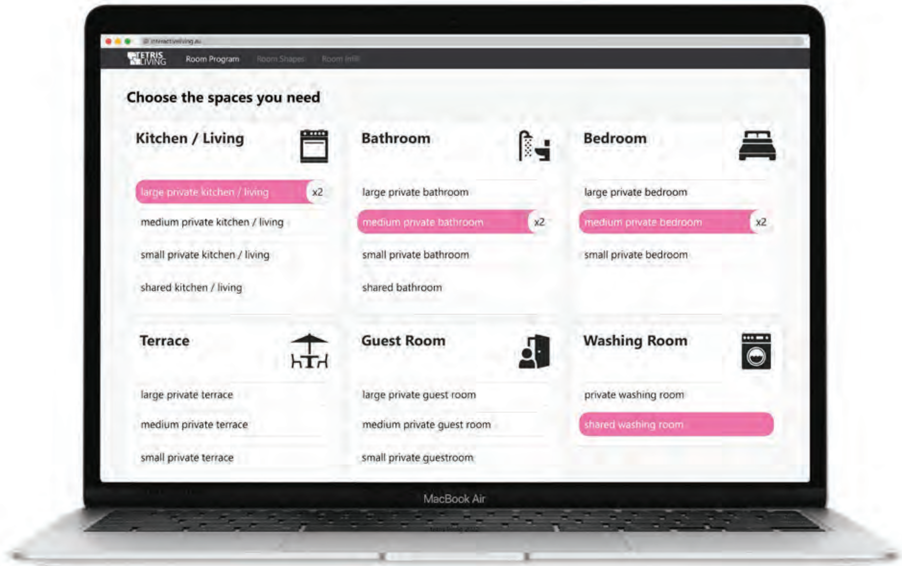
PART DETAILLING

PHYSICAL MODEL MAKING

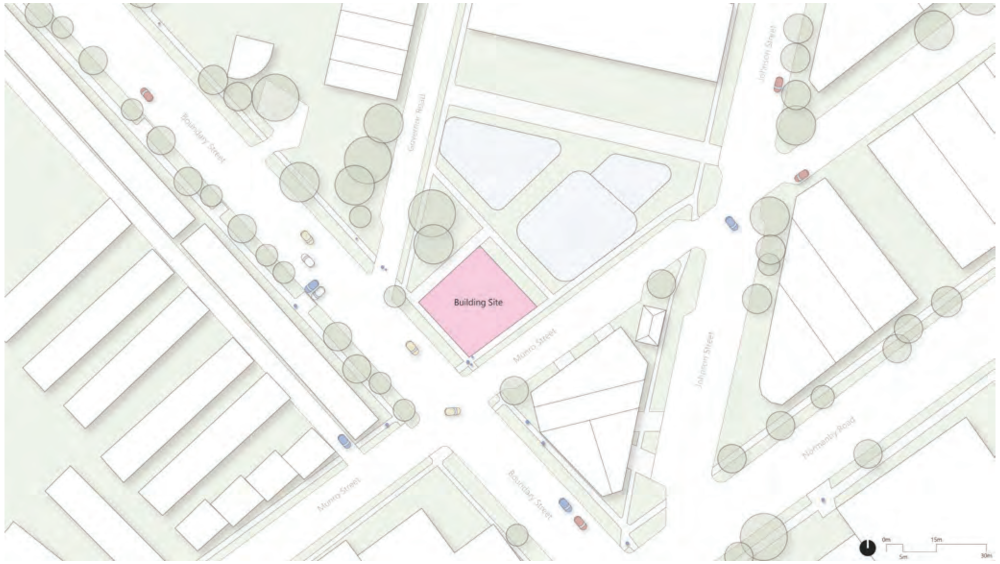




AGGREGATION + AUTOMATED DETAILING

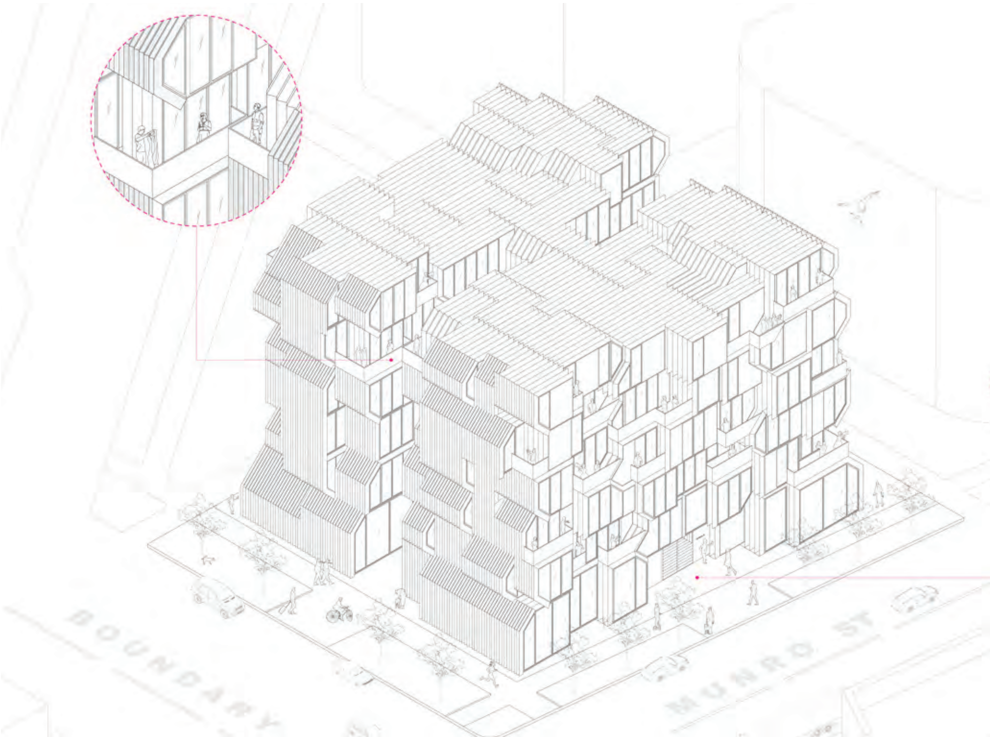


UI MOCKUP CONFIGURATOR

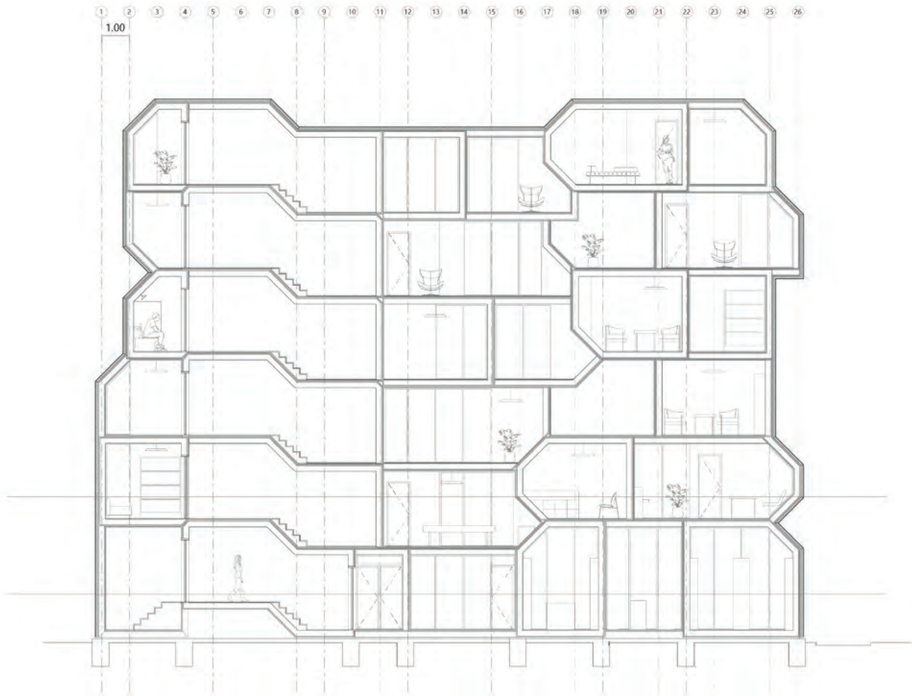


SITE PLAN FINAL BUILDING

PERSPECTIVE APARTMENT EXAMPLE



ISOMETRIC DRAWING FINAL BUILDING



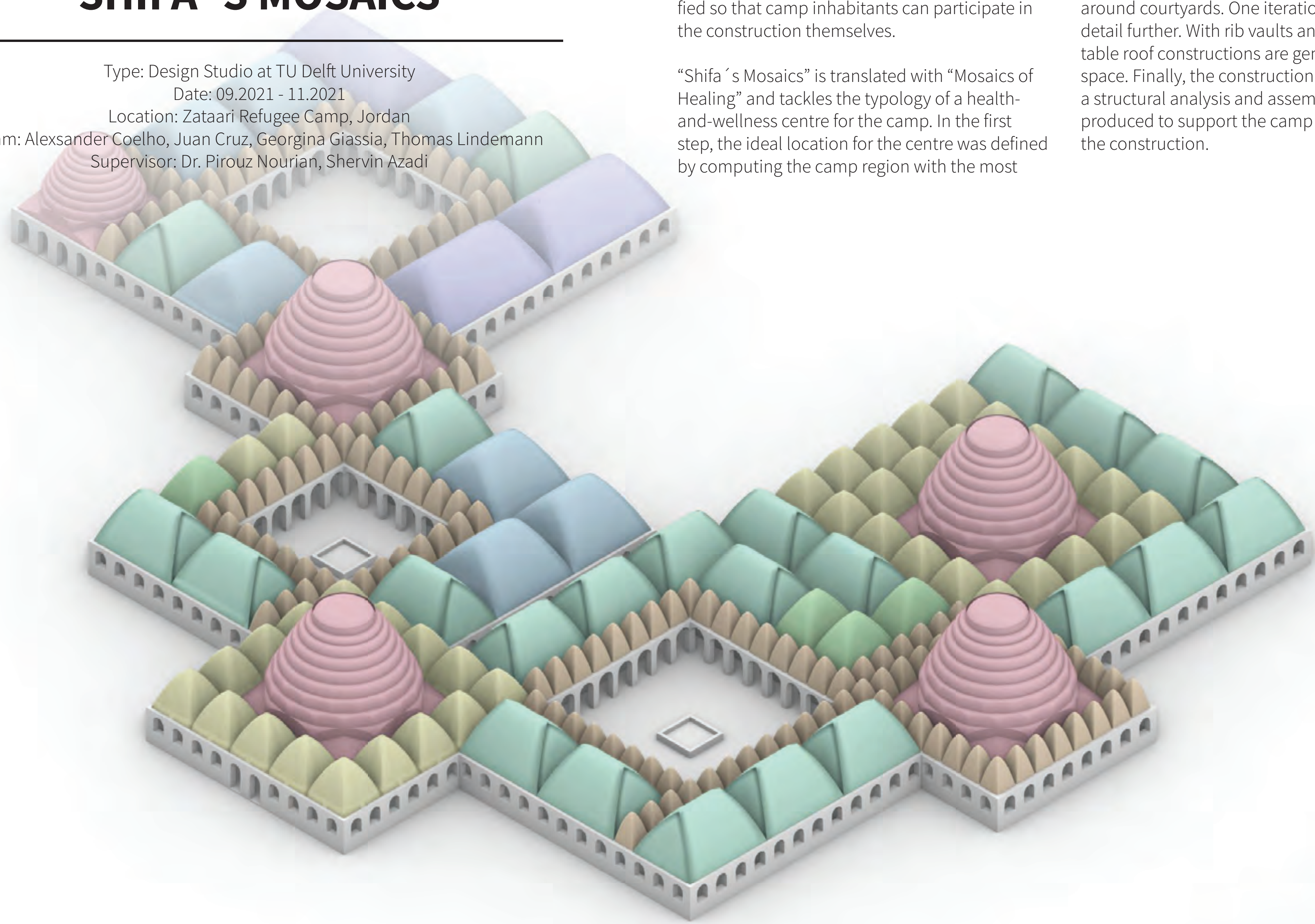
BUILDING SECTION

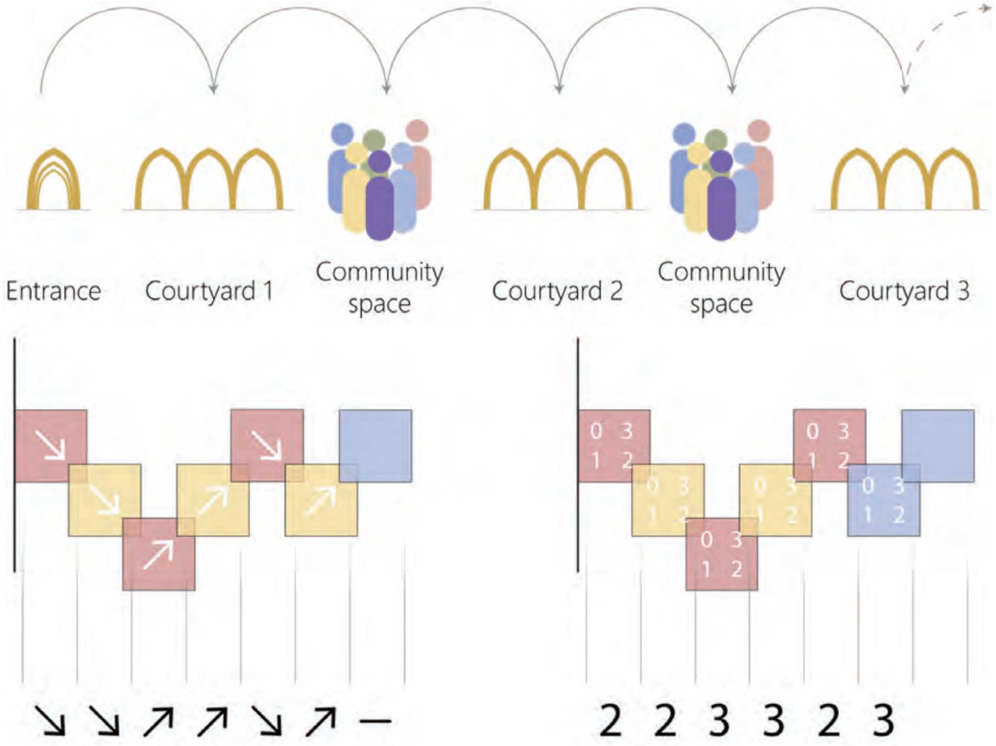
EARTHY:
SHIFA´S MOSAICS

Type: Design Studio at TU Delft University
Date: 09.2021 - 11.2021
Location: Zataari Refugee Camp, Jordan
Team: Alexsander Coelho, Juan Cruz, Georgina Giassia, Thomas Lindemann
Supervisor: Dr. Pirouz Nourian, Shervin Azadi

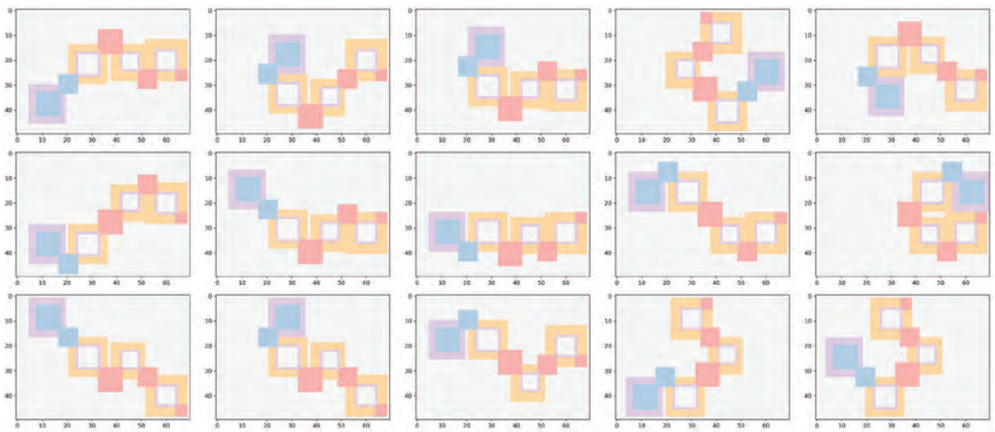
The concept of the design studio „Earthy“ is the development of semi-temporary accommodations and buildings for the refugee camp „Zataari“ in Jordan. Buildings are to be created from local materials such as compressed earth blocks. The construction process needs to be highly simplified so that camp inhabitants can participate in the construction themselves.

“Shifa´s Mosaics” is translated with “Mosaics of Healing” and tackles the typology of a health-and-wellness centre for the camp. In the first step, the ideal location for the centre was defined by computing the camp region with the most need for these services. Then, a room program was created that reflects the requirements and wishes of the camp inhabitants. Incorporating the historic typology of the courtyard house, a generative design methodology was developed to produce valid spatial configurations, centred around courtyards. One iteration was chosen to detail further. With rib vaults and muqarnas, suitable roof constructions are generated for each space. Finally, the construction is validated with a structural analysis and assembly guidelines are produced to support the camp inhabitants with the construction.

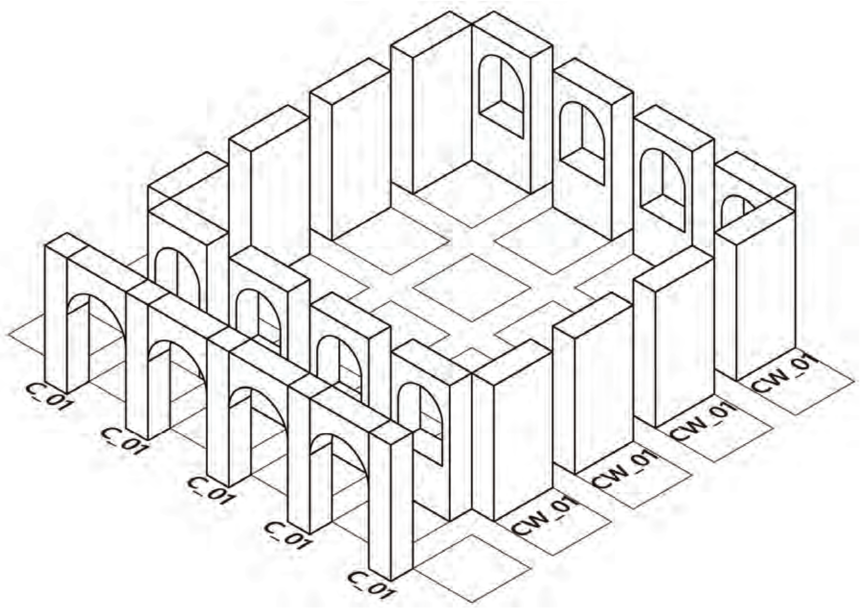




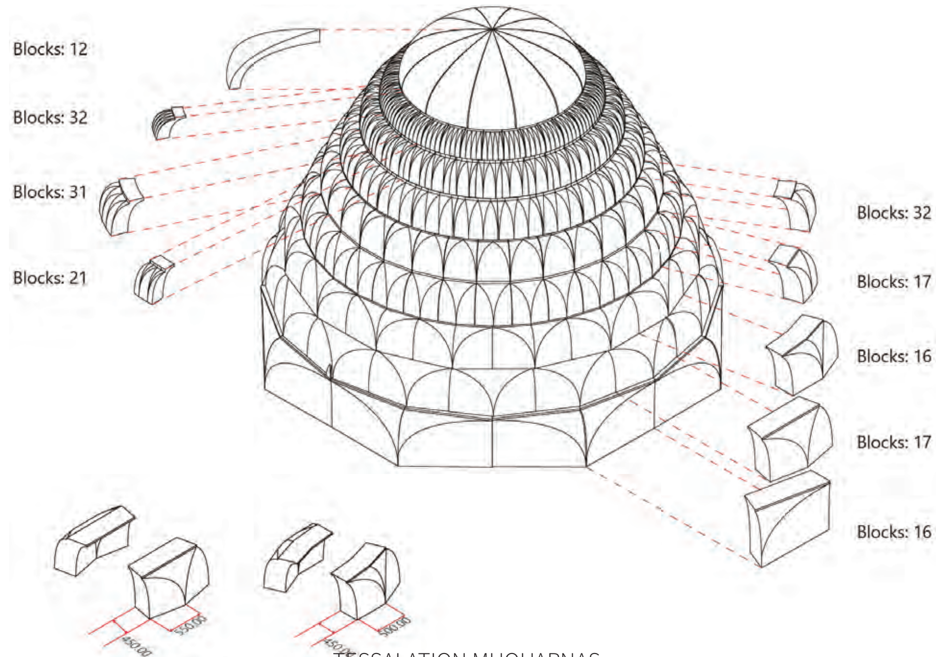
DESIGN CONCEPT AND RULES



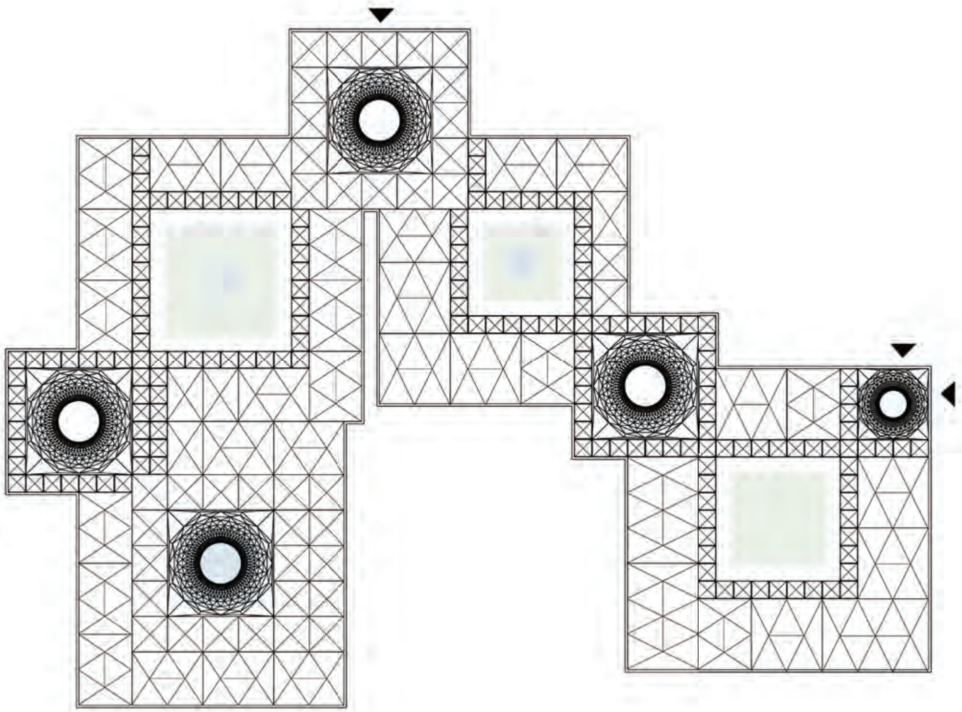
COMPUTED ITERATIONS



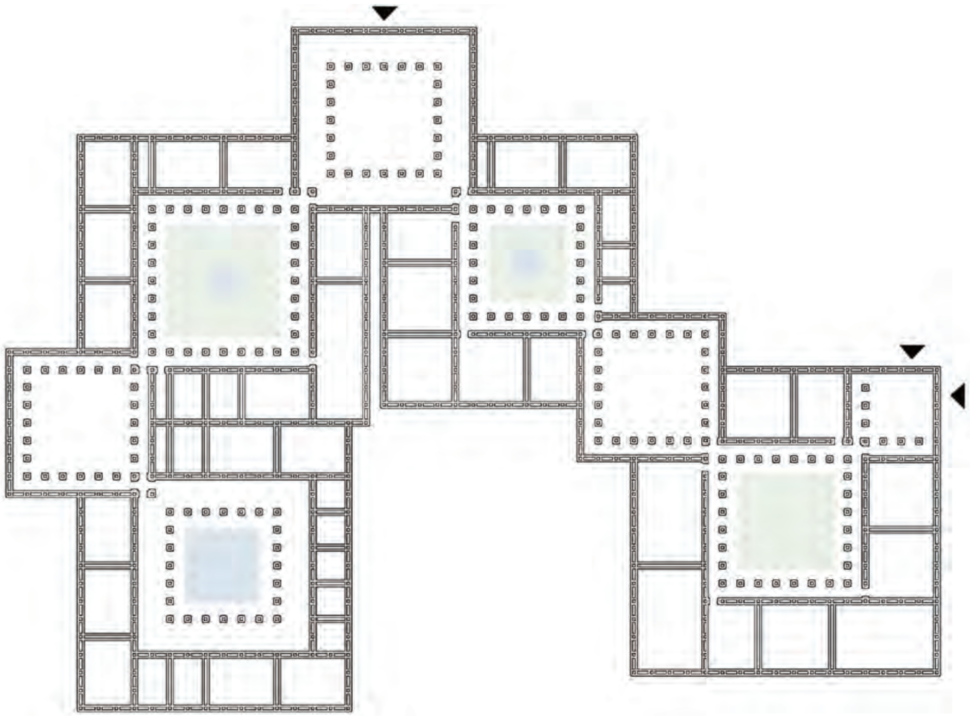
COMPUTATION WALL ELEMENTS



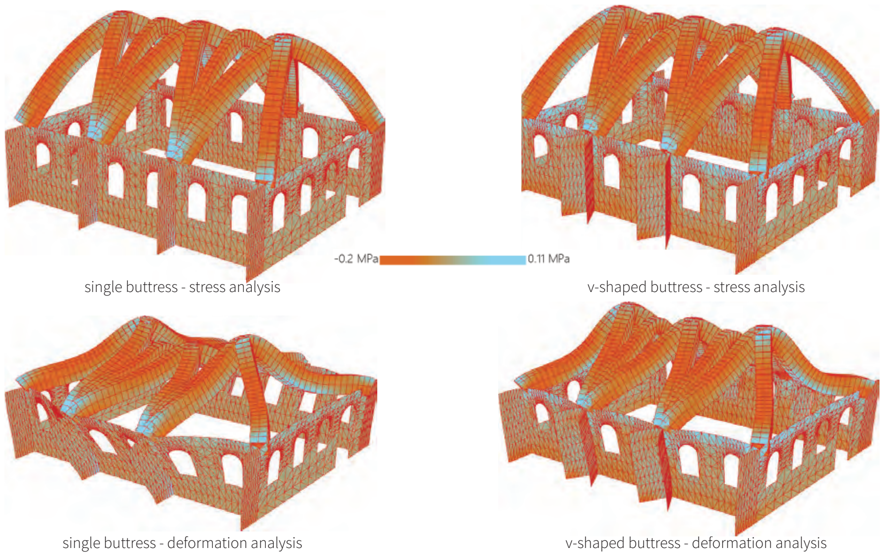
TESSALATION MUQUARNAS



CEILING PLAN



FLOOR PLAN



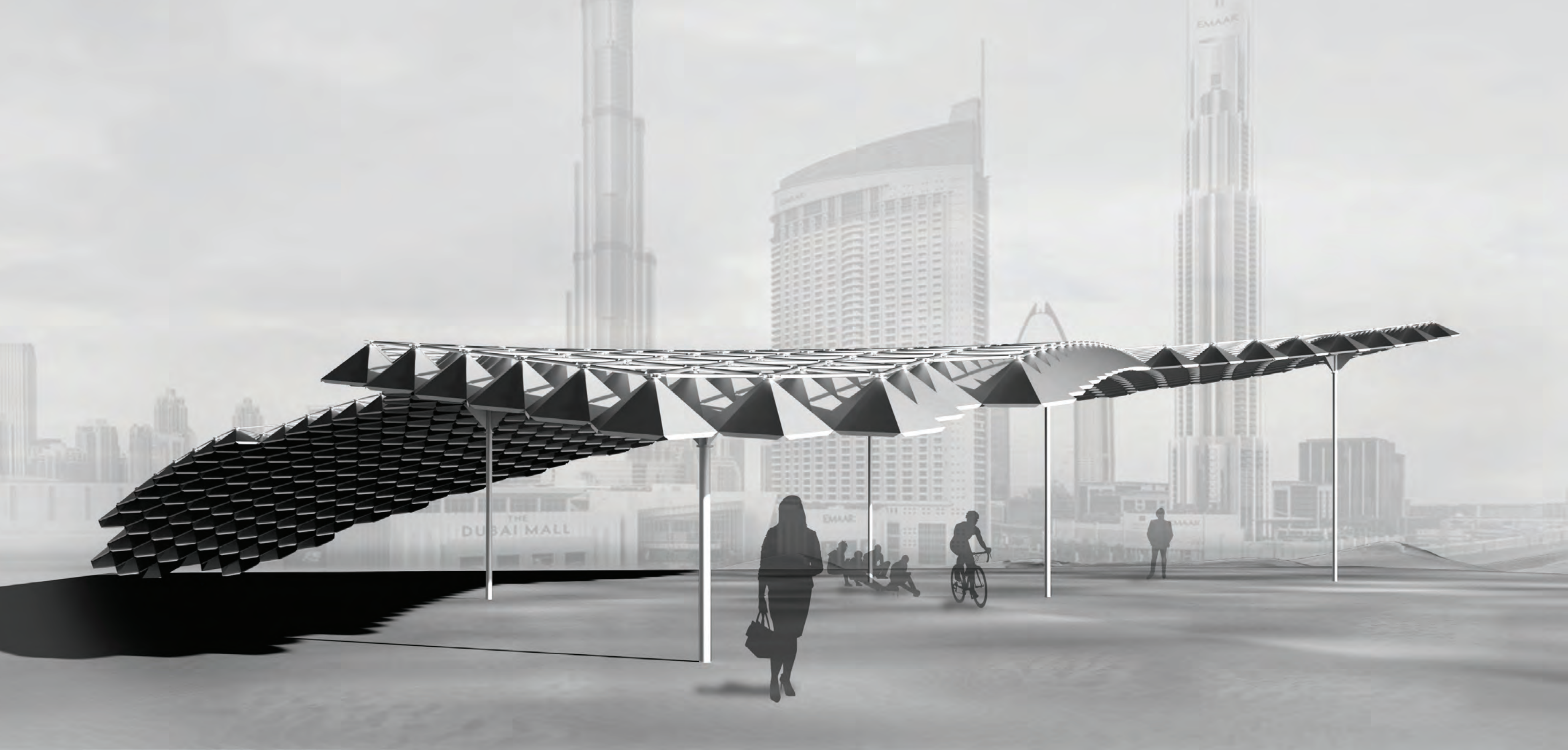
STRUCTURAL ANALYSIS

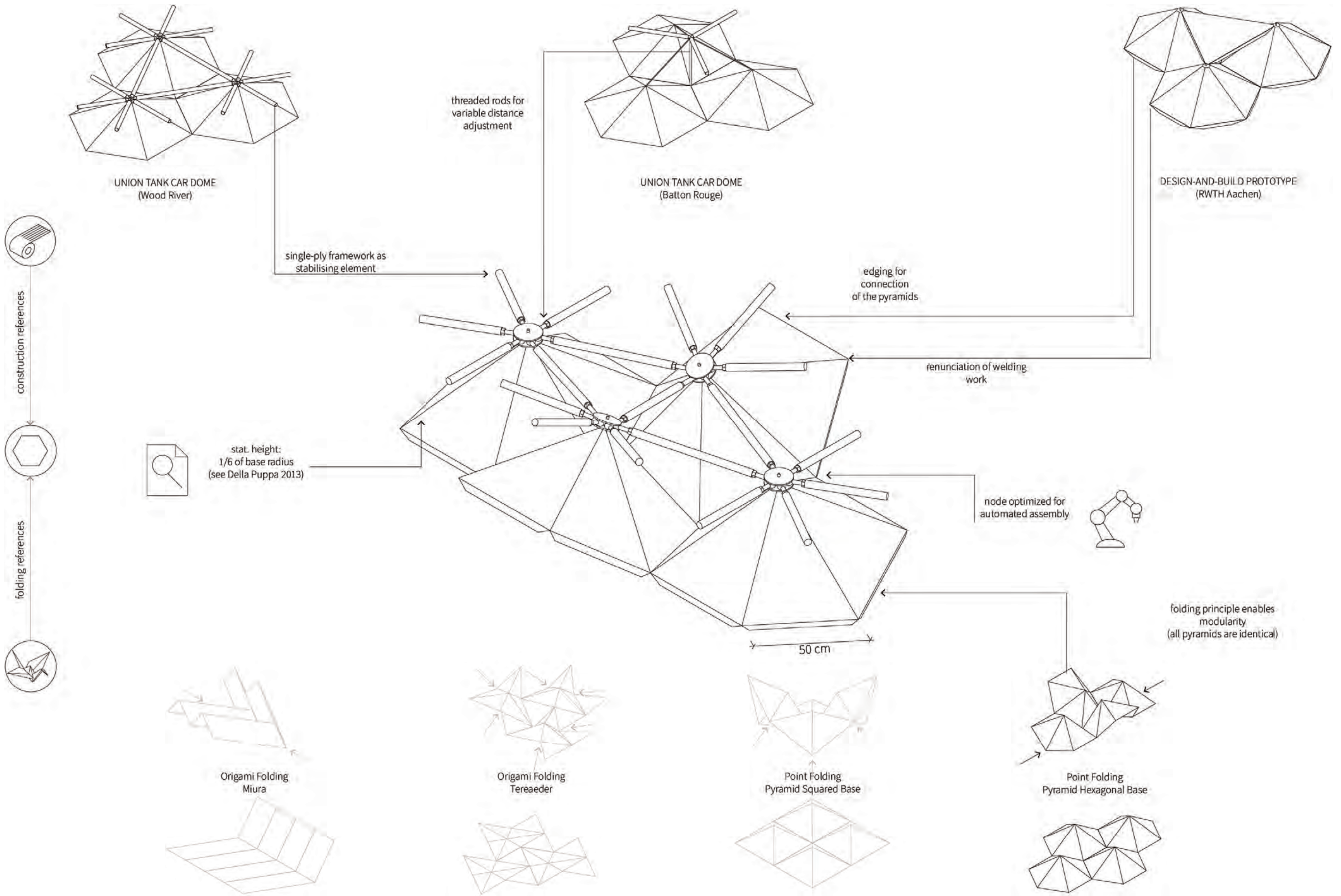
IMPRESSION

HEXAFORM

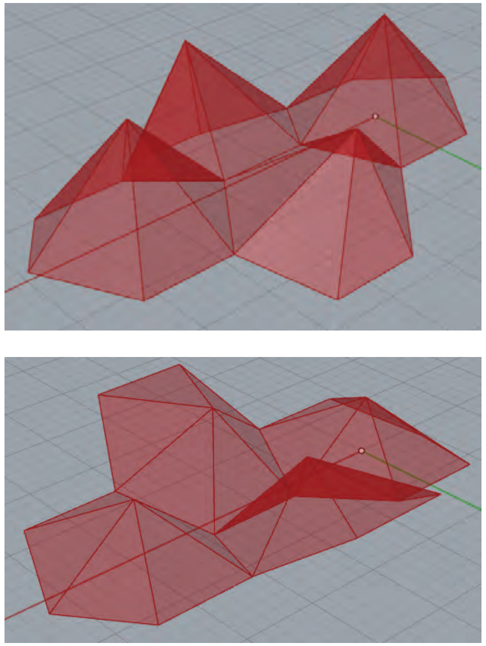
Type: Bachelor Thesis at RWTH Aachen University
Date: 04.2019 - 07.2019
Supervisor: Univ.-Prof. Dr. techn. Sigrid Brell-Cokcan

Hexaform shifts the production process for free form buildings on a whole new level, based on a modular lightweight construction. Hexaform is a building system working with the automation of sheet metal folding. The basis is formed by prefabricated hexagon pyramids, which are riveted together and stiffed with a framework. The results in a spatial folding that is based on the principles of origami. With the precise coordination of the individual folding processes, a spatial free-form surface of pyramids is created. The framework is also a variable structure: with the help of threaded rods, the length of the rod can be shortened or lengthened and can thus react to the changed distances of the spatially curved pyramid structure. The folding and pre-assembly process is carried out in a fully automated mobile factory.
Since all components are preserved in their shape and length, Hexaform can be completely dismantled and is therefore suitable for both temporary and stationary free-form constructions.

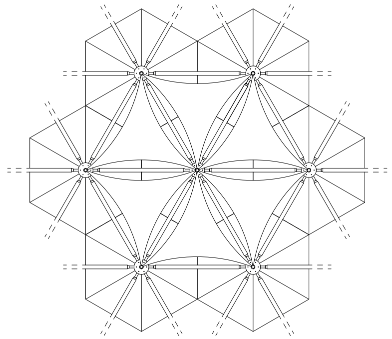



UNION TANK CAR DOME
(Wood River)
threaded rods for
variable distance
adjustment
UNION TANK CAR DOME
(Batton Rouge)
DESIGN-AND-BUILD PROTOTYPE
(RWTH Aachen)
construction references
folding references
single-ply framework as
stabilising element
edging for
connection
of the pyramids
renunciation of welding
work
stat. height:
1/6 of base radius
(see Della Puppa 2013)
node optimized for
automated assembly
folding principle enables
modularity
(all pyramids are identical)
50 cm
Origami Folding
Miura
Origami Folding
Tereaeder
Point Folding
Pyramid Squared Base
Point Folding
Pyramid Hexagonal Base

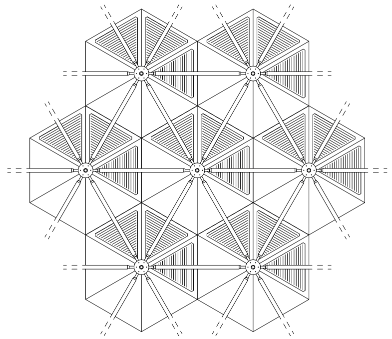
MODEL OF AN ASSEMBLY UNIT IN 1: 5



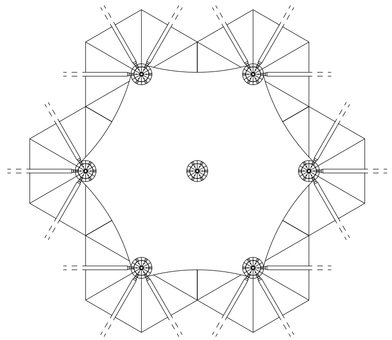
PARAMETRIC MODEL



sail elements

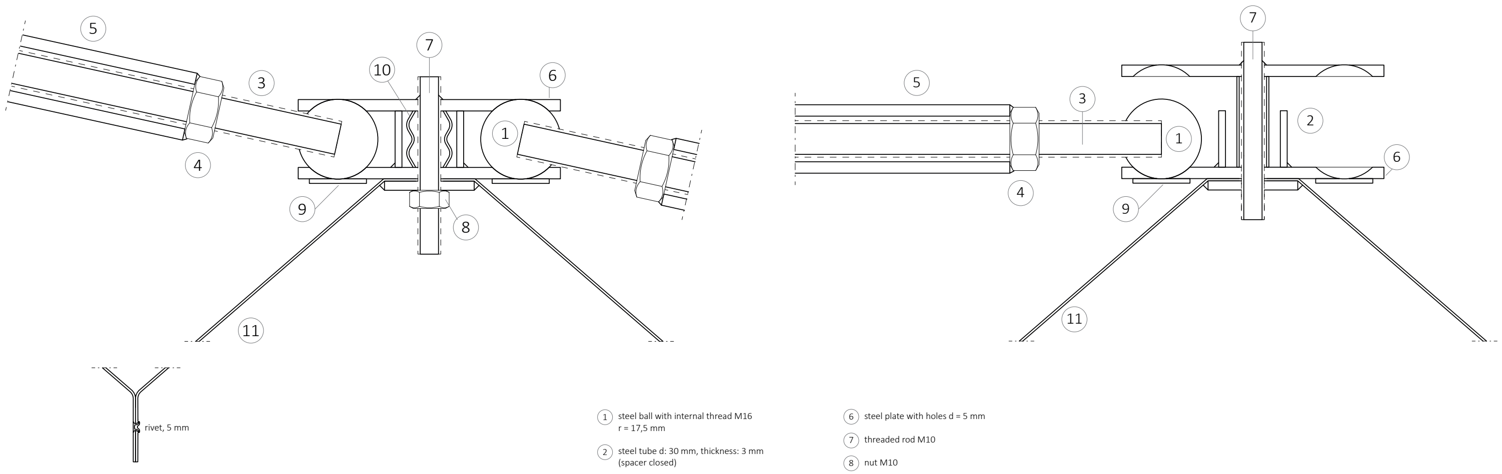


solar modules in direction of solar radiation



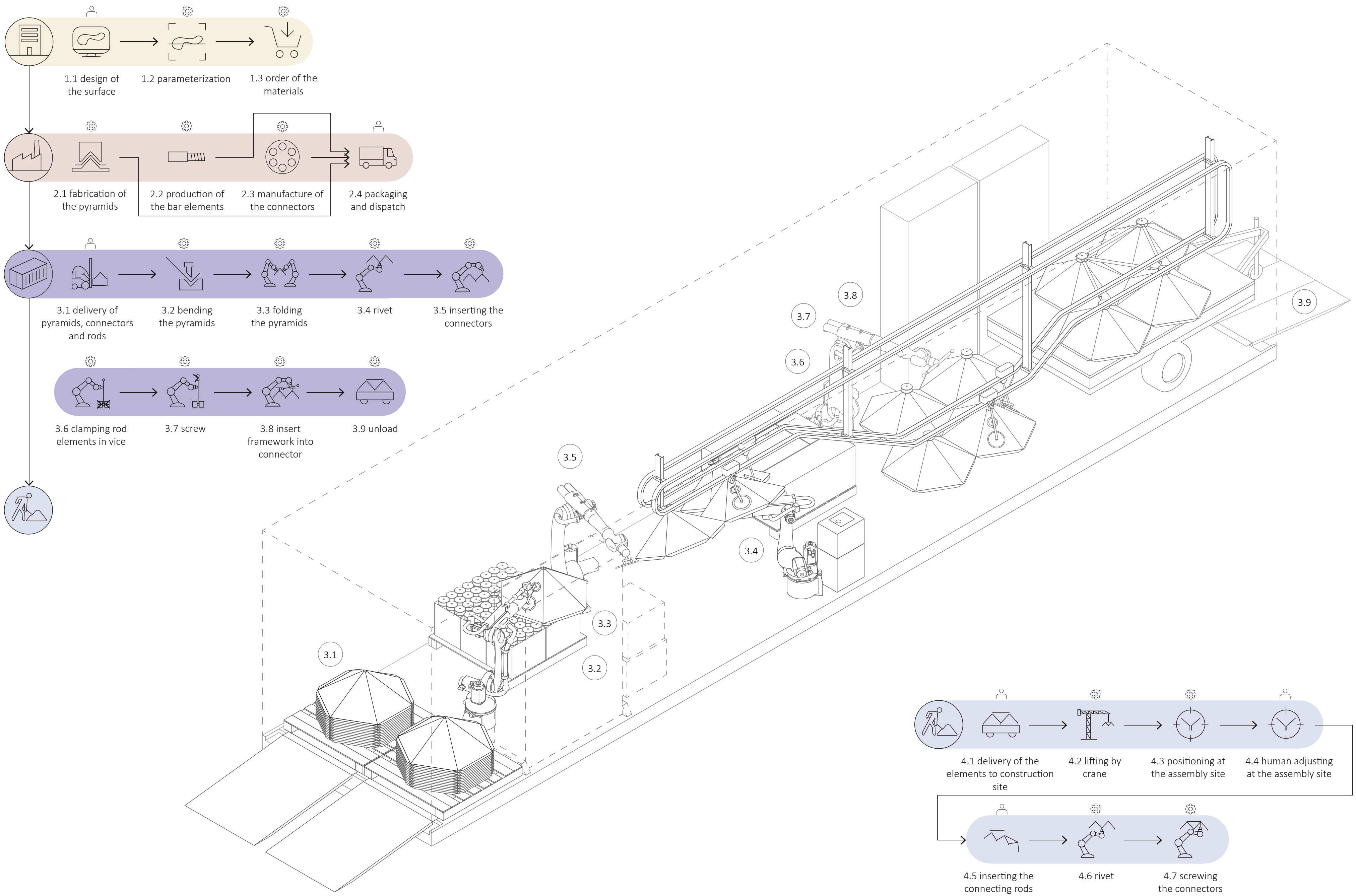
sail structure

FEATURED VARIANTS

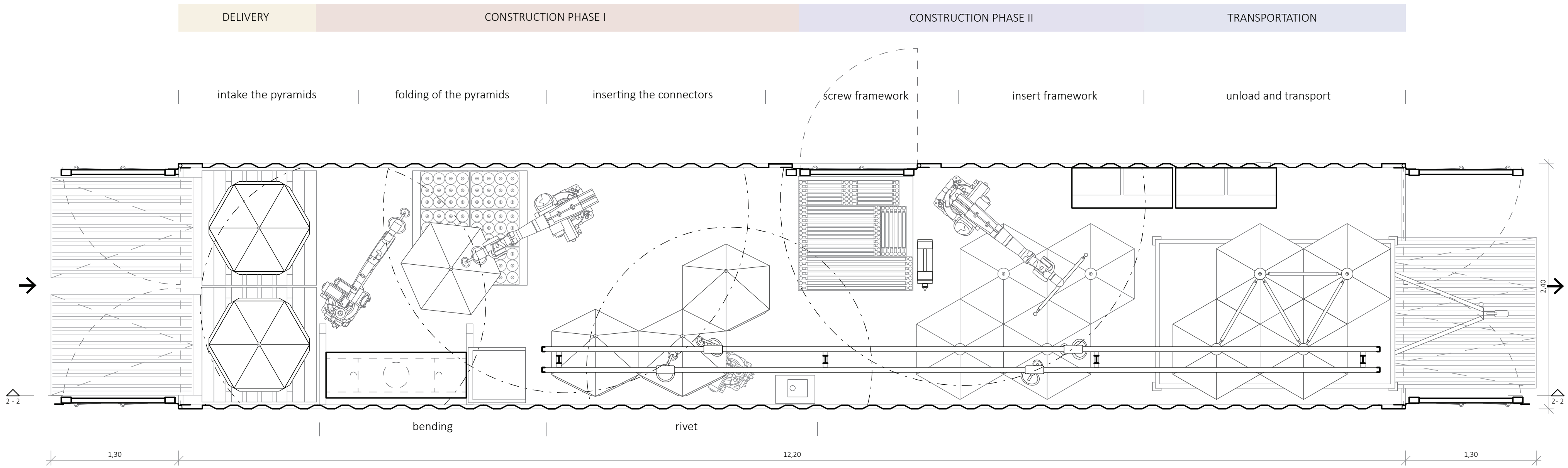


1. steel ball with internal thread M16 r = 17,5 mm
2. steel tube d: 30 mm, thickness: 3 mm (spacer closed)
3. threaded rod M16
4. nut M16
5. aluminium tube d: 30 mm, thickness: 5 mm
6. steel plate with holes d = 5 mm
7. threaded rod M10
8. nut M10
9. magnet (fixing aid)
10. hose d: 15 mm (spacer open)
11. pyramid d: 1 mm

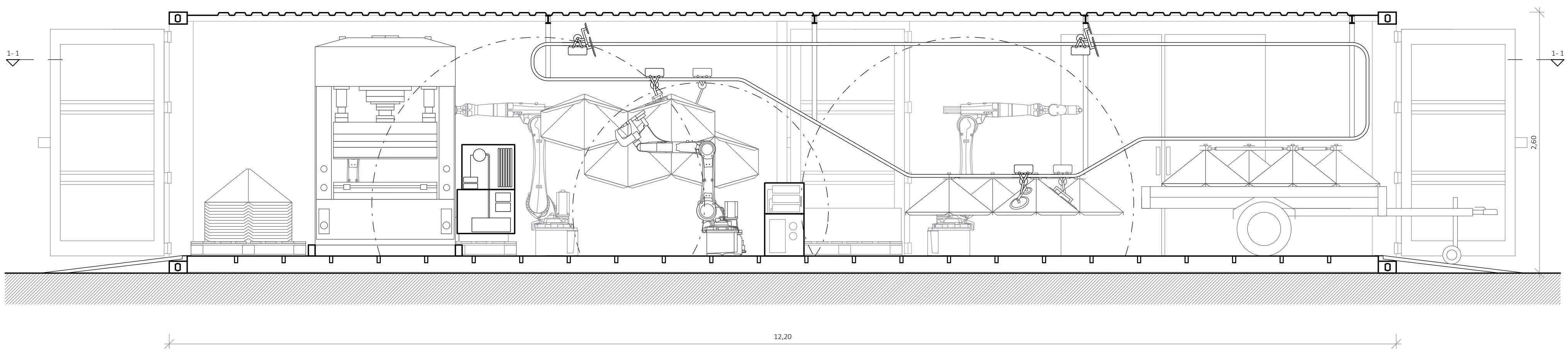
DETAIL: NODE IN OPEND AND CLODED STATE



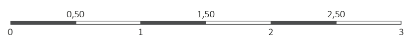
SYSTEM PROCESS AND MOBILE FACTORY LAYOUT



floor plan 1-1



section 2-2

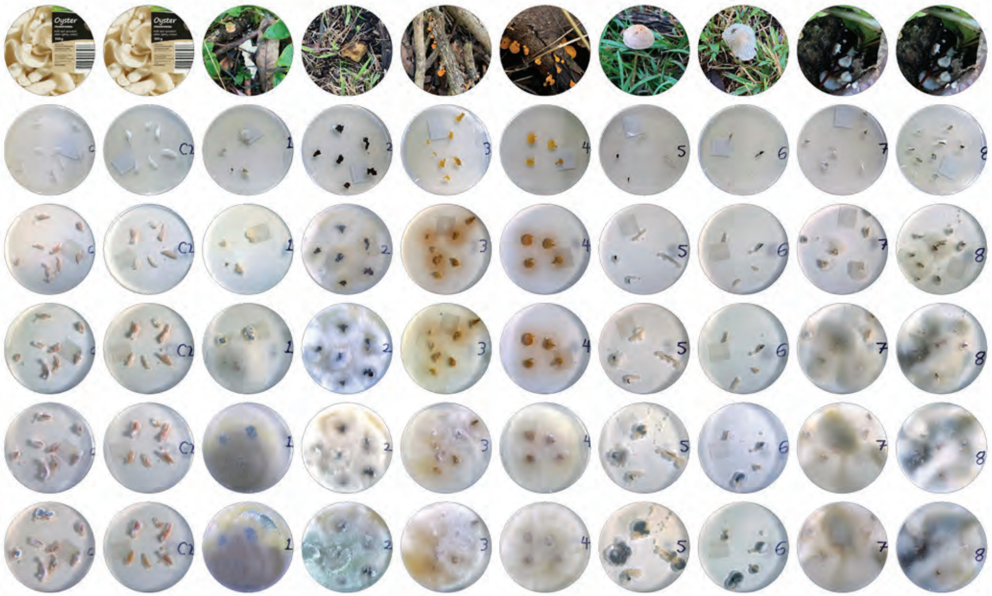


THE MOBILE FACTORY

MADE BY ROBOTS: WILDLIFE HABITAT

Type: Elective at University of Melbourne
Date: 02.2022 - 06.2022
Location: Melbourne, Australia
Team: James Urlini, Pearl Thompson
Supervisor: Prof. Rochus Hinkel

The course „Made by Robots“ was all about using robotic clay printing to create habitats for urban wildlife. A specific plot on the outskirts of Melbourne was chosen to locate the project. In an initial analysis, we identified endangered species in this specific urban ecological system, which are mostly birds and frogs. We choose to build a feeding station for them- meaning to create the optimum conditions for fungi and mosses to grow. Once funghi and mosses are populated, smaller animals like slugs, spiders and ants will follow. These animals then are serving as food for the endangered frog and bird populations.
To create the design, we did several experiments on how to grow mosses and funghi in combination with clay printing. We identified the perfect conditions regarding geometry, humidity and sunlight. Based on that, we developed modular clay elements, each serving a specific function for growing fungi, and mosses, and transporting moisture and light.
For that, four different kinds of prints are produced: Bottom Pieces, Top Pieces, Regular Pieces and Connectors. While Connectors and Regular Pieces can be connected with two other prints, Bottom- and Top Pieces can only connect to one other element.
The resulting prints are modular pieces, that can be freely assembled into towers, with internal properties to match the local requirements.
Three of these towers have been assembled on the chosen site and are currently populated by fungi and mosses. The project will be exhibited at Melbourne Design Week 2023.



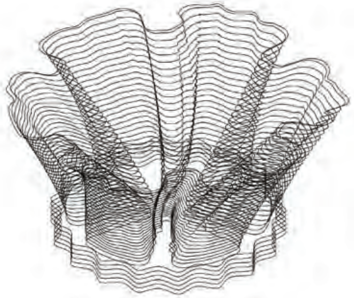
GROWTH EXPERIMENT OF MYCELLIUM IN PETRIDISHES

GROWTH EXPERIMENT OF MOSSES

MYCELLIUM SUBSTRATE APPLIED ON 3D CLAY PRINTS

3D PRINTS WITH SUBSTRATE AFTER 5 DAYS

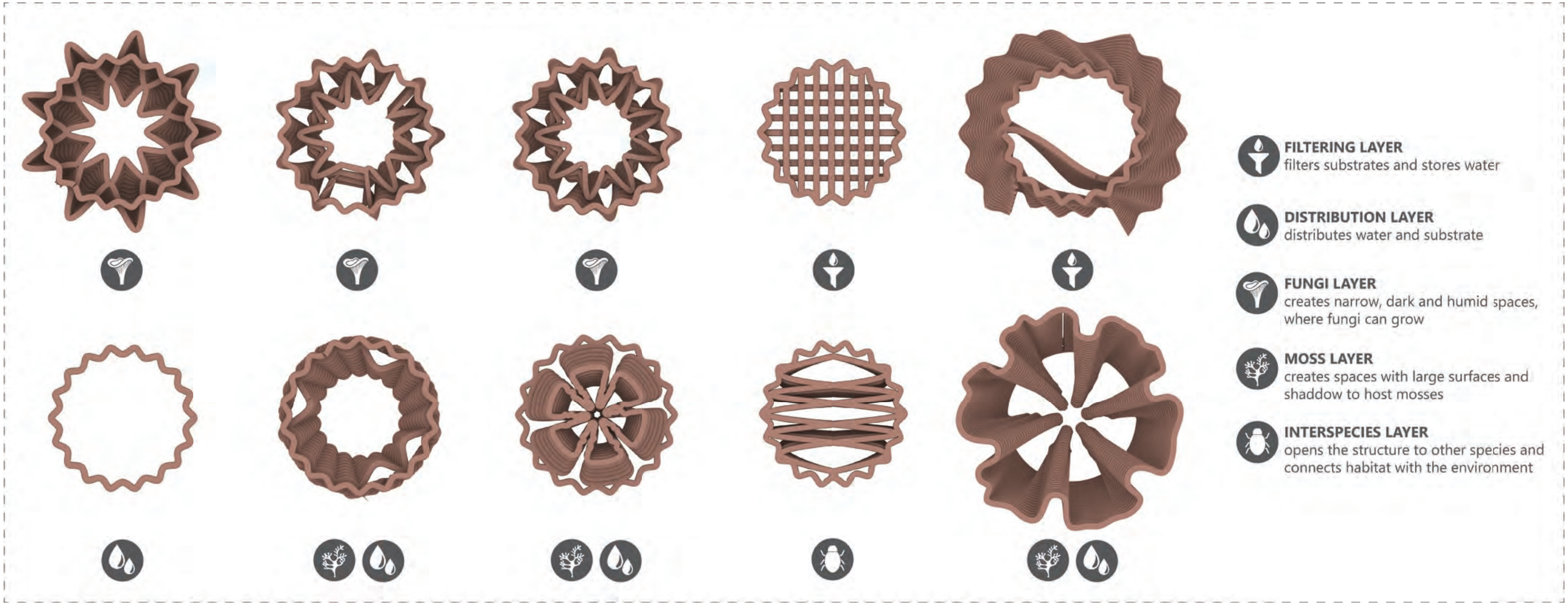
INITIAL MODEL



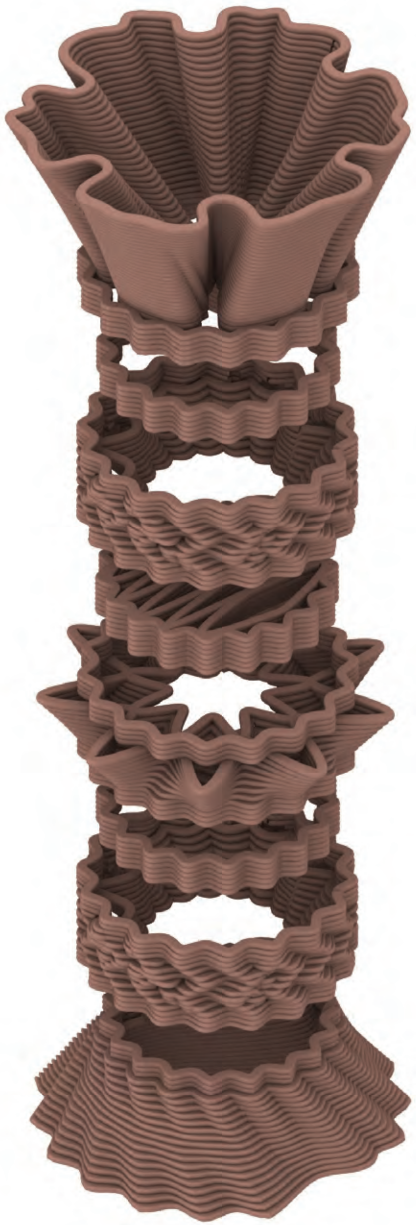
PRINTING PATH (SLICED MODEL)

ROBOTIC CLAY PRINTING

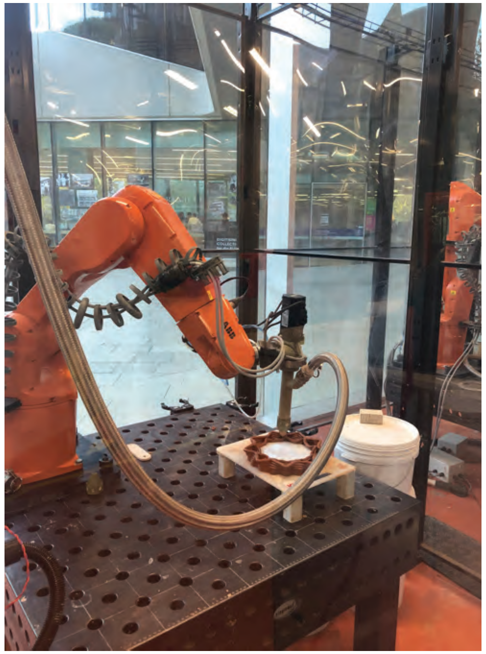
FIRED PRINT



MODULAR DESIGNS AND USECASES



COLUMN EXPLOSION



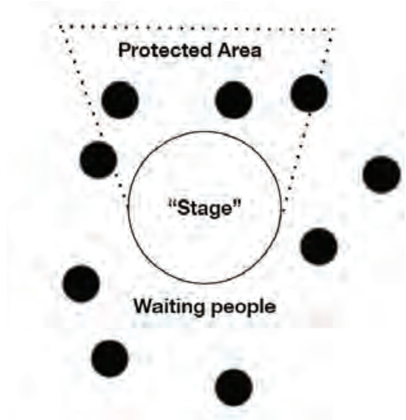
PRINTING AND ASSEMBLY

FINAL DESIGN ON SITE

THE JANSEN TREE

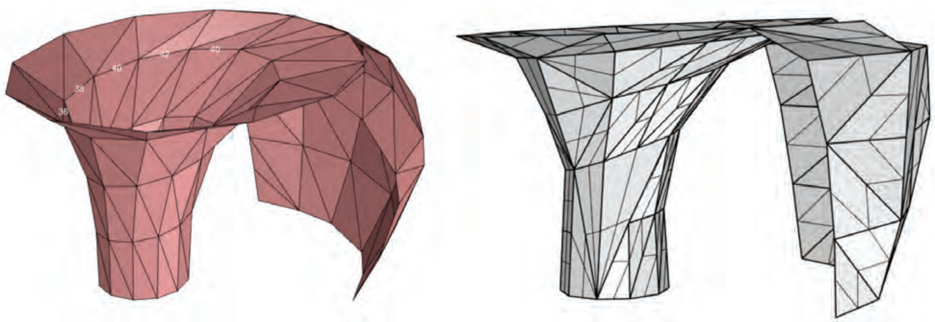
Type: Internal Student Competition TU Delft
Date: 02.2021- 04.2021
Team: Cas Verhoeven, Tong Wu, Trishita Chatterjee
Supervisor: Lia Tramontini, Arie Bergsma

The Facade Design Competition was embedded within the Master´s course „Facade Design“. The task was the creation of a free-form pavilion using a specific glass facade system by Jansen in combination with 3D-printed metal facade nodes. The number of nodes, as same as the change of angle incorporated in the nodes, was strictly limited. Our proposal was a public transport station with a tree-like structure in the middle, transitioning into a windshield. The 3D-printed nodes should be created with the DMLS technique. This method allows high printing accuracy and allows us to integrate an optical sensor and a light into the node. Through this addition, the pavilion can interact with waiting people by tracking their movements or showing relevant information, such as a warning light indicating a bus or ferry approaching. As an initial location, a prominent position in the harbour of Rotterdam was chosen. Our proposal was awarded the first prize in the competition by a Jury consisting of delegates from Jansen, Knippers Helbig and gmp architects.

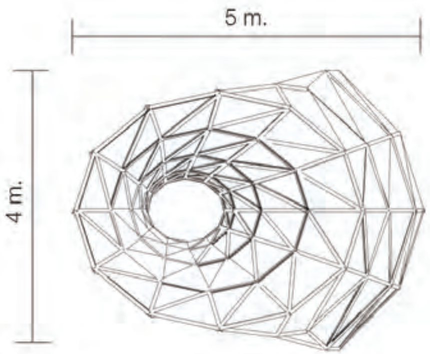


DESIGN CONCEPT

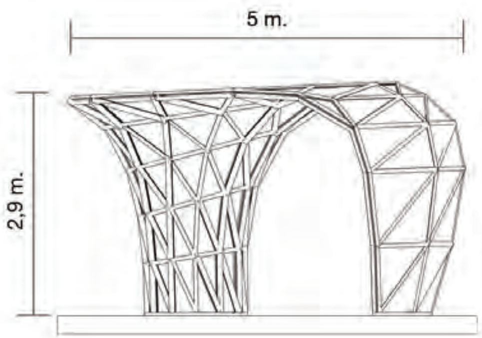
INITIAL SHAPE



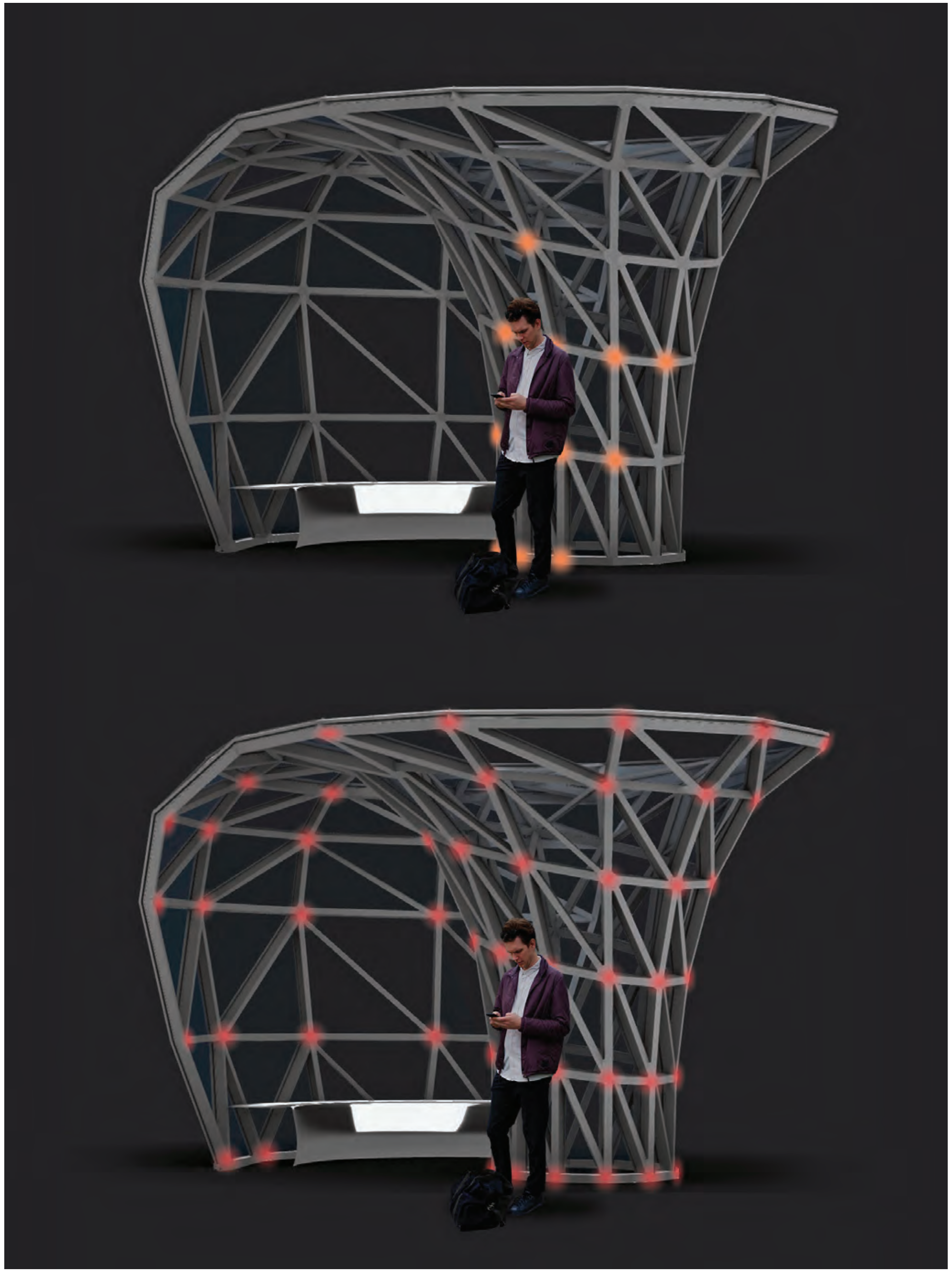
TRANSLATING DESIGNS TO VALID MESH SURFACES



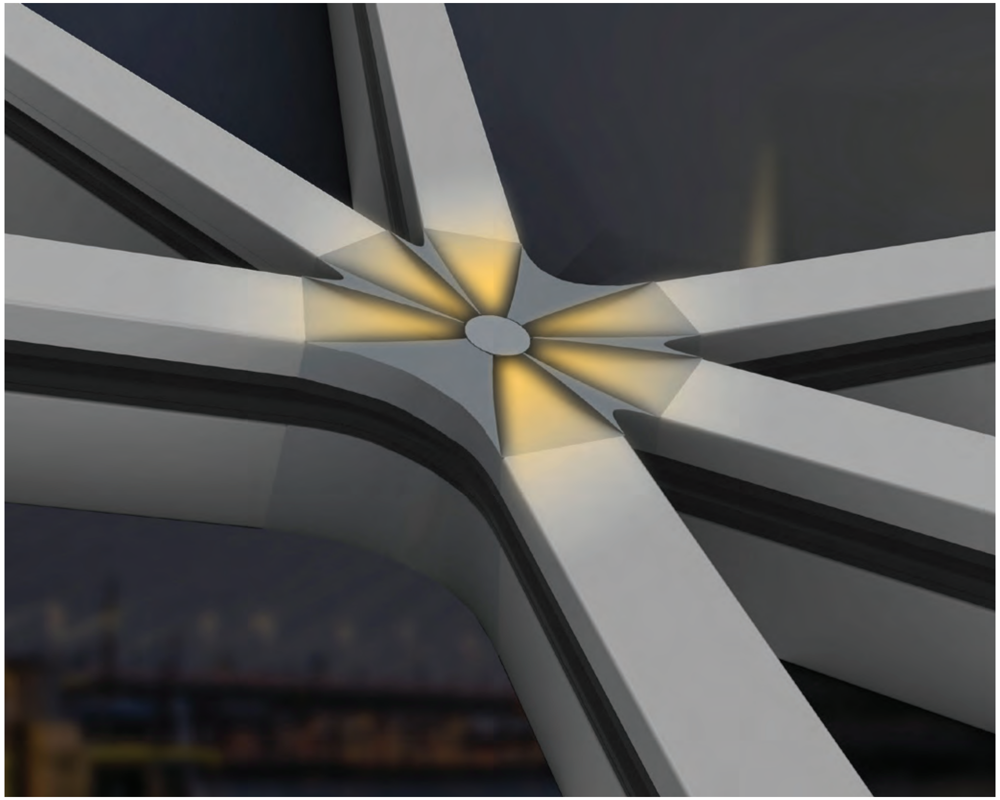
PLAN VIEW



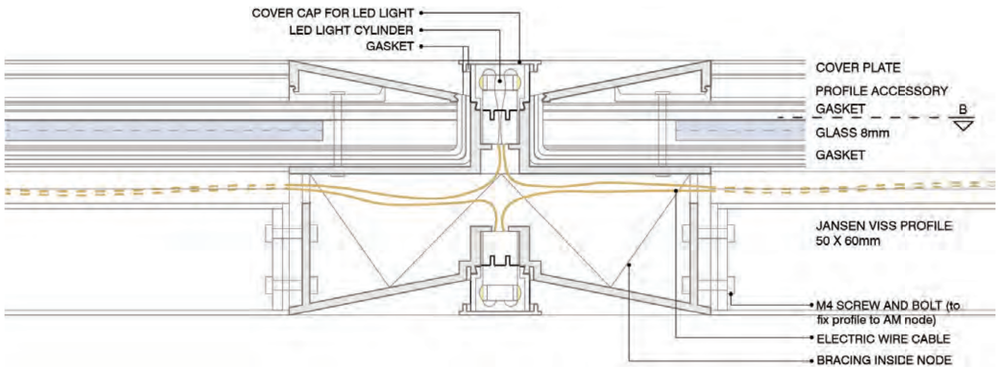
ELEVATION



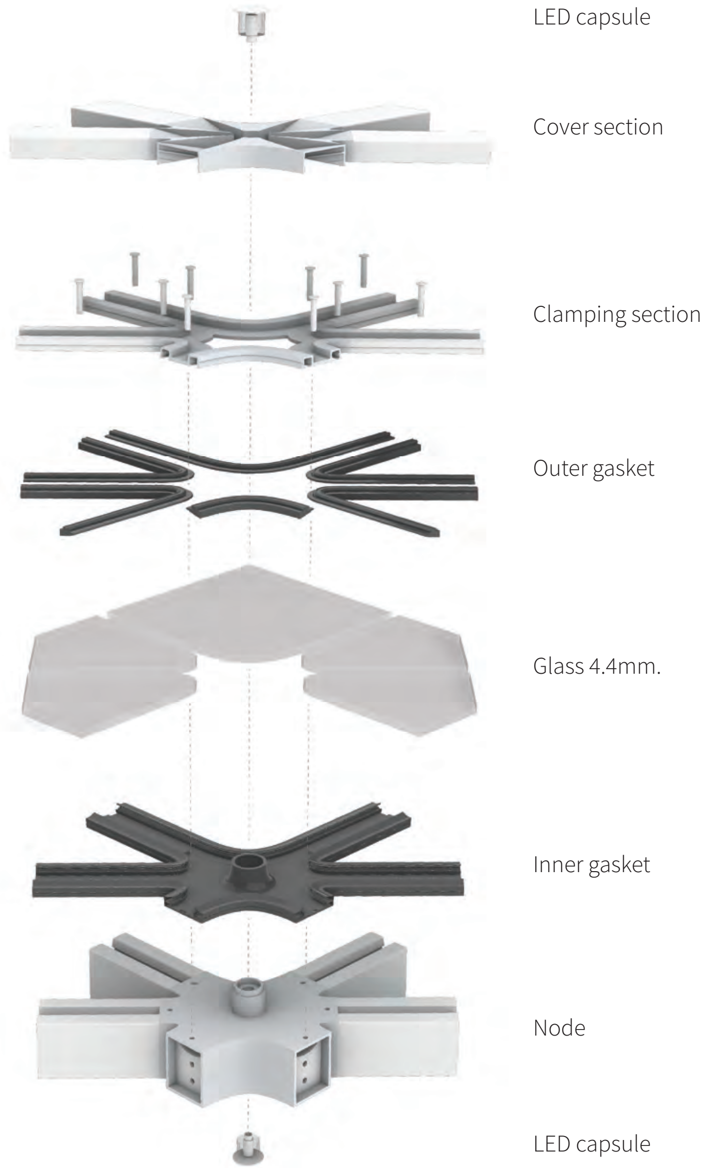
INTERACTIVE LIGHTING THEMES



VISUALIZATION FACADE NODE



FACADE NODE DETAIL



EXPLOSION DETAIL OF THE FACADE NODE

TIM
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FOLIO

TWOTHOUSAND
TWENTY
THREE