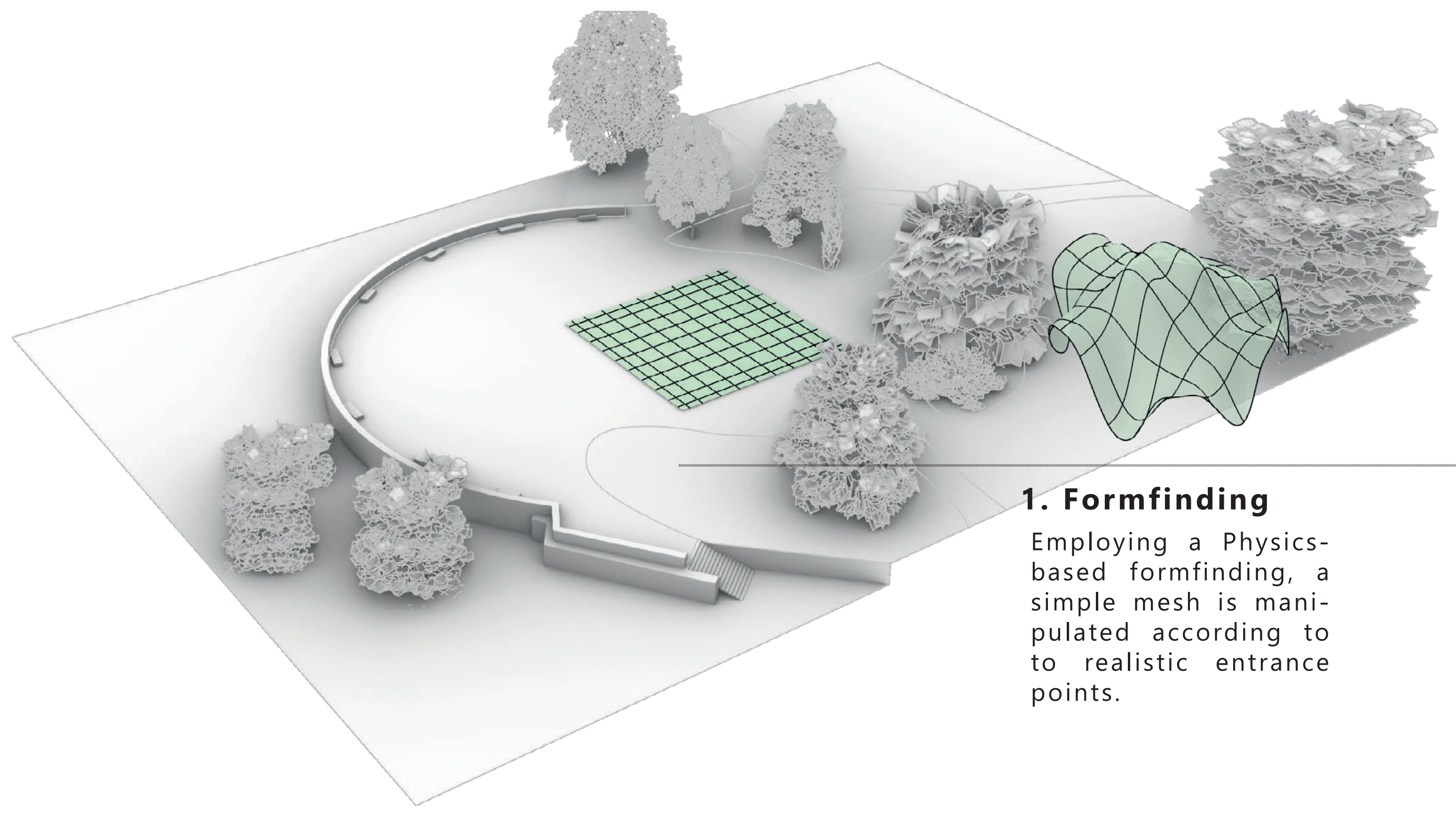
PavilionGrowth

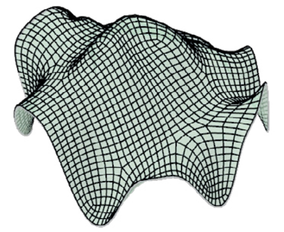
Year completed: 2024

From nature we learn about cellular based formfinding, visible in a thousand different moments, like when a Mushroom grows. This Project seeks to explore modular form finding as an experimentative architectural approach. Based on a simple mesh plane a form is found using Rhino Kangaroo. The shape is simulated in an FEA Analysis environment Karamba 3D. A digital voxelization approach in Wasp then provides the platform to simulate discrete aggregate growth of modules along compression stress paths. We can directly Impact the Module shape while exploring Building logics and fiel-driven aggregation. Finally, real-world parameters such as a minimum required module density and structural weakpoints refine the final growth logic. A distinct advantage is theis presented through the grwoth logic, which also serves as potential assembly order.



1. Formfinding

Employing a Physics-based formfinding, a simple mesh is manipulated according to to realistic entrance points.

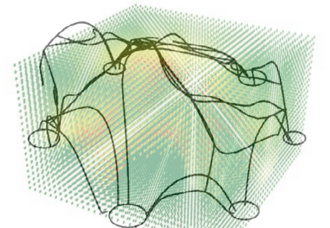


2. Mesh Logic

FIlling a coherent Mesh logic into the desired shape.

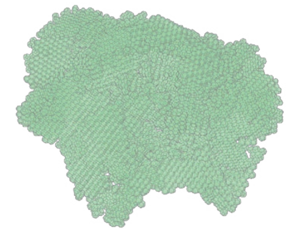
3. FEA Analysis

Finite-Element-Analysis enables to run compression and shear Tests in the attempted Shell-Form.



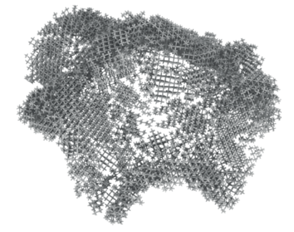
4. Topology Optimization

Reducing a realistic amount of Volume around the most important stress lines give a template for later aggregation



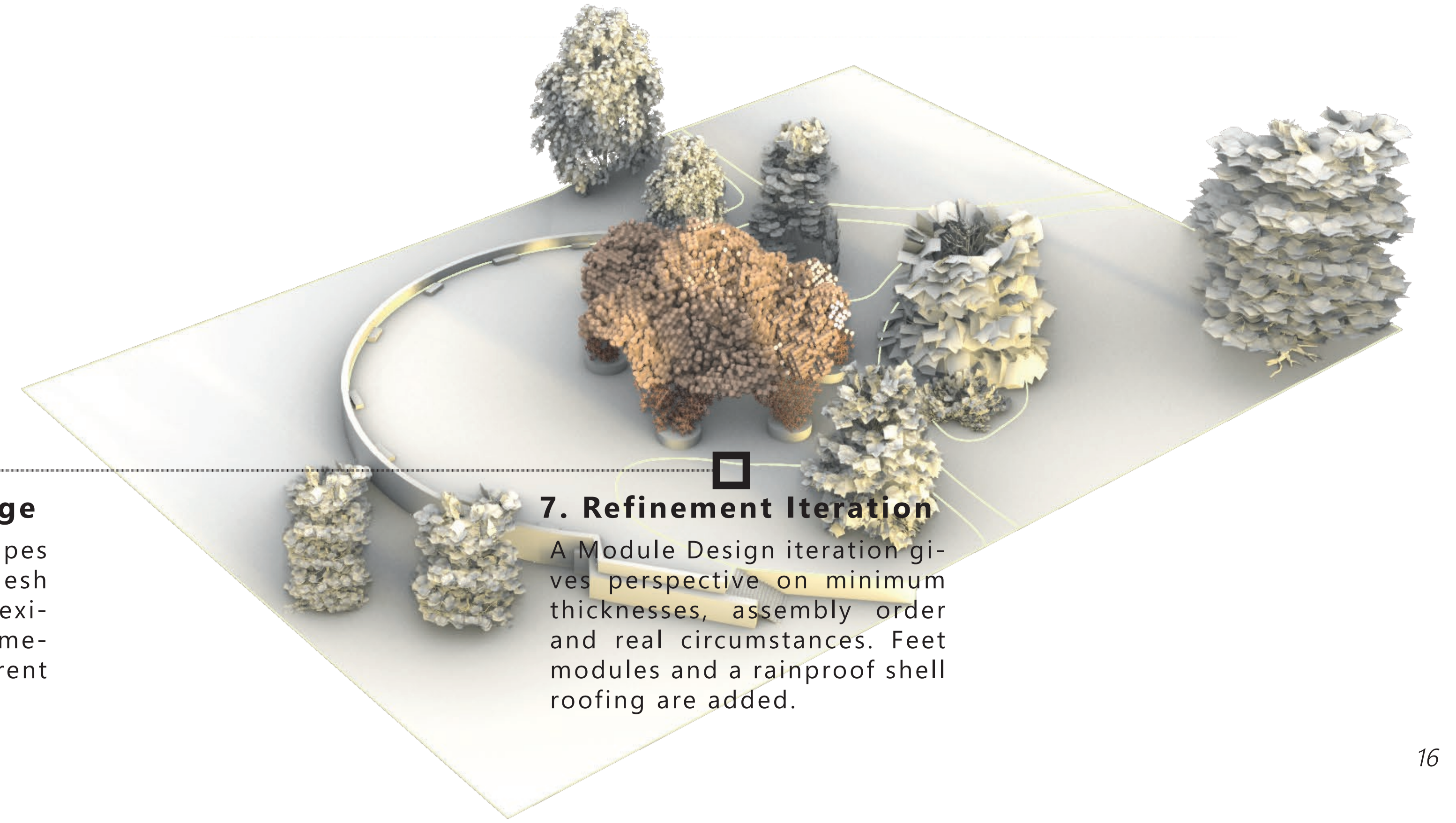
5. Field-Driven Aggregation

Stochastic Agggregation-methods enable Module growth based on optimized topology proximity.



6. Module Design Stage

Different platonic shapes can represent different Mesh combinations and complexities. Ordered and ungeometric approches bear different possbile assembly orders.



7. Refinement Iteration

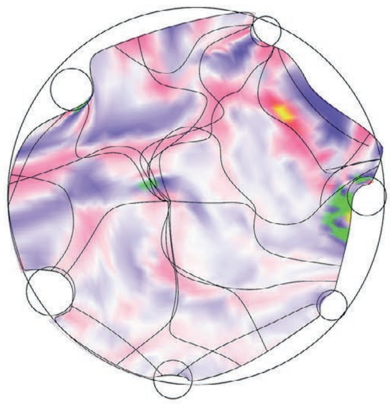
A Module Design iteration gives perspective on minimum thicknesses, assembly order and real circumstances. Feet modules and a rainproof shell roofing are added.

1. Formfinding

Employing a Physics-based formfinding, a simple mesh is manipulated according to to realistic entrance points. This ensures a regular buildup logic going forward. We can apply this to any unregular shell shape that proves durable in the following analysis.

3. FEA Analysis

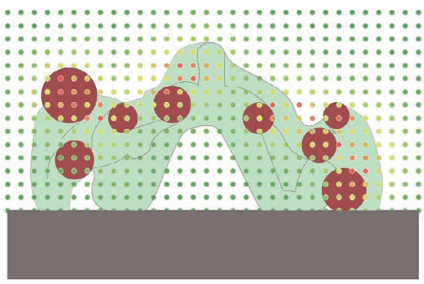
Nature optimizes material usage



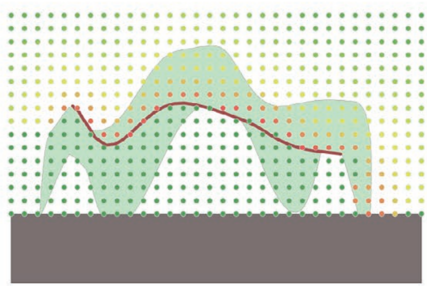
We can adapt this with our own simulated needs

According to the original idea, the force lines will serve as a path for spawning modules. The shape is analysed as a shell and put to different material constraints under gravity load. This already gives away near values for shear and compresion stresses in our final module design. Finite-Element-Analysis enables to run compression and shear Tests in the

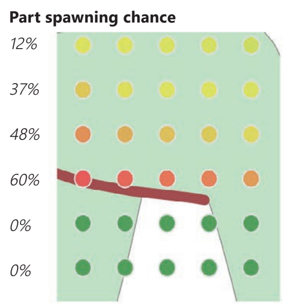
4. Topology Optimization



Section of the force-line driven field

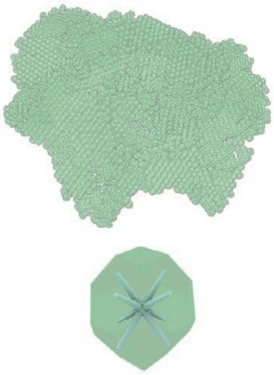


Section of the shell-based field



For the next step the Wasp aggregation algorithm is employed. a stochastic aggregation based on Chances can spawn parts with higher chances near selected geometries. To fill the structurally critical areas within the shell, the projected force lines serve as a base geometry to attract higher spawning chances near it. It is cross-multiplied with the original shell to create values of combined proximity evaluation and serves a pointgridaround a regular shell with criticla enforcements where needed and digitally assessed previously. An automatic static based formfindingis enabled.

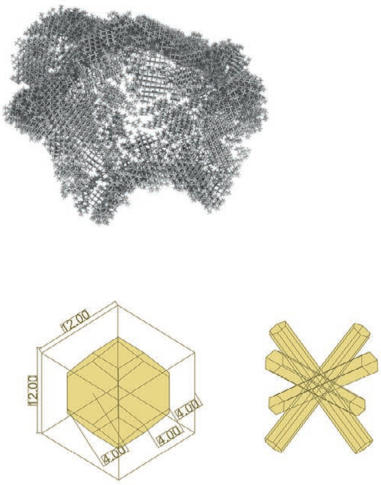
5. Field-Driven Aggregation



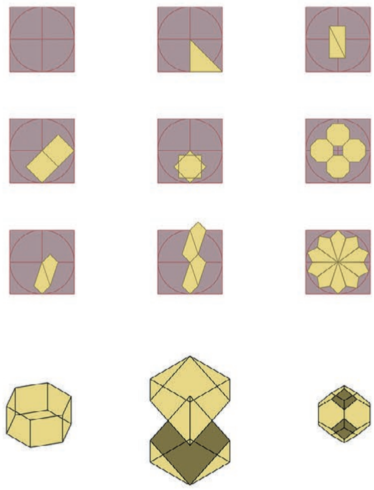
Aggregation:	**Field-Driven**
Module:	**Dodecahedronal**
Part number:	**7288**
Num:	**246-C**

The spawning alorithm takes the previously optimized spawning values from the field. It works from a part based logic, with connections and directions for them. Rules can enable connections and this design utilized the platonic shape theory. Complex platonic shapes are widely used in space and engineering research for high functional combinations and high structural durability.

6. Module Design Stage



The Dodecahedronal shape provides good fill options with filigrane modules

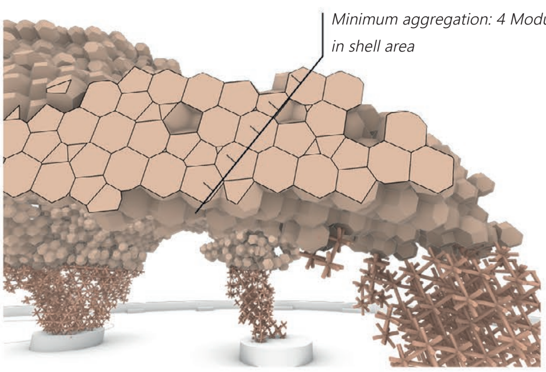


The shape design needs to consider complex connection lines. exemplaric shape approaches and their filling logic

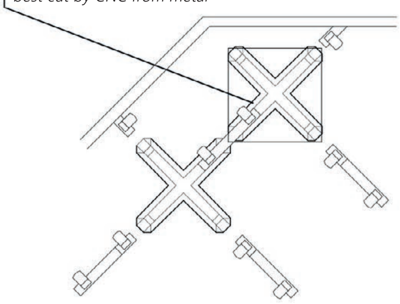
Different platonic shapes can represent different Mesh combinations and complexities. Ordered and ungeometric approches bear different possbile assembly orders. This experiment tried to have different platonic shaopes presented in the assembled aggregation. The real-world implications differ greatly and for further steps constant iteraiton back to aggreagtion shapes must be considered.

7. Refinement Iteration

Minimum aggregation: 4 Modules in stress-middle, 2 in shell area



Clicking screwless approach saves assembly time and is best cut by CNC from metal



A Module Design iteration gives perspective on minimum thicknesses, assembly order and real circumstances. Feet modules are added and a two-material path is chosen. Solid blocks from leftover wood and a metal clicking mechanism is perfect to later deconstruct and rebuild the structure.

Perspective