

# COMPUTATIONAL STRATEGY AT THE MACRO-SCALE

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## Abstract

*This research is an experimentation on computation as a multi-performance, optimisation-oriented process and concurrently as a form-finding technique. It aims at integrating social and environmental aspects at the building and urban level.*

## Introduction

This research lays the foundations on the overall theme of the project, focusing on users and user experiences as a driver. On the macro scale this meant that environmental and social aspects, emerged from the interviews carried out with students, were selected as parameters for the script. These include specifications on views and sunlight. Social behaviours, for instance interaction at bigger scales, were also taken into consideration, in the shape of collective and congregation spaces. Thirdly, the idea of architecture as a landscape was introduced specifically for this scale. Firstly, it envisions the creation of paths through a sort of sloped park in which units are scattered around, both for inhabitants and other users. In this way, the project challenges the traditional idea of architecture by offering accessibility to all users and avoiding the creation of a barrier. Secondly, it was envisaged as a porous system in which light could penetrate and reach almost every unit.

Architecture as an ecology that involves dynamic and varied relations between macro- and micro-environments conditions and individual and collective inhabitation was also described by Michael Hensel. Nature inspires this outlook, as he views it as a multifunctional integration across several scales. He eventually recognises that this approach would require a retooling for architects regarding methods and techniques and their relation and phasing within the design process (Hensel and Menges, 2006).

While Hensel sometimes seems to focus more on materials, this research aims at applying these principles on a macro scale and it intends to create a design process in which different scales are combined.

The framework of this research is also based on techniques of self-organisation and in particular those inspired by Artificial Neural Networks. What is particularly interesting of these learning systems is the lack of a hierarchical process and their denial of the existence of a unique linear path to an optimum solution. Yet, this does not indicate the lack of parametric constraints (Derix and Jagannath, 2014). The idea was that, by implementing certain rules, the script would create an array of possible patterns and solutions all of whom would still fit the intended architectural results. It would then be up to the designer to analyse more in depth further spatial qualities, inaccessible to computation.

## Starting point

The model at the basis of the script is composed by living units, that are grouped by three and interact with each other by means of a moving wall. Each unit presents a core, with all the furniture, and its centre hosts the main structural support. The side opposite to the entrance of each unit is the most private and where the wall experiences the least bending. For this reason it was deemed to be the most appropriate location for openings. In terms of circulation, it would take place through the centre of the compounds, with paths moving on the sides only when multiple units are joined together.

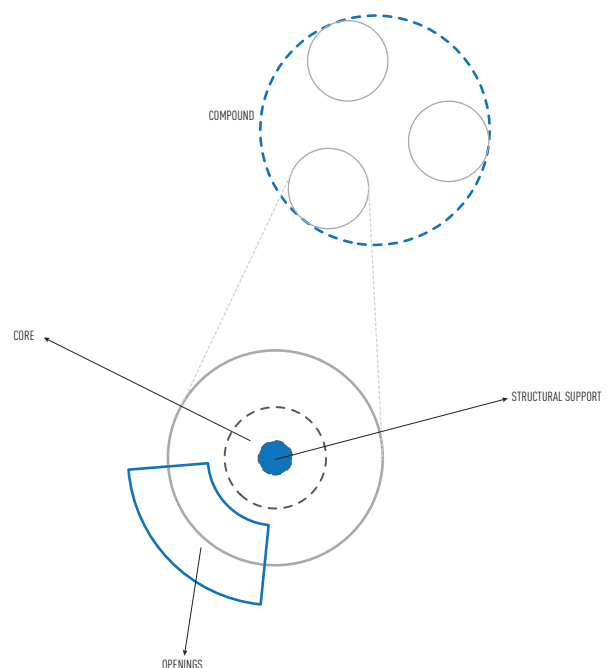


Figure 1: Schematic representation of project concept

## Research - Manual Form-Finding

A first form-finding process (Figure2) was conducted manually by stacking the compound into different configurations while fulfilling the parameters of sunlight and privacy. Circulation was left to be analysed only afterwards. These models were not intended as optimisations with a final unique solution, but rather to create a set of possible configurations with different spatial qualities.

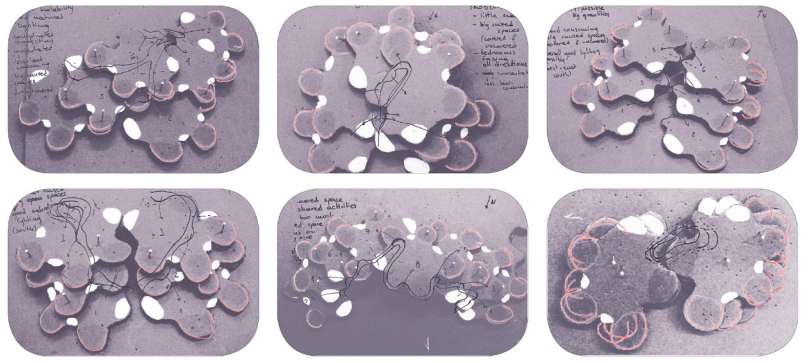


Figure2: Manual Form-Finding

## Research - Test I

The first computational test (Figure3) was an exploration into a multi-criteria optimisation and form-finding with a focus on porosity. The aim was to guarantee that each of the units was given enough sunlight and not overshadowed by those above with sunlight optimisation.

The second parameter that was introduced was a basic structural analysis. By using the principle of the centre of the core as the main support structure, the aim was to minimise their distance and the angle of the forces.

These two parameters were optimised simultaneously with Octopus, rather than by means of iterations.

This first experimentation was quite limited in terms of form-finding process because of oversimplification of the starting point and the lack of circulation parameters. For this reason in the subsequent experimentation Kangaroo Physics was used to achieve a better form-finding solution and circulation paths introduced.

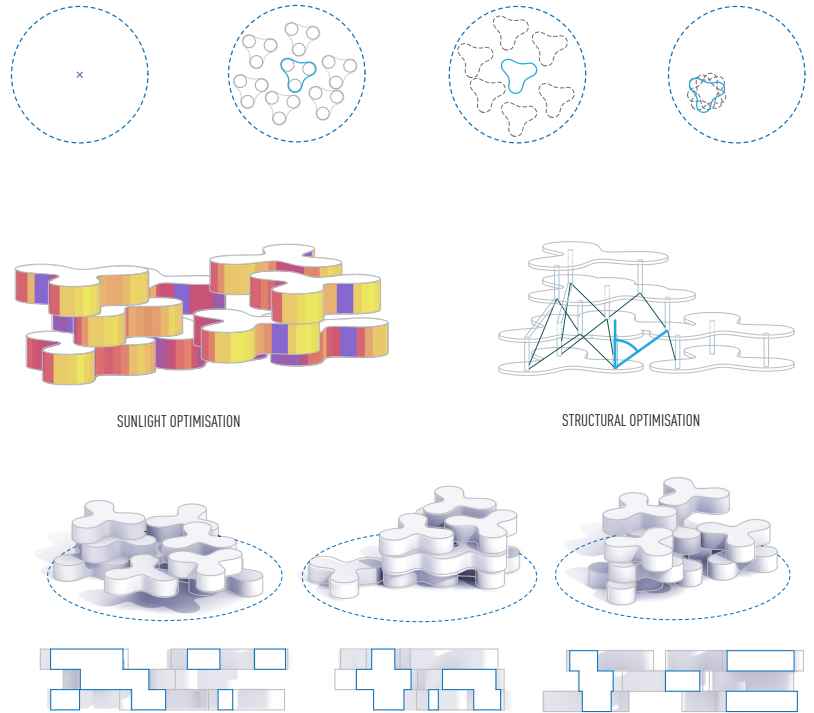


Figure3: Movements allowed for form-finding (first row from top), parameters for optimisation (second row), Results examples with sections (third row)

## Research - Test 2

The second computational investigation integrated more parameters from the interviews into the script and created a more precise model, while maintaining the positive results of porosity found in the previous one.

From the interviews, an uneasy relation with a particular dutch housing model emerged, specifically the one with an external running balcony that connects each apartment. Very often, bedrooms and student rooms face this public corridor, too, and are prevented from having the desired privacy. The project then focuses on views (Figure4a) and intends to shield the rooms from both the passageways and other units' windows.

The script creates floor slabs (Figure4b), which join different compounds together while respecting the principle of views. The aim was to create different socialisation and activity opportunities between compounds and not only units.

As in the previous script, a parameter here implemented is the maximisation of sunlight (Figure4c), an obvious desire for the residents.

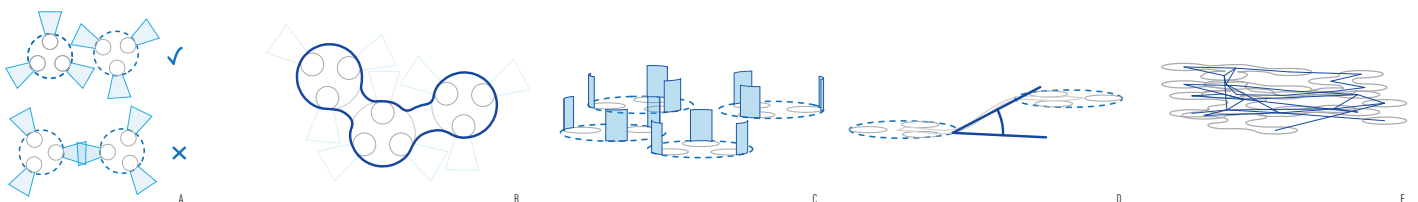


Figure4: Parameters used in the script: views and privacy (A), floor joining (B), sunlight maximisation (C), ramps slope (D), shortest walk (E)

Circulation was another theme that was explored and introduced in the computational strategy. The aim was to connect the building, already made porous by the above-mentioned passages, and allow accessibility to this landscape building to external users as well. This would be accomplished by means of ramps, which were divided into private, intended for the residents, and public. The ramps connect directly a floor slab to the closest ones. Two parameters were considered, their slope (Figure 4d) and the creation of the shortest path possible (Figure 4e) from each unit to the entrances at the ground floor. Moreover, they are continuous so that they do not become just mere corridors but a way of experiencing the space.

While some rules have been implemented in order to create the different paths, a more advanced way of creating them would be by using agent-based design processes, as for instance previously explored at TU Delft (Mostafavi, Yu and Bioria, 2014). The drawback of this approach could be the need of a hierarchy in the design process, meaning that agent-based simulation would be the first step and the other parameters would follow. Yet, this could offer new possibilities not explored by the current script.

Eventually, compared to the first script, structure was not implemented, which anyway remains a fundamental part of the architectural process.

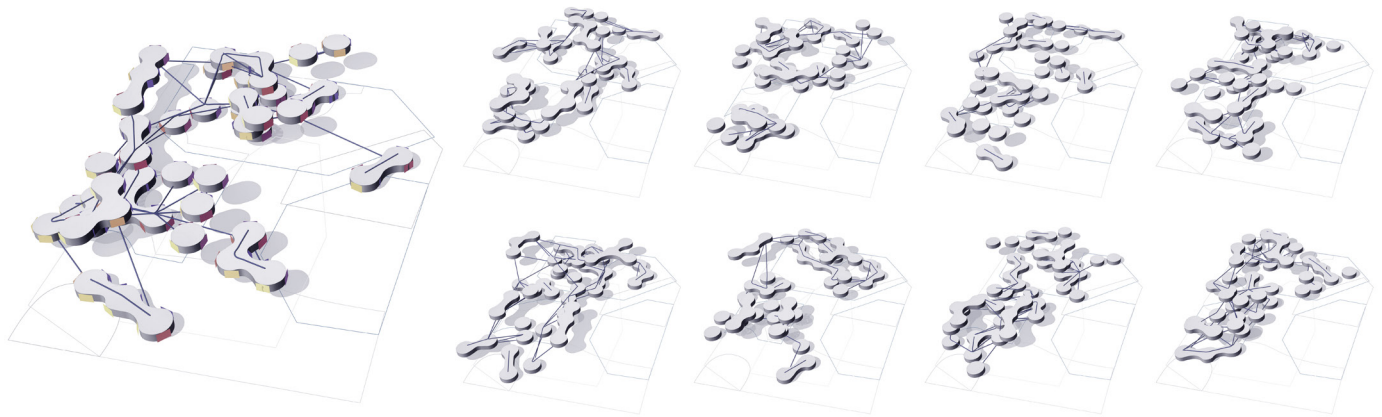


Figure5: Possible configurations resulting from the script

## Conclusions

The research was an experiment in the framework of computation at the macro-scale, multi-parameter integration and self organisation for form finding. Specifically, it tries to find a balance between computational and human intelligence by following a non-hierarchical process so that to leave enough space to the designer for better considering spatial qualities inaccessible to computation. The lack of hierarchy also guaranteed that multiple criterias could be integrated simultaneously.

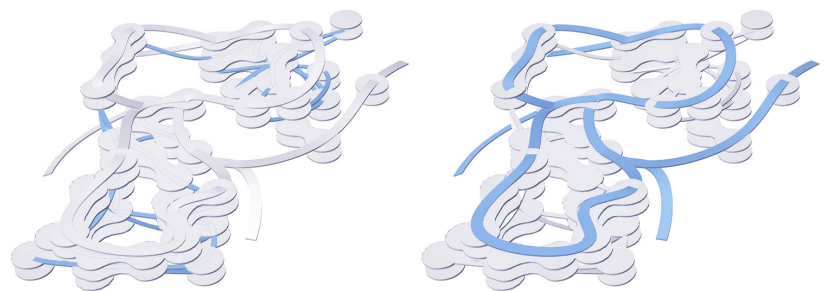


Figure6: Example of paths with the separation into private (left) and private (right)

## References

Hensel and Menges, 2006. Differentiation and performance: multi-performance architectures and modulated environments. *Architectural Design AD*, 76 (3), pp.60-69

Derix and Jagannath, 2014. Near Futures: Associative Archetypes. *Architectural Design AD*, 84 (5), pp. 130-135

Mostafavi, Yu and Bioria, 2014. "Multi-scalar agent-based complex design systems - the