Reflection WindScape

A Computational Route Architectural over a Wind-simulated sculpture, that shows TU Delft most prestigious projects.

Institute:

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Abstract

The Technical University Delft has great ambitions for the future. Becoming a well-known university in the world is one of them. Therefore the TU Delft should reconsider the impression that they carry out of the TU Delft Campus. My site is located in the center of the campus, where the 80-meter-high faculty of EWI (electronics, math and Informatics) is generating a standing vortex (wind that is pushed down) on pedestrian level that forces people to step off there bikes and conquer the wind. At this location WindScape will guide the wind away over the pedestrians and use the wind as an energy source. The building contains study cells and an exhibition route, that shows the highlights and prestigious projects of the Technical University of Delft. The continuous character of the building refers to the continuous wind flows that has been the starting point of my design. A CFD-simulation (generating a protective windsulpture), several Pythonscripts (programme placement and route generation) and grasshopper (final skin components and construction) have been used to generate WindScape.

Introduction

The wind that blows rapidly around the EWI-faculty of the TU Delft has caused accidents in the past and is still a problematic point in center of the TU Delft Campus. It was evident to me that something needs to be done at this location, because it is vastly used by pedestrians and cyclists and tram users will step out at the most anoying point off the TU Delft-campus when the wind blows from south-west.

![fig.1 Cyclist blown away at site](https://www.youtube.com/watch?v=U6QtxJNhioG)

In relation to the TU Delft ambition of becoming a high-level university something need s to be done at the image of the campus as well. The executive board of the TU Delft addresses that the faculties should leave their own ´castle´, so there will be more interaction between the buildings. Also a research institute of the TU Delft, FlowMotion, says that the buildings are reflecting the way of thinking in the sixties: Big solitaire buildings that do not play a role in public space. With WindScape I try to connect the EWI building (especially the restaurant on the first floor) with the mekelpark, so EWI starts playing a role in the public realm.
**Methodology**

**fig. 2** Overview of processes in WindScape project

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**Windprofile simulation**

Several Computational Fluid Dynamic (CFD)-simulations have been run to generate Windprofiles of the building site. The surfaces that were generated in grasshopper by analyzing data from CFD, is pointing out where in space a certain wind speed occurs. The chosen profile (fig. 3) is a surface that is showing where in space a wind speed of 14 m/s occurs. Close to the adjacent building, EWI, the profile tends to go down. This is because of the standing vortex that's pushing wind downwards around the EWI-Building (fig. 4). This profile has been chosen because it can be used as a windscreen that is guiding wind over the current problematic wind zones.

![Windprofile simulation](image)

*Fig.3* Windprofile that guides wind upward

*Fig.4* Diagram of problematic wind
Function placement

After analyzing all activities that an exhibition and study cells contain I concluded that 8 different types of appearances existed in my project. The criteria for subdividing the activities into cells were: sunlight demand, ventilation demand, sound productive/sensitive and fixed position. A toilet has different properties (no sunlight demand, a ventilation demand, not sound sensitive and not sound producing and has a fixed position), while an exhibition (needs sunlight, needs ventilation, is sound productive, not sound sensitive, does not need a fixed position) has different properties. All these cells have been put into a relational system in which they attract (toilet cell to study cells) or repulse to other cells (exhibition cell to study cell) (fig 5). In this python component also height restraints, a wind analysis, sun analysis and existing programs (tram, toilet and lecture halls) are being captured. Cells that are demanding sunlight will be more attracted to areas on the surface that have a higher sunlight radiation. In a similar way cells that need ventilation, prefer to go to a area on the wind sculpture that has a high average wind speed. The existing programme of the EWI-building has also been used to inform my program placement. My building can for example use the toilets of the EWI-building, so my toilets should be placed further away from them.
Routing generation

An interesting part in the process of my project is the Routing Generation. After the last step, function placement, we only had nodes in space where cells are being positioned. In this step, the connections between the nodes are growing, following certain rules. In fig 7, roots are growing from the nodes until they touch another root, making a connection between the nodes. The roots have a maximum and minimum slope that stays between the range of a ramp. In this way, the building does not need stairs and becomes accessible for people in a wheelchair. This process is being repeated until all nodes have their connections reached.

Fig.7 Growing roots from function positions in order to generate routing between positions
A skin needed to be covered around the generated nodes and routes to create a building. The Dalain conference center by Coop Himmelblau was taken as a reference. Interesting in this project is that a ceiling can turn into a wall and vice versa. In my project I tried to turn walls also into floors, so they could be used as functional outdoor space (fig 8). The initial wind sculpture has been divided into segments with constructional elements so the feature of continuous curves (reflecting the motion of wind) can take place. In the bird view render, no curve ever ends on the buildings surface, leaving a spectacular view for all visitors and all people that pass the TU Delft (fig.9).
Research and design

A lot of research has been done to create an understanding of the current environment and its future planning. Some data has been found useful to my project, wind and solar research, while other data simply was not important enough to mention in the end, for example the flora and fauna conditions. In a computational and non-standard building architects should be more critical in what they research or not. Also in relation to time it's important to have an idea of what the design should be capable of doing so scripts and modeling can be written in preferable directions.

My design eventually required a subdivision in fragments, while my scripts where intended to create a more fluid 'meta-ball' shape building. Transforming it into something different then the first intention caused me to make concessions on many levels.

Graduation Lab Theme and case study

Computational and Non-standard architecture differs from modern architecture in the way it is formed and fabricated. In my case study environmental aspects, wind, sun and site, all played a role in forming my building. Also the function demands like height is being generated in a computational way, which gives every space unique spatial qualities. Even though a lot of parameters are being used, this can also lead to incontrollability, especially when parameters are conflicting. A Repulsion and Attraction-logic seams right, while it does not exclude major mistakes.

A cell can be afraid of other cells and therefore stay in a position which does not have the properties it prefers. Another logic, point-in-space, should be more reliable. Stepping away from mass-production into mass-custumisation is something standard architecture would not do. In my building every element is unique. When designing with mass-custimized shapes, an contructional thought is necessary. The steel frame solved the constructional part of my building, but was implemented in a late stage. Even though it is not a big issue, knowing this from day one could have let to more experimentation from an esthetical point of view.

Methodical line of approach and chosen method

The chosen method of the design to use computational processes in order to generate a building is in line with the hyperbody studio. The form of the building could have been more informed by the computational proces, but a segmented logic seemed hard to embed extra constraints. The use of advanced software: CFD, grasshopper, python, Geco and weaverbird was a fruitfull learning but time-consuming experience. Different (software) steps in a computational proces makes the input-output capacity of a computational proces slow and sometimes impossible. One system for informing the design stage would be enough, instead of three: wind logic, function placement and connection logic.

Relation project and wider social context

The building designed is unique in its place. A building that would recieve amazed looks when people pass by. The use of computer calculation abilities will create more and more of these buildings in the future. This building has a lot to offer to the visitors of the exhibition because of it is interesting routing. The building will insert an impuls in its environment, by attracting more children and curious people from all over the world in the center of the TU Delft Campus.