

# Reflection

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## 1 Introduction

This reflection explores the personal and academic journey I undertook during the development of my graduation thesis, Wind Driven Design. The project aimed to integrate wind behavior into early-stage architectural design decisions, particularly for a high-rise structure in the urban context of Rijnhaven. This project challenged me to step far outside my comfort zone, into the complex worlds of fluid dynamics and computational simulations. This reflection discusses my initial position, the skills I developed, the insights I gained, and how this thesis has shaped my perspective as an architectural designer.

## 2 Bridging the gap

The concept for this project was largely inspired by my experiences during an internship at RoosRos. I recall a conversation between an architect and a structural engineer in which a conflict emerged: the engineer claimed that a particular beam was structurally unfeasible and proposed relocating it. However, this adjustment would compromise the architectural vision, making it unacceptable. Neither the architect nor the engineer could find a satisfactory solution. Ultimately, the issue was resolved by a third person—someone with a technical background who worked closely with architects on a daily basis.

Situations like this are common in the architectural design process. They highlight the importance of professionals who possess enough interdisciplinary knowledge to bridge the gaps between fields—individuals who can find solutions that satisfy both technical and design requirements.

This project seeks to bridge a similar gap: between wind engineers and architects. The goal is to support architects in considering wind effects throughout the design process—without requiring them to consult a wind engineer every time a design change is made. I believe, that by doing this, it can lead to buildings that are not only better designed, but also more thoughtfully integrated.

### 3 Getting started

When I began this project, I had little idea of the technical complexity I was about to engage with. My background in architecture did not include any knowledge of fluid dynamics, and I barely knew how to code in python. I had never heard of OpenFOAM. Despite this, I was drawn to the topic. I was interested in the ways in which an architect can influence such an invisible force and how a designer can use it to the benefit of a pedestrian. I dove into the project with a healthy dose of naivety and enthusiasm, supported every step of the way by my research mentor, Clara, who patiently introduced me to the principles of simulation-based wind analysis.

The learning curve was steep. Early simulations crashed constantly, and generating a workable mesh felt like solving a riddle in an unfamiliar language. But slowly, I began to understand the process, appreciate the logic behind the tools, and found satisfaction in smaller and larger successes. Eventually, I was able to run several successful simulations that offered meaningful insights into wind behavior. That progress felt like a genuine achievement—not just academically, but personally. It showed me that with persistence and support, I could navigate technical terrain I once found inaccessible.

### 4 Personal insights

One of the most striking lessons I learned throughout this process is how unpredictable wind behavior can be. Initially, I assumed downdrafts would be the primary issue I would face, but my simulations revealed otherwise. The most significant effects occurred on the leeward side of the buildings—an area I had not expected to be so problematic. In hindsight, these results made sense, but they also underscored the limits of relying solely on intuition or even literature.

This experience taught me a critical lesson: in wind design, assumptions are dangerous. Real understanding requires testing—whether through wind tunnel experiments or CFD simulations. This realization has reshaped how I view the design process. It's not enough to trust in general principles; context-specific testing is essential to truly understand how a design will behave in the real world. This insight has made me more cautious, but also more curious and analytical in my design thinking. Furthermore, it took away my fear of calculations and simulations.

### 5 Design process

After completing the research phase, I transitioned into the design phase, using the insights from my simulations to inform my design process. Since the site and program of requirements remained consistent, I could directly integrate my findings into the design strategy. This felt like a natural progression—from research to application.

However, the integration wasn't always as straightforward as expected. Some hypotheses I had going into the design phase didn't hold up under further simulation. For instance, I had assumed that rounding off both towers would reduce wind speeds on the leeward side. While this worked for the southeast tower, it had the opposite effect on the northwest one. Surprisingly, the wind conditions actually worsened, leading me to reverse the rounding and opt for a squared-off shape instead.

This phase reminded me that even well-reasoned assumptions need to be validated. Design is an iterative process, and wind adds a layer of complexity that requires constant re-evaluation and flexibility.

## 6 Skyscrapers

As part of this project, I designed a 200-meter-tall residential tower. It was not only chosen for its dramatic wind impact but also for its relevance to the ongoing development of Rijnhaven. High-rise buildings inevitably leave a significant mark on their surroundings, which makes it crucial to reflect not just on their technical aspects, but also on their social and urban implications.

One of the key urban benefits of high-rise development is its ability to support mixed-use programming. A vibrant neighbourhood depends on a steady flow of people throughout the day, which is achieved by combining functions like housing, retail, workspaces, and public amenities. In low-density neighbourhoods, such a mix is difficult to sustain: there are too few people to support local shops, and offices typically prefer locations close to public transport—often missing in sparse urban fabrics.

High-rise, by contrast, enables higher population densities on limited land, which in turn makes multifunctionality viable. It allows us to cluster different uses vertically, creating buildings that are alive throughout the day and night. Moreover, dense neighbourhoods make investments in public transport more feasible, reducing car dependency and supporting a more sustainable urban model.

Skyscrapers often suffer from a reputation of being monolithic and disconnected from street life. However, this does not have to be the case. When designed thoughtfully, with active plinths and integration into the urban fabric, tall buildings can become social and architectural anchors. A building of such scale offers the opportunity to refer to the skyline as well as the street level, as mosques and cathedrals did in the past.

## 7 Design recommendations

Based on the findings of my thesis, I can reaffirm that architects must incorporate wind considerations in the earliest stages of the design. Waiting until the final stages to address wind issues—when the design is already fixed—often leads to inefficient and visually disruptive solutions. Starting earlier not only

improves pedestrian comfort and safety, but also preserves architectural freedom.

During this project, I explored a wide range of massing strategies to test their impact on wind behavior. This broad, comparative approach proved effective: even when the tested forms didn't align perfectly with the final design, they still offered valuable insights. By identifying general patterns and sensitivities, architects can make more informed decisions early in the process, adapting and refining their designs with greater confidence.

## 8 Future research

Due to limited computational resources and time constraints, this research was restricted to a single wind direction and one specific location—Rijnhaven in Rotterdam. However, wind conditions vary significantly depending on orientation and context. To develop a more universally applicable design approach, future research should expand to include multiple wind directions and diverse urban environments.

By broadening the scope, it would be possible to create a more comprehensive designer's guide that could be used across different sites and cities. Such a guide would empower architects to address wind issues with more confidence and precision, even without deep technical knowledge of CFD. This research could serve as a foundational step in that direction.