Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Kwan-Lin Wang
Student number	4930371

Studio		
Name / Theme	Building technology graduation studio / Climate & Energy	
Main mentor	Martin Tenpierik	Climate Design
Second mentor	Michela Turrin	Design Informatics
Argumentation of choice of the studio	Applying informatic design methods to execute climate design can greatly reduce the time and effort of analysis and optimization of energy performance of multi climate conditions.	

Graduation project	
Title of the graduation project	Building Design Approaches and Performance Under Predicted Climate Conditions
Goal	
Location:	Amsterdam, the Netherlands
The posed problem,	Since the building energy consumption is strongly related to the weather environment current building energy strategy of envelope, heating, cooling, and ventilation system would be affected by climate change. Within the context of climate change, the indoor discomfort period tends to be longer year by year (D'Agostino et al., 2021). Overheating is one of the main concerns related to the impact brings to the living environment which not only influences the comfort level but also led

	to thousands of mortalities in recent years in Europe. On the other hand, the reduce building-related carbon emissions, building performance optimization (BPO) is commonly applied to optimize indoor comfort and energy demand. However, the weather for BPO is mostly collected in the past 20 years, and the result of building performance simulation and optimization could be not accurate during the building lifespan period (Herrando et al., 2016). In performance prediction, the energy balance of building operation energy in Europe will have a great change, with the decrease of heating demand of 38% to 57% and increase of cooling demand of 99% to 380% judging by location in the future (D'Agostino et al., 2021) while most of the buildings are not designed with sufficient cooling capacity in this concern. The uncertain external environmental condition causes the misjudging of design decisions, further, the discomfort and potentially unsafe living environment. Additionally, there is not a concrete method to generate the most suitable design option concerning both current and future climate conditions yet.
research questions and	How to determine what design characteristics have the main influence on building operation energy and indoor comfort under both current and predicted future climate conditions by using computational simulation?
design assignment in which these result.	Defining the main design decisions for the case study building to have well energy performance in both current climate and

	predicted future climate conditions while ensure the indoor comfort level.

Sub questions:
What will climate conditions be within the lifespan of the building(s) we are designing and building now?
How to minimize the operation energy demand throughout building lifespan under climate change conditions?
How to optimize the comfort hours by changing the envelope component?
What design decisions and design factors have a higher influence on energ y consumption and indoor comfort?
How to evaluate the building performance through the building lifespan?
What is the methodology for simulation and optimization of the energy performance with different design decisions and for climate change conditions??

Process

Method description

This graduation project focus on the influence on our living environment and essential consideration of reaction needs to be taken with the climate change environment. the methodology is composed of two main research methods: Literature review and Simulation-based performance study.

literature review

In order to know the performance of the building, the understanding of the predicted future climate conditions is important as the first step of the literature review. Then to acquire the knowledge of generating the suitable weather data file for simulation. Following is the potential impact on the living environment with current buildings and the reference of future proof design projects.

The second part of the literature review is the comfort definition. The indoor comfort demand is stable in contrast with the outdoor environment. But the user's comfort is an elemental factor to be considered. In this chapter, there are several types of comfort to be discussed. Thermal comfort, air quality, visual, and acoustical comfort. Acoustical comfort is not the main concern, due to the focus being on the impact of climate change.

As one of the design decisions that would considerably influence indoor comfort, the envelope properties is the next chapter. In this chapter, the reference of improving indoor comfort and energy saving with the envelope design approach is shown. But insulation materials also have environmental costs and embodied carbon which should also be taken into account.

Energy for building operation is in the 2.4 chapter. Since envelope design is not able to provide a comfortable indoor space in the whole year, the energy usage for heating, cooling, lighting, and ventilation is demanded. Energy performance is a common index to evaluate the sustainability of buildings. The current energy regulations can be a proper reference for the simulated and optimization objects to follow in this study.

Last but not the least, the simulation and optimization approaches and methodology. The Simulation-based studying would be executed in Grasshopper environment. Understanding the theory of simulation and optimization could figure a method to reduce the expensive simulation and evaluation process. The review also shows the various inputs and expected outputs of simulation and optimization.

Simulation and optimization

The estimation of building performance in the future condition will be carried out in the computational environment. The goal of this research is to determine what design characteristics have a major impact in the climate change context while minimizing the building operation energy and carbon emission through the building lifespan. It is necessary to define:

Output variables:

> A set of design indexes from the design library input, energy demand, carbon emission, and comfort condition during the period of building lifespan.

Input parameters:

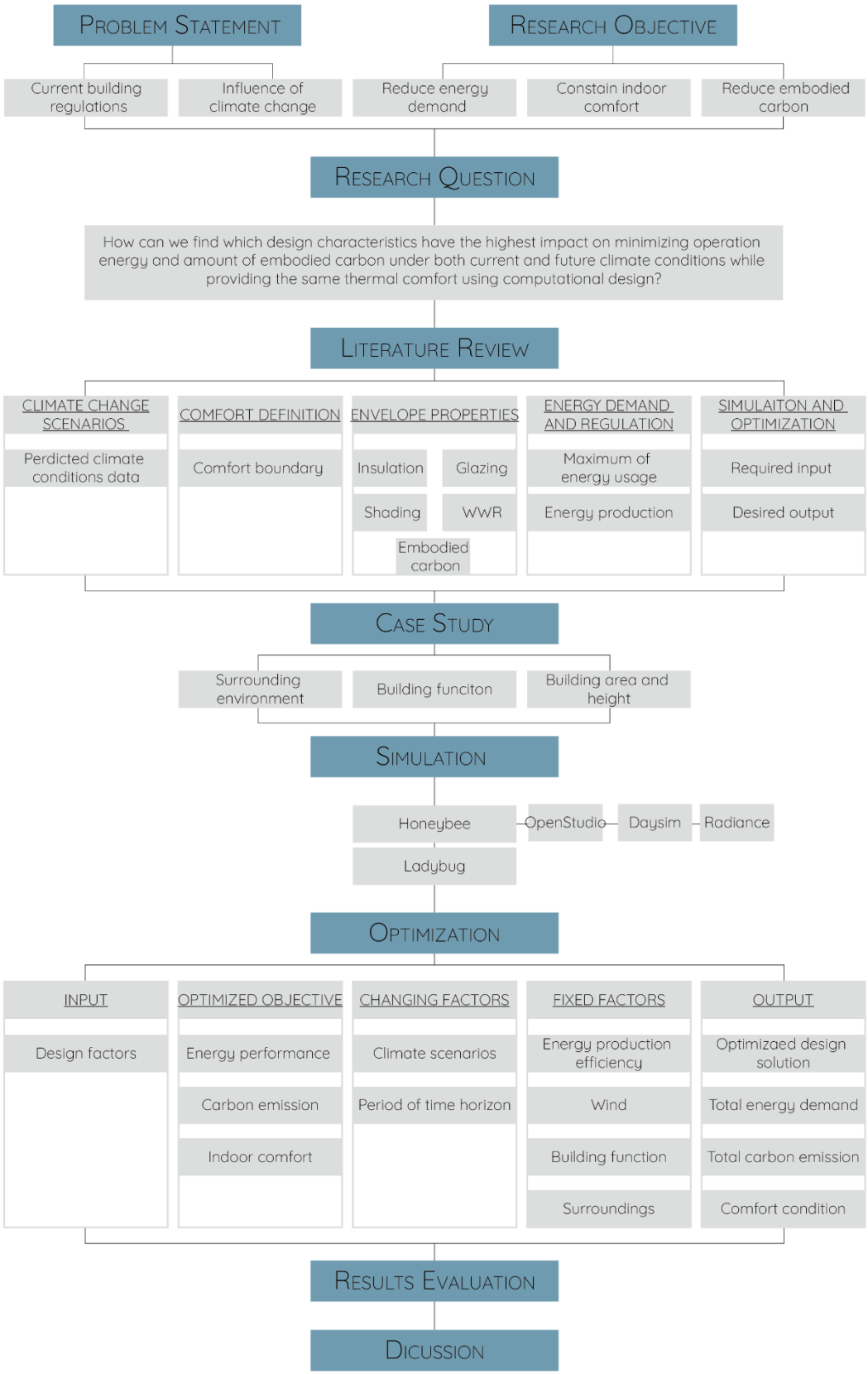
> The variety of climate conditions hourly files is the main changing input with the design factors library and the fixed factors, like building function and building area.

Since the focus of this study is on the impact of climate change on building performance study, only the factors with direct influence would be taken into consideration. The research method is applied to a case study object which provides building function, area, height, and location and these factors will be used as constant input in the simulation. To determine the sensitivity of different design factors, the local sensitivity analysis evaluates the output with only one input is changing and others remaining constant. By this method, the design factors with greater

influence on the building performance can be selected and used as the changing input in the optimization.

The optimization objective would be energy efficiency and indoor comfort, with the desired output as design options based on variant climate scenarios and time periods.

The last part is analyzing and discussing all the optimal results of the design variables. The optimization results are generated based on different climate scenarios, different considerations of various priorities of the period of building lifespan, and renovation possibility. Furthermore, the difference of design approach and the related energy and environment coast under the consideration with and without the changing weather environment.



Literature and general practical preference

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Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

My master track is building technology. Building technology aim to improve building performance or construction method by integrating architecture design thought with engineering knowledge. To achieve sustainable architecture design, energy efficiency and carbon emission are the main features to evaluate building performance. Under the influence of climate change, architects and engineers need recognized that building performance and thermal performance through out the building lifespan is not constant but would changing by the time. By convert building design factors into parametric model, the building performance can be simulated and analysed with informatic design methods. This thesis tend figure out the main factors which would need to be improve or renovated when facing climate change within the next 60 years.

2. What is the relevance of your graduation work in the larger social, *professional and scientific framework.*

With the impact of climate change, there is no guarantee for buildings to provide indoor comfort or low energy demand. This trend would cause greater social and environment damage with indoor overheated and higher amount of carbon emission. Before we are suffering from the warming climate situation, we must prepare our living environment to have higher tolerance of the weather changes. Combine meteorology study and building energy performance optimization method, we