

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	Sasha Virginia Rodriguez Arambatzis
Student number	4508076
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Studio		
Name / Theme	Building Technology; Sustainable graduation studio	
Main mentor	A. van den Dobbelsesteen	Chair Climate Design & Sustainability
Second mentor	T. Konstantinou	Chair Building Product Innovation
Argumentation of choice of the studio	Interested in sustainable façade design, climate design, and indoor comfort. Therefore, I chose a topic within these areas of expertise, where I also want to learn how to design using cutting edge interactive/adaptive technologies.	

Graduation project	
Title of the graduation project	Office user oriented façade design
Goal	
Location:	The Netherlands
The posed problem	The aim of this research is the designing of an interactive/adaptive office façade which adapts according to user satisfaction factors and to outdoor conditions, in order to increase work productivity, while also being as energy efficient as possible in order for the façade to help the building become nearly energy neutral.
research questions and sub-questions	<p>Main question: <i>“How can an interactive/adaptive office building façade element be designed to optimally satisfy its users in order to increase work productivity and to support nearly energy neutrality of office buildings?”</i></p> <p>Sub-questions: <i>User satisfaction – “How does employees’ surroundings affect office users work productivity, which are the user satisfaction factors that can affect work productivity, and what are the comfortable limit values of these factors?”</i></p> <ol style="list-style-type: none"> 1. What is the impact of the employees’ surroundings on their work productivity? 2. Which factors affect users’ satisfaction and therefore work productivity? 3. What are the comfortable limit values for user satisfaction?

	<p><i>Façade design – “How to design a façade, what are passive and active design measures, and how and which of the users satisfaction factors can be implemented into façade design?”</i></p> <ol style="list-style-type: none"> 4. How to design a façade according to The New Stepped Strategy? 5. What are passive and active design measures? 6. Which of the factors that affect user satisfaction can be implemented into façade design and how can this be done? <p><i>Interactive/adaptive technologies – “Which existing cutting edge interactive/adaptive projects and technologies (passive and active) are of relevance for this research and how can these technologies be integrated into a façade, along with the user satisfaction factors?”</i></p> <ol style="list-style-type: none"> 7. What are the existing cutting edge passive and active façade technologies and what are their challenges and potentials? 8. How to integrate users satisfaction factors into a façade along with passive and active technologies? <p><i>Energy – “How can an energy efficient façade be designed, taking into account the relationship and dependency between façade and energy, and how can a façade help a building achieve nearly energy neutrality?”</i></p> <ol style="list-style-type: none"> 9. How to design an energy efficient office façade? 10. How can a façade support the energy neutrality of office buildings? <p><i>Design, validation, and evaluation – “Which criteria fits for the purpose of this research, how to have multiple façade designs which influence the facades’ performance and user comfort, and which of the design configurations is the most suitable to be further developed in this research?”</i></p> <ol style="list-style-type: none"> 11. What is the most relevant criteria for the design in order for the façade to function properly? 12. How do different design configurations influence the performance of the facade and the comfort of the office users? 13. Which design configuration meets up with the user satisfaction limit values, preferences, and does it help support nearly energy neutrality?
<p>design assignment in which these result.</p>	<p>The development of an office façade element, for a pre-selected case study (Applied Physics Building within the TU Delft Campus), which is designed in order to suffice office users’ needs of comfort and outdoor conditions for the increase of work productivity and to support nearly energy neutrality of office buildings.</p>

Process

Method description

The research methodology consists of four research phases.

Phase I – literature study

In phase I, the necessary literature will be assessed in order to gain sufficient knowledge on the relevant subjects, to analyze them sufficiently in order to have a good understanding of these. These subjects are factors that affect user satisfaction and work productivity, indoor comfort limit values, the implementation of these factors into a façade, façade design according to the new stepped strategy, existing cutting edge passive and active technologies for the identification of their challenges and potentials, the implementation of user satisfaction factors into these technologies, and understanding the relationship and dependency between façade and energy and analyzing implementation methods for the realization of an energy efficient façade. These questions are addressed by scientific literature research, simulations, case study, interviews/surveys, prototypes/models and necessary drawings and visualizations.

Databases

The databases that are going to be used for searching scientific literature are for example, Google Scholar, ResearchGate, Scopus, and ScienceDirect. These last two have peer-reviewed literature to ensure the quality of the obtained information. Google Scholar and ResearchGate on the other hand refer more to scientific papers, articles, and books from different Universities, countries, and continents. Therefore, their quality can be also guaranteed. Sources from Government agencies, such as regulations, will also be used. The literature is organized by the structure of the research and therefore to the sequence of the sub-questions. Researches from 2000 and onwards were only selected. Literature before this time will only be used if it is considered to be the founding literature of a subject.

Phase II – research through design

In phase II, based on the outcomes of the literature study, a design criteria will be determined. The façade element will be designed based on this criteria and also based on the current office façade grid of the Applied Physics building (case study) located on the TU Delfts' Campus. Multiple concepts will be designed and assessed by doing computational simulations of these concepts in order to identify how the façades perform theoretically, to see if they meet up with the user satisfaction limit values, and to check if it helps support nearly energy neutrality. The design configurations will be assessed against advantages and disadvantages and ultimately the best design will be chosen and will be optimized in order for it to be validated. The design will start in a linear process in the beginning and then an iterative process will take place, which is always going back to the main question and criteria to check if the problem is being solved by the proposed design.

Phase III – validation

In phase III, the chosen façade will be validated through the implementation of the design into a case study, which is the office façade renovation of the Applied Physics building on the Campus of the Technical University of Delft (TU Delft), the Echo building. With visualizations of the designed façade into the case study, interviews will be held with the current office users of the building where they will indicate their preferences. Furthermore, the necessary calculations will be performed in order to assess if the designed façade is structurally stable and if it sufficiently supports the nearly energy neutrality of the building.

Phase IV – finalization

In phase IV, after having optimized the façade design according to the validation results, different illustrations will be made in different angles and positions and also prototypes or scaled models will be built in order to show how the facade could look like. Drawings, such as plans and elevations, will be drawn. Ultimately, different details of the façade will be made along with 3D designs. In this way the design of the office-user oriented façade will be performed. Figure 1 shows the research approach in a scheme.

Vision

Phase I

Literature study

User satisfaction

Facade

Adaptive technologies

Energy

Work productivity

New stepped strategy

Passive

Energy production in facade

Factors

Integration of factors and facade

Active

Implementation methods

Limit values

Facade & energy

Biomimicry

Regulations

Integration of factors into technologies

Climate

Criteria

Phase II

Research through design

Design concepts

Simulations

Criteria

Concept 1

Design Builder

Preliminary design

Case study

Concept 2

Design Builder

Advantages & disadvantages

Optimizations

Concept 3

Design Builder

Phase III

Validation

Implementation

Calculations

Case study

Structural

Interview office users case study

Energy

Optimizations

Phase IV

Finalization

Prototype or models

Illustrations

Drawings

Final design
Office-user oriented facade design

1:1 facade detail

Visualizations

Plans

Scaled models

3D-Design

Elevations

Details

Literature and general practical preference

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Reflection Relevance

Societal relevance

The development of an office façade element which adapts according to user's needs, which consists of their comfort and health, will ultimately increase work productivity of office employees. Therefore the development of such a façade has not only social relevance, but also an environmental and an economic relevance. Health issues, such as stress and anxiety, can be then avoided. Besides health benefits, there is also an economical benefit in the development of such façade, not only because it lowers health costs, but also because satisfied employees will miss work less than usual and also could take less than usual to finish the tasks assigned. When a façade automatically adapts according to office users and their behavior, also less energy is being consumed ultimately lowering energy costs.

Scientific relevance

The scientific relevance of this research is that it highlights topics that are not very well know yet and that it shows how an interactive/adaptive energy efficient façade could be designed which also takes office users' satisfaction factors into account. This research takes into account results from previous researches and studies in the field of climate design, indoor comfort, façade design, building product innovation, sustainability, and renovation.