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	Eleni Chatzi Nestoros
Student number	5854067

Studio		
Name / Theme	Building Technology Graduation Studio / Façade and products design – Outdoor environmental quality	
Main mentor	Alessandra Luna Navarro	Façade and products design
Second mentor	Michela Turrin	Computational Design
Argumentation of choice of the studio	My academic experience has been marked by a diverse range of courses, including facade design, climate design, and computational design. During my last course, I realized my interest also in user-centered and socially impactful solutions, prompting my desire to integrate these skills in a graduation studio. I am particularly interested in a multidisciplinary approach that combines qualitative and quantitative research methods, focusing on providing facade solutions to enhance outdoor thermal comfort in urban environments. Given the growing challenges of urbanization, particularly overheating in Mediterranean countries like Italy, I am eager to contribute to transformative measures and leverage my expertise to address comfort issues at an urban scale.	

Graduation project	
Title of the graduation project	A multi-disciplinary approach to assessing the influence of facade on outdoor thermal comfort: A case study of Milan.
Goal	
Location:	Acquabella district, Milan, Italy
The posed problem,	Intensive urbanization has led to a phenomenon known as the Urban Heat Island Effect (UHI), where cities demonstrate higher temperatures than rural areas. Urban morphology,

	particularly the three-dimensional form of buildings and spaces, contributes to the phenomenon of overheating. Milan, being a metropolitan city, faces high temperatures and low outdoor thermal comfort mostly due to its compact urban tissues, which prevail over other characteristics of the city. This is linked directly to material properties, including low albedo, poor thermal conductivity, high emissivity, and other factors related to the urban fabric like vegetation degradation. More specifically, the influence of building facades on outdoor thermal comfort has been investigated in the latest years, considering facade geometry, materiality, greenery, orientation, and adaptability. While existing studies offer valuable insights through simulations for assessing Outdoor Thermal Comfort (OTC), they primarily approach the issue computationally, lacking integration of objective monitoring, and user data (subjective). This prevents a thorough examination of the microclimatic and personal parameters that are affected by building facades. The multi-domain influence of facades emphasizes the need to include users in assessments beyond simulations, highlighting a lack of empirical methods associated with facade impact. This gap, compounded by limited literature on participatory approaches, such as workshops and interviews, prevents effective assessment of outdoor thermal comfort and other environmental quality domains.
research questions and	Research Question: How can a multi-domain approach be implemented to assess the influence of facades on outdoor thermal comfort?

	Sub-questions: 1. What are the tools, workflows, and current methods to measure OTC? 2. What is outdoor thermal comfort and how is it affected by the built environment? 3. How does facade influence urban inhabitants' satisfaction levels? 4. How can empirical and computational methods be combined to assess Outdoor Thermal Comfort (OTC)? 5. To what extent can the perceptual aesthetics of facades influence pedestrians' perception of the thermal environment? Design Question: What facade design solutions can be used to effectively mitigate overheating and improve outdoor thermal comfort for pedestrians in Acquabella district?
design assignment in which these result.	The purpose of this study is to close the knowledge gaps mentioned in the previous section. Considering these gaps, the following research goals have been formulated. Research objectives: 1) To study the role of objective and subjective elements in defining comfort and the influence of facade in Acquabella district, Milan. This part of the research will include investigating the ways to evaluate thermal comfort, the methods to combine subjective thermal sensation and objective thermal perception, and the limitations and conditions that comfort should be assessed in this specific district of Milan.

	2) To design a workflow, following a systematic empirical investigation, that applies qualitative and quantitative research methods in defining and assessing comfort. This workflow incorporates a statistical analysis of the user responses that will first be used to develop profiles and provide input user data for the simulations. In the second phase, the results of the simulations will be validated with onsite monitoring campaigns, testing the accuracy of the workflow. 3)To provide measures for facade design that could be implemented to achieve better levels of pedestrians' thermal comfort without compromising the aesthetic and architectural integrity of the Acquabella district.

Process

Method description

The study will be conducted in three phases:

The first phase will include the conduction of research on the definition and methods of Outdoor thermal comfort (OTC) evaluation. This includes an examination of the thermal indices, and understanding the occasions for their application, by also considering the environmental and personal parameters that are crucial for assessing the thermal perception of pedestrians. Also, the research involves the computational tools and existing method combinations for OTC. This part of the research will also include an analysis of the impact of facades on outdoor environmental quality, examining thermal comfort and visual comfort with a focus on perceptual aesthetics. Finally, the research aims to correlate the impact of facade on OTC to the subjective thermal sensations of pedestrians. In the same phase, an investigation will be conducted on Milan’s urban fabric regulations, alongside the collection of climate and geometric data of the study area.

In the second phase, the design of the workflow will be presented. The use of only computational methods towards a holistic OTC assessment has proven incomplete and inaccurate. Therefore, within this workflow, the integration of both user preferences and computer simulations is proposed, incorporating qualitative and

quantitative data as design inputs. This integration will include simulations, a participatory workshop, online surveys, and the formulation of a portable sensor system for field measurements. Firstly, a participatory workshop will be conducted in collaboration with the Cista social district, and the community members of Acquabella district. The objective is to identify the most thermally uncomfortable areas of the district, allowing focused analysis. Following the workshop, the long-term survey will be distributed to a larger sample. The survey includes questions for the general satisfaction of the people towards the built environment of Acquabella and asks for an evaluation of the district in terms of outdoor environmental quality. The second survey will be distributed in the district during the monitoring campaigns, collecting information on personal characteristics and individual thermal perceptions. This data will be used to create user profiles for a more comprehensive assessment later on. Ultimately, a model will be developed, incorporating climate data, urban morphology, facade materials at points of interest, and vegetation percentages. This model will extract simulations running throughout the entire procedure, informed by user-generated data.

The objective of the third and final step is to provide the inhabitants of the district with practical solutions to enhance the comfort and attractiveness of the district's weak spots. This phase aims to form an understanding of the factors influencing the thermal sensation of the district as well as identify the properties of the built environment that are worsening the issue. This analysis will help formulate feasible options, such as changing the wall color, altering the outer layer of a building's facade, modifying pavement tiles, or increasing greenery. The suggested measures offer decision-makers the freedom to allocate the weights depending on the desired goals. The plans will, also, need to accommodate the limitations and the region's architectural barriers, resulting in a coherent and more visually appealing neighborhood.

Literature and general practical references

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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 research " A multi-disciplinary approach to assessing the influence of facade on outdoor thermal comfort: A case study of Milan." is a multidisciplinary approach that aligns with the AUBS program's broad objectives. The MSc track "Building Technology" giving a particular focus on the technical elements of architecture, allowed me to integrate climate, computational, and facade design in the graduation project. The investigation of the facade's impact on outdoor environmental quality and the assessment of heat mitigation strategies fall under the umbrella of facade products and design. The study also emphasizes outdoor environmental quality—especially the growing concern of outdoor thermal comfort—closely aligning with the scopes of climate design. Computational design serves as the methodology for data extraction and analysis, but also in the formation of a workflow that supports data-driven and climate-responsive design solutions.

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

This research has the potential to contribute to the field of urban climate design by addressing the increasing importance of outdoor thermal comfort as a current issue. The study focuses on improving the outdoor thermal quality of a specific district of Milan, and therefore has a significant impact in offering feasible solutions to this community, regarding the built environment and the building envelopes . Stakeholders and community members will gain information, understand the possible implications, and be able to weigh the different design options. By incorporating personal preferences through a user-oriented approach, the workflow guarantees that the design solutions are not only effective but also consistent with users' needs and desires.

The integration of computational design not only improves methodological aspects but also sets a precedent for future practices, emphasizing the importance of addressing user issues in a comprehensive and personalized manner. The workflow created as part of this study may enable broader implementation, through the introduction of innovative methodologies aligned with current trends in data-driven design solutions.

Overall, the relevance of my final project lies in its potential to foster a multi-domain mixed methods approach to shaping discourses on comfortable user-centered urban planning practices.