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	Roelof Jan Kooistra
Student number	5076773

Studio		
Name / Theme	Building Technology	
Main mentor	Atze Boerstra	Building Services Innovation
Second mentor	Alessandra Luna Navarro	Façade Design and Engineering
Argumentation of choice of the studio	I have chosen this studio because I believe that the built environment should revolve around the health of its users, placing the user at the center through a combination of technical and design solutions. I am also convinced that we can fulfill comfort requirements more efficiently in terms of energy. It's not just about engineering or design, but about the art of technology.	

Graduation project	
Title of the graduation project	**Interactive Breezemaker** *Individual control over elevated airspeeds in open-plan offices in a temperate maritime climate during the summer to enhance thermal comfort*
Goal	
Location	Open-plan offices in temperate maritime climates.
The Posed Problem	Design an effective method for creating increased airspeeds and air distribution that is individually controllable in open-plan offices in a temperate maritime climate, integrated as a construction product, contributing collectively to the creation of a comfortable thermal environment in an energy-efficient manner.

Mainquestion	- How can we effectively provide personalized air velocity for occupants in open-plan offices during summer?
Subquestions (literature)	- What is the effect of increased airflow on an individual's thermal comfort, considering parameters such as metabolic rate, radiant temperature, air temperature, and humidity levels? - What is the effect of personal control on applications providing elevated airspeed? - What are the advantages and disadvantages of various applications that enhance airflow to promote thermal comfort?
Subquestions (design)	- How can we effectively integrate a breezemaker application integrated in open-plan offices? - How does the individual use of increased airflow impact the thermal comfort of other users in the space?
Design assignment in which these result	An interactive breezemaker, integrated as a building product that meets the requirements of personal control to enhance the thermal comfort of an individual during summer.

Process

Method description

Firstly, a literature review was conducted. A small part of it will be summarized after P2. Additionally, it is expected that in later research, occasional references will be made to other literature. From Q3 onwards, the focus will primarily be on designing, simulation, and testing.

First, the design concept will be conceived. These are the guidelines/design frameworks upon which further development will be based. Among other methods, the Morphological Chart method (Van Boeijen et al., 2014) will be utilized.

Next, a crucial design variable will be determined through simulation using Ladybug and Honeybee. Specifically, the determination of the Mean Radiant Temperature.

Now that all factors are known, the design process will go hand in hand with simulation. The concepts will be simulated to identify areas for optimization. CFD simulations will be employed for this purpose. The goal is to manufacture the optimal shape of the enclosure for an application that generates an airflow meeting the requirements set in the literature.

Subsequently, the initial design is developed, leading to more design variations. This involves exploring multiple designs and expanding the functionality of the concept. These variations are then presented to focus groups for evaluation, after which they are returned to the drawing board to create the final drawings.

Literature and general practical references

Hellwig, R. T. (2015). Perceived control in indoor environments: a conceptual approach. Building Research and Information, 43(3), 302–315. https://doi.org/10.1080/09613218.2015.1004150

Oh, W., & Kato, S. (2018). The effect of airspeed and wind direction on human's thermal conditions and air distribution around the body. Building and Environment, 141, 103–116. https://doi.org/10.1016/j.buildenv.2018.05.052

Van Boeijen, A., Daalhuizen, J., Zijlstra, J., & Van Der Schoor, R. (2014). Delft Design Guide: Design Strategies and Methods.

Xie, Z., Xie, Y., Cao, B., & Zhu, Y. (2023). A study of the characteristics of dynamic incoming flow directions of different airflows and their influence on wind comfort. Building and Environment, 245, 110861. https://doi.org/10.1016/j.buildenv.2023.110861

Zhai, Y., Arens, E., Elsworth, K., & Zhang, H. (2017). Selecting air speeds for cooling at sedentary and non-sedentary office activity levels. Building and Environment, 122, 247–257. https://doi.org/10.1016/j.buildenv.2017.06.027

Zhou, J., Zhang, X., Xie, J., & Liu, J. (2023b). Effects of elevated air speed on thermal comfort in hot-humid climate and the extended summer comfort zone. Energy and Buildings, 287, 112953. https://doi.org/10.1016/j.enbuild.2023.112953

Reflection

1. The topic relates to thermal comfort, which is a part of climate design, and occupant control, which aligns with an aspect of facade engineering. This is part of the Building Technology track, where you are trained to become a technically sustainable designer of the built environment
2. With more warm days and an increase in internal heat gain, there is a tendency to achieve the comfort level by lowering the air temperature. This consumes a considerable amount of energy. Another approach is to play with the airspeed, which significantly reduces energy consumption and provides individuals with the opportunity to have more control over their personal thermal comfort