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	Wei Wei
Student number	5770653

Studio		
Name / Theme	Building Technology Graduation Studio	
Main mentor	Atze Boerstra	Climate Design
Second mentor	Alessandra Luna Navarro	Façade and Product Design
Argumentation of choice of the studio	High-tech and expensive installations are not always the best solution for improving comfort and energy efficiency for a sustainable building. Low-tech and cheap products like ceiling fans also has the capability to enhance comfort while still being affordable.	

Graduation project	
Title of the graduation project	**Office Desks as Diffuser of Air Flow Induced by Ceiling Fan**
Goal	
Location:	MATE Lab, TU Delft
The posed problem,	• Fans has been proven to be an energy- and cost-efficient way to provide cooling by increasing air movement (Arens et al., 2009, André et al., 2024) • Desk fans and ceiling fans are capable to provide comfort in warm and humid condition at 30°C/60% RH in typical summer clothing (0.5-0.6 clo) at sedentary office activity level (1.0-1.1 met) for single occupant (Zhai et al. ,2013, Zhai et al., 2015, Zhai et al., 2017) • Ceiling fan has the potential to become a low-energy-demanding and heat-resilient design solution for existing, non-air-conditioned offices. • The understanding of how different office desk layouts and control methods impact occupants' perceptions of air movement. • This research aims to investigate the relationship between the spatial arrangement of office furniture, the placement of ceiling fans, and the interactive

	control behavior (of a group of people) on the occupants' perception of air movement and overall comfort.
research questions and	Primary Question: How effective are ceiling fans under different desk layouts in warm and hot environments to diffuse air flow and expand thermal comfort zone to achieve collective thermal comfort? Sub-Questions: 1. How do the desk layouts impact the air speed distribution perceived thermal comfort across various seating locations? 2. Can a single ceiling fan provide collective thermal comfort for a group of (up to) 4 people? 3. Does the prediction of thermal comfort models (PMV, SET*, modified SET*, etc.) match the experiment result of human subjects?
design assignment in which these result.	1. Desk layouts and their capability to diffuse ceiling fan air flow. 2. A comparison of predicted thermal comfort level and results from the experiment. 3. An insight of interactive control behavior for selecting fan rotation speed within a group of (up to) 4 people.

Process

Method description

Phase 1: Literature Research

The focuses of literature review are:

1. How does elevated air speed improve thermal comfort and what is the correlation with thermal comfort models e.g. PMV, PPD, SET.
2. What is the actual air speed preference of humans compared to the thermal comfort models?
3. What is the air speed suggestion or limit in current standards (ASHRAE 55, NEN-EN-ISO 7730, NEN-EN 16798)?
4. The characteristic of air flow distribution induced by ceiling fan (lab measurement and CFD simulation)
5. How do interior layout (chairs, desks, partition, etc.) influence the distribution of air flow?

Phase 2: CFD Simulation

The aim of CFD simulation is to have an initial glimpse of how different layouts influence the air flow distribution. The simulation result also helps to decide which layouts should be examined further in the lab.

Phase 3: Lab Measurement

1. Measurement of air speed distribution in unoccupied lab.

2. Measurement of air speed distribution with several desk layouts.
3. Predict thermal comfort level at various seat locations with PMV, PPD or SET.

Phase 4: Lab Measurement with Human Subjects

Validate the prediction from previous phase with human subjects through survey.

Phase 5: Data Analysis

Analize the data from CFD simulation and lab experiment for "result" and "discussion" chapters.

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)?

   Research of ceiling fans is a "fresh" topic in this faculty. Integrating ceiling fan to office layout has the potential to provide sustainability values in terms of "well-being of people", "energy efficiency" and "heat resilience". With the experiment of ceiling fan and desk layouts, integrated with thermal comfort knowledge that I learned during my master's study, an innovative way to utilize ceiling fan and desks will be proposed for better built environment.

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

   Ceiling fans have been widely used in warmer climate zone, e.g., China, Japan, south-east Asia, California (USA). However, in The Netherlands, the presence of ceiling fans is rare due do the moderate climate. As global warming is a foreseen trend, extreme heat occurs more often in summer season and a heat-resilient solution is needed especially for existing non-AC building stock. Ceiling fan is a cost-efficient and energy-efficient option to offset thermal discomfort by providing elevated airflow. This thesis will provide an insight of how the thermal comfort level and the air speed preference when a ceiling fan is shared by multiple occupants, which can be adopted into climate design process for more sustainable buildings. With my thesis I hope to raise the attention in The Netherlands for utilizing ceiling fan.