THERMAL COMFORT
SATISFACTION
Research Brief

PARTNERSHIP INITIATIVE
INTEGRATED DESIGN LAB
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Figure 1:
Vision of occupant feedback interface for open concept office

Source: https://www.pae-engineers.com/news/articles/a-holistic-approach-to-thermal-comfort

Keywords:
Thermal Comfort, Satisfaction, Personal Control

CONTENT OVERVIEW

THERMAL COMFORT + SATISFACTION SUMMARY

Thermal comfort satisfaction can vary due to a variety of factors. Occupant interaction and control provides each occupant with a unique thermal preference that can inherently affect their perceived thermal comfort. The type of ventilation can also influence an acceptable temperature range and extend it beyond what is considered standard.

I. Perception of Thermal Comfort with Personal Control

For the past several decades, buildings have relied on HVAC systems to deliver a neutral thermal environment. The conditions of these environments are designed to be constant through time and uniform throughout the space. However, this may not be the ideal system to improve occupant thermal comfort (Luo 2018). In a review of thermal comfort studies, seven out of nine studies revealed that users rated thermal comfort as the top priority to improving satisfaction in a building (Rupp 2015). There are several contributing factors that could influence a person's thermal comfort satisfaction. A study done at UC Berkeley found that personal control over conditions (i.e. operable window, thermostat, personal heater) has an overwhelmingly positive impact on overall satisfaction (Huizenga 2006). A literature review conducted by researchers at University of Texas at Austin on thermal comfort found that occupants had higher thermal comfort satisfaction when they were able to control their environment (Park 2018). These studies show that providing occupant control over thermal environments have significant impacts on overall thermal comfort (Huizenga 2006, Park 2018, Tanabe 2015, Wagner 2007).

II. Perception of Thermal Comfort with Type of Ventilation

Other studies show that the type of air – natural ventilation or mechanical air delivery— within the building can impact the tolerance of thermal conditions (De Dear 1998, Leonhart 2007). A study by Richard de Dear and Gail Brager on thermal comfort preference found that occupants in a naturally ventilated building have a much greater tolerance for indoor thermal conditions in comparison to buildings with purely mechanical HVAC systems. In naturally ventilated buildings, occupants become accustomed to the thermal modulation that is induced by changes in outdoor weather conditions and are able to adapt and be comfortable across a wider range of temperatures (De Dear 1998). Naturally ventilated spaces will not please all occupants at once, however the agency and personal control that these mechanisms give occupants will likely improve their overall thermal satisfaction (Ring 2000).

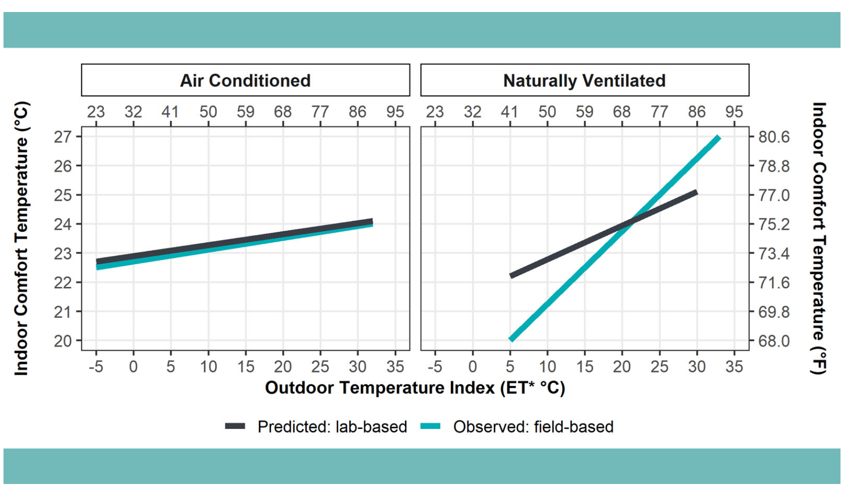

Figure 2: Graph displaying thermal comfort in a mechanically conditioned verse a naturally ventilated building.
Source: https://cbe.berkeley.edu/research/adaptive-comfort-model/

Perception of Thermal Comfort with Type of Ventilation Cont..

In spaces that are only mechanically conditioned, the indoor environment essentially isolates occupants from the outdoors, allowing for the HVAC systems to control the indoor thermal environment. This control comes with a greater energy cost and acclimatizes occupants to a narrower thermal range. Even the best managed mechanically conditioned spaces will only satisfy a portion of occupants due to personal thermal preferences (Ring 2000). ASHRAE's Standard 55 measures acceptable thermal comfort by the temperature range that satisfies 80% of occupants, thus 20% of occupants can be inherently dissatisfied within the "ideal" comfort range (ASHRAE 55-2017). ASHRAE 55 is based on Fanger's Predicted Mean Vote (PMV) model which is meant to find the "average response of a large group of people experiencing the same conditions" (van Hoof 2008). This model has received criticism for its design because the original sample of the study only included college students in sedentary activity. "Real buildings involve much larger and diverse samples of real occupants as opposed to college-age subjects" (van Hoof 2008).The experience of thermal comfort can differ individually due to factors such as gender and age (Rupp 2015, Hall 2010). Studies have found that females have a higher sensitivity to cool temperatures but less sensitivity to humidity than males (Rupp 2015). The elderly have preferences for warmer temperatures than young adults (Rupp 2015). To improve overall satisfaction, the diversity of demographics of the building should be considered when determining the indoor environmental parameters (van Hoof 2008).

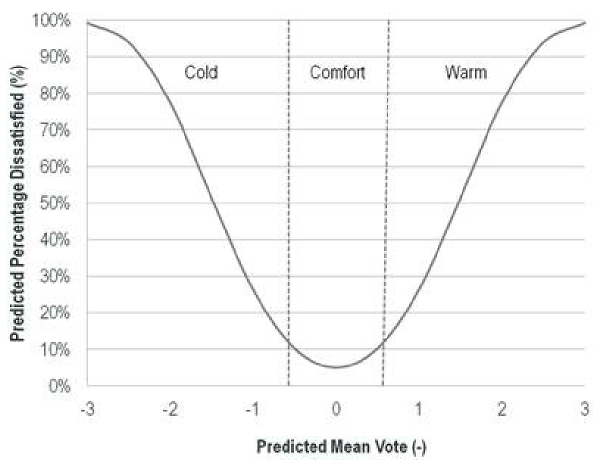

Figure 3: Fanger's Predicted Mean Vote comfort model showing predicted percentage dissatisfied.
Source: https://www.rehva.eu/rehva-journal/chapter/comfort-modelling-in-semi-outdoor-spaces

III. KEY REFERENCES

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