

OCCUPANT BEHAVIOR STUDY

THERMAL COMFORT IN THE CLASSROOM

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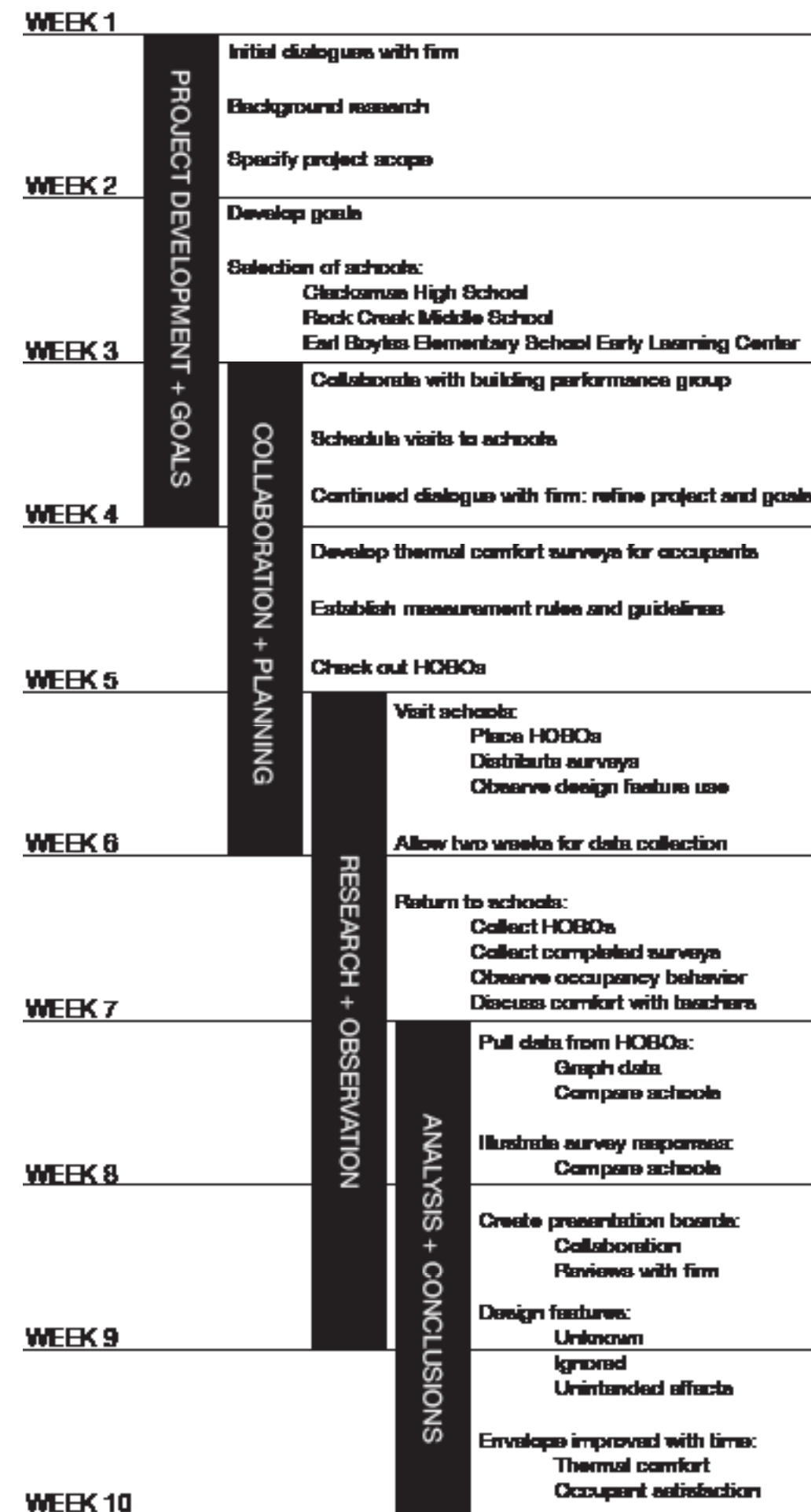
Project Overview

This is a post occupancy behavior study focusing on thermal comfort in three school buildings in the Greater Portland area designed by Boora Architects. Through a combination of data collection, survey questions and personal observation, the result is an evaluation of the thermal performance of Clackamas High School, Rock Creek Middle School, and Earl Boyles Elementary School.

Each school had specific design considerations and they span 12 years of evolving design strategy and changing trends in an attempt to use more passive approaches to achieve thermal comfort. In conjunction with another student group focusing on the building envelope performance of the same schools, this research intended to provide qualitative information to supplement their investigations and provide a more holistic understanding of thermal performance.

Conclusions

Quantitative data can provide excellent insight into the way design considerations translate into building performance and overall occupancy satisfaction. By comparing collected data to occupant survey data, it becomes clear that there is a great improvement in comfort as considerations became focused on envelope performance and passive heating strategies. It is also important to develop a system to inform occupants of any special design considerations if they are to work effectively throughout the lifecycle of the building.

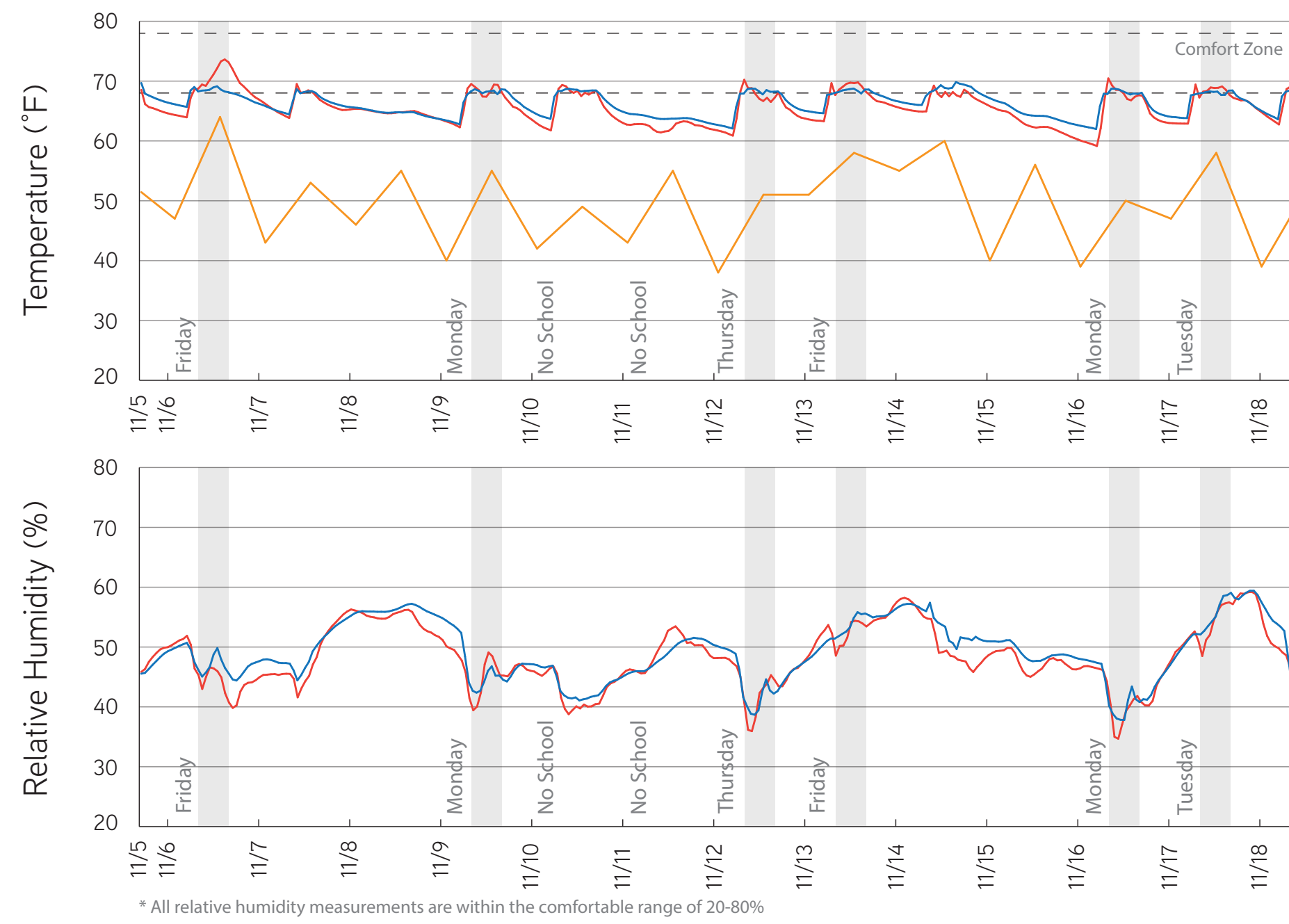


Clackamas High School

Location: 14486 SE 122nd Ave, Clackamas, OR
Year of Completion: 2002
Square Footage: 275,000 ft²
Occupancy: 2,213



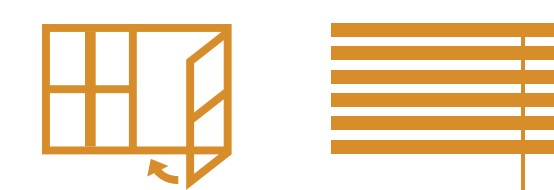
Thermal Comfort Data



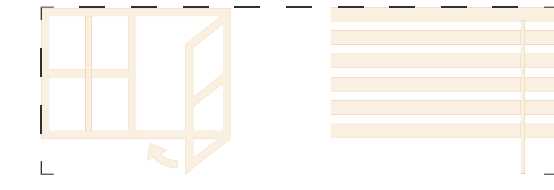
* All relative humidity measurements are within the comfortable range of 20-80%

Outdoor Temperature (Min + Max) North Classroom South Classroom Occupied Hours

Device Controls



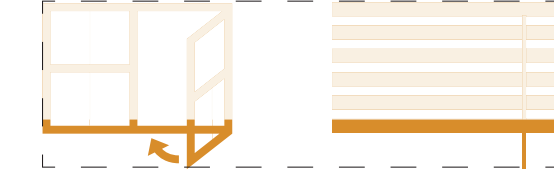
0% Satisfied



20% Neutral

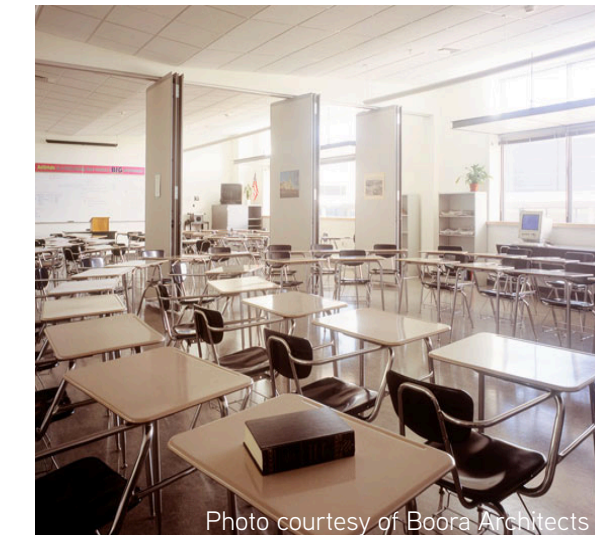
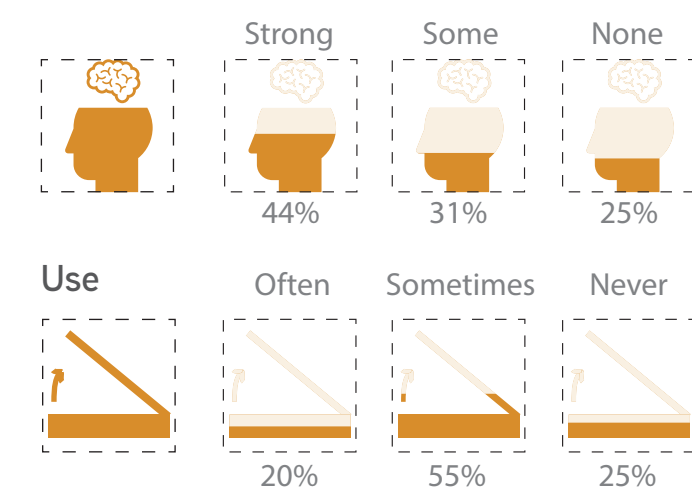


80% Unsatisfied



Natural Ventilation System

Understanding/Awareness



Occupant Feedback

"Far too cold. We need a manual thermostat. Last week, I had two students wrapped in blankets."

"I am cold constantly. Kids bring blankets to class. I have to wear thermal clothing, scarves, and coats."

"It is too hot when it's hot [outside] and too cold when it's cold [outside]."

"The natural ventilation system works better in the north-side classrooms."

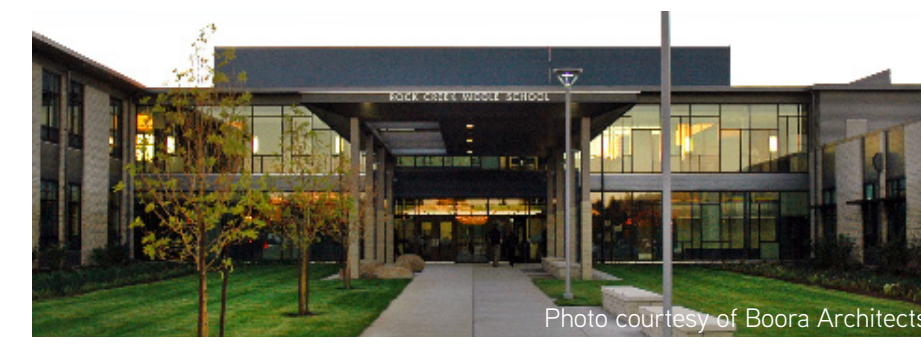
"The thermal comfort is inconsistent - blazing hot in fall - cold in winter."

Building Specific Technology

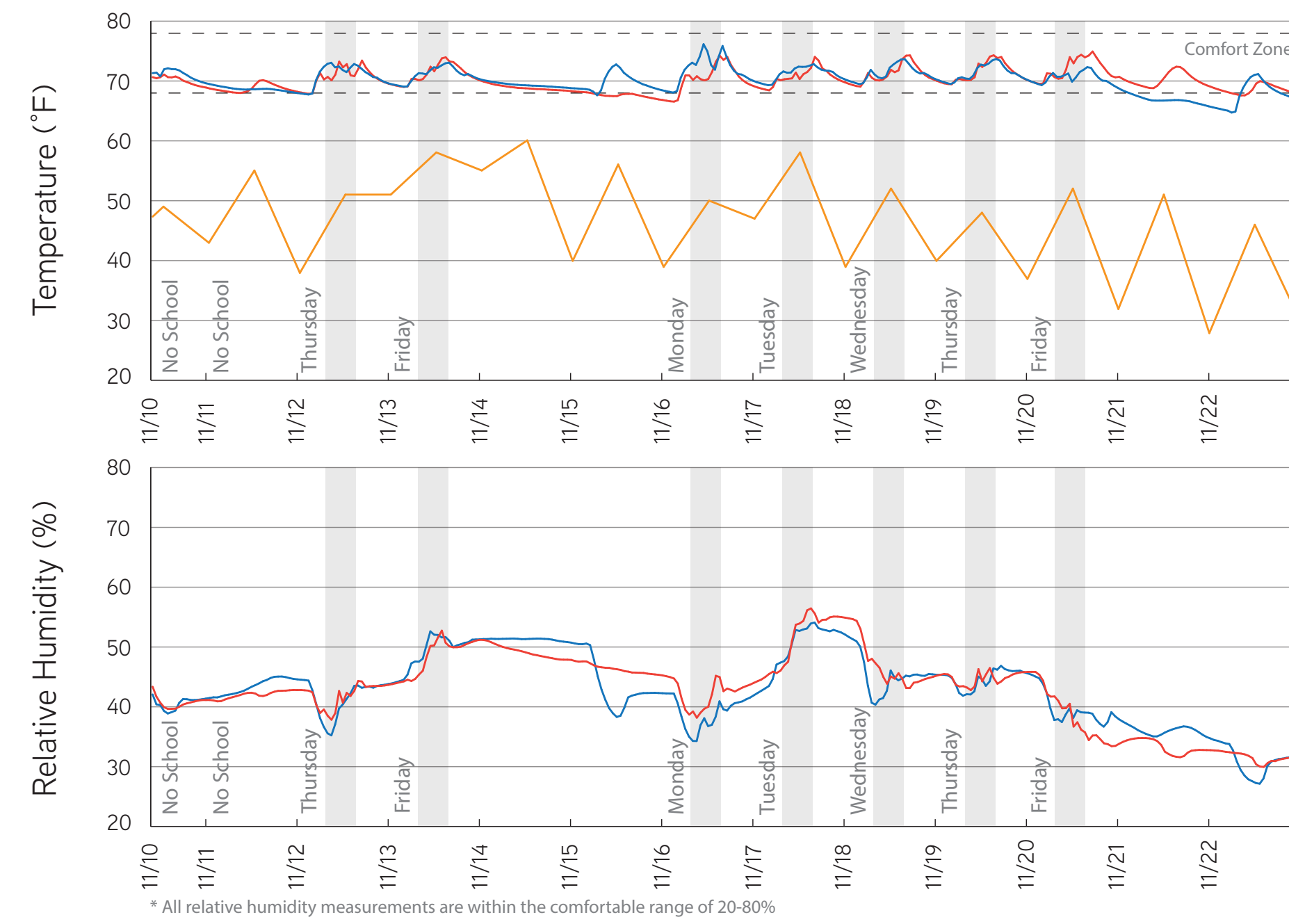
Located at the windowsills are operable vents that allow the influx of outside air without opening the entire window. There seems to be a disconnect between design intent and user understanding. The majority of teachers responded that they had little to no knowledge of how the system operates and even some who did replied that they do not use it.

Rock Creek Middle School

Location: 14897 SE Parklane Dr, Happy Valley, OR
Year of Completion: 2010
Square Footage: 129,000 ft²
Occupancy: 750



Thermal Comfort Data



* All relative humidity measurements are within the comfortable range of 20-80%

Outdoor Temperature (Min + Max) North Classroom South Classroom Occupied Hours

Device Controls



No Occupant Feedback Available



Thermal Comfort Satisfaction



Clackamas High School



Earl Boyles Elementary

Methodology

In order to collect some quantitative data as a baseline, we placed HOBO sensors in a North and South facing classroom in each building. The sensors measured temperature and relative humidity every 15 minutes over the course of two weeks, averaging the recorded data every hour. In addition, we surveyed teachers in each school (half in Clackamas and all in the Earl Boyles addition) to find out their personal thermal comfort and temperature control ability in each room. We asked a series of questions in each survey set as well as a number of questions that were specific to each building.

Class Observation

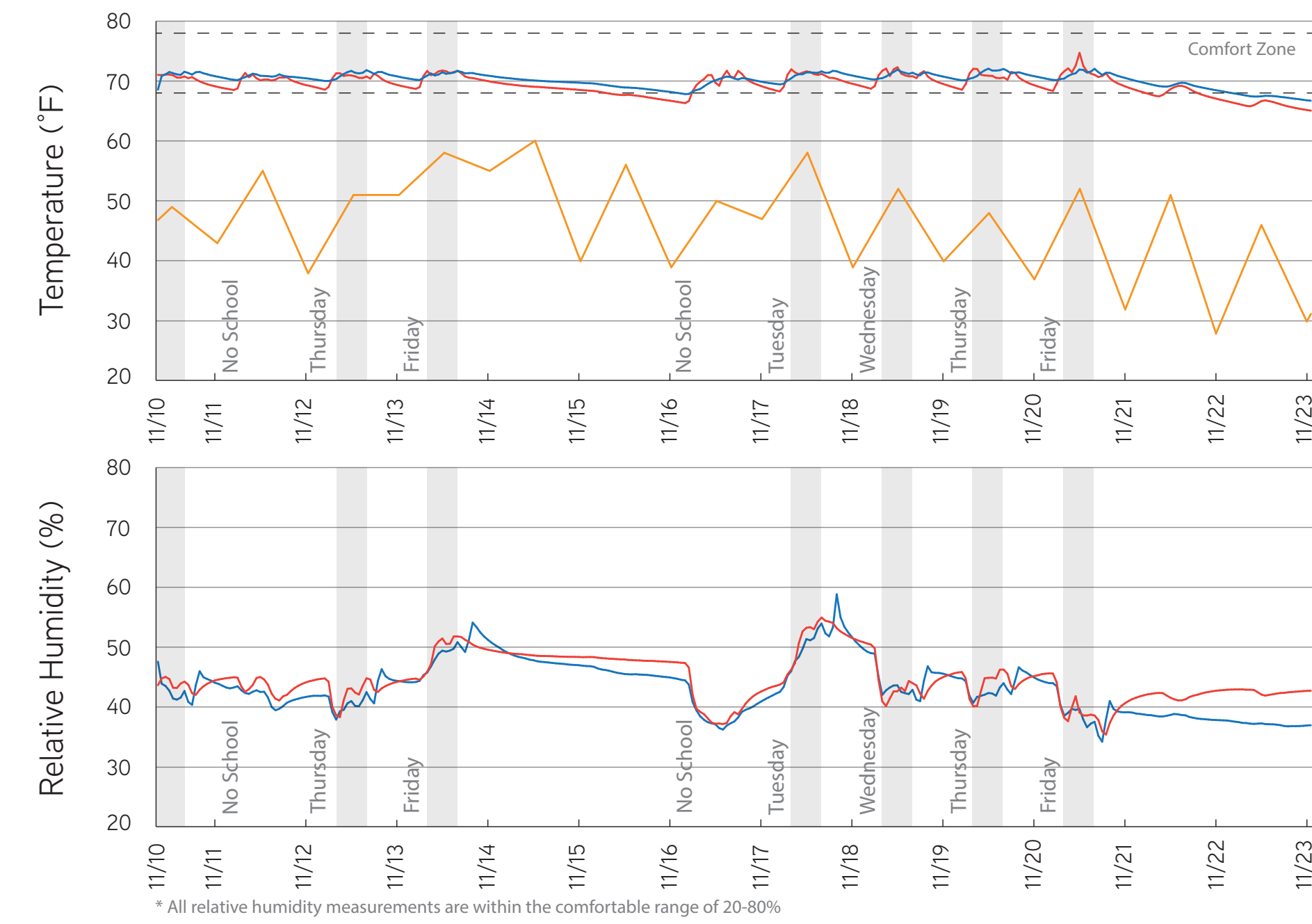
To further supplement our findings, we observed two class sessions at Clackamas High School in the rooms where the HOBO sensors were located. This provided some personal insight into how the students and teachers behaved over the course of the day and the type of activities that went on in the rooms that could potentially effect thermal comfort. Clackamas had the most consistent negative feedback which was verified by the HOBO data. We found that most students were dressed in warm clothing over the course of the class period and each teacher we spoke with expressed their problems with the cold classroom environment. Also, the ventilation system seemed to be forgotten and even used as extra shelf space in one of the rooms.

Earl Boyles Elementary School

Location: 10822 SE Bush St, Portland, OR
Year of Completion: 2014
Square Footage: 15,000 ft² addition
Occupancy: 188



Thermal Comfort Data



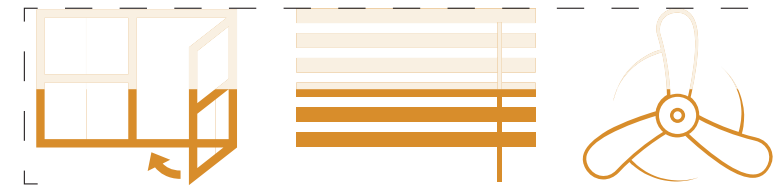
* All relative humidity measurements are within the comfortable range of 20-80%

Outdoor Temperature (Min + Max) North Classroom South Classroom Occupied Hours

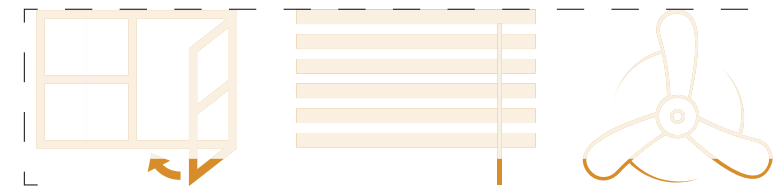
Device Controls



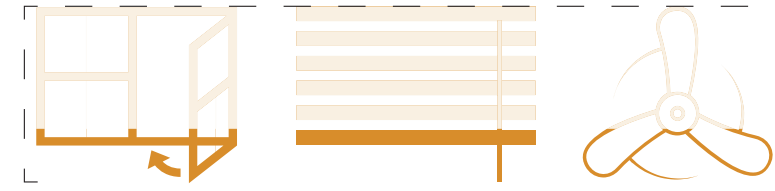
50% Satisfied



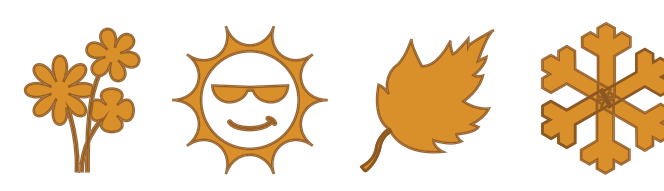
17% Neutral



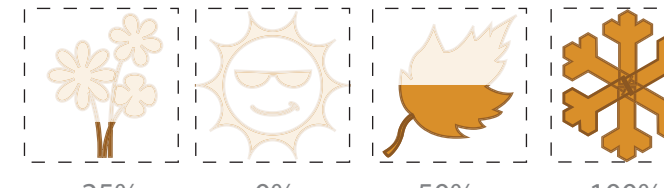
33% Unsatisfied



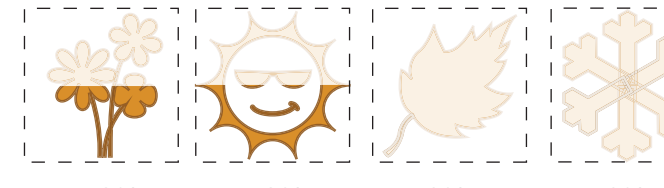
Seasonal Comfort



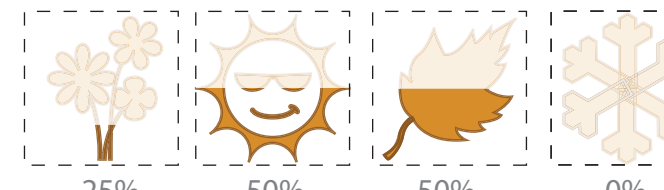
Comfortable



Neutral



Uncomfortable



Occupant Feedback

"In early fall, mornings were okay, afternoons were extremely hot."

"On sunny days, by the afternoon it gets very hot."

"I love the fan but can't always use it because it blows the papers around. It only helps 1/2 the class."

"It is frustrating to not have much control over the heat in room, other than opening windows or fan. Fan has to be on low so that it won't blow students' work. Heat coming from the upper walls often makes any student work or posters taped up fall off. This occurs especially in winter. So much sunlight coming in also effects how I can control lights... which in turn effects my SMART board projector."

Building Specific Technology

Earl Boyles had the strongest focus on thermal comfort with a very well insulated and airtight envelope. The building is designed to allow the heat generated by the users to keep the interior spaces within the thermal comfort zone. This building tested the strongest in terms of thermal comfort satisfaction.