

project team

Design Assistance: Betterbricks Integrated Design Lab

_andscape: Walker Macy

Utility Support: Seattle City Light

Client: University of Washington As a laboratory dedicated exclusively to research, the program demanded an adjacency and tight connection Architects: **ZGF Architects LLP** between lab and office spaces. Project phasing and Contractor: Hoffman Construction Company campus considerations (the completion of the Johnson Hall Mechanical, Electrical, Fire Protection Engineers: Affiliated Engineers, Inc. quadrangle) argued for a north-south phase 1 orientation Structural, Civil: KPFF Consulting Engineers, Inc. that resulted in more difficult eastern and western facades. _aboratory Consultant: Research Facilities Design Ultimately, labs were chosen on the west side because: Energy Modeling: SOLARC Architecture + Engineering, Inc.

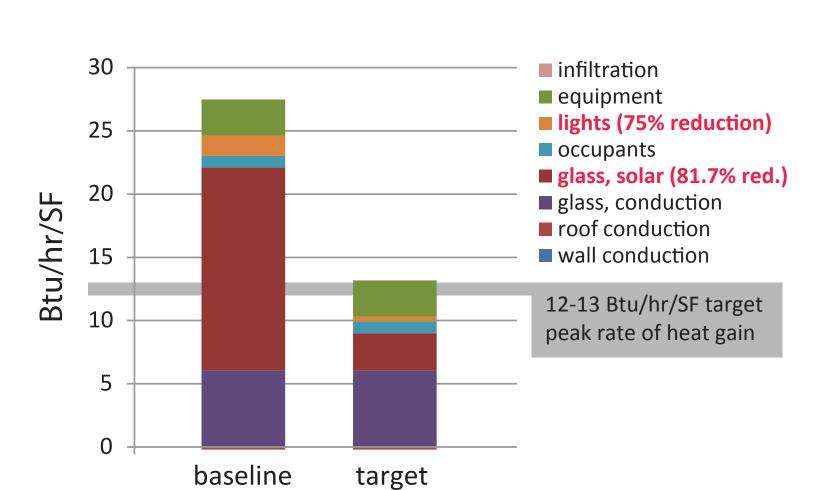
1) Bus and truck traffic on Stevens Way to the west could Electro Magnetic Interference: Field Management Services Corp. provide noise and pollution not conducive to operable Acoustics: SSA Acoustics Vibration: Vibro-Acoustic Consultants

> 2) The labs, with high air changes required for interior air quality and safety, were less impacted by peak solar conditions presented on the western facade. The adjacency of labs and offices prevented a cross ventilation strategy and necessitated a stack configuration to provide air flow.

1 site response

integrated design: load reduction

This model revealed a peak load of about 27 Btu/hr/SF in the take place: solar shading and daylighting.



Peak load condition: July 10, a.m.

significant advances in the evolving molecular engineering utility design assistance and incentives, a comprehensive program. The facility will provide the necessary research approach was taken to minimize building energy use. laboratories and faculty offices to bring together students Computational fluid dynamic studies ensured researcher safety while reducing air changes from the campus and researchers in bioengineering, chemical engineering, standard of 10 per hour to 6. Laboratories will employ nanotechnology, electrical engineering, mechanical low-flow VAV fume hoods, and chilled beams will be engineering, and materials science engineering, which used to supply cooling where additional ventilation is not are currently dispersed throughout campus. Associated molecular and nanotechnology instrumentation will also be required. Best practice load reduction strategies include consolidated into the new facility to provide greater synergy a facade strategy that optimizes daylight while reducing and enhanced research capabilities. peak solar cooling loads.

project overview and sustainability approach

The new Molecular Engineering Building is centrally located Designed to achieve or exceed LEED Gold, the Molecular

The natural ventilation strategy for the office portion of the building is a direct extension of these strategies. Given sustainability from the outset of the project. State projects Seattle's mild climate, the University was interested in reestablishing the precedent of not providing mechanical cooling for faculty offices, while providing beautiful, comfortable spaces that express direct connection to the Commitment, putting the University on the path to carbon campus and greater environment.

Engineering Building embodies an integrated design

impacts of laboratory operations—largely due to the

that focuses on the specific and significant environmental

enormous ventilation demands and the energy associated

with moving and conditioning this air. Supported by local

NATURALLY VENILATED OFFICE LABORATORY MECHANICAL/AUXILIARY/SERVICE

RESEARCH LAB

climate

neutral operation.

Seattle's mild climate presents ideal opportunities for natural ventilation. Analysis was done using local airport (Boeing) typical meteorological year (TMY3) data, supplemented with eight years of data collected from the Atmospheric Sciences Department, at an adjacent building on campus. Major findings:

on the University of Washington's main Seattle campus,

at the juncture of the city's street grid and the Beaux Arts

axis of the campus. The new phase I building will provide

approximately 90,000 GSF of space, complementing the

University's existing engineering facilities and fostering

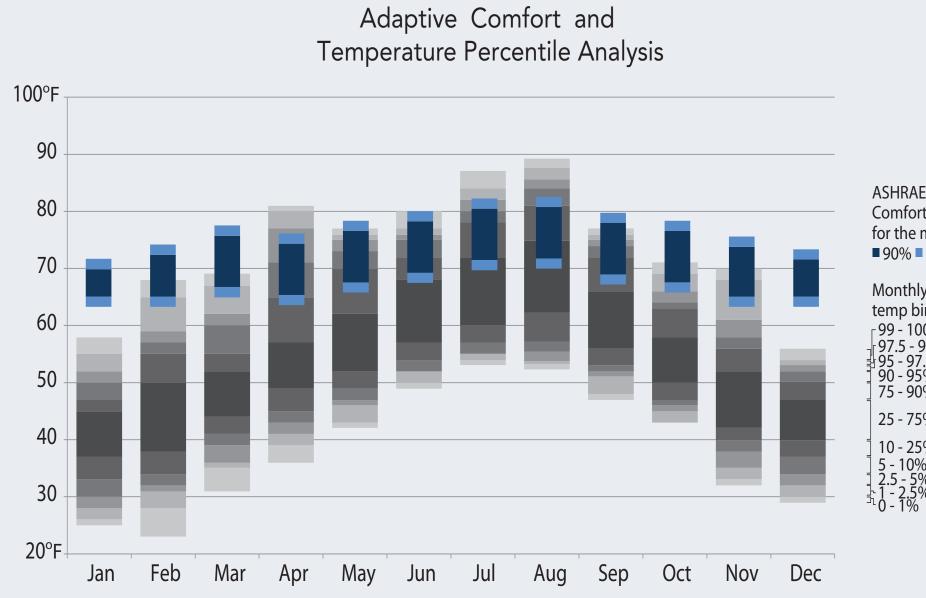
The client and design team were committed to

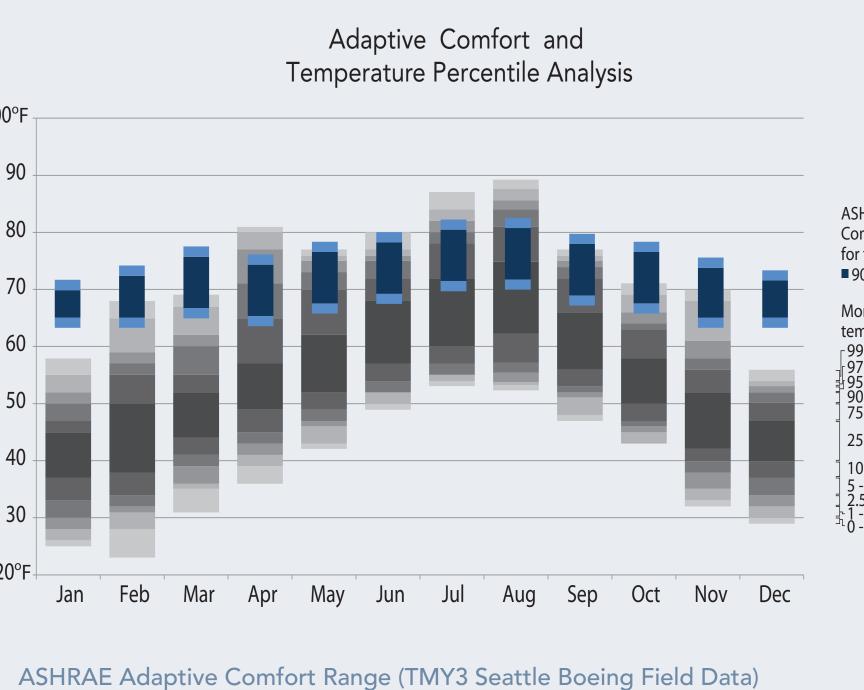
are required to achieve a minimum of LEED Silver, and

the UW President Emmert was an early signatory to the

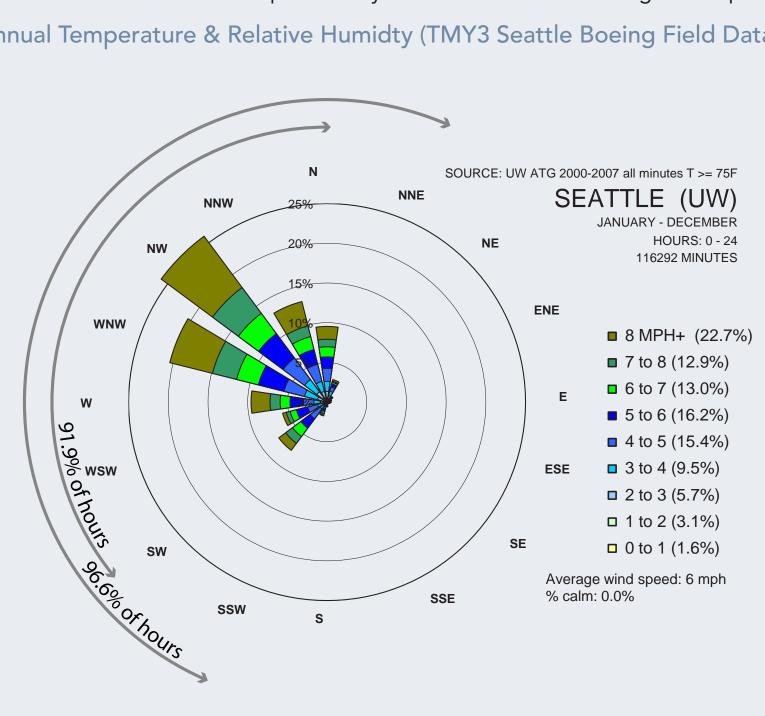
American College and University President's Climate

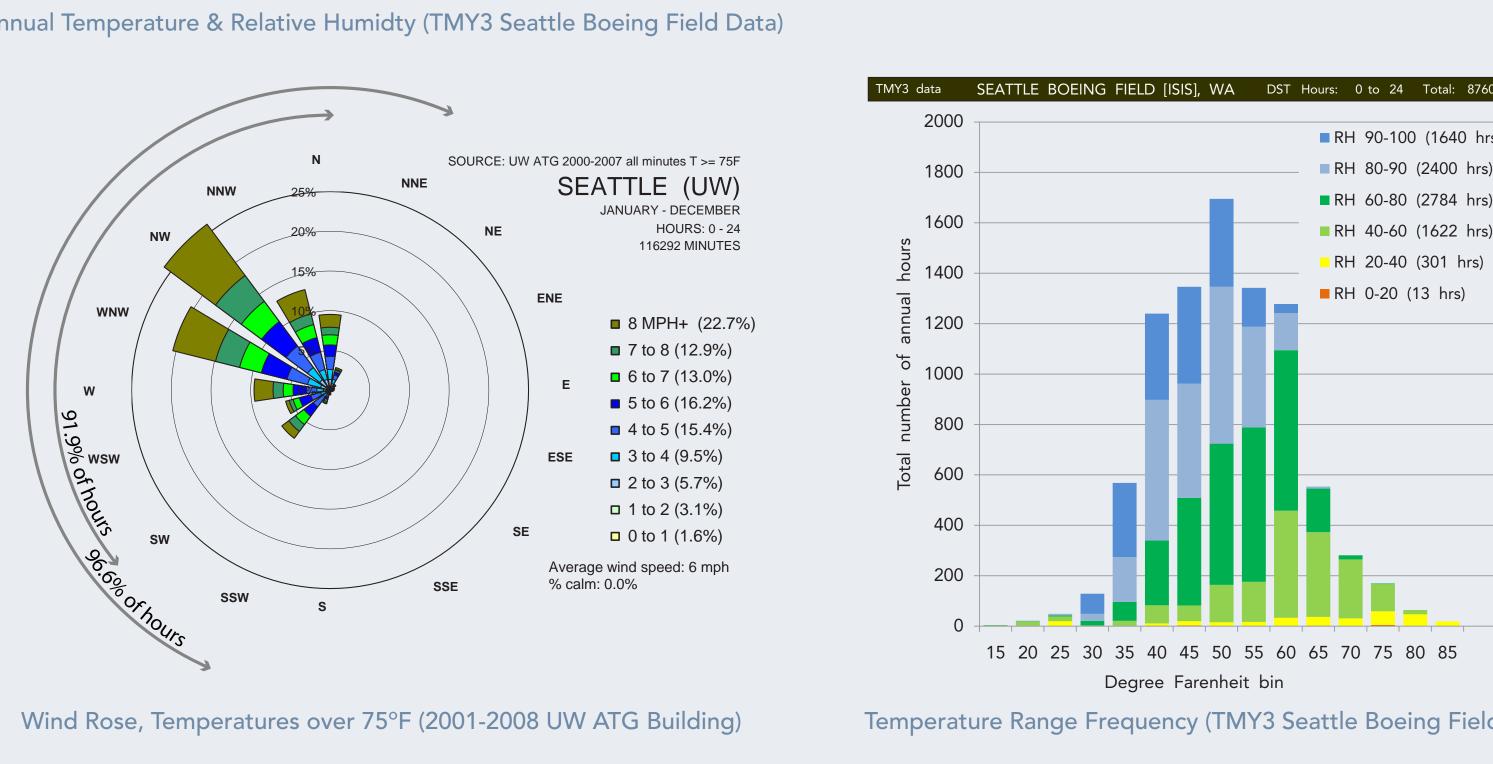
- 97% of all operating hours would be within the adaptive comfort range.
- Peak temperatures typically occur in late afternoons in July and August.
- Local wind data showed a clear seasonal pattern, with a strong directionality exhibited when temperatures exceed 75°F.





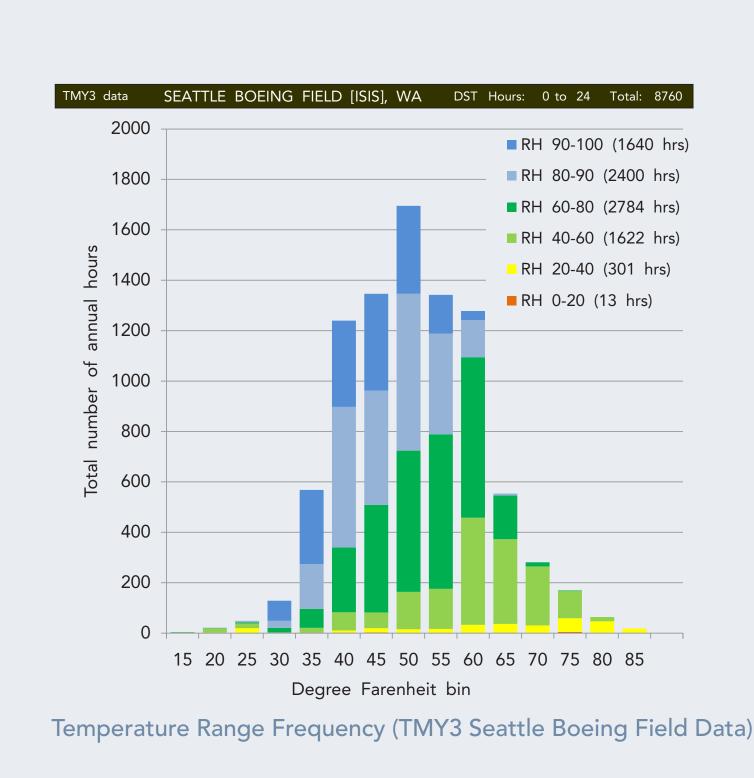
• RH 0-20 (13 hrs) • RH 20-40 (301 hrs) • RH 40-60 (1622 hrs) • RH 60-80 (2784 hrs) × RH 80-90 (2400 hrs) + RH 90-100 (1640 hrs) Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Annual Temperature & Relative Humidty (TMY3 Seattle Boeing Field Data)

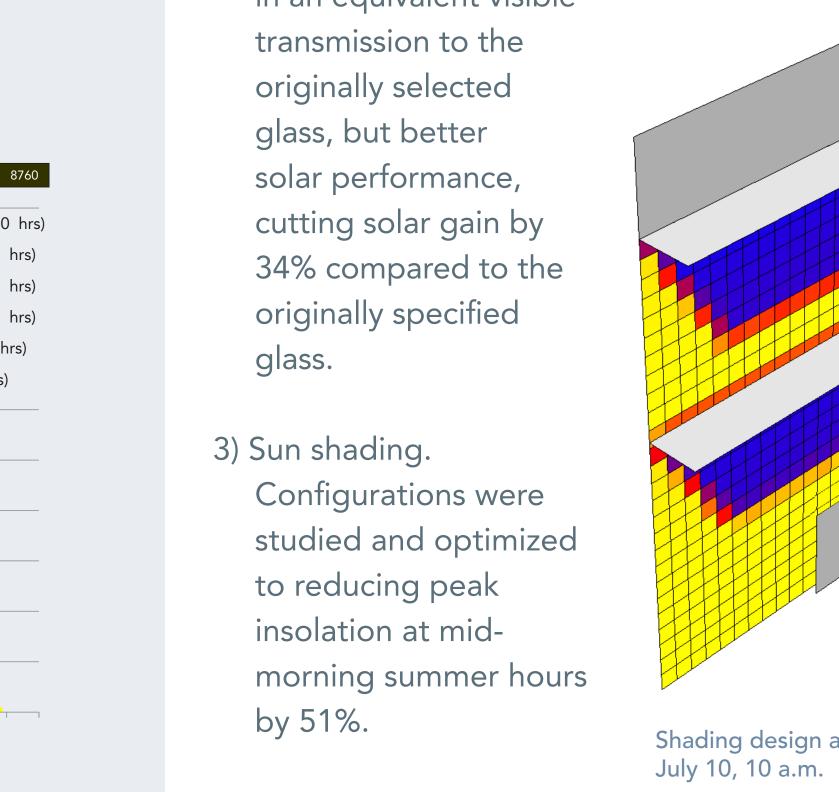






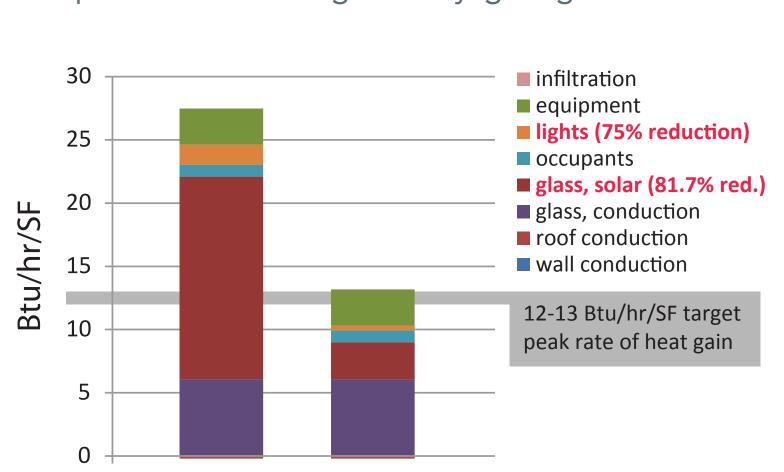
SEATTLE BOEING FIELD [ISIS], WA DST Hours: 0 to 24 Total: 8760





An initial energy model was constructed in eQuest in order to understand expected peak cooling load conditions. For natural ventilation to work in this temperate climate, peak loads should be limited to less than 12.5 Btu/hr/SF. Anything in excess of that threshold would require additional air flow which could be physically disruptive or uncomfortable, potentially blowing papers or chilling occupants in cooler weather.

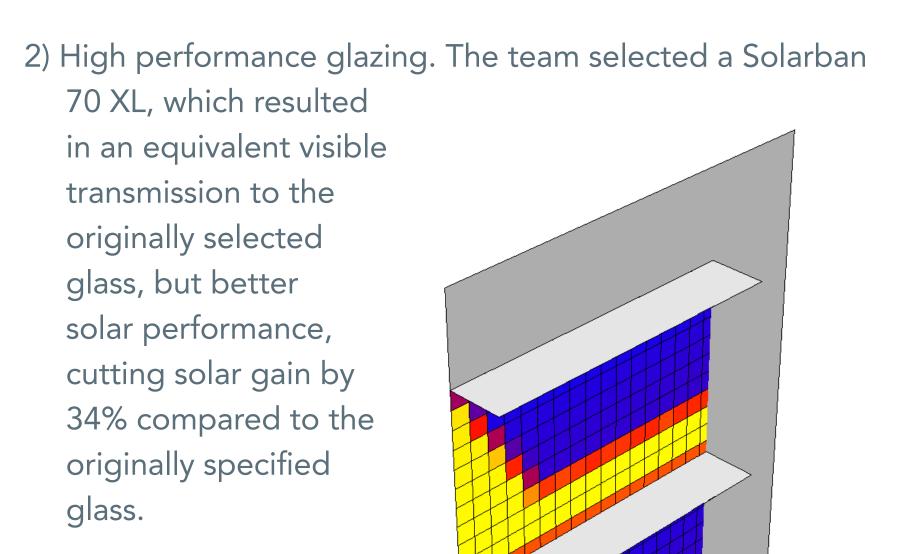
office, and two areas where significant heat reductions could



2 facade

For natural ventilation to work, solar gains through the facade needed to be reduced by approximately 80% from peak conditions. Three steps were taken to reach this threshold.

1) Reduction of glazed area of the facade by 41%. The team undertook studies of options to reduce glazing area, while maintaining a visual transparency and connection to the outdoors and prioritizing glazing higher in the wall, contributing more to daylighting.



Shading design at peak solar load:

Overcast sky daylight factors modeled in Ecotect and Radiance

3 daylight

78.5% during peak load conditions.

glare or direct sun was an issue, resulting in the

selection of daylight optimized internal blinds.

These automated blinds (with manual override)

automatically position themselves to block direct

sunlight, while redirecting daylight to the ceiling.

Additionally, the blinds permit cross ventilation

utilizing a guidewire to minimize movement from

4 airflow pathway

A series of daylight studies (using both physical A simple, single-zone air flow model provided preliminary stack sizing, models in artificial sky and digital models through Ecotect and Radiance) was used to optimize based on input of internal loads, stack height, and the differential between daylight in the space and reduce the electric ambient exterior and desired interior lighting load by a predicted 31.5% annually, and temperatures. Based on worst case configuration on the highest flow, an air flow pathway of 45 square feet Internal sun control options were studied for their effect on daylighting and ventilation when was determined to provide enough in

> cross sectional area for passive draw. Upper windows, mechanically actuated to be open when needed, were sized to meet this criteria. Lower windows, manually operated by the building occupants, provide an equal area in excess of what is

Ultimately, programmatic requirements necessitated reducing ventilation stack areas by about 25% from their ideal sizing. However, the sizing still allowed the stacks to work in most situations, with solar, wind, and fan assists to ensure successful operation throughout the entire year.

An IES Macroflow model confirmed that performance was within expected parameters that initial climate analysis predicted, with interior temperatures not exceeding 83°F for 97% of annual

5 stack assist

Min.: (inlet area $[a_1+a_2+a_3+a_4]$

MECHANICALLY OPERATED,

FOR VENTILATION NEEDS

SIZED AND CONTROLLED

MANUALLY OPERATED FOR USER CONTROL

Diagram of ventilation inlets and outlets

Typical office window wall section

Jan Feb Mar Apr May Jun Jul Aug Sep Od Nov Dec Jan

Baseline Excludes Mass
With Mass
With Mechanical Assist.
With Mass
Excludes Mechanical Assist.
With Mass
With Mass

Thermal model predicting interior temperatures

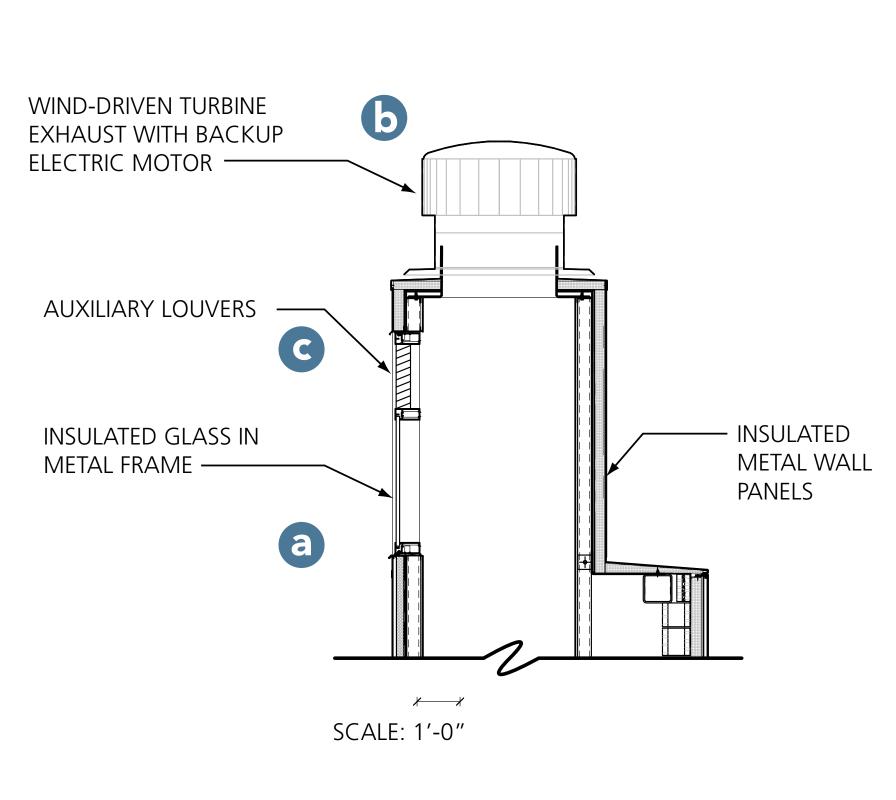
stack area $[min(b_1,b_2)]$

Programmatic considerations meant each stack could only be about 75% of the ideal size for purely passive draw, meaning that an additional assist for airflow would be required. The approach to stack assists was threefold:

a.) Glazing the WSW wall of the stack, to allow western afternoon sun to increase air temperatures and buoyancy at the top of the stack during summer

b.) A wind actuated turbine at the top of the stack (with backup electric power to turn the turbine when wind is not available);

c.) Additional louvers to open when there is no wind, but electricity is not available or needed.



Solar chimney and turbine stack assists

3 systems integration: radiant heating & thermal mass

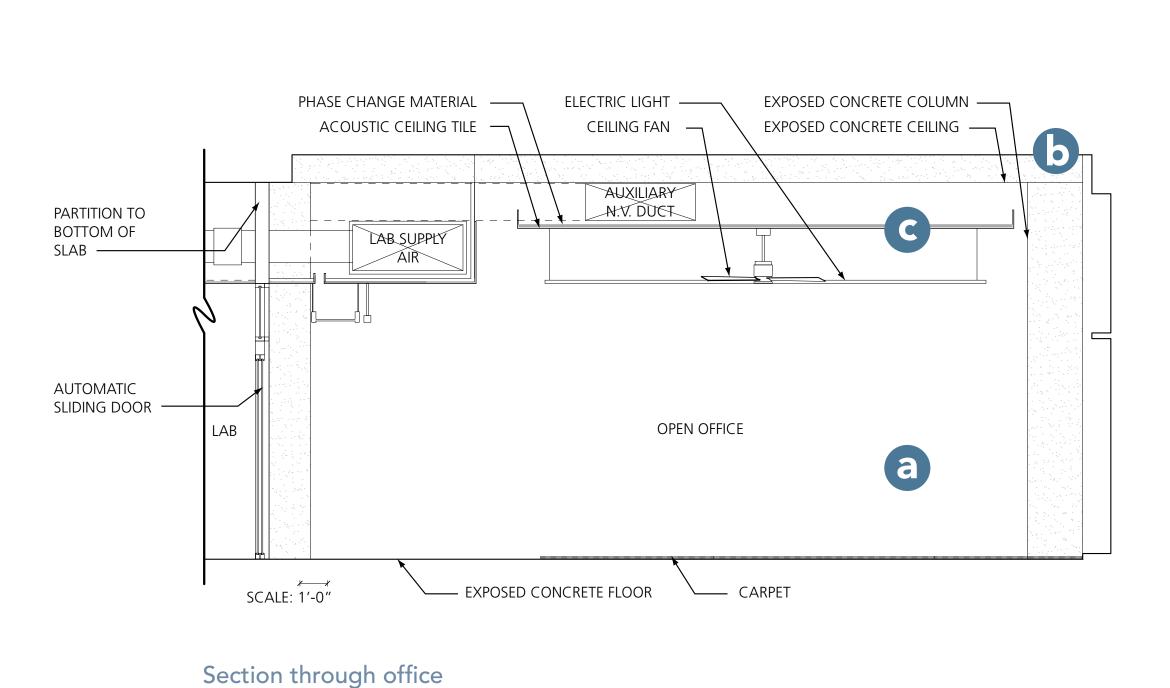
Working with the structural engineers, a system was developed to place rigid insulation with the slab assembly, exposing thermal mass in the ceiling and floor of all spaces, limiting "wasted" radiant heat to the slab and resulting in better zoning control of each space.

Acoustic and architectural considerations prevented the exposure of all available thermal mass. Carpeting was provided immediately around desks, and a ceiling cloud was developed in the center of the room. However, significant mass was still exposed in:

a.) Floors in raceway and circulation areas

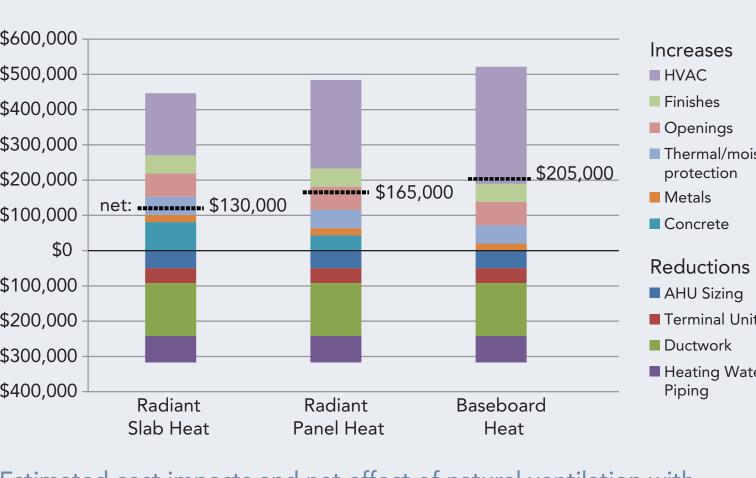
b.) Ceilings on room perimeter, which allows additional airflow around ceiling cloud

c.) Phase-change material in the open office ceiling cloud and private office



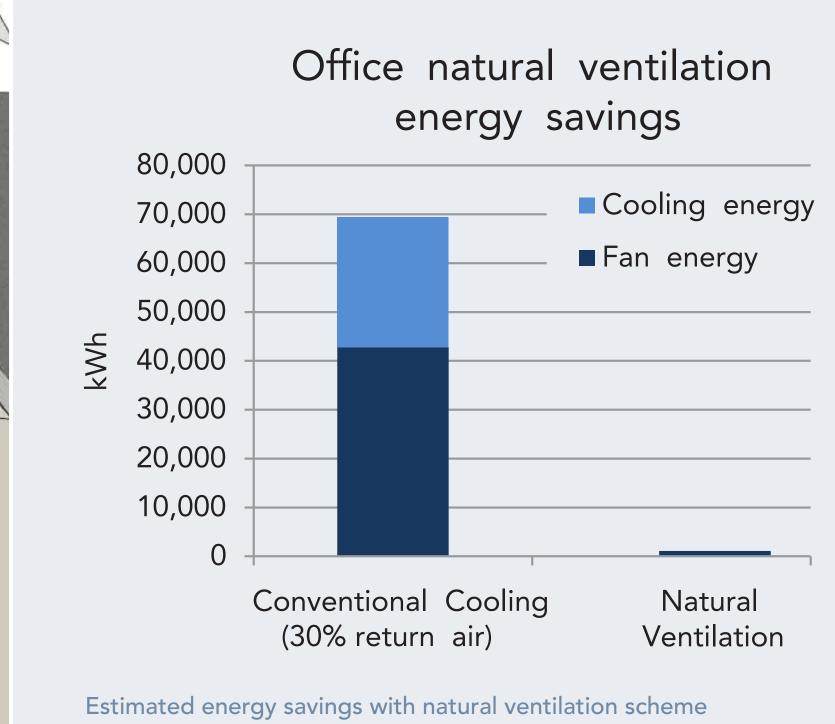
results

COST: A cost analysis undertaken at the end of design development looked at three options to provide heat in conjunction with ventilation, and included elements that would add cost as well as those that would be reduced. Ultimately, the best option, with radiant heat in the floor slabs, only added \$130,000 to the project budget, approximately 0.25% of the building's



multiple heating systems

ENERGY: Final whole building energy studies are still underway. However, an early building energy model and specific ventilation models estimate that cooling energy for the office will be reduced by over 98%.

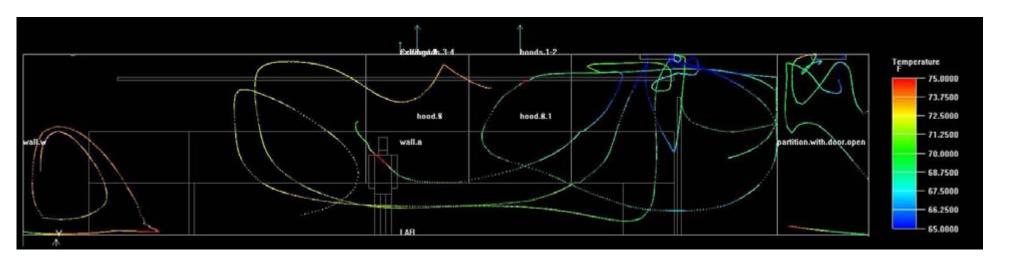


1 lab/office interface

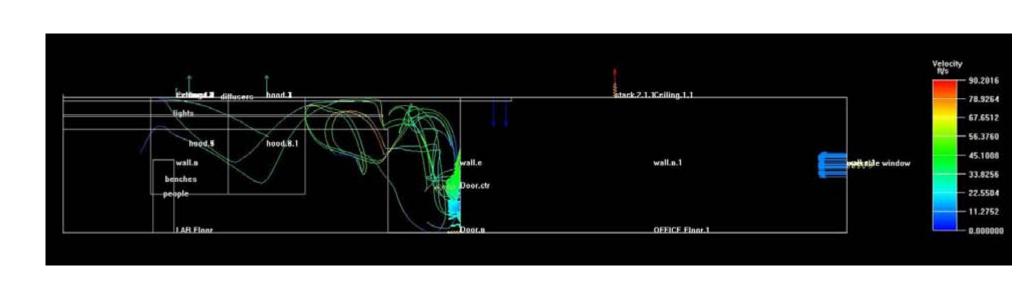
hroughout the project, providing for the safety of lab researchers while optimizing energy performance was the highest priority of the design team. CFD studies showed that 6 air changes per hour (ACH) could provide required safety parameters while significantly reducing the energy consumption from the campus standard of 10 ACH.

Basic safety parameters required a full airtight partition between the office and labs, with automatic sliding doors limiting cross-flow. 500 cfm of laboratory makeup air was introduced on the office side of the partition, ensuring negative pressure for the laboratory exhaust.

To test the efficacy of this strategy, CFD studies were employed to simulate typical and worst case conditions of the impact of office natural ventilation on laboratory airflow. Permutations included negative and neutral pressure in laboratory, and the effect of 35 mph winds pushing air into the office, with laboratory doors closed and held open.



CFD study showing tracing particle (pollutant) in lab with worst case infiltration through lab wall with 35 mph wind and open door to office.



CFD showing effect of natural ventilation in office in lab with neutral pressure between spaces.