Health & Wellness

IN HIGH PERFORMANCE BUILDINGS

March 1, 2019

Presented by Daniel Luddy
90% of our time is spent indoors.
Project Highlights

Rocky Mountain Institute | ASPEN, CO

Orchards at Orenco | HILLSBORO, OR

Bullitt Center | SEATTLE, WA

Yale & Harrison | SEATTLE, WA
Tropical Beach
Forest
Mountains
Thermal Comfort

Daylight

Ventilation
Early Adopter
Make it Desirable
Key Takeaways

Challenge the Basic Design Assumptions
Provide Levels Of Control
Balance Performance & Livability
Have a Plan B To Adapt to Change
Thermal Comfort
Conventional Thermal Comfort

One thermostat for everybody
Thermal Comfort in the News

**The New York Times**

*Chilly at Work? Office Formula Was Devised for Men*

**Science News**

*Building standards aren’t to blame for chilly offices*

**npr**

*Women, There’s A Reason Why You’re Shivering In The Office*
The 6 Components Of Thermal Comfort

- Human Comfort
- Activity
- Clothing
- Temperature
- Mean Radiant Temperature
- Air Velocity
- Humidity
CHALLENGE DESIGN ASSUMPTIONS

Expanded Thermal Range

- Operational Temperature (°F)
- Humidity Ratio (lbs H₂O per lbs dry air)

- Upper Boundary (PMV = 0.5)
- Lower Boundary (PMV = -0.5)
- Room Hours
Mean Radiant Temperature

Daily Temperature Swing

Zone Air Temperature
HAVE A PLAN B TO ADAPT TO CHANGE

Manage the Heat

Thermal Mass

Phase Change Materials
PROVIDE LEVELS OF CONTROL

Air Velocity

Ceiling Fans
PROVIDE LEVELS OF CONTROL

Local Control
CBE
Thermal Comfort Tool

Select method: PMV method

Air temperature
77.0 °F
Use operative temperature

Mean radiant temperature
77.0 °F

Air speed
20 fpm
Local air speed control

Humidity
50 %
Relative humidity

Metabolic rate
1.2 met
Standing, relaxed: 1.2

Clothing level
0.5 clo
Typical summer indoor

PMV
0.08

PPD
5%

Sensation
Neutral

SET
77.4°F

Complies with ASHRAE Standard 55-2010

Psychrometric chart (air temperature)

Dry-bulb Temperature [°F]

Humidity Ratio [lb/W lb]

Create custom ensemble
Dynamic predictive clothing
LEED documentation

globe temp SolarCal specify pressure ST TP Local discomfort Help

t_e 32.0 °F
t_h 0.0 %
W_s 0.0 lbm/lb

h 0.0 btu/lb
Post-Occupancy Survey Results

- Overall Building
- Thermal Comfort
- Acoustic Quality
- Office Layout
- Air Quality
- Office Furnishings
- Cleanliness
- Lighting

1 = Very Dissatisfied
7 = Very Satisfied

CBE Baseline
RMI Pre Occupancy
RMI Post OCC
Key Findings

74% of occupants feel the building increases productivity.

78% of employees tend to spend more time at the office because they like the space in which they work.

83% of employees agreed the Innovation Center assists them in articulating the RMI brand.

Very positive and strong results that support our cost analysis.
Daylighting
Façade Component Selections

- External Horizontal Shading
- External Screen Shading
- Glass Treatment Frits
- Electrochromic Glazing
Façade Component Selections

SECTION - MULLION CAP + LIGHTSHELF
- Mullion Cap
- Daylight Glazing
- Lightsheet
- Internal Operable Shade
- Vision Glazing

SECTION - MULLION CAP + EXTERNAL SHADE
- Mullion Cap
- Daylight Glazing
- External Shade
- Internal Operable Shade
- Vision Glazing

SECTION - LIGHT LOUVERS OR REFLECTIVE FILM (3M)
- Daylight Glazing with Light Louvers (or Reflective Film)
- Internal Operable Shade
- Vision Glazing

SECTION - LIGHT SHELF
- Daylight Glazing with Light Shelf
- Internal Operable Shade
- Vision Glazing

SECTION - 2 SETS OF BLINDS
- Daylight Glazing
- Internal Operable Shade
- Vision Glazing

SECTION - TRANSLUCENT OR GLASS WITH CONTINUOUS FRIT DAYLIGHT GLAZING
- Translucent Daylight Glazing
- for Glass with Continuous Translucent FRIT
- Bottom-Up Internal Operable Shade
- Vision Glazing
Provide Levels of Control

Radiance Analysis

Baseline

Light Shelf

Redirecting Film

Light Shelf & Redirecting Film

Luminance (Occupant perception)

0

10,000

20,000 cd/ft²
PROVIDE LEVELS OF CONTROL

Shading Control
Inputs for Systems Decisions

Automatic

- Floor Heating
- Pre-Cooling the Space
- Ventilation

User Overrides

- Automated Windows/Natural Ventilation
- Automated Exterior Blinds
- Wall Fans

User Controlled

- Manual Windows
- Ceiling Fans
- Personal Cooling/Heating Chairs
- Interior Glare Shades

Have a plan B to adapt to change

Simple Concepts, Complex System Interplays
Ventilation
Components of Air

- Oxygen: 20%
- Nitrogen: 78%
- Inert Gases: .97%
- Water Vapor: 1%
- Carbon Dioxide & Other Gases: .03%
Air Contaminates

- Carbon Dioxide
- Formaldehyde
- Lead
- Carbon Monoxide
- Nitrogen Dioxide
- Particulates
- VOCs
Impact of Better Air Quality on Productivity Increases in Analytical Tasks

- Crisis Response: 90% increase in productivity with a ventilating rate of 20 cubic feet per minute per person.
- Information Usage: 250% increase in productivity with a ventilating rate of 40 cubic feet per minute per person.
- Strategy: 100% increase in productivity with a ventilating rate of 20 cubic feet per minute per person.

**Source:** Harvard T.H. Chan School of Public Health's Center for Health and the Global Environment
BALANCE PERFORMANCE & LIVEABILITY

Ventilation Impact

- EUI 35.5
  - $185,081
  - $109,636
  - $91,568

EUI (kBtu/sqft/year)

ASHRAE 90.1-2010 Baseline  2015 Seattle Energy Code  Proposed Design
Plant Research

THE NASA Guide TO Air-filtering Houseplants

WHAT'S IN OUR AIR?

TRICHLOROETHYLENE FORMALDEHYDE BENZENE XYLENE AMMONIA

AIR-FILTERING PLANTS
Best Practices
Best Practices

HIGH PERFORMANCE BUILDING - TYPICAL FEATURES

- High Efficiency Water Fixtures
- Air Source Heat Pump
- Higher Outside Air Rates
- Solar PV
- Low Plug Loads
- Daylight Glazing + High Ceiling Heights
- Views to Outdoors
- Raised Floors
- Heat Recovery
- Efficient Lighting

Operable Windows

Radiant Sails

Occupant Controls
Challenge the Basic Design Assumption
Provide Levels of Control
Balance Performance & Livability
Have a Plan B to Adapt to Change
Questions?
Creating a better environment

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