



# Access to Nature for Human Health & Sustainability

Nature of Place Symposium  
Phipps Conservatory  
Feb 19-20, 2020

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Erich Fromm used **Biophilia** to describe the psychological orientation of being attracted to all that is alive and vital.

EO Wilson and Stephen Kellert described the links that human beings subconsciously seek with the rest of life as the **Biophilia Hypothesis**







## **Access to Nature for Human Health & Sustainability**

**Views**

**Circadian Light**

**Solar Heat**

**Thermal Variability – Alliesthesia**

**Natural Ventilation**

**Access to Nature – Active Design**

**Sounds of Nature**

**Smells of Nature**

**Sensory Feel of Nature**

**Natural Materials**

**Nature's Complexity and Order**

**Community**

# Biophilia and Human Health?

Cardiovascular S



Endocrine System



Integumentary S



Skeletal System



Muscular System



Digestive System



Immune System



Respiratory Sys



Urinary System



Nervous System



Reproductive Sys





**How important are  
Views of Nature and Community  
to human health?**

## Views = Health

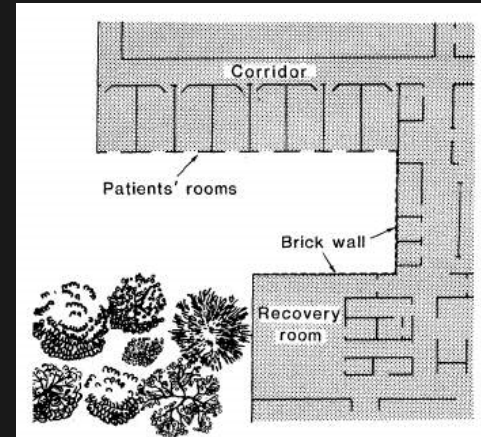
### Pennsylvania Hospital / Ulrich 1984

In a 1984 observational field study at a Pennsylvania hospital, Ulrich identifies an **8.5% reduction in post-operative hospital stay** (7.96 days vs 8.7) for gall bladder surgery patients who had a **view of a natural scene** from their hospital room, as compared to those with a view of a brick wall. Patients with a view of nature also received fewer negative evaluations from nurses and took fewer strong analgesics.

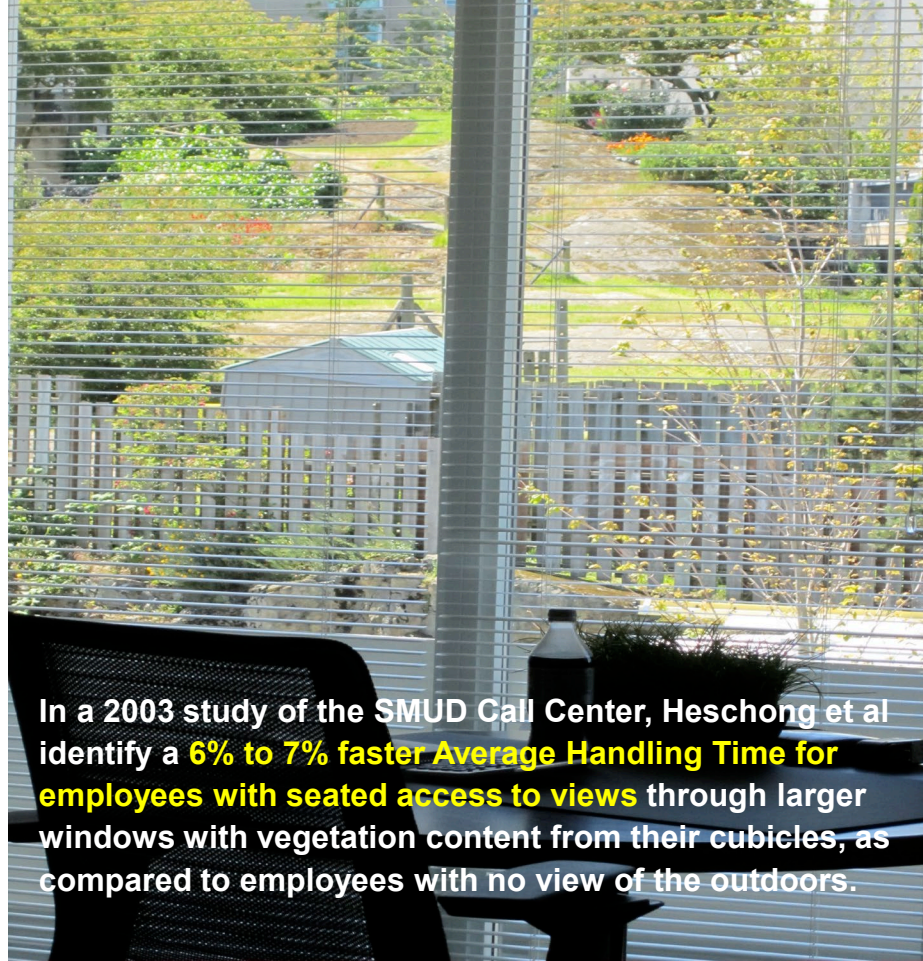
First cost increase: \$1,000 / bed

Annual productivity savings: \$884 / bed

ROI: 88%

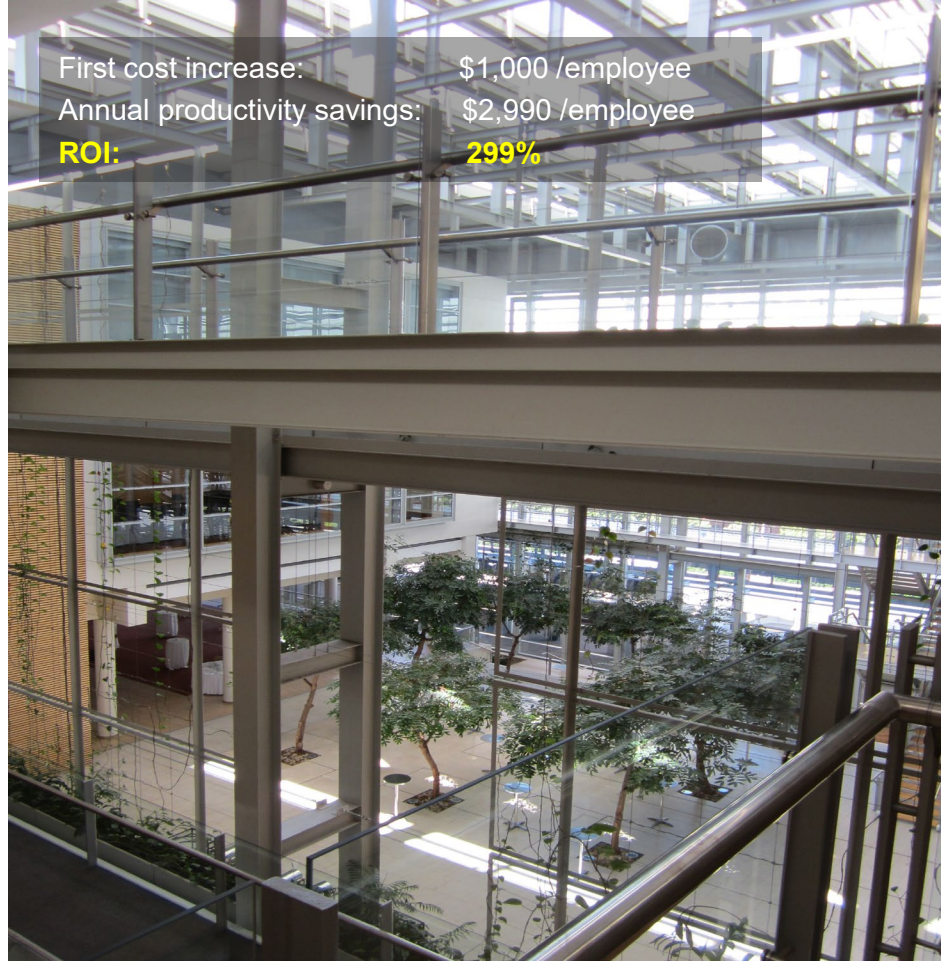


Evidence Based Design/ Pebbles Project: Ulrich, R. (1984) View Through a Window May Influence Recovery From Surgery. Science, 224(4647), pp.420-421.



In a 2003 study of the SMUD Call Center, Heschong et al identify a **6% to 7% faster Average Handling Time** for **employees with seated access to views** through larger windows with vegetation content from their cubicles, as compared to employees with no view of the outdoors.

First cost increase:	\$1,000 /employee
Annual productivity savings:	\$2,990 /employee
<b>ROI:</b>	<b>299%</b>




# Maximize Views



# **How important is Circadian Daylight and Sunshine to human health?**

Daylight circadian spectrums and intensity, sunshine  
heat, sterilization and (bad) microbial reduction?



First cost increase:	\$1,000 / bed
Annual health savings:	\$10,000 / bed / year
<b>ROI:</b>	<b>1,000%</b>

In a 2005 building case study of Inha University Hospital in Korea, Choi identifies a **26% reduction in average length of stay** among surgery ward patients in **SE daylight rooms**, as compared to those in low daylit rooms, during spring and fall seasons.

# Make Daylight Dominant





## *daylight is circadian and hormonal*

**+28% Alertness**

**+36% Concentration**

**+14% Mental Wellbeing**

In a 2005 4-month longitudinal study, researchers identified statistically significant improvements in self-reported alertness (28.1%), work performance (19.4%), vitality (28.4%), and mental well-being (13.9%), (Mills, Tomkins, & Schlangen, 2007).

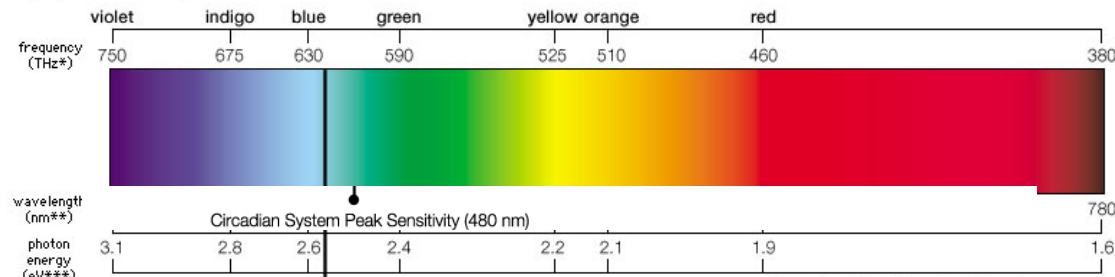
**+6.8% Typing Speed**

A 2013 study discovered “subjects performed significantly better in terms of typing speed under CW light and Daylight than WW light”, typing an average 269 words per minute under WW light conditions and 287 words per minute under DL conditions. (Shamsul, Nur Sajidah, & Ashok, 2013).

**+3.3% Information Processing**

A study in Germany measured a 3.3% increase in speed of information processing after switching from yellowish to bluish light (Lehrl, et al., 2007).

Light, the visible spectrum



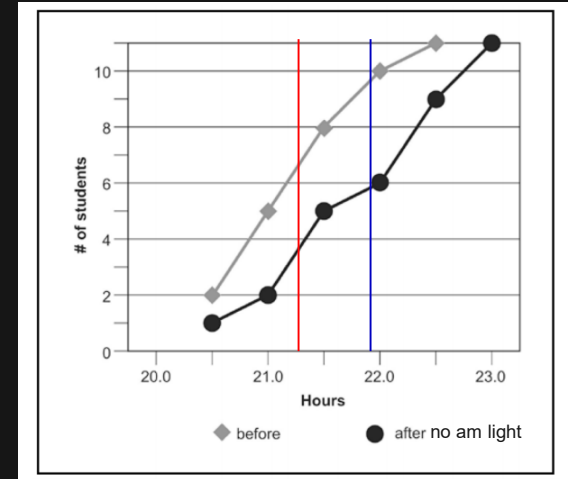


## Daylight = Sleep Cycles (and Performance)

### North Carolina School/ Figueiro and Rea 2012

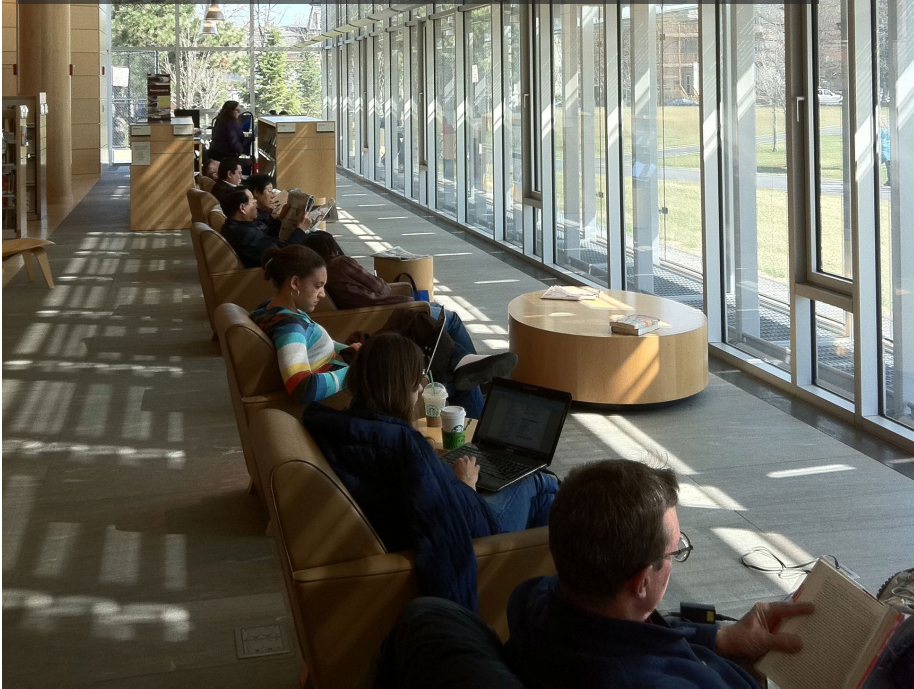
In a 2010 study of sleep cycles of 8<sup>th</sup> grade students in the Smith Middle School in Chapel Hill, Figueiro and Rea identify that student exposure to short-wavelength **morning light significantly regulates their circadian clock and improves sleep times by as much as 30 minutes.**

Wolfson and Carskadon (1998) identified that poor performing students obtained about 25 minutes less sleep per night and went to bed on average 40 minutes later on school nights than those who were good performers.



Dim Light Melatonin Onset DLMO  
● (after – no morning light)

In a 2005 study of 89 patients undergoing elective cervical and lumbar spinal surgery at Montefiore Hospital in Pittsburgh, PA, Walch et al identify a **22% reduction in analgesic medication use** after surgery among patients **in bright, sunny rooms**, as compared to patients located in dim rooms.



First cost increase: \$1,000 / bed  
Annual health savings: \$28 / bed  
**ROI: 3%**

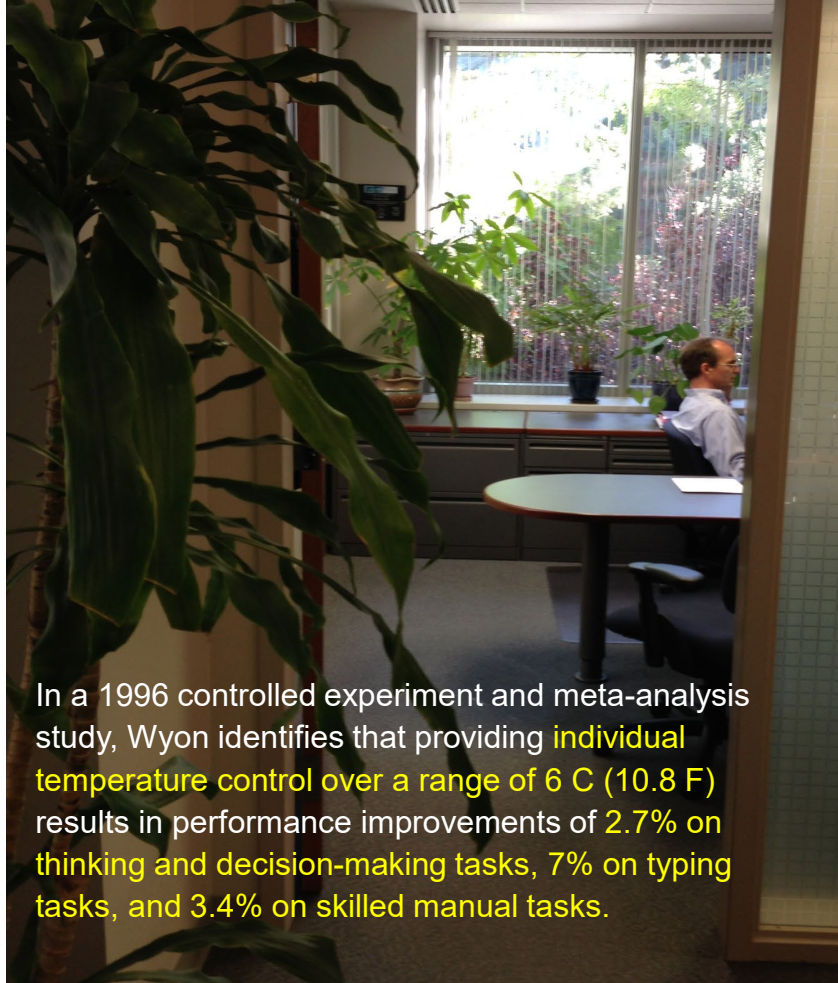
# Celebrate Sunshine



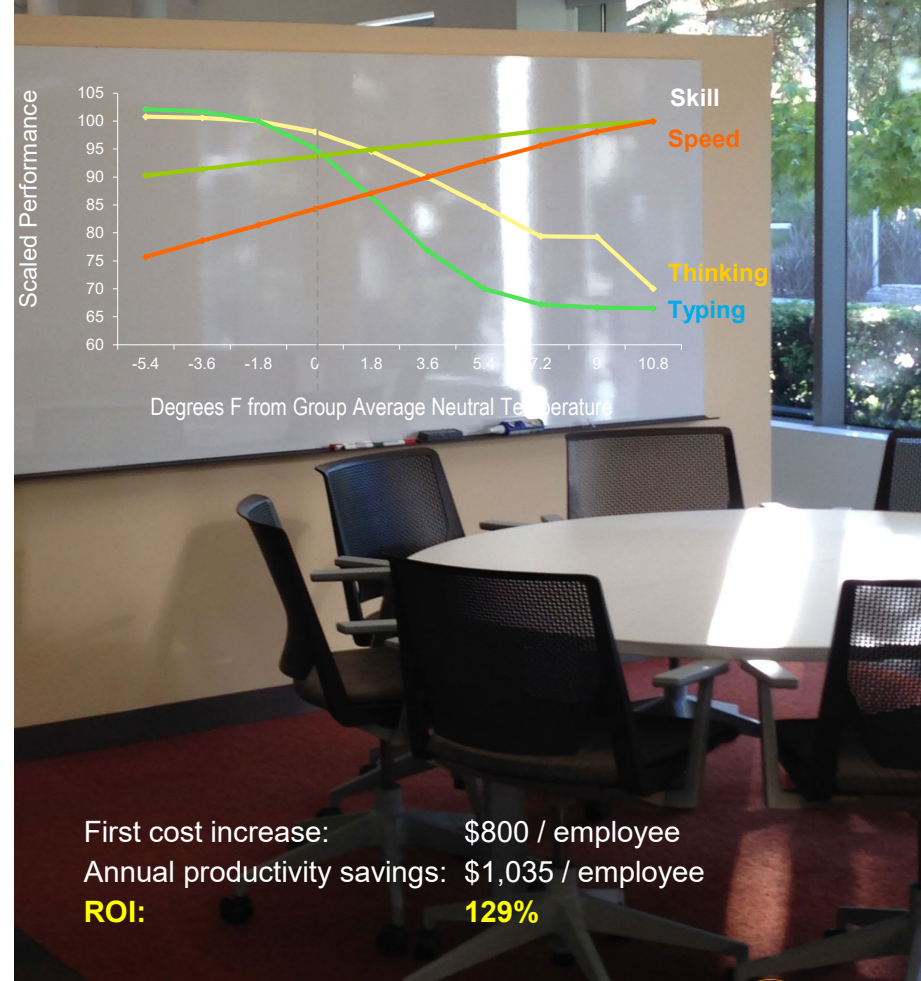
**How important is  
Dynamic Thermal Conditions  
(Alliesthesia)  
to human health?**

Outside air circadian temperatures, radiant temperature variability,  
relative humidity and vapor pressure variability for human health





In a 1996 controlled experiment and meta-analysis study, Wyon identifies that providing **individual temperature control** over a range of 6 C (10.8 F) results in performance improvements of **2.7% on thinking and decision-making tasks**, **7% on typing tasks**, and **3.4% on skilled manual tasks**.

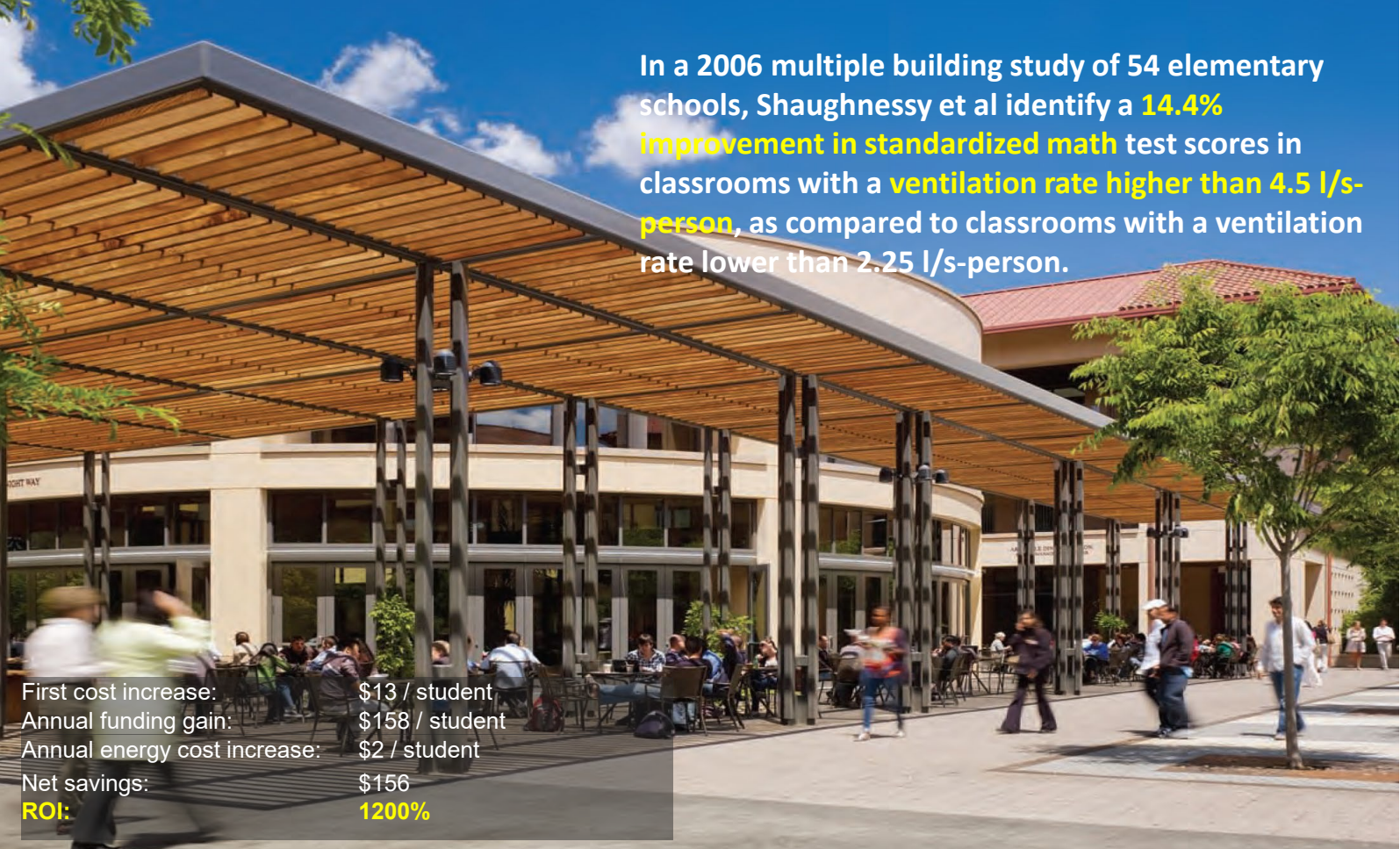


# Give Back Temperature Control



# How important is Natural ventilation and increased outside air to human health?

Outside Air (OA) variability and content  
(is outdoor air microbially worse than indoors?)  
Do outdoor fine particulates increase indoor microbials?  
(Is dilution key to reducing human bacteria and viruses)



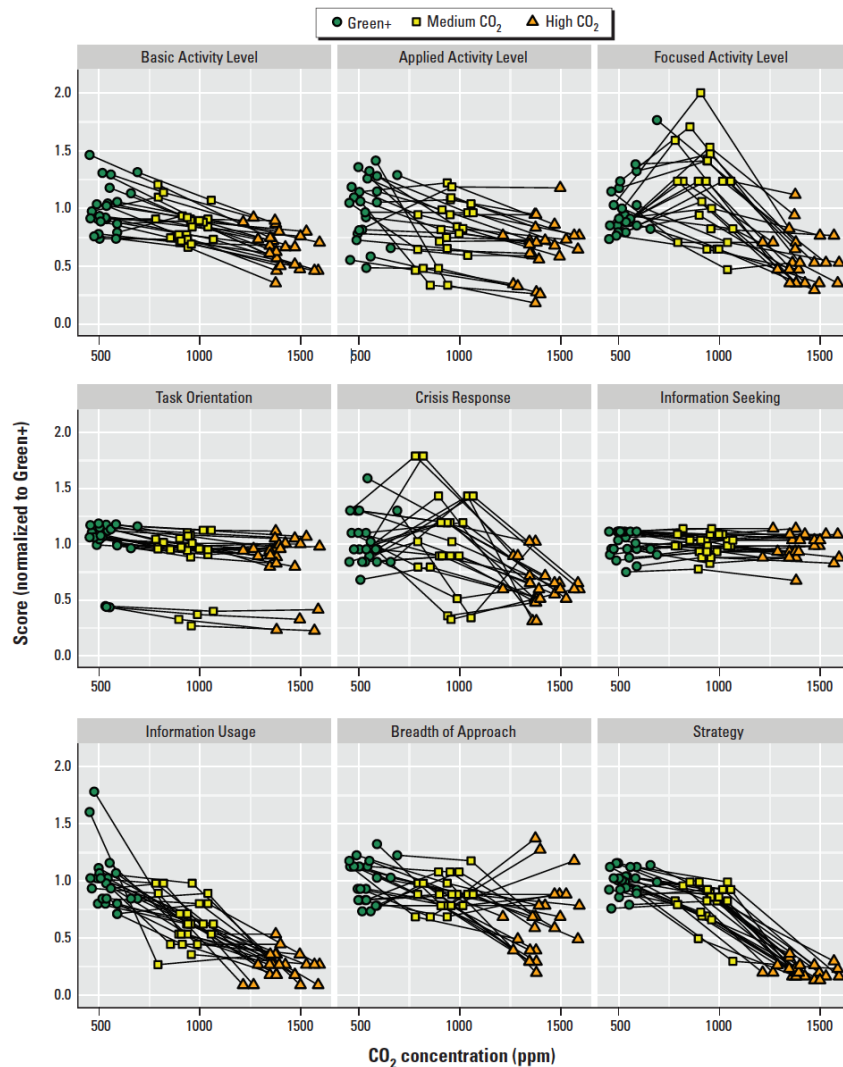
In a 2006 multiple building study of 54 elementary schools, Shaughnessy et al identify a **14.4% improvement in standardized math** test scores in classrooms with a **ventilation rate higher than 4.5 l/s-person**, as compared to classrooms with a ventilation rate lower than 2.25 l/s-person.

First cost increase:	\$13 / student
Annual funding gain:	\$158 / student
Annual energy cost increase:	\$2 / student
Net savings:	\$156
<b>ROI:</b>	<b>1200%</b>

# Increase Outside Air







## *Outdoor air is cognitive and strategic*

### ***Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments***

Joseph G. Allen, Piers MacNaughton, Usha Satish, Suresh Santanam, Jose Vallarino, and John D. Spengler, Environmental Health Perspectives • volume 124 | number 6 | June 2016

In a 2004 multiple building study in France, Preziosi et al identify a **57.1% reduction in sickness absence** and a 16.7% reduction in doctor visits among workers with **natural ventilation** in their workplace, as compared to those with air conditioning.



First cost increase:	\$1,000 / employee
Annual health savings:	\$181 / employee
Annual productivity savings:	\$85 / employee
<b>ROI:</b>	<b>27%</b>

# Open Windows



# **How important is increased access to outdoor spaces and community to human health?**

Microbial diversity and probiotics of the outdoors?

Lung activity and outdoor exercise?

Biophilia as air cleaner, humidifier, thermal regulator...

Dynamic sounds, smells, biophilic and sensory cues



## *Landscape design = Individual Productivity*

### **Georgia Schools / Tanner 2000 (School)**

In a 2000 multiple building study of 14 schools in Georgia, Tanner identifies a statistically significant relationship between quality and functionality of a school's outdoor space and students' academic achievement, indicating a **14.5-point (7%) increase in standardized test scores for each one-point improvement in rating of outdoor space on a scale from 1-10.**

First cost increase:	\$84 / student
Annual O&M cost increase:	\$5 / student
Annual productivity savings:	\$176 / student
<b>ROI:</b>	<b>204%</b>

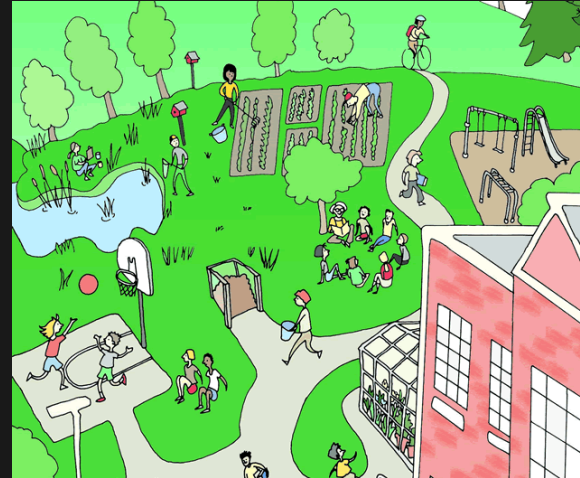


Image: Wisconsin Green and Healthy Schools Program



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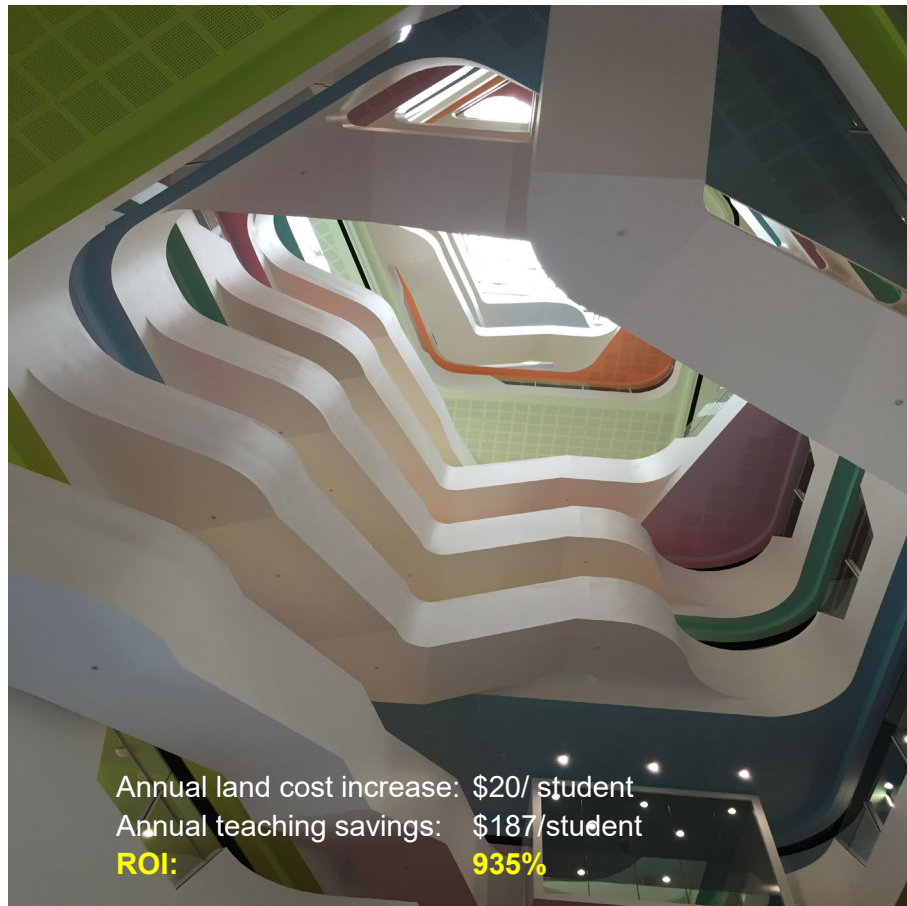
# Ensure Access to Nature







In a 2004 Chicago field study of 17 children professionally diagnosed with ADHD, Kuo and Faber Taylor et al identified a **17% improvement in performance (digit span backwards test)** after a 20 minute walk in a **park** as compared to built urban settings.



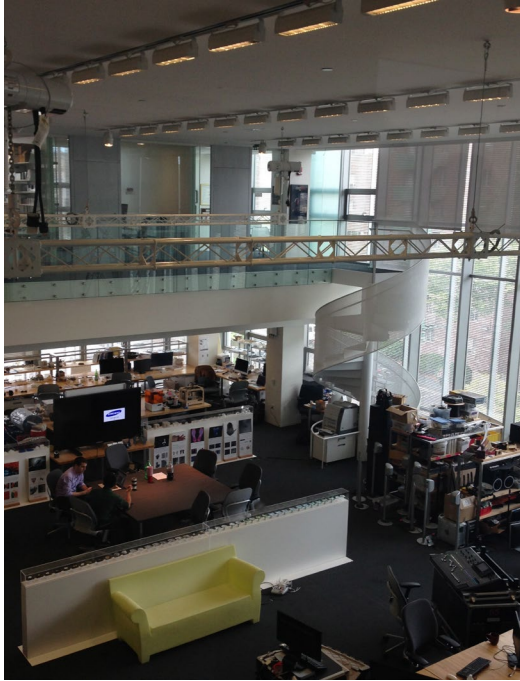
# Design for Active and Fit





### Unknowns?

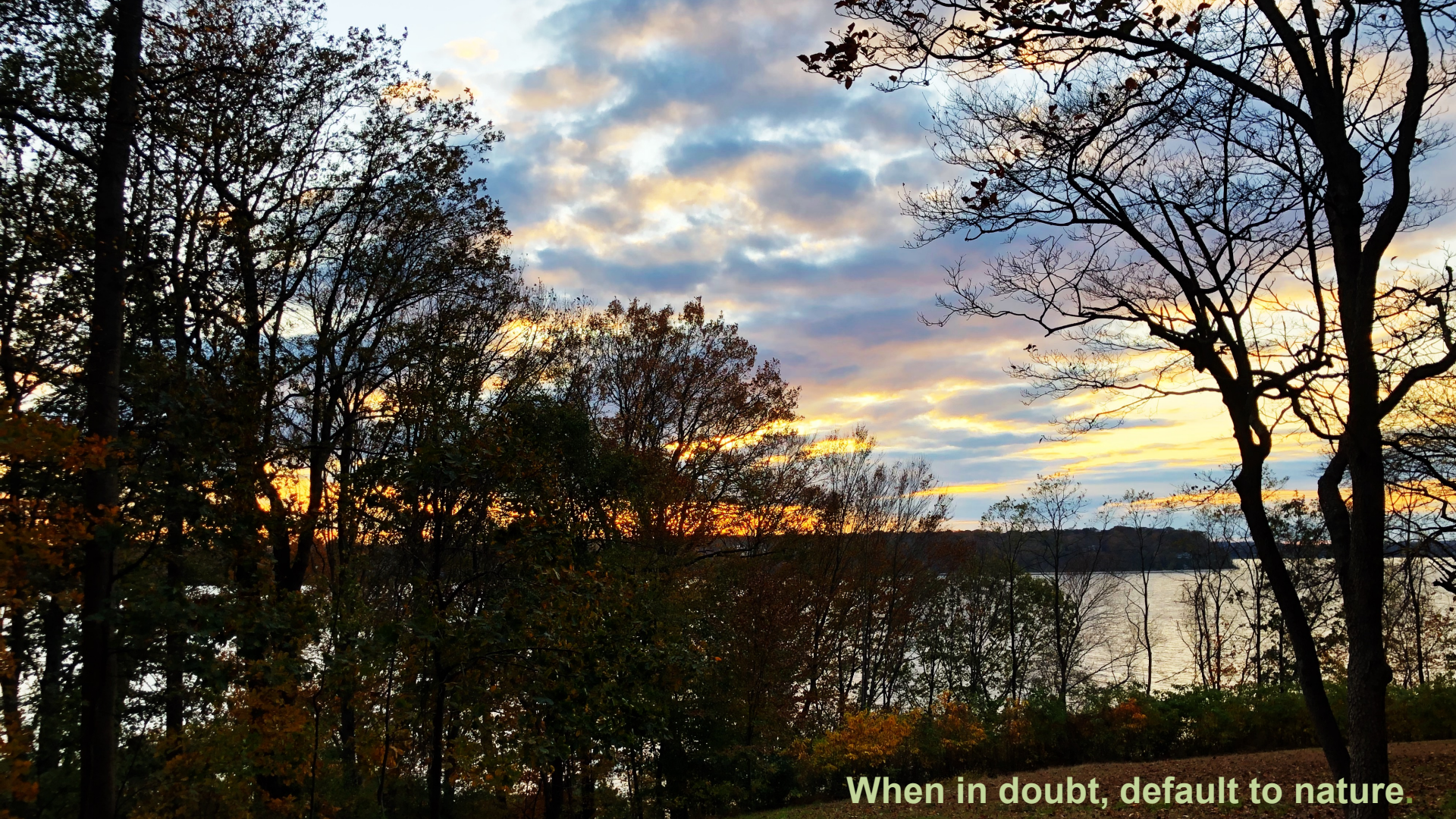
Sounds of Nature  
Smells of Nature  
Sensory Feel of Nature  
Natural Materials  
Nature's Complexity and Order  
Craft – the Human Hand  
Art – Nature's Imagery  
Community  
Dynamics of Culture, Time and Place



# Support Community & Collaboration





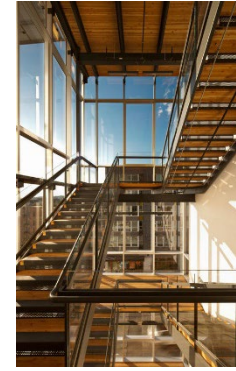
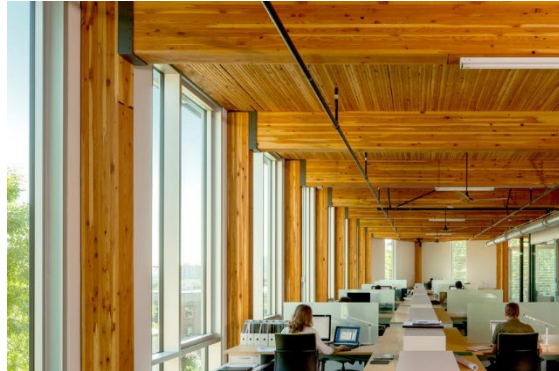


**When in doubt, default to nature.**





GHD Theater - Daylit & Naturally Ventilated **Theater**, University of Queensland Australia (Richard Kirk, Hassell)



Bullitt Center Daylit & Naturally Ventilated **Offices**, Seattle (Miller Hull, PAE Eng)

## Mixed Mode: Daylight & Electric Light



**Terry Thomas Offices in Seattle (SmithGroup and DPR)**  
Natural Cooling only with demand controlled ventilation



**H.E.B. Retail in Texas (Lake Flato and Arup)**  
Natural Cooling + A.C. (Side by Side & Changeover)

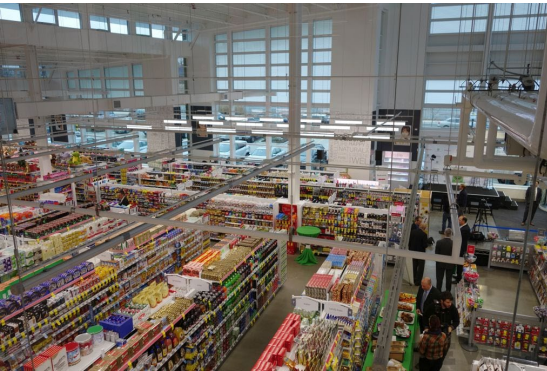


# Mixed Mode: Natural Cooling & Mechanical

The Leala **Hotel** in Kovalam India (Charles Correa)  
Natural Ventilation + A.C. (Side by Side or Zoned)



Walgreens **Retail** in Illinois (Camburus, GI Energy)  
Natural Ventilation + A.C. (Changeover)



# Mixed Mode: Natural Ventilation & Mechanical





The sixth floor "Garden in the Sky" is used frequently for formal and informal meetings and events.

Institute of Building Research **Offices** in Shenzhen, China (Ye Qing)  
Natural Cooling + A.C. (Changeover)



Ng Teng Fong **Hospital** in Singapore (Studio 505, HOK, CPG Eng)  
Natural Cooling 70% patient rooms, each bed with garden



**Mixed Mode: Outdoor & Indoor Work/Learn/Play/Heal**





## Access to Nature for Human Health & Sustainability

Views

Circadian Light

Solar Heat

Thermal Variability – Alliesthesia

Natural Ventilation

Access to Nature – Active Design

Sounds of Nature

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The Intelligent Workplace – A living laboratory at Carnegie Mellon University