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Many of us are asking ourselves how we can best use our time during the disruption caused by the COVID-19 pandemic. For many, one answer is “learn something new”.

To support people and companies with a vision of the future in which preserving access to nature and interior landscaping is **more relevant than ever**, Green Plants for Green Buildings has created an edited version of our continuing education course, The Economics of Biophilic Design. It looks at the science behind the crucial role nature plays in maintaining our wellbeing, and includes research data from five sectors (education, health care, retail, workplace, and communities) on the impact biophilic design has on health, productivity and profits. We hope you’ll share this compelling information with your teams and create talking points for your client conversations.

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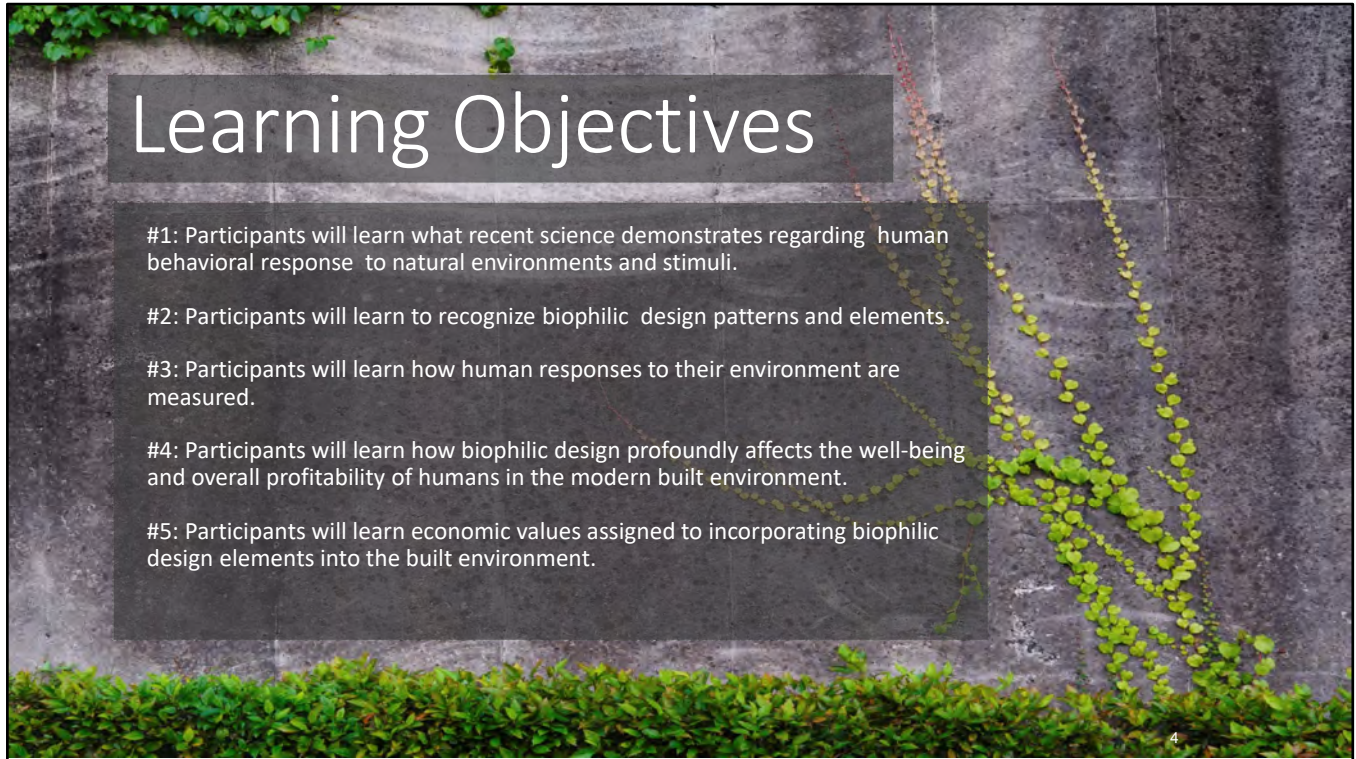
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Course Description

This program will examine the economic argument in favor of biophilic design using case studies from five sectors; workplaces, health care, education, retail and communities. Research from neuroscience and endocrinology show the crucial role that experiencing nature has for our physiological well-being. Today we will describe the research involving biophilic design and its impact on human health and productivity.

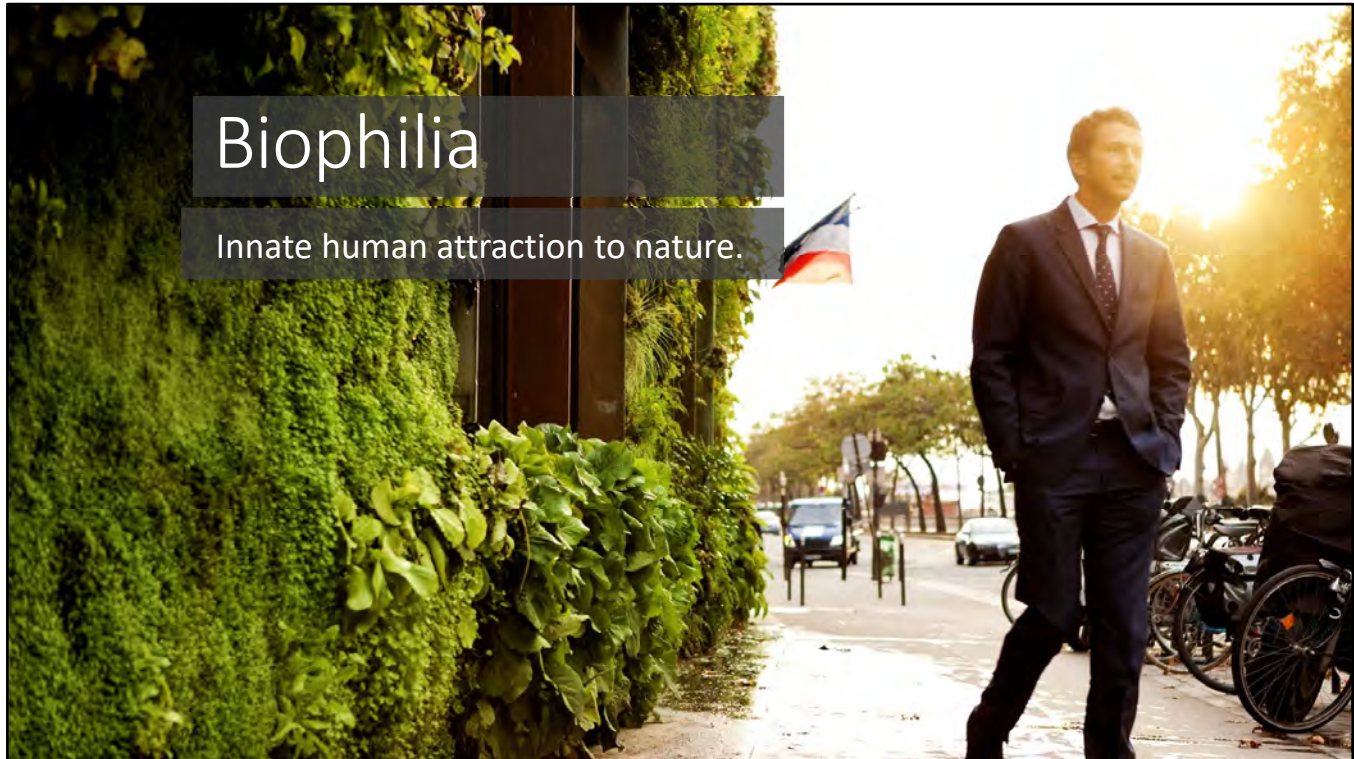


Learning Objectives

- #1: Participants will learn what recent science demonstrates regarding human behavioral response to natural environments and stimuli.
- #2: Participants will learn to recognize biophilic design patterns and elements.
- #3: Participants will learn how human responses to their environment are measured.
- #4: Participants will learn how biophilic design profoundly affects the well-being and overall profitability of humans in the modern built environment.
- #5: Participants will learn economic values assigned to incorporating biophilic design elements into the built environment.



“Life around us exceeds in complexity and beauty more than anything else humanity is ever likely to encounter” – E.O. Wilson



- Biophilia when translated from Latin means “love of life or living systems”.
- Biophilia as a hypothesis was first expressed by German social psychologist Erich Fromm in 1964 and later popularized by American biologist EO Wilson, in his 1984 publication ‘*Biophilia*’.
- Wilson’s description was “Biophilia is the innately emotional affinity human beings have for other living organisms. Innate means hereditary and hence part of ultimate human nature.” – E.O Wilson
- Over the last three decades the scientific and design communities have begun to recognize biophilia and perform experiments designed to prove or disprove the hypothesis. And the research evidence is flooding in. Scientists are proving the biophilia theory.
- And this makes such sense! Humanity has spent 95% of its evolutionary history in the embrace of the natural environment. We are hardwired to respond to the stimuli of our natural surroundings.
- Biophilia implies that humans hold a biological need for connecting with nature on physical, mental, and social levels, and that this connection affects our personal well-being, productivity, and societal relationships.



To increase our comfort and productivity, humans have traditionally improved the places in which we live and work.

Technological advancements in building design have improved the health and welfare of building occupants and paid little attention to our physiological needs.

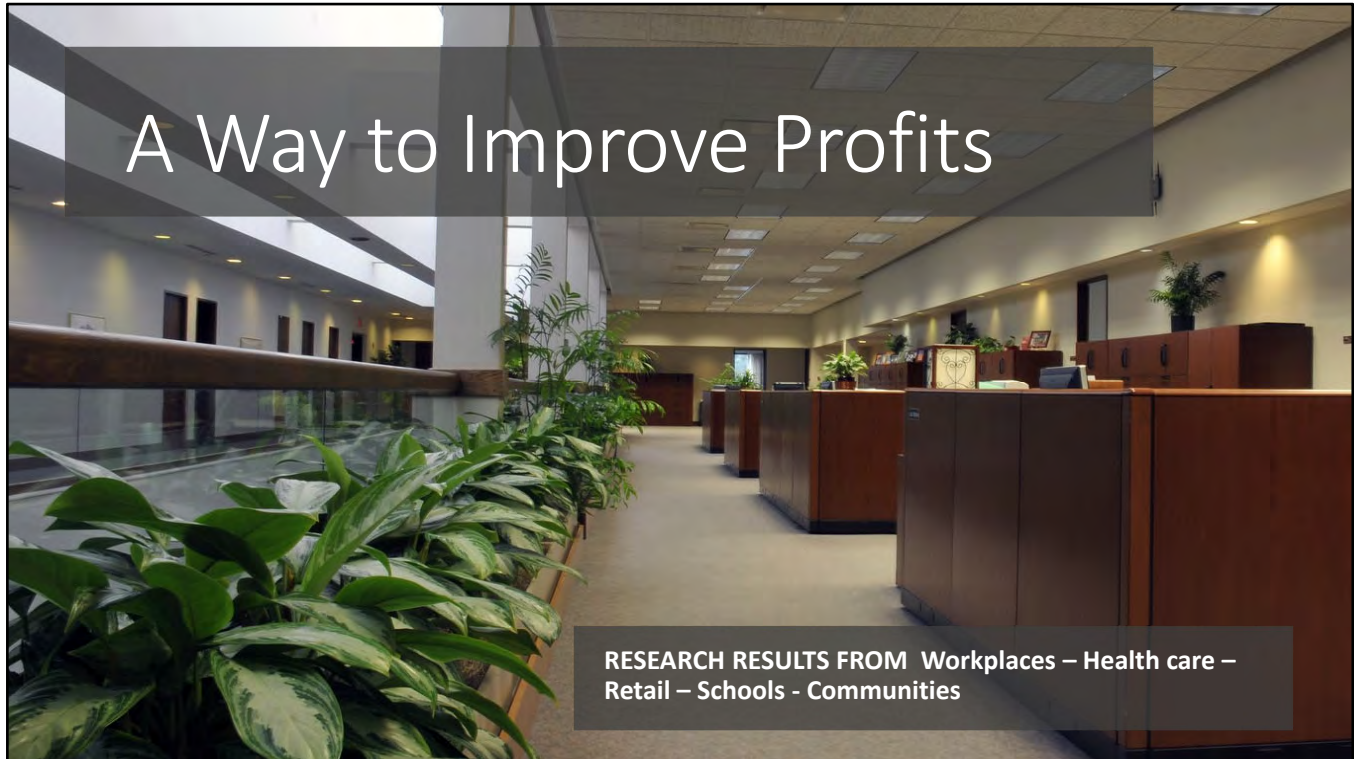
Recent advancements in our understanding of the subtle neurological and physiological functions associated with exposure to nature have allowed us to identify strategies to improve productivity, strengthen the social fabric of communities and increase economic gains.

While biophilia's cognitive benefits have been well documented, the economic benefits of biophilic design remain relatively under-documented.

And sharing some of these economic benefits with you is what I'd like to do here today.



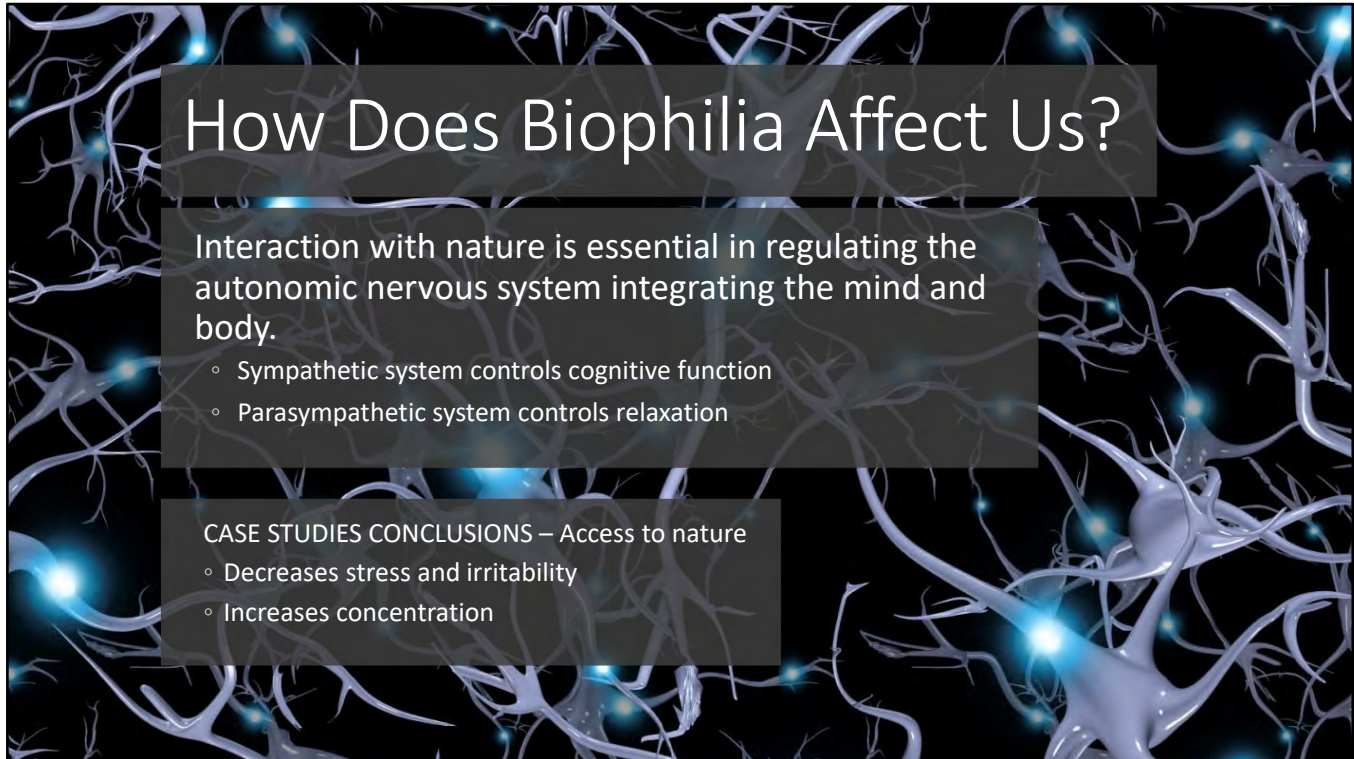
- As of 2007, the majority of the human beings around the globe, are urban dwellers, despite having spent 95% of our evolutionary history in natural environments. The migration to cities has only occurred within the last 200 years and our bodies and minds have been unable to adapt to such a drastic change in our environments.
- Urbanization has brought with it higher levels of stress, crime, depression and lower levels of productivity and learning, sometimes in the forms of absenteeism and presenteeism.
- In regards to this lower level of productivity, did you know that in the workplace, the loss of productivity costs are 112 times greater than energy costs?
- Considering this, it can be concluded that incorporating nature into the built environment is not just a luxury, but a sound economic investment for anyone in the business of managing people.
- We're not going to be able to turn back the rural exodus. We need to make our cities and urban environments more livable. This can be achieved in part through greater access to nature which restores and enhances our mental health and well-being.



- Today's presentation will
 - make the connection between biophilic design and human well-being,
 - examine how productivity, health, and well-being can be measured
 - and translate those measurements into economic savings and gains.

We wish to demonstrate the economic value of paying attention to biophilic design to improve profits. While some perceive plants as a luxury, the science says they are a way to improve profits.

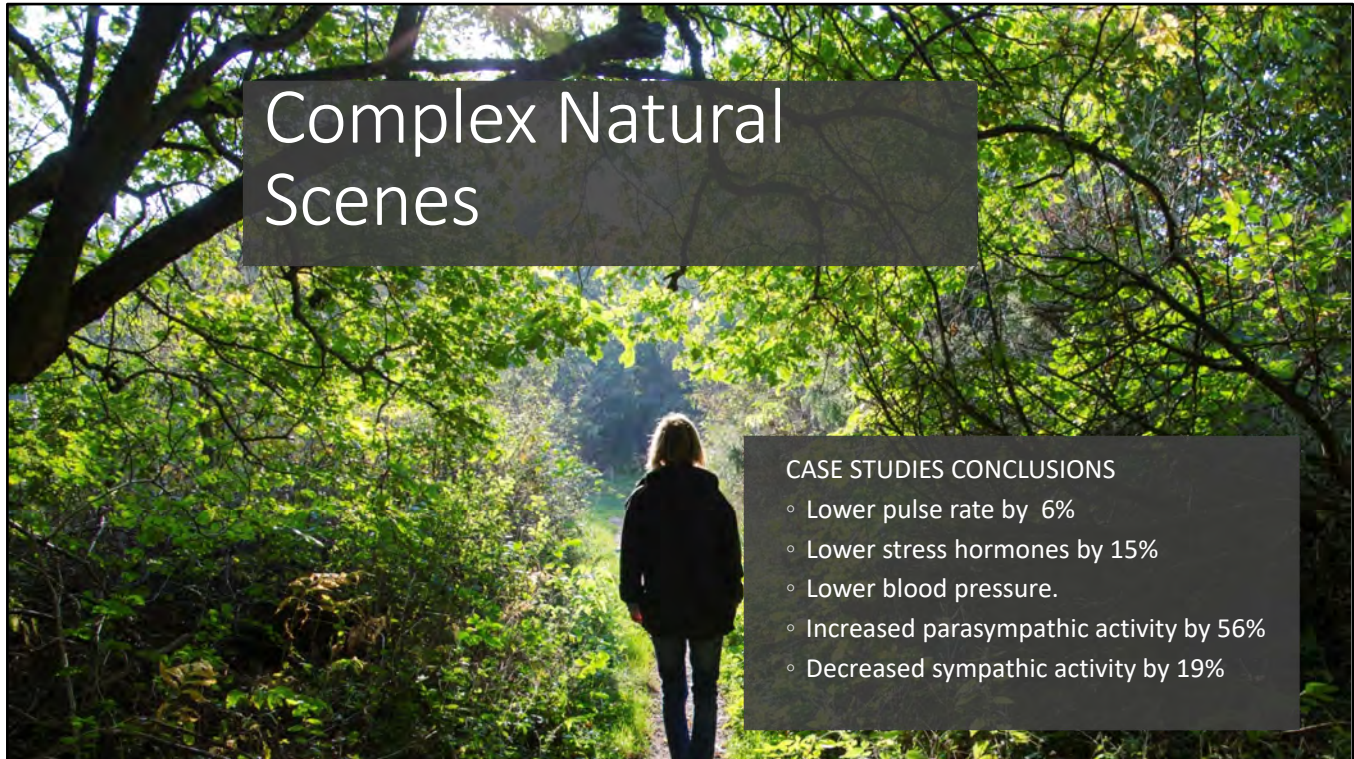




- There is a neurological and physiological basis for biophilia.
- The human body's autonomic nervous system consists of two elements: the sympathetic and the parasympathetic systems.
- The sympathetic system stimulates the human body when cognitive function is needed.
- The parasympathetic system serves to relax the body, and is used for internal processes such as digestion.
- The body is in an ideal state of balance when the natural balance between sympathetic and parasympathetic is achieved. Scientists call this homeostasis.
- In non-restorative or chaotic environments, the sympathetic system becomes highly stimulated in a "fight-or-flight" mindset, leading to sensory overload.
- When this happens, the parasympathetic system is suppressed, disrupting the body's physiological regulation, and resulting in mental fatigue. This combination induces stress, frustration, irritability, and distraction.
- Studies show that interacting with nature provides an increase in parasympathetic activity, resulting in reduced sympathetic activity. This in turn leads to decreased stress and irritability, and increased levels of concentration.



- In the large rear portion of our brain's visual cortex are the mu (opioid) receptors.
- When our eyes perceive natural scenes, the mu receptors are highly stimulated, triggering feelings of pleasure. The more dynamic the natural scenes - such as moving water, leaves in a breeze, fish swimming in an aquarium, or a flickering fire - the more our attention is held. This is an environmental and physiological state of being in which creative task performance is increased.
- In studies where subjects were exposed to views with less visual richness - such as a blank wall or a tree-less street - less pleasurable mental reactions were triggered, including those associated with stress. (Biederman & Vessel, 2006)



- How did nature affect research subjects?
- Studies shows that, when compared to those who walked through urban areas, subjects who walked through forests had
 - Reduced pulse rate of 3.6-6%
 - Lower systolic blood pressure
 - Reduced stress hormone levels by 13.4-15.8%
 - Increased parasympathetic activity – more relaxed by 56%
 - Decreased sympathetic activity by 19% - remember this is the “fight or flight” reflex

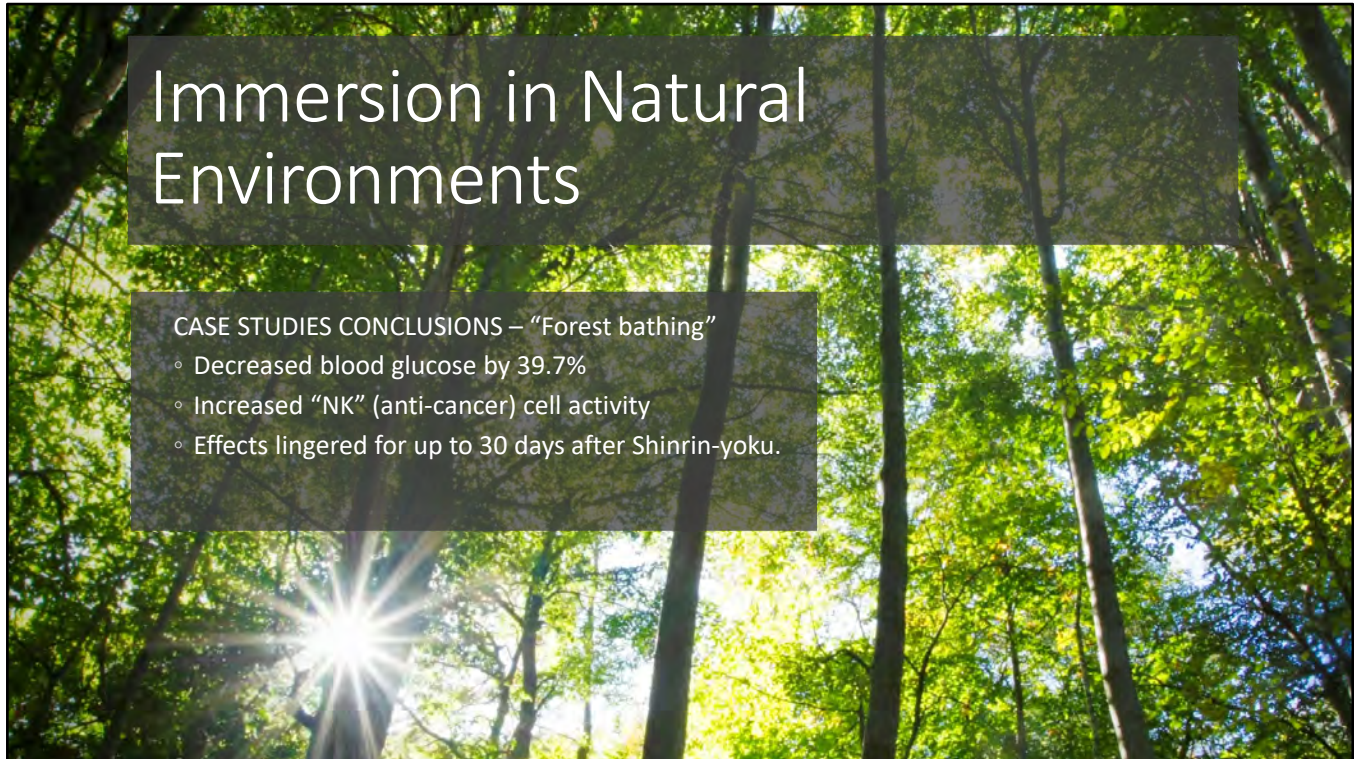


Reducing Stress

Stress causes mental health disorders and cardiovascular diseases.

Direct access to nature can alleviate feelings of stress.

- According to the World Health Organization, mental health disorders and cardiovascular diseases are expected to be the top two global disease burdens by 2020 (WHO, 2008).
- Stress is a known cause of both these disorders.
- In America, treatment for cardiovascular disorders accounts for \$1 of every \$6 spent on healthcare. (CDC, 2011).
- The good news is that over and over again, research results indicate that access to nature can alleviate feelings of stress.
- In one study, after viewing videos of natural environments and urban environments, test subjects heartbeat intervals rates were measured. Those subjects viewing natural environments experienced positive cardiac deceleration and beneficial physiological arousal. (Laumann et al., 2003).



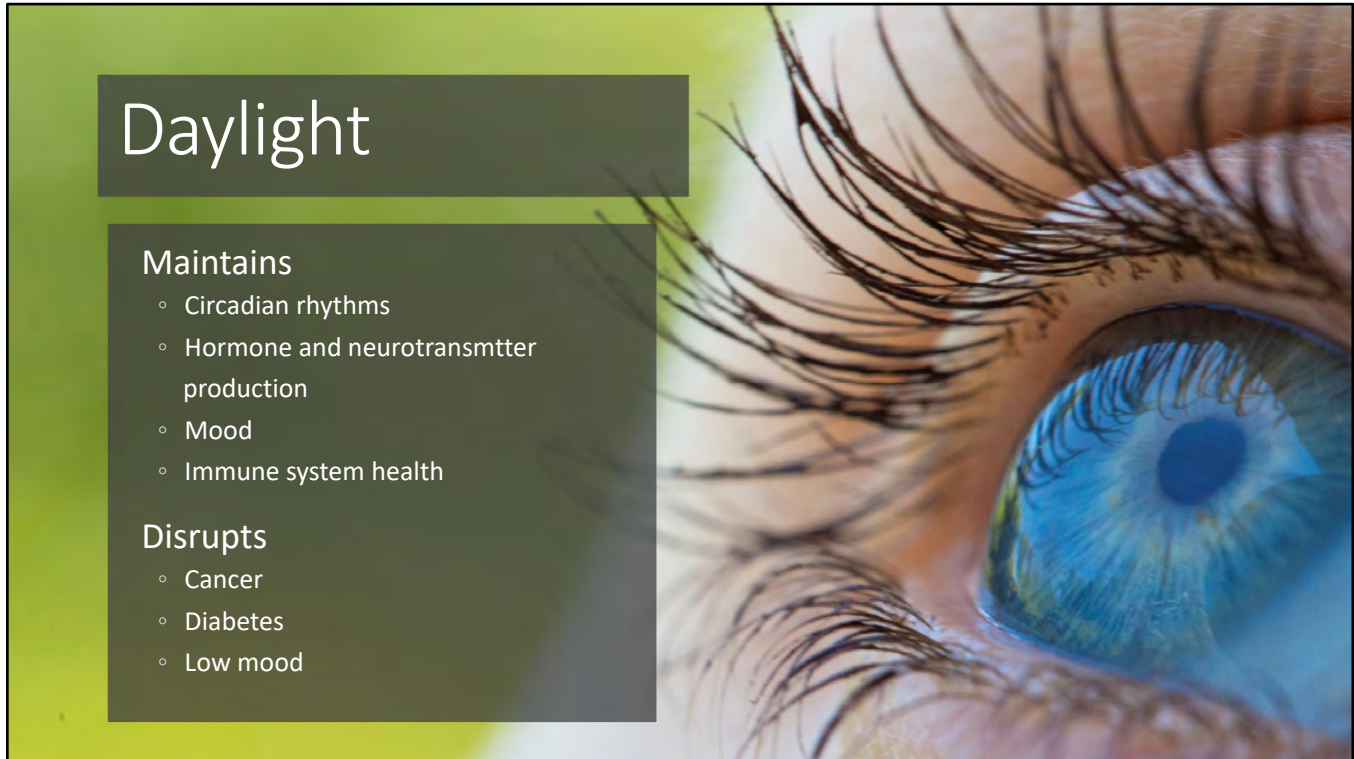
Another field of research surrounding human interactions with nature provides solid evidence of the benefits of natural environments on human health.

Shinrin-yoku is the ancient Japanese practice of restorative walks through natural settings, most often forests.

- In English, the direct translation of Shinrin-yoku is “forest bathing”.
- Research performed over the course of six years tested Shinrin-yoku’s ability to effectively decrease blood glucose levels in patients who walked 3-6 kilometers in forested areas.
- Compared with other forms of exercise, which effectively reduced blood glucose levels by 21.2%, forest bathing decreased blood glucose by an impressive 39.7% (Ohtsuka, 1998).

Forests excrete organic compounds called phytoncides, and as we breath them, human hormonal secretion and autonomic nervous functions are stabilized.

- New Shinrin-yoku studies show that inhaling these pungent compounds has tremendous health benefits that are difficult to reap in the urban and built environments.
- Such benefits include increased Natural Killer (NK) cell activity (vital for deterring cancer) for up to 30 days after the forest walk.



Our body's response to daylight is another important clue as to how we can harness the power of biophilia.

Do you know anyone who is affected by Seasonal Affective Disorder (SAD)?

Daylight affects both our eye functions and our inherent circadian rhythms, the daily cycle of hormonal activity observed in living organisms.

Exposure to natural light balances our hormonal levels of serotonin (linked to our mood) and inhibits the production of melatonin (used to regulate sleep).

- When there is an imbalance of serotonin and melatonin in our bodies, our sleep-wake pattern is disturbed, which in turn inhibits the functioning of our neurological and immune system functions.

Light therapy works by exposing the retina to specific wavelengths of light to treat imbalances of circadian rhythm.

Sunlight on a clear day is 500 to 1,000 times greater than artificial lighting (Boyce, 2010). This is an important consideration while designing indoor environments to incorporate more natural light.

Inefficient access to natural daylight and excessive exposure to artificial light can lead to disruption of hormone regulation and circadian rhythms, which in turn can increase the risk of developing cancer, diabetes, low mood and depression.



- One of the many components of biophilia's influence is the connection that humans have with certain fractal patterns that appear commonly in the natural world.
- Fractal patterns found in nature can positively affect human neural activity and parasympathetic system mechanisms. In a case study, when subjects were shown images of fractal patterns in nature or townscapes of the built environment, they were more relaxed when exposed to natural landscapes.
- The study concluded that in environments with many stimuli and patterns, the patterns that are most likely to hold our attention and induce a relaxed response are fractal patterns commonly found in nature (Hagerhall, 2008).
- The human brain has evolved to process shapes and forms found in nature and does so with minimal effort. This reduces energy required to process imagery and allows for restoration to take place. This is known as perceptual fluency.



Before we move into the next segment, I'd like to break up the presentation and get your involvement in our experience here today.

There are index cards and pencils on your chairs and if you don't have them please flag me and we'll bring you one. I'd like you to take a moment to close your eyes and visualize your personal vision of a healthy workplace. To help you visualize it is probably better to close your eyes so that your eyeball eyes don't distract your mental eyes. So you are in your ideal workplace...What happens there?. ... What does it look like?... It could be anything from clean bathrooms to a respectful boss and responsible co-workers.

Take a few minutes to think about this...and write your thoughts down on the index card. Then I'd like you to pair up with your neighbor and take turns telling each other what you've got down on your card.

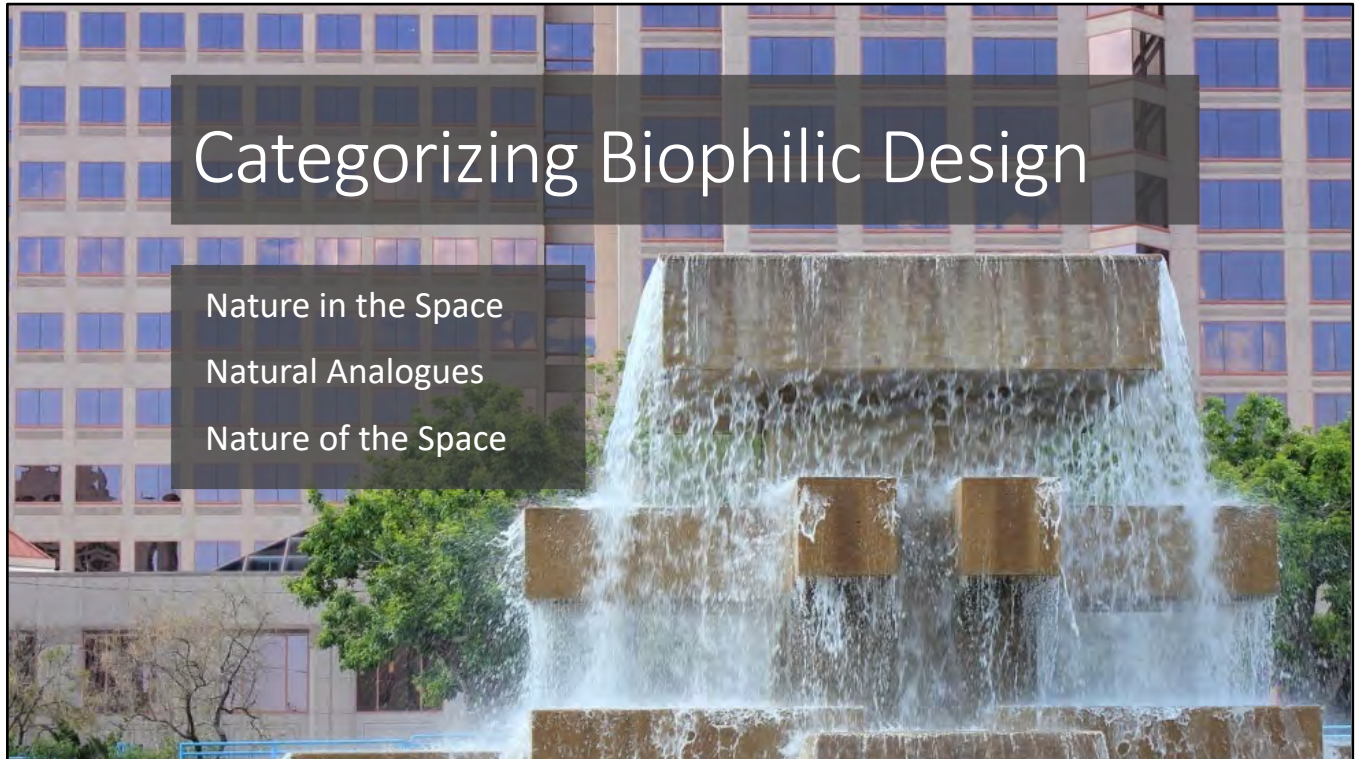




Biophilic design aims to restore natural stimuli in the built environment so that our physiological, cognitive and psychological connections to the natural world are maintained, restored, and enhanced.

This design ethic is based on research evidence gathered over the last 50 years.

Photo: Mike Lewis, Foliage Design Systems, Orlando, FL



Three pillar concepts serve as the tenets of biophilic design.

I like to think of it in this way. Within the biophilic design toolbox there are three tools.

The tools are Nature in the Space, Natural Analogues, and Nature of the Space.

A design solution may use one, or all, of these tools in creating or retrofitting a space that connects its inhabitants with nature.



Nature in the Space refers to the incorporation of plants, water and animals into the built environment. Examples include potted plants, water features, aquariums, and courtyard gardens, as well as views to nature from the inside of the building. Of the three tools, these direct connections to nature—especially dynamic nature that incorporates movement— produce the strongest biophilic reactions.

The very strongest responses were to Nature in the Space designs that included visual and other sensory diversity, plants at different levels and distances, dynamic movement like those expressed in breezes and water, and sound and aromatic scents.

Photo: Janice Goodman, Cityscapes, Boston.



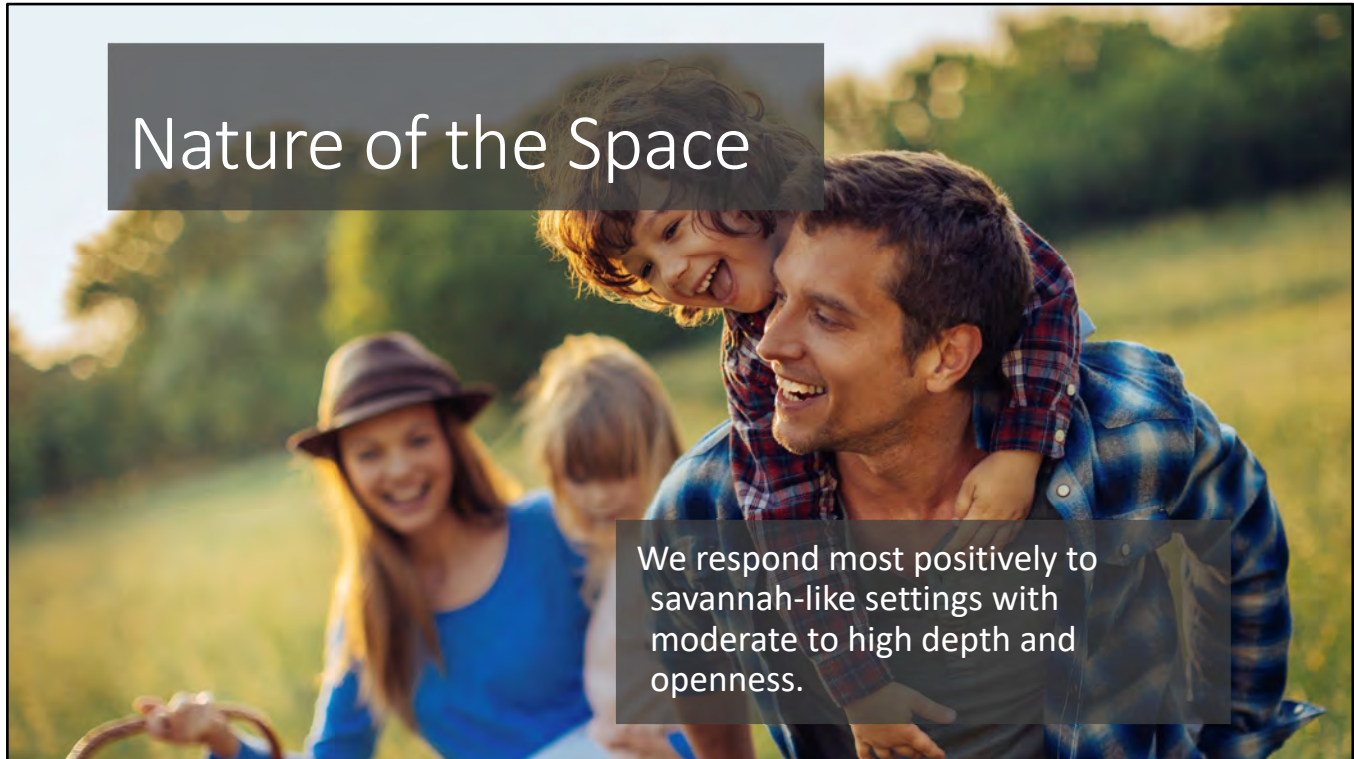
Natural Analogs

The second tool in the biophilic designer's toolbox are natural analogs.

Natural analogs provide an indirect connection with nature and are useful in projects where living natural stimuli are not feasible.

What are they? They are objects, colors, shapes, patterns and sequences, like fractal patterns, which are found in nature. Where do they appear? They appear in artwork, furniture, textiles, decor and ornamentation.

The well-being benefits of exposure to natural analogs are measurable and effective although less effective than exposure to the first tool, nature in the space.



The 3rd tool is Nature of the Space.

Nature of the Space refers to the way humans respond psychologically and physiologically to different spatial configurations.

As mankind developed in the savannahs of Africa, our species' existence among low-growing grasses, clusters of shade trees, and broad vistas have yielded a modern-day affinity for similar landscapes in indoor and outdoor environments (Kellert et al., 2008).

In fact, more specifically, we are hard-wired to prefer open spaces that are savannah-like settings with moderate to high "depth and openness".

This is good to know – that our brains are wired this way. When does it mean when applied to an indoor environment?



So of these 3 tools, clearly for us as plant people, the first tool “Nature in the Space” is the tool we are using most frequently. And this tool is a little like a Leatherman or multi-tool; we have plants, we have lighting, we have water features and dynamic movement.

What is dynamic movement? It is a little like vitamin DM. It makes all of the other biophilic design elements more powerful.

What does dynamic movement look, feel and sound like? Moving water, swaying branches and grasses, birdsong, crickets and natural fragrances and aromas.

With research done in an office setting, the most positive physiological responses were recorded in environments where dynamic movement was a design element.

Researchers measured better focus, mental stamina, and productivity— desirable traits that all office managers and employers seek (Kahn, 2008). Worker productivity was enhanced and absenteeism was reduced by up to 15%.



In this section of our presentation we are examining the fiscal implications of plants and nature-based design in four sectors:

- Workplaces;
- Healthcare;
- Schools;
- Retail stores.

As the medical and behavioral data began to accumulate, economists got involved and began to establish the economic cost of things like

...absenteeism due to depression

...or the economic gain to a medical facility when a patient requires less pain medication and is able to be released earlier.



In the past, the economic benefits of reconnecting people to nature were often overlooked because of the difficulty in economically quantifying the variables associated with the positive outcomes.

Then scientists began to tackle this issue and the research results of neuroscientists and economists were correlated with the result that we are now able to establish the economic cost of things like absenteeism due to depression or the economic gain to a medical facility when a patient requires less pain medication and is able to be released earlier.

Over the last quarter century, case studies have documented that ignoring human affinity for nature diminishes the potential for financial growth.

We can begin to understand the fiscal implications of biophilic design across the economy by examining five of these sectors:

- Workplaces;
- Healthcare;
- Retail stores;
- Schools; and
- Communities

The numbers presented are powerful evidence that when biophilic design strategies become incorporated into traditional design strategies positive impacts on human health, child development, community safety, and worker satisfaction will follow. And these effects translate directly to increased profits.



How do scientists take the evidence for these productivity benefits and translate it into economics?

Current research uses both direct and indirect approaches.

•**Direct** measures of productivity encompass quantifiable reported values. These metrics can be assigned monetary values in their respective settings and directly converted to cost savings for a company or institution.

•**Indirect** measures of productivity include absenteeism, tardiness, hours worked, safety rule violations and other measures that add up quickly in a corporate budget (Miller, 2009).

•For this presentation, indicators of productivity will include the following and will be translated into dollars where most applicable:

- Illness and absenteeism
- Staff retention
- Job performance as related to mental stress and/or fatigue
- Healing rates
- Classroom learning rates
- Retail sales
- Violence statistics



WHY BOTHER?

I'm glad you asked 😊

Industries spanning a variety of sectors—from hospitals to corporate offices—spend, on average, 112 times the amount of money on people as they spend in energy costs.

This is precisely where the argument for biophilic design begins to pique the interest of business & building owners, CEOs, school superintendants, and policy-makers.

Small improvements in productivity and reduced absenteeism could boost profits and the bottom line more dramatically than reducing energy costs. In short, productivity drives profit.



2011 Bureau of Labors statistics say that professional and business employers pay their employees an average of \$33.24 an hour or \$67,880 per year—fifteen workers alone can cost an employer over \$1 million in salary (Bureau of Labor Statistics, 2011a, 2011b).

The main causes for deficient productivity include absenteeism, loss of focus, negative mood, and poor health. The built environment, though not always the cause of these stressors, when well-designed, can relieve some of these unwanted symptoms.

In the last decade, American psychologists have aggregated the five strongest requirements for basic functioning that, if neglected, can trigger worker comprehension problems and dissatisfaction at the office (Kellert, 2008). These are:

- Need for change (varying temperature, air, light, etc.)
- Ability to act on the environment and see the effects
- Meaningful stimuli (stagnant atmospheres cause an onset of chronic stress)
- One's own territory to provide safety, an identity, and protection
- View to the outside world

These research findings present an argument for putting plants, in addition to the building entry, in the employee areas. Where is profit being made or lost? Where your staff is.

Absenteeism

The problem

- Private sector: annual absentee rate per employee 3%
- Public sector: annual absentee rate per employee 4%
- Compounded costs over time

Minor reductions in absenteeism can yield significant annual savings

Biophilic design implemented in the workplace can reduce absenteeism, reduce complaints, improve productivity, and help enhance employee retention strategies.

In 2010, the US Department of Labor reported the following statistics:

For the private sector an annual absenteeism rate of 3% per employee—or 62.4 hours lost, per year, per employee. Based on an average wage of \$32 an employer will lose \$2,074 per employee per year to employee absences. A company with twenty employees will lose over \$41,000 in salary costs.

The number is even more dramatic for the public sector where the annual absenteeism rate is 4% per employee—or 83 hours per year per employee. Government agencies will lose \$2,502 per employee, per year to employee absences.

In both sectors, efforts to reduce absenteeism by even a fraction of a percent through the implementation of biophilic design can yield substantial financial benefits for an organization.



The potential for building design to cut human resources costs is highlighted by a 2011 study of an administrative office building at the University of Oregon (Elzeyadi, 2011), in which:

- 30% of the offices overlook trees and a manicured landscape to the north and west
- 31% overlook a street, building and parking lot to the south and east
- 39% of the offices are on the interior of the building, offering no outside view at all.

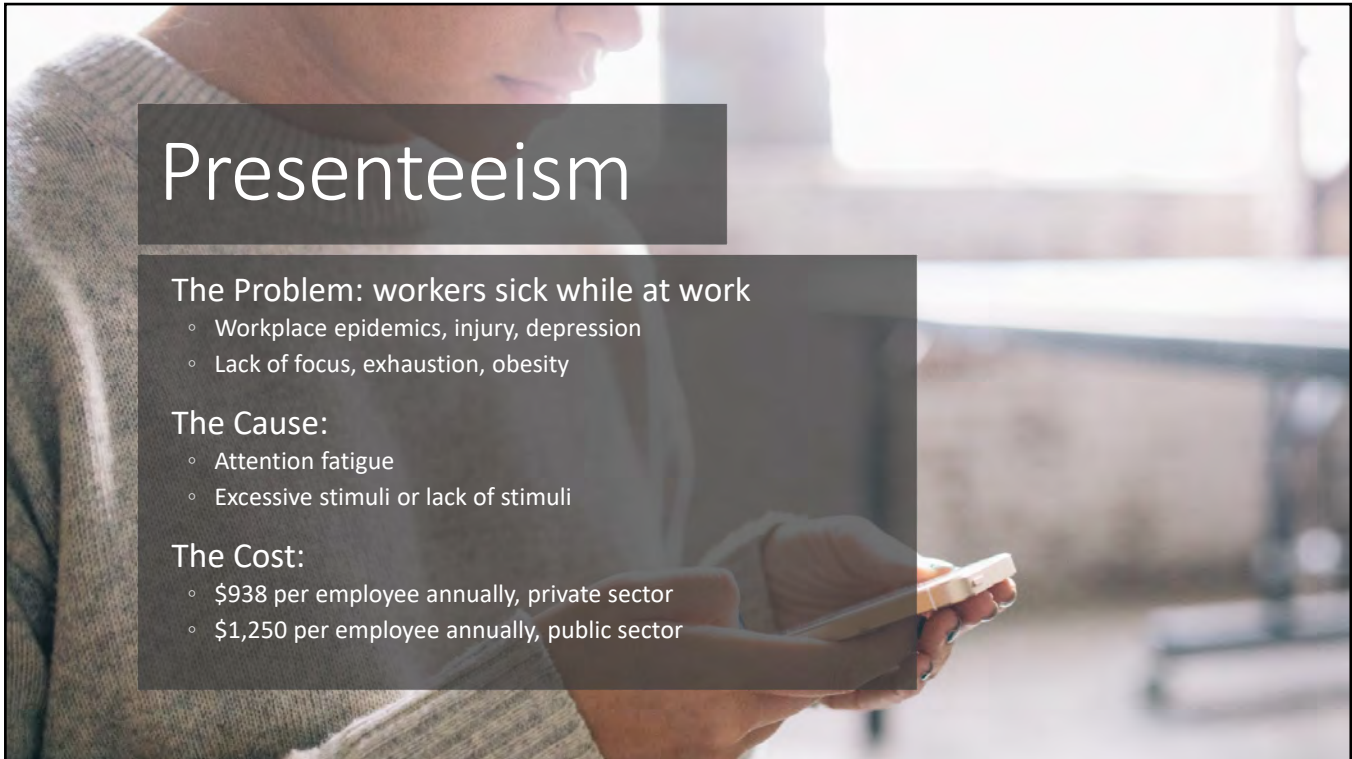
When asked to rate scenes according to their preference, the building's occupants heavily favored the vegetated views over the urban views, and either view over none at all.

- Views significantly affected worker's levels of happiness, mood, and other behaviors.
- The **quality** of the view from their office significantly affected how they behaved at work.
- Employees with external views of nature took an average of 57 hours of sick leave per year, compared with 68 hours per year of sick leave taken by employees with no view.
- When placed on a continuum, employees with an urban view ranked between the other two groups, in terms of both preference of view and sick days taken.

Architectural elements explained 10% of the variation in sick leave days taken, with the quality of a person's view concluded to be the primary predictor of absenteeism.

Employees with better views were likely to spend more time at their desk, while those with urban or no views at all were more likely to spend their lunch breaks seeking spaces with more pleasing views.

These findings, taken together, indicate that people's access to natural scenery is significantly correlated to their job satisfaction, health, and productivity.



Presenteeism

The Problem: workers sick while at work

- Workplace epidemics, injury, depression
- Lack of focus, exhaustion, obesity

The Cause:

- Attention fatigue
- Excessive stimuli or lack of stimuli

The Cost:

- \$938 per employee annually, private sector
- \$1,250 per employee annually, public sector

Presenteeism describes the phenomenon in which workers clock in sick or are mentally removed from the workplace, causing labor-related financial losses for the company.

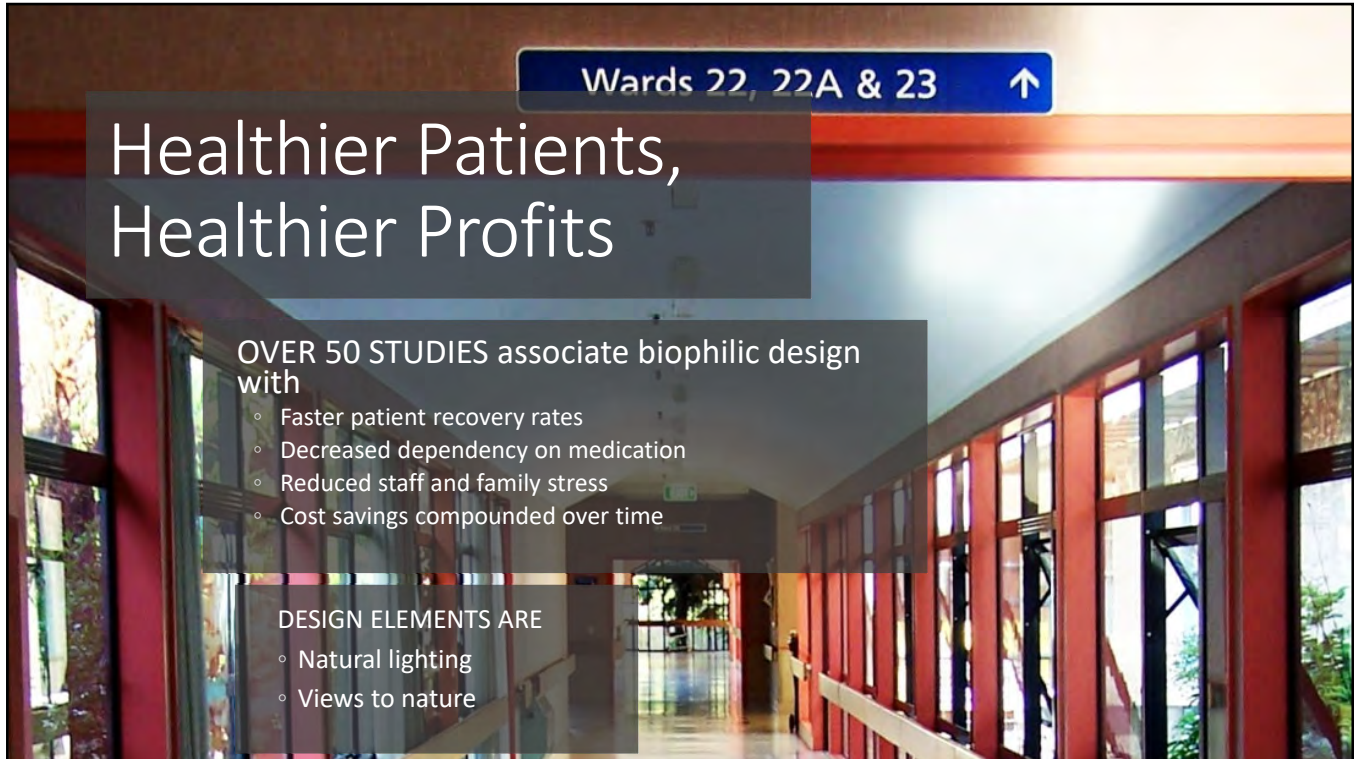
Lower productivity results from poor health, exhaustion, headaches, workplace epidemics, and injury. According to recent studies, presenteesim appears to be costing US employers more than absenteesim.

Attention fatigue, a key problem associated with presenteeism, occurs in environments where focus upon a task is difficult, due to lack of stimuli or due to sensory overload from excessive stimuli. This causes stress to slow the heart and breath rates while simultaneously arousing digestion in an attempt to raise energy levels. The combination induces lowered concentration and decreased effectiveness (Maas, 2011).

Presenteeism costs employers, per employee, per year, \$938 in the private sector \$1,250 in the public sector.

- For a company with 100 employees, this equates to over \$100,000 lost per year in unproductive time at work.

We get bored with visually boring spaces. Rather than being a distraction, nature serves as a resource that renews our attention, reinstating our cognitive functioning. Providing access to natural day light, outdoor views, and natural ventilation can reduce eyestrain, relieve mental fatigue and return workers' attention to their work.



Turning our attention to the health care industry, over fifty studies have been published that associate biophilic elements as the primary influences for faster recovery rates for patients, decreased dependency on medication, reduced staff and family stress, and improved emotional wellness.

In 2010, the United States spent \$40 billion on healthcare construction (US Department of Commerce, 2011).

If biophilic design strategies, including access to nature and daylight, are considered during the design and construction phase, the potential exists to cut annual **operational** costs. These operational savings keep compounding over the service life span of the building.

Studies also show that incorporating even the smallest elements of biophilic design into facilities can reduce the cost of both patient care and staffing, while improving medical outcomes and medical staff mood.

Photo: Thompson Peak Hospital Healing Garden. Scottsdale, Arizona. Gensler.



In 1984, Roger Ulrich pioneered a seminal study to measure the influence of natural and urban scenes on patients recovering from gallbladder surgery. Some patients were provided with views to nature, whereas others looked at brick walls.

With all other variables equal, his findings revealed accelerated recovery rates and reduced stress for the patients who had views of nature.

He found that patients with a view to nature are more likely to experience hospital stays that are 8.5% shorter, with fewer negative observational comments from nurses...we want to avoid those..... and significantly less post-surgical pain medication.

If cost figures from the Agency for Healthcare Research and Quality are applied to the Ulrich study, the cost of patient care could have been reduced by over \$161,000 if patients were released just one day sooner.

Photo: Henry Ford Hospital, West Bloomfield, MI



Addressing the psychological needs of patients, visitors and staff has economic benefits as well.

Stress levels increase in patients, visitors and medical staff when there is high responsibility and low control. This is a very common dynamic in our personal lives and institutional health care worlds. If you have ever had to await the diagnosis for a symptom that is “not well understood” or had to puzzle through the health insurance maze you have experienced this high consequences/low control phenomena. It is crazy making!

For health care providers, constant stress, in addition to damaging their own wellbeing, diminishes their alertness which can be crucial to the comfort and health of their patients.

The good news is that studies in horticulture therapy directly credit access to nature and daylight with reducing patient and staff stress, and increasing staff satisfaction, along with reducing patient medication use. (Sadler et al., 2008).



Healing gardens are a biophilic design remedy rapidly being embraced by health care thought leaders like those who built the Henry Ford Hospital in West Bloomfield, MI pictured here.

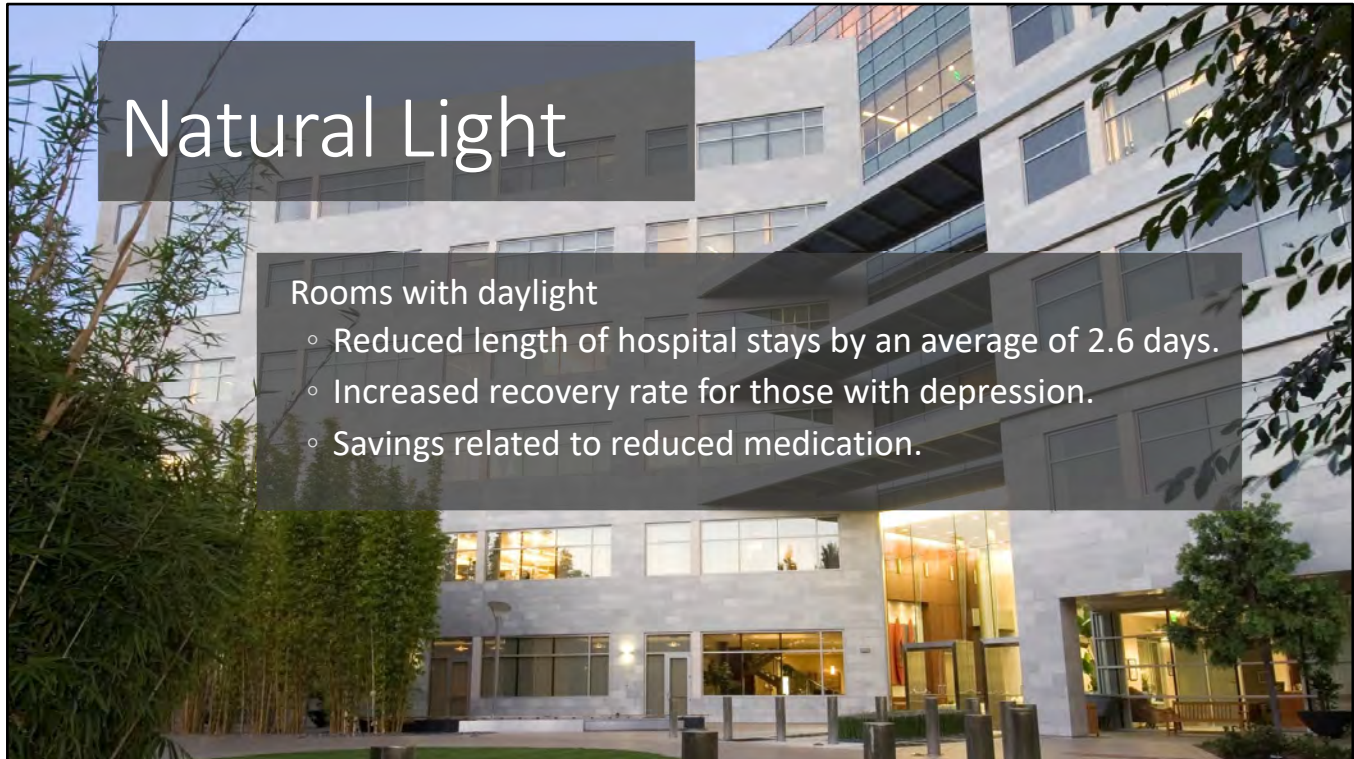
These indoor and outdoor garden spaces have repeatedly been found to promote good health and act as a place of social connectivity for patients.

Research results include these:

95% of people visiting patients, surveyed across four independent hospitals, reported feeling more relaxed, rejuvenated, and positive. They also reported feeling more able to cope with the ongoing medical situation (Marcus & Barnes, 1995).

Nurses and hospital staff reported feeling less anxiety and depression, and greater job satisfaction. They also reported faster recovery from stress and increased job performance.

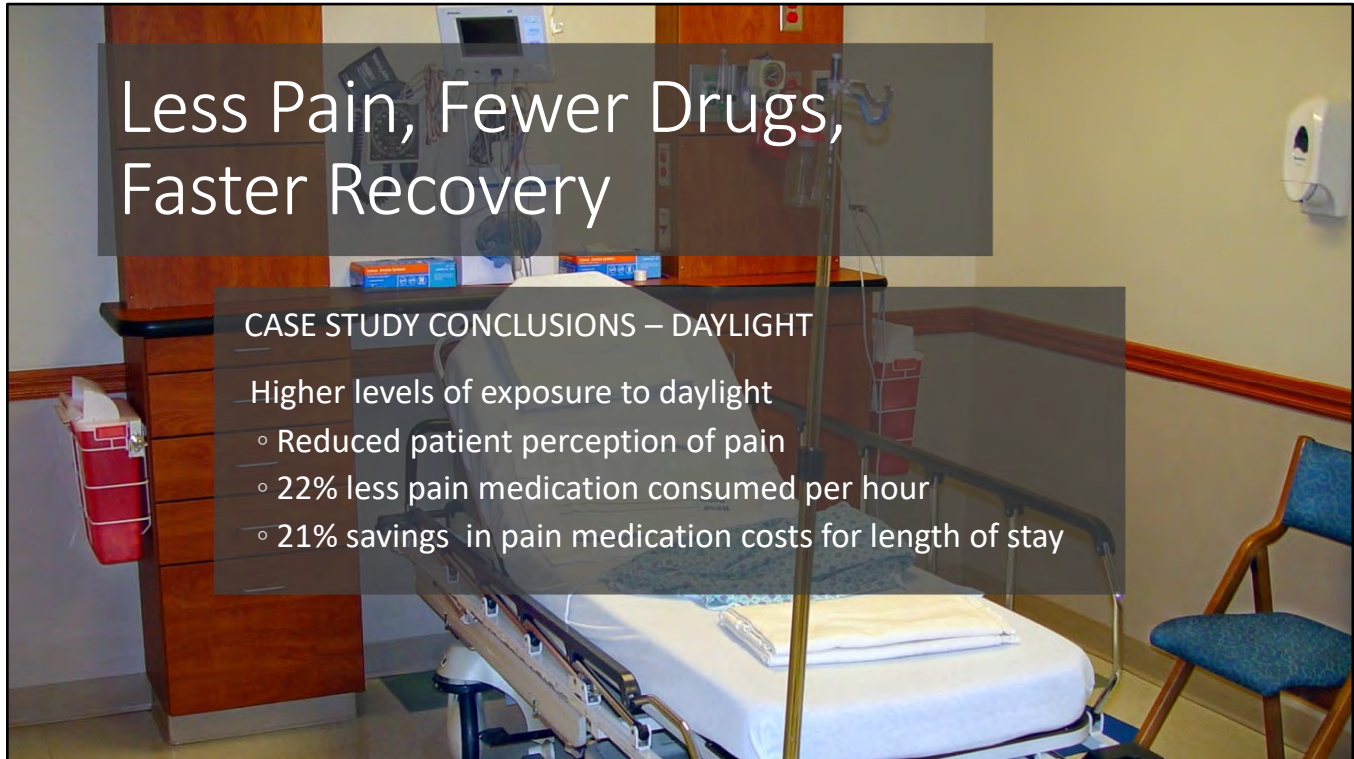
Photo: Henry Ford Hospital, West Bloomfield, MI



174 patients being treated for bipolar disorder and depression were the focus of another study (Beauchemin & Hays, 1996). Patients who were treated in rooms with natural daylight were discharged from the facility an average of 2.6 days earlier than the patients being treated in dully lit rooms.

To assign this data economic significance, pharma-economists at the University of Texas estimate that the treatment of each case of bipolar disorder costs a minimum of \$11,720 (Begley et al., 1998).

If one applies this cost to the context of the study, and if a fraction of this value was deducted because of reduced treatment time, \$272,000 could have potentially been saved if the other 87 patients in this study also been released earlier as a result of recovering in naturally lit rooms.



The cost of medication in America has skyrocketed in the last fifty years.

More money per person is spent on healthcare in the United States than in any other country (WHO, 2009).

The United States collectively spent \$2.6 trillion in healthcare costs, which equals more than 17% of the nation's Gross Domestic Product (U.S. Department of Health & Human Services, 2010).

In 2005, a study assessed the significance of sunlight in a hospital room on patients' recovery. The study measured pain medication – the amount and the costs.

The study determined that patients exposed to greater doses of sunlight perceived less pain, took 22% less pain medications per hour, and accumulated 21% less in pain medication costs for the length of their stay (Walch et al., 2005).



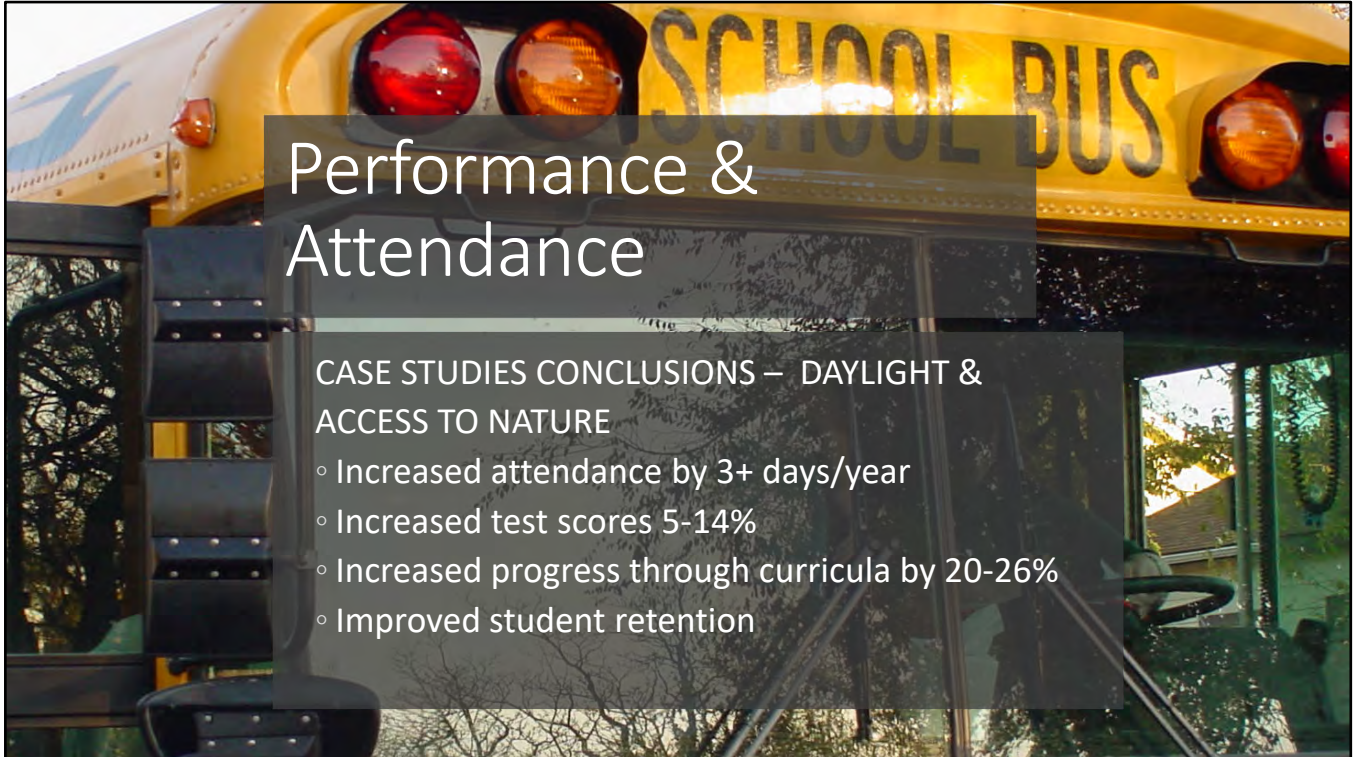
Moving on to the education sector, the classroom is perhaps the most influential environment outside the home where children will experience rapid brain development and expansion in social skills. It is critical to infuse these learning environments with as many positive attributes as possible.

When children, just like adults, become engaged in nature, their neural mechanisms are allowed to rest and recover.

Attention restoration is critical for children in school. Without it, students will increasingly respond to distracting stimuli, experience greater loss of focus, and have difficulty managing daily tasks (Wells & Evans, 2003).

Current research shows that biophilic design implemented in the classroom can increase test scores, learning rates and improve mood.

And that students who play in school yards that provide access to nature have been shown to experience improved mental restoration, and demonstrate better behavior, with enhanced focus.



In studying daylight in classrooms, attendance was found to increase by 3.2 to 3.8 days/student/year when compared with attendance at non-daylit schools.

The research from multiple studies shows good day lighting “improves tests scores, reduces off-task behavior, and plays a significant role in the achievement of students” (Kats, 2006).

It was found to increase test scores between 5-14% and increase learning rates by a 20-26%. (Heschong, 1999).

The greatest improvements were seen in classrooms with both daylight and windows with direct views of nature.



Annually the United States spends over \$661 trillion dollars on elementary and secondary (K-12) education with the cost of averaging \$10,249 per student (US Census Bureau, 2009). Can the effectiveness of this public investment be increased?

The research results indicates the answer is “yes”. More students in class, more on task, progressing through their studies more quickly, testing higher.

For local school districts, increased student attendance has economic significance to the school because their level of state and federal funding depends upon their daily student attendance numbers. Avoiding student absenteeism means avoiding the loss of tax revenue.

According to The National Center of Secondary Education and Transition, an improved school experience may increase student retention as students move through the education system. This has positive economic implications for our national economy (Lehr et al., 2004).

The Center estimates that a student who drops out of high school will earn \$9,245 less per year than a high school graduate (Employment Policy Foundation, 2001).

Furthermore, the Alliance for Excellent Education estimates that if the group of students who dropped out of the 2007 high school graduating class, had actually graduated high school, the national economy would have benefited from an additional \$329 billion in income over their lifetimes (Alliance for Excellent Education, 2007).



In preparing for this presentation I read a study and I thought this would be fun to see if our group gets the same results as the researchers.

What I'd like to ask you to do is to take a moment to visualize your ideal grocery store. Close your eyes and visualize it. Then use the index cards if you still have them because they will be a handy way of "reporting the research results".

After you have had a chance to express your thoughts on the cards I'll invite a couple of you to share what your thoughts on your ideal grocery store.

And in exchange I've got a present for you.



These days people spend a lot of time in retail areas; these are the places we buy our groceries there, catch up with friends, spend our lunch breaks, and shop for ourselves and others.

The average American spends \$12,990 in retail settings per year. Biophilic design strategies provide a way for this \$3.9 trillion market to increase sales while providing a more enjoyable consumer experience.

A 2003 study revealed that 10% of shoppers enter a store in a negative mood. (*Negative affect: The dark side of retailing.*) Sometimes shopping activity is constrained by time or budget, which can make the shopping experience stressful and irritating, and leads to avoidance behavior. (*The effects of urban retail greenery on consumer experience: Reviewing evidence from a restorative perspective.*)

Retailers in malls and outdoor markets across the world, from suburban America, to central Istanbul, to Singapore, are using biophilic design to increase their customer's comfort levels and sales.

Greenery has a mitigating effect on stress, negative mood, and discomfort. The psychologically soothing and calming effect of nature has been used to draw shoppers into stores and boost sales, significantly improving profit margins for stores and property owners with biophilic elements compared to those without.



The research evidence demonstrates that consumers are likely to buy more merchandise in stores with natural vegetation. It is not a coincidence that store and mall layouts intentionally guide shoppers through a maze of products surrounded by strategically placed plants, trees, and skylights. These small yet powerful influences on consumers lead retail stakeholders to enjoy greater profits. (Joye, 2010).

Access to nature may take the form of integrating clustered trees, semi-open spaces, refuge from the sun, water features, multiple-view corridors, and high levels of visual access. This later, visual access from an elevated level, replicates the spatial configuration of the African savannah that I mentioned in Nature of the Space.

Think about the places you like to shop and I'll bet there are some biophilic design elements there.

Daylight in the retail setting also offers an easy method for stores to dramatically boost their sales—simply by ensuring that natural light floods the retail floor space.

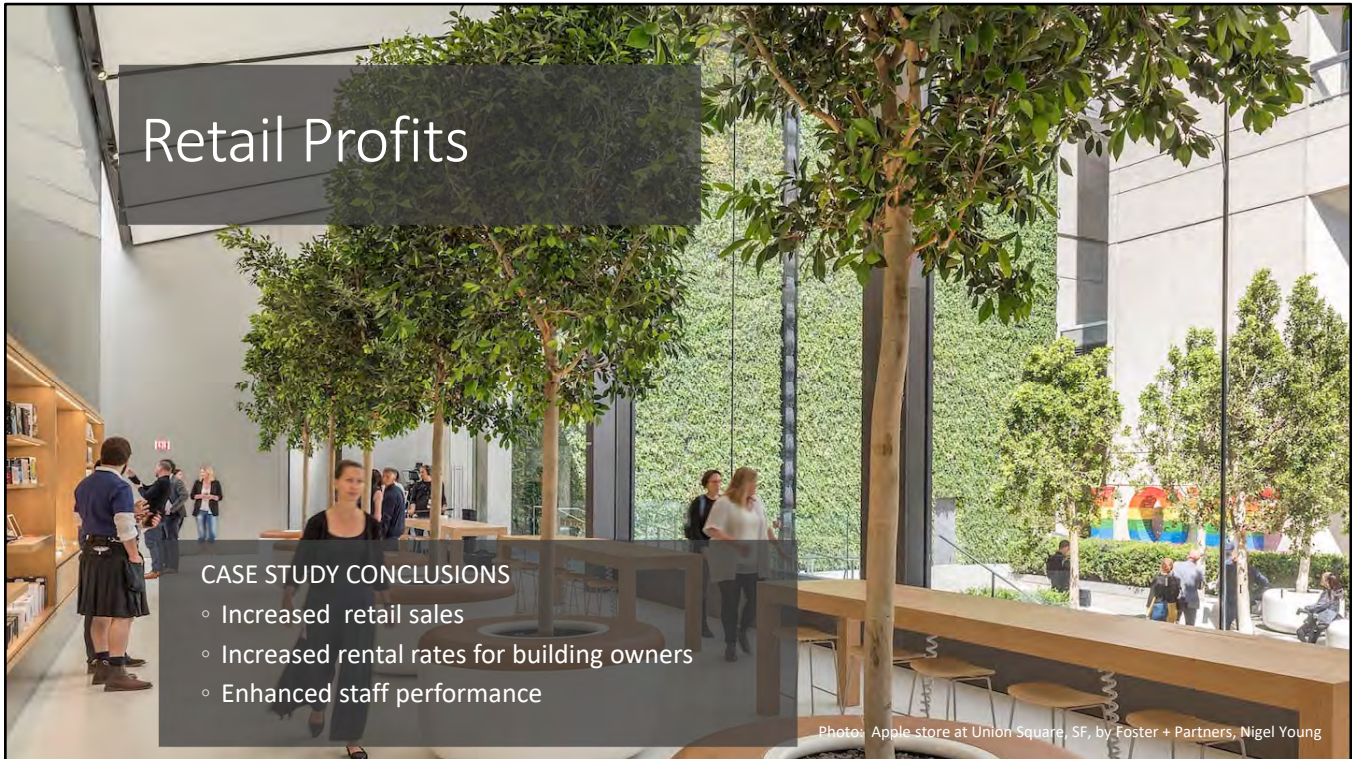
Non-skylit stores experienced a 15%-40% increase in gross sales after the installation of skylights.



In another study, when shown images of retail settings with greenery, respondents indicated that an acceptable price to pay was:

20% more for an item in a convenient shopping venue (i.e. sandwich for lunch);
25% more for general shopping item (i.e., a new jacket or watch); and
15% more for specialty shopping (i.e., a gift for a family member) (Wolf, 2005).

Photo: Janice Goodman, Cityscapes, Boston.



In a 2003 study when customers were asked to imagine their ideal food store, several groups spent more time describing their preferred shopping environment rather than the items they need to see in stock so that they could buy them.

They wanted to shop in “a spacious, bright, green, and nice atmosphere, with appropriate music in the background”. Subsequent studies found that shoppers were more inclined to enter a shopping mall when it contained vegetation and that “the presence of greenery led to higher exploration rates within the space.”

A third study found that “places with greenery are often regarded as destination places to be visited and enjoyed. As a result shoppers are prepared to travel farther, pay more for parking, pay more for the goods they buy, and stay longer in these locations than those without greenery.”

Add to this the information contained in a Natural Resources Defense Council report that “major urban quality upgrades can add 22% on average to rental rates for retail buildings.

Plus those working in the retail environments (customer sales associates, cashiers, hospitality, etc.) experience the same wellbeing benefits of improved mood, focus and behavior and quicker recovery from stress when they have access to nature.

[Photo: Apple Store at Union Square, Foster + Partners](#) by Nigel Young



Urban communities are economic webs consisting of homes, commercial spaces, public buildings, transportation hubs and parks.

Decades of research has been done on the affect access to nature has on a community. The research has looked at a variety of factors including property values, tourism (including visits to city parks and park buildings that drive collective wealth), direct use (recreational opportunities within parks), health (savings in medical costs due to increased physical and mental health), community cohesion (the avoidance of antisocial problems)

Based on this research and cost benefit analysis, we can quantify in dollars the importance of providing people with access to nature in the built environment and reveal the economic value of trees, parks, and other forms of nature in neighborhood design and urban planning.



Across the US people are willing to pay more for good views of distance, views of water, and views of large trees. The economics of this is easy to measure.

Multiple studies have reported the following:

Good landscaping aesthetics coupled with large shade trees add an average of 7% to rental rates.

High quality landscaping increased the sale value of housing by 4-5% (Laverne & Winson-Geideman, 2003).

People will pay up to 127% more for a property with a view to water such as a bay or lake (Benson et al., 1998).

People will pay a 5% premium for on properties within 500 feet of a park.

This is not an uncommon trend in the real estate market. People are willing to pay for nature, validating its consideration during a project's design phase.



Community cohesion describes the feeling of closeness people have to their communities.

Housing developments with large trees have been found to attract people to be outdoors, engage with neighbors, and develop stronger social bonds (Heerwagen, 2006), which in lowers community tensions and aids social integration.

To measure social capital in economic terms, one study showed the financial value of park-specific volunteerism by quantifying the monetary value of volunteer hours, which in Philadelphia with its abundant park space, yielded a community cohesion value of \$8.6 million (Harnik & Welle, 2009).

For 2015 study, the researchers measured the relationships between exposure to nature, community cohesion and crime rates. They asked a group of 2,000 participants from various communities to report on their access to nature, the amount of time spent in nature, and how much nature they can see from their homes. These responses were then pooled to come up with a measure of the community's exposure to nature.

The results were striking: Contact with nature appeared to have a significant effect on promoting community ties and reducing violence.

Controlling for other factors such as socioeconomic deprivation, population density and unemployment, exposure to nature accounted for a full 8 percent of variance in community cohesion — meaning that people felt closer to their communities. To put that in perspective, individual factors such as age, income and gender together accounted for only 3 percent of the variation. ([Weinstein](#), 2015)



Even in prison environments, nature's calming influence reduces mental fatigue, depression, anxiety and outbursts of anger.

Prison inmates, after participating in gardening projects, have shown reduced hostility.

Looking at community violence and crime in Chicago, researchers conducted a study of 145 public housing residents with varying proximity to nature.

Residents living in greener settings demonstrated higher scores in attention span and reliability.

Further, the study found that some types of domestic violence were 25% less prevalent in the greener housing developments (Kuo & Sullivan, 2001a).

Another 2001 study reported 52% fewer felonies in the greener buildings, 7-8 % of which could be linked to increased access to nature (Kuo & Sullivan, 2001b).

Applied across Chicago's 12 family public housing developments, assuming that the rates of crime remain fairly consistent across each development, and assuming that each of these felonies resulted in arrest and incarceration, it is estimated that 52% fewer felonies results in a rough savings of \$162,200 to the Illinois Department of Corrections each year (Chicago Housing Authority 2011, Durose & Langan 2003).



The many physical and mental health benefits that access to nature provides both adults and children have been described in earlier in this presentation. We've learned how nature helps the brain reset itself, how our blood pressure becomes stabilized, and our capacity for creative problem solving is restored.

In closing I'd like to take a closer look at how biophilic design can improve the lives of our youngest and most vulnerable human beings.

As adult role models and stewards of their world, it is incumbent upon us to provide growing children with environments that help them develop healthfully and meet their psychological needs.

In a study of teenage girls, researchers found that those with green space immediately outside their homes demonstrated more self-discipline than those without, by a margin of 20%. Self-discipline was measured as a function of concentrating, inhibiting initial impulses, and delaying gratification (Taylor et al., 2001).

Mastery of these personal skills often results in higher rates of professional, academic and personal success.



In one generation – just 30 years – kids are getting outdoors half as often as their parents, while child obesity rates have tripled and the use of Ritalin to address ADHD has skyrocketed.

Outdoor activities, rather than drug prescriptions, have been identified as a means of treatment for obesity and have been championed by medical professionals.

10% of the nation’s medical costs (c.\$150 billion) is attributed directly to obesity. \$2,200 per person per year can be reduced if sedentary individuals become more physically active three or more days per week.

Nature has major implications for the way we treat for ADD and ADHD. Children with ADHD who take a 20-minute walk through a park are likely to exhibit significantly better concentration than by doing the same walk in a downtown area with no greenery.

If exposure to nature could be used as a way to minimize symptoms of ADD and ADHD in children, a 10% reduction in spending on this medication would result of savings of \$228 million annually.



A few quick slides summarizing the previously discussed economic benefits of biophilic design.



Communities

IMPACT of BIOPHILIC DESIGN

Reduced health inequalities

Increased longevity

Reduced stress

Community cohesion

25% - Reduced violence/aggression

20% - Increased self discipline among youth

8% - Reduced crime

Medical Facilities

IMPACT of BIOPHILIC DESIGN

Post-Surgery

- 20% less painkillers
- 8.5% shorter hospital stays

Chemotherapy

- Increased effectiveness of treatments

Depression

- Shorter stays of 3.5 days

Staff and Patients

- Decreased anxiety, stress
- Improved mood, outlook, co- operation

Retail

IMPACT of BIOPHILIC DESIGN

Consumers willing to pay 25% more
Longer duration spent in store
Higher frequency of repeat business
Buffers stress of shopping

Education

IMPACT of BIOPHILIC DESIGN

School Curricula

20-26% faster progression

Improved attendance (3.5 days)

Improved attention

ADHD symptoms reduced

Improved test scores (15-18%)

Improved self discipline

Ecological literacy & Environmental Values Social skills

Less stress

Employers

IMPACT of BIOPHILIC DESIGN

10% of employee absences can be attributed to architecture with no connection to nature

Absenteeism accounts for 4% of operating costs

Views and access to greenspace

Increased productivity (6%)

Reduced stress

Increased creativity

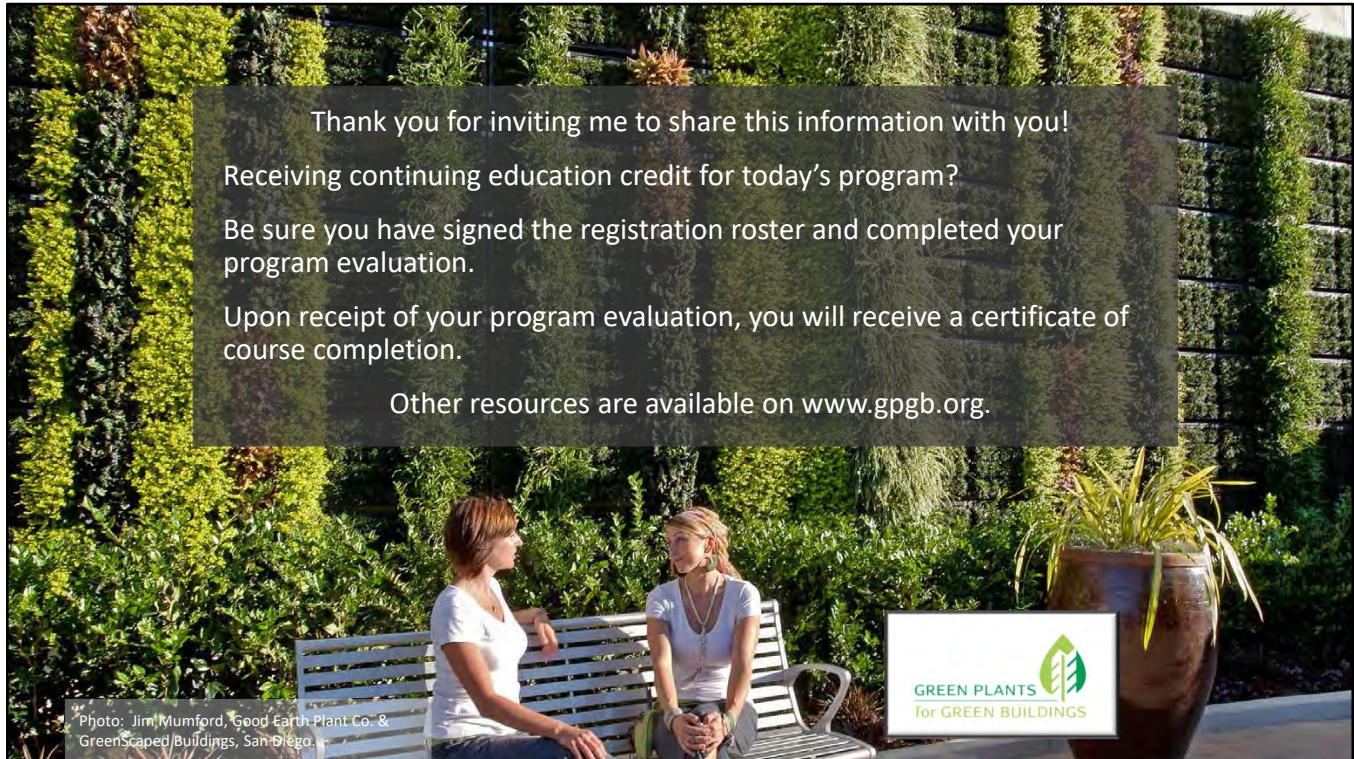
Increased employee mood and job satisfaction



- Humans have evolved and progressed alongside nature and its systems.
- Because of this, the human mind and body function with improved efficiency when natural elements are present.
- This statement is supported by research from neuroscience and endocrinology which shows the crucial role that experiencing nature has for our physiological well-being.
- Biophilic design optimizes productivity, healing time, learning functions, and community cohesion as the perfect partnering mechanism for business vendors, hospital owners, school administrators, contractors, and city planners alike who are seeking to reap maximum value through development and design.

- Implementing biophilic design into our workplaces, healthcare system, educational environments and communities is not just a nice amenity. It has profound economic benefits. It is now imperative that we bring nature into our built environment.

- The benefits of biophilia include improved stress recovery rates, lower blood pressure, improved cognitive functions, enhanced mental stamina and focus, decreased violence and criminal activity, elevated moods, and increased learning rates.
 - From the evidence presented, biophilic elements show productivity increases among staff when provided with nature in the workplace, with economic benefits ranging from \$1,000 per employee to \$3.6 million company-wide.
 - In the \$2.5 trillion healthcare industry, simply increasing views from hospital beds to nature could yield over \$93 million in annual savings nationwide as patients require less time in the hospital to recover from major surgery.
 - The significant nationwide healthcare savings in recovery from these surgeries alone indicates that testing the effects of biophilia in other areas of healthcare is a worthwhile and potentially lucrative endeavor.
 - Retail shops with natural greenery and daylighting consistently yield higher profit margins than their dim counterparts, offering a 12% competitive advantage for shops with more greenery and 40% for quality daylighting.
 - Children, the most vulnerable yet influential members of society, have been found to improve their test scores by 7-26% and have fewer absences from school when they are given access to daylighting.
 - The network of communities that span the United States can economically benefit from the presence of nature, as a result of access to park space, while also encourage less crime and less need for medication within community inhabitants.



This concludes our presentation today. Thank you so much for your time and attention.
Do you have any further questions or comments?

Photo: Jim Mumford, Good Earth Plant Co. & GreenScaped Buildings, San Diego.



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Photo: Shane Pliska Location: Planterra, West Bloomfield, MI

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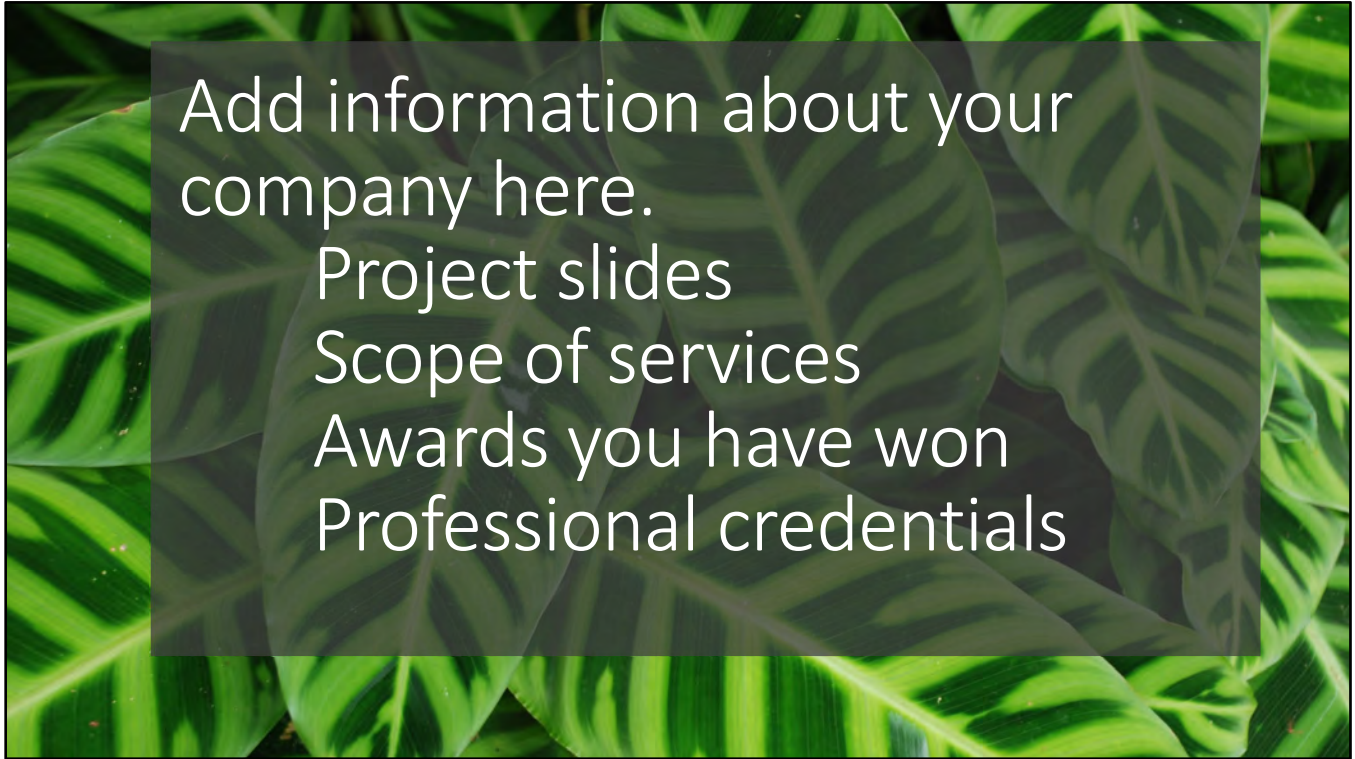




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