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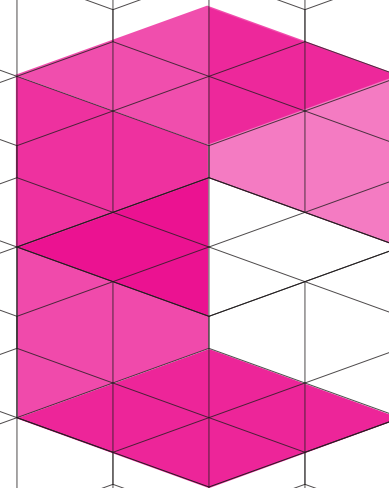
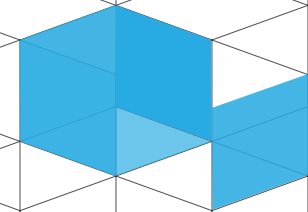
UNFOLD THE BOX

spatial wellness in the modern workforce

Our modern economy has transitioned into a service industry and manufacturing model where workers are expected to be creative, alert, and continuously function at a high cognitive level. Globalized commerce with company outposts around the world has blurred the boundaries of time zones and the traditional work day. Many previously physical tasks have now become mental tasks as technology changes how we work and employers are leveraging their investment in human resources by optimizing workplace environments to maximize the health and performance of their labor force.

We spend the majority of our life indoors and finding time and space to recuperate throughout the day is critical to workplace morale, productivity and employee health. Employers are responding by offering spatial amenities such as private rooms for new mothers, nap-pods for jet-lagged business travelers, and yoga studios for increasingly sedentary employees, often without a comprehensive understanding of how the spaces are utilized or whether they are achieving their desired objectives.

This white paper is focused on creation of wellness in the workplace through spatial design. *Unfold the Box* interrogates the history and development of spatial amenities in the workplace and envisions concepts for the modern workforce, translating research evidence into design.



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Spatial wellness in the modern workforce

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Introduction

Historical use of space for workplace wellness

Since the days of hunting and gathering to the agricultural and industrial revolutions of modern society, humans have sought places of refuge, comfort, rest and rejuvenation among the laborious acts of survival. This has led humans to be builders and creators of space to provide peace and safety or what might now be thought of as home.¹ As Heidegger states, “we do not dwell because we have built, but we build and have built because we dwell, that is, because we are dwellers.”¹ When it comes to placemaking for restorative environments, the home can be considered the *ur*-space for break, rest and wellness. It is, therefore, not surprising that for much of history, the place of work was connected to the home.² Although there is no particular architecture typology reflecting this program, the shop house, in which the workplace and dwelling coexist in shared space, has existed since Roman times, continuing today in urban environments with the shop or storefront interacting with the street, while the private quarters of the home remained behind or above, easily accessible for a break to recharge during the workday.²

The workday itself has changed immensely over time, eventually affecting the relationship between home and work. In the seventeenth century, the home was for production (in the form of food, making clothing and educating children), while the realm beyond the home was for public activities such as religious gathering and entertainment.² Today, these roles have completely reversed, bringing entertainment into the home in the form of television and video games and large-scale production of food and education are now generally activities that happen outside of the home.² Before this shift, there was fragmentation of functions within the home, separating public versus private, production help versus family. As production and commerce began to move away from the home to the public realm, this division of functions was eventually reflected in city planning, further separating private life from means of production and commerce. “Along with urban space, people’s time became fragmented, bound by punching of time clocks and new time periods required for ‘commuting.’”²

The industrial revolution heralded a new work culture focused on productivity. This fundamental shift in working away from the home decreased the ability for workers to find space to recharge and restore energy to continue productive work, or merely to eat lunch in an often dangerous industrial setting.

The tea break was born in Britain, giving a short mid-morning break to get a jolt of caffeine in order to make a worker more efficient when they went back to work.





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If 'home' is the original wellness space, then the shop house typology in which the worker lives over the shop is the original workplace 'wellness room.'

The work-life balance that once naturally existed in the time of the shop house was now replaced by maximum production, spatially segmented for specialization to maximize profits, which neglected the cost to the wellbeing of the worker. By the turn of the twentieth century, scientific inquiry into what was referred to as “industrial fatigue” and how to gain the most productivity from factory workers was the new popular science in Britain.³ “Anxieties about the exhaustion of the working population were mobilised to legitimate an extension of physiological knowledge from the laboratory into society, and to justify interventions in the organisation of the workplace by a new breed of industrial experts, placing scientific knowledge at the centre of debates about management and the organisation of work.”³ In 1915, the Health of Munition Workers Committee (HMWC) was formed to make recommendations based on workers’ fatigue, working hours, and matters regarding “personal health and physical efficiency” of the people working in factories and workshops.^{3,4}

These matters on working health were presented to British Parliament, which gave recommendations regarding breaks and having tea instead of the more popular worker’s beverage of choice at the time: alcohol.⁴ The tea break was born in Britain, giving a short mid-morning break to get a jolt of caffeine in order to make a worker more efficient when they went back to work. Similarly, in the United States, worker conditions were beginning to improve after the turn of the twentieth century. In 1938 the Fair Labor Standards Act was introduced to ensure workers had fair wages and a maximum of an 8-hour workday.⁵ This was eventually amended to include a 15-minute work break.⁵ Slowly, companies were beginning to reflect these new working values.⁶ Professor Howard Stanger, an historian of industrial relations at Canisius College in Buffalo, NY, noted in an interview, “they installed in-house lunch rooms, rest rooms where workers could get away from the drudgery for a while. Partly, the reforms were designed to keep the unions out, but the workplace was changing and the coffee break became part of that change.”⁶

After almost a century of reforms targeting workers’ wellness in relation to their productivity, the trend of some workplaces today are beginning to realize additional holistic measures to define spaces to recharge in the workplace. Wellness rooms have been a new corporate amenity for employers to competitively attract and retain employees and give them a private place to escape and rejuvenate while at work. This trend has coincided with trends in society that once again finds workers not taking breaks, often eating lunch at their

workspace while staring at a computer screen. The ability for space to again create wellness in the workplace, to be designed based on scientific evidence, including the use of color, nature, light and thermal in physical and virtual space, may define the productivity of the service economy in the 21st century.

The benefit of spatial wellness in the workplace

There are many reasons why employers should consider designating space to non-task oriented functions. At the most basic level, employers have a legal responsibility to accommodate certain activities in the workplace. The Affordable Care Act mandates that employers designate dedicated private spaces to support nursing mothers, but offering other areas of respite within the office may hold a wide range of positive benefits not only for employees but the company as a whole. As more employees are forced to manage chronic diseases while holding a job, such as cancer treatment or diabetes, designated workplace health rooms featuring amenities such as a comfortable place to sit, access to a sink and refrigerator may be simple, beneficial resources to promote health and reduce absenteeism. The specific function of any wellness room will be determined by the needs, desires, and culture of the people using these facilities. Surveys of the intended and potential users are paramount to determine what kinds of spaces should be provided. A company requiring employees to work across different time zones, for instance, may benefit from providing a space to nap. The space may be outfitted to allow workers to briefly recharge from sleep deficiency with a quiet and clean place to lie down.

Wellness spaces should ultimately facilitate reduction of stress among workers, since stress in the workplace takes a toll on human health, productivity and economic output. According to the American Institute of Stress, some common symptoms of stress include difficulty concentrating, trouble learning, forgetfulness, difficulty making decisions, reduced work efficiency or productivity, problems communicating, as well as a number of debilitating chronic physical symptoms. Therefore, it is not difficult to imagine that helping employees manage stress is also in the interest of employers. Incorporating space within the workplace to facilitate known stress reduction activities may be a simple way to encourage this behavior. For example, the practice of yoga has been shown to lower serum cortisol levels associated with stress and anxiety.⁷ A study published in *Occupational Medicine* showed that yoga is effective in reducing stress in the workplace and that businesses can benefit from allocating resources to stress management within the office.⁸ Similar to yoga, mindfulness meditation programs can effectively reduce symptoms of stress and anxiety.^{9,10}

In other studies, mindfulness meditation training was shown to improve multitasking performance of computer workers and concentrative meditation even enhanced cognitive flexibility and improved creativity.^{11,12} Spaces set aside within the workplace to facilitate activities such as yoga, meditation, or even prayer need not require any extravagant features. An infrequently used, out of the way conference room could even be re-purposed for these activities.

Furthermore, evidence shows that helping employees manage their stress and overall health and well-being not only benefits employees themselves but the company as a whole. In their survey of workplaces, the American Institute of Stress estimated the cost of stress to American businesses may be as high as \$300 billion dollars a year.¹³ Kalia found that individuals with stress and related disorders experience more impaired physical and mental function at work, miss more work days and use more health care services and others demonstrated that U.S. employers spend 200 to 300 percent more for the indirect costs of healthcare, such as sick days, absenteeism, loss of productivity and early retirement of skilled employees, than they do for actual health care payments.^{14, 15} Promoting wellness in the workplace reduces absenteeism, lowers healthcare costs, and builds a higher return on investment for employers.¹⁵ Offering wellness spaces and programs sends a message to employees that their employer cares about them and their value to the organization.

The wellness room: a modern spatial concept

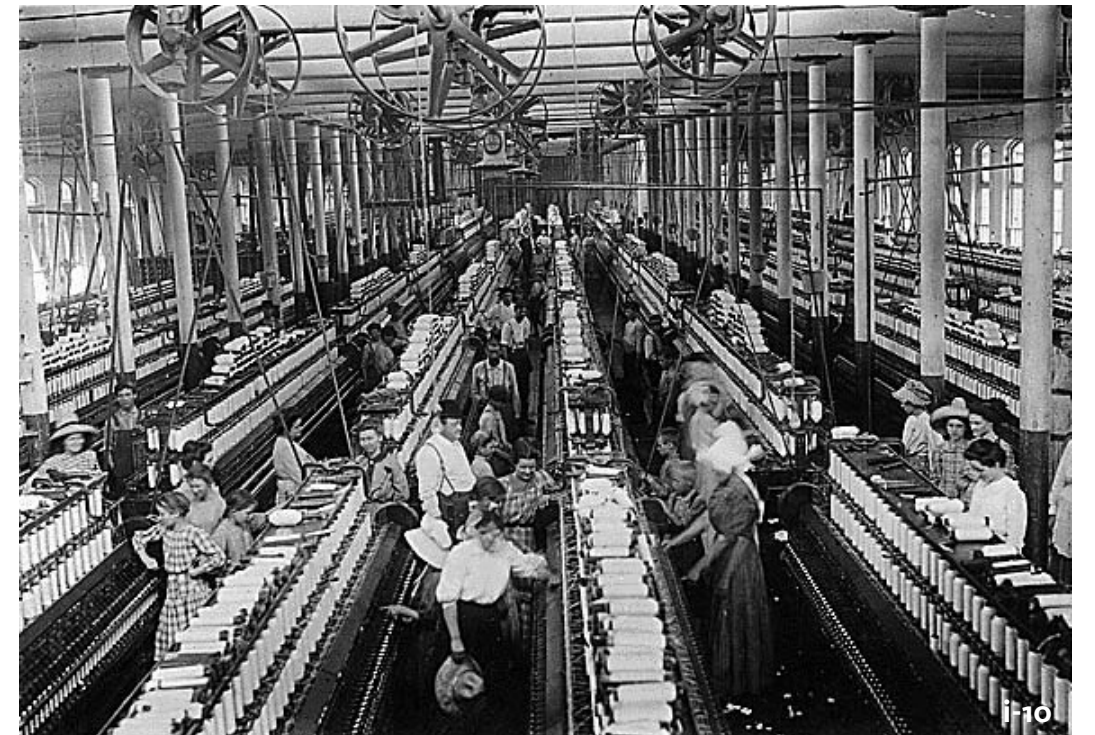
There is no single definition of what a wellness room is, but rather, a space category within the workplace of today encompassing a broad range of recuperative activities. A wellness room should be a spatial realm where workers can temporarily retreat to escape the stressors of the workplace. The prevalence of the open office plan is in part due to its capacity to facilitate collaborative engagement and increased occupant density. However, designated spaces where workers can quietly reflect and recharge are intended to mitigate the disadvantages of this system.

While sufficient evidence exists to support the benefit to companies when employees are rested, well and engaged, the design and configuration of space to meet a diversity of cultural and worker needs is less evident. Companies are exploring options and creating a knowledge base as to what works. Many larger employers have provided on site fitness rooms for employees. Apple’s Steve Jobs was perhaps one of the first to introduce wellness rooms into the workplace. In Apple’s infancy, he instituted 30-minute meditation breaks and provided space and instruction for both meditation and yoga. Nike provides relaxation rooms where employees can nap, meditate, do yoga, or even pray in private. Companies like Zappos and Asana also offer nap rooms while at Twitter employees enjoy a fitness zone where they can choose between crossfit, yoga, meditation, or a massage. Google is another advocate for promoting employee

...helping employees manage their stress and overall health and well-being not only benefits employees themselves but the company as a whole



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In 1938 the Fair Labor Standards Act was introduced to ensure workers had fair wages and a maximum of an 8-hour workday. This was eventually amended to include a 15-minute work break.



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wellness, offering a range of programs and spaces to support employee health and well-being. Meditation, yoga, and nap rooms nurture the spirit while themed recreational zones encourage fun and collaboration. The individual offerings of these companies are strongly linked to the culture of each organization.

Elements for wellness: a review of the literature

Sleep and Napping in the Workplace

Many societies across the globe have traditionally observed periods of break during the workday, often in the form of a long mid-day break where workers partake in a large meal with family and perhaps include, as in several Mediterranean and southern European cultures, a post meal siesta during the heat of the afternoon before returning to work to finish the day at 7 or 8pm. With increased globalization, however, the economic pressure to compete and meet the demands of customers has influenced lawmakers to adopt the more rigid 9 to 5 work day schedule. The substantially shortened lunch break threatens the midday nap once common in countries such as Greece and Spain as they conform to the stricter schedule of their European counterparts. Currently, the culture of midday napping during work hours is strongest in Asian countries. In factories and offices throughout China, many companies grant a two-hour lunch break. Using the time for a nap while at work is culturally viewed as a healthy activity to restore the body's balance. Workers bring pillows and blankets from home to make the most of a midday snooze at their desk. The "inemuri" or "sleeping while present" is a common activity in Japan where one can take a nap while at work or perhaps in the car of a subway train. The practice is viewed not as a sign of laziness but of hard work.

Despite a long history of cultural responses developed to balance the need for sleep with work, the current relationship between sleep quantity and health has become concerning in recent years. The National Sleep Foundation reports that adults between the ages of 18-64 need between seven and nine hours of sleep per night, but the U.S. Center for Disease Control proclaims that one in three adults do not meet this standard and declares sleep disorders a public health epidemic.¹⁶ The main culprit appears to be sleep deprivation. Shift patterns, working across different time zones, international travel, the use of artificial lighting and hand held technologies at night bear much of the blame.¹⁶ Once grounds for dismissal, the workplace nap is gaining acceptance as a counteractive measure to redress the ill effects of the tired brain. A growing body of research touts the restorative effects of a brief midday nap for subjects experiencing sleep deprivation.¹⁷ A well known NASA study in collaboration with the FAA has increased safety across many industries with the implementation of a napping protocol for cross-continental airline pilots. Participants of the study showed significant improvements in reaction time and far fewer performance lapses.¹⁸ There is considerable research revealing beneficial outcomes for those



The original employee napping pod and personal wellness space: your own car



who engage in a nap. Studies reveal certain cognitive functions, productivity, and even creativity improved for individuals who partook in a 30-minute nap.¹⁹ A short 20-minute nap was found in another study to improve sleepiness, performance level and self confidence of task performance.²⁰ Takahashi and Arito found that a brief nap after lunch under prior sleep deprivation helped maintain alertness and performance for research participants.²¹ Tietzel and Lack found that a 10-minute nap following sleep restriction significantly improved cognitive performance and alertness.¹⁷ Later research by Brooks and Lack affirmed that 10 minutes appeared to be the most effective nap duration for improving alertness and performance to avoid “sleep inertia,” the feeling of grogginess which can occur upon waking from a nap.²² Other studies highlight the benefits of a brief nap for improvements in learning and improved cognitive operations.¹⁹ Even for those not sleep deprived, a nap can enhance alertness and productivity.²³

The benefits of napping are not simply functional. Measurable physiological changes occur as the result of a nap, as well. Research by Faraut, et al. revealed that norepinephrine levels in sleep deprived individuals return to normal after napping, suggesting that damaging metabolic changes caused by lack of sleep can be reversed with a recharge nap.²⁴ In another study, Faraut proposes napping as a counteragent for sleep loss to reduce accidents and cardiovascular events.²⁵ Similarly, a study by Naska found that napping three times a week for 30 minutes reduced incidences of coronary death by 37%.²⁶

The performance and health benefits of napping are clear, yet the negative stigma of partaking in a midday snooze persists. Sleep deprivation, at least in western cultures, is often viewed as a badge of honor, symbolizing hard work and dedication to one’s job, while napping is often relegated to the domain of the lazy. One need only picture the American cartoon caricature of a lazy worker, Homer Simpson, who for 30 years has been

caught snoozing at his desk. Avoiding this perception has led sleep deprived workers to sneak off to their cars, or worse, the restrooms to catch up on restorative sleep. On the other hand, work culture in China and Japan reflect the opposite point of view to western culture. An uncomfortable nap slumped at one’s desk communicates diligence to the job and commitment to one’s employer. The consequences of fatigue are numerous, spanning a range of physical, mental, and financial effects. Using the guidance from a wealth of research can help to balance

associations and perceptions of workplace napping. Normalizing this activity by providing appropriate spaces to rest within the office can improve quality of work, nurture creativity, and replenish depleted emotional resources.²⁷

Environmental elements of wellness: Biophilia and productivity

Productivity in the workplace is crucial to employers. Maximum efficiency throughout the day is unfeasible; however, research suggests biophilia in the work environment has the potential to create restorative environments, which overall facilitate better work productivity and contentment. Attention Restoration Theory (ART) put forward by Kaplan and Kaplan, postulates that directed attention from focusing on a task for a long period of time leads to mental fatigue.²⁸ The authors propose that workers who are tired could return to a more efficient state after being exposed to nature, or more specifically exposed to scenes that encourage soft fascinations, which are “patterns that hold attention without being too overstimulating and permit a more reflective mode.”²⁸ ART gives the ability to recover from stress, while the Stress Restoration Theory (SRT) focuses on the power of nature to recover from psychological and physiological stress.²⁹ These theories spurred a range of scientific research studies to test the validity of the idea and have demonstrated that exposure to nature or natural biophilic elements in workplace environments could improve occupants’ overall well-being and health, cognition and stress.

Designing natural or biophilic elements in the workplace consists of three main categories: *nature in space*, *natural analogues* and *nature of space*.^{30,31} *Nature in space* is “the direct, physical and ephemeral presence of nature in a space or place.”³¹ This includes sensory stimulus regarding nature, such as visual, auditory, or olfactory that are associated with a positive interaction with nature or natural processes. *Natural analogues*, is a representation of nature or natural patterns. This could be as simple as artwork that is a literal image or representation of a natural element, such as a tree, or the use of natural materials such as wood.³² *Nature of space* is the actual spatial configuration of a room or place. This should include four biophilic design patterns: prospect or an unimpeded view (Kaplan would refer to this as “extent”); refuge (or as Kaplan would refer to as “being away”) this would be a break in the normal activity or environment; mystery, which is “the promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment; and finally risk/peril, “an identifiable threat coupled with a reliable safeguard.”³¹

If biophilic elements are not already incorporated into the workplace environment, then providing a dedicated space with biophilic elements could be developed to give workers the ability to change their environment from the typical office work setting. “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 in the office space.^{30,33} These include the need for change or a variable environment (thermal, air movement, light, etc.), ability to interact with one’s environment and have the ability to see the effects, “meaningful stimuli (static atmospheres cause an onset of chronic stress)”, a private place or individual territory, and views to the outside world.³¹

A mix of sensory factors should be implemented in biophilic design approaches to creating space for restorative environments. As humans, we have adapted to living in many types of environments with a variety of stimuli that may or may not be impacting our health. The Savanna Hypothesis, put forth by Orians, argues that the early spatial environment of human evolution left an indelible impression in the primal core of our psyche.³⁴ Therefore, it is theorized that environments that replicate similar elements of the savanna are inherently preferable or pleasurable. The early savanna would have had a high diversity of plants and animals for food and resources, areas with trees for shade and protection from the elements in contrast to open grassland that would provide unobstructed and clear views.³⁴ The features of the savanna could therefore be linked to the biophilic design strategies when considering what a person needs to be well. The visual field including what nature we are exposed to inside and outside (windows and daylight), the acoustics, the smells and thermal environments in a space or combination of all of these elements together have the potential to participate in making a space more conducive to stress and attention recovery in the workplace.

Environmental elements of wellness: View and visual field

The visual field, including access to daylight and views, is associated with stress-reducing and mood-enhancing sensory elements. In a survey of 1,614 office workers in North America, it was reported that 78% of respondents associated natural light and views with an improvement in their overall happiness and well-being, 73% of those respondents claimed it improved their work satisfaction and 70% believe their work performance was enhanced due to views.³⁵ A study observing daylight’s effect on two groups of nurses exposed to different average illuminances throughout the day (765 lux for the



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‘windowless’ group, while the ‘windowed’ group was exposed to 627 lux) showed the windowed group had improved behavioral indicators of mood and subjective alertness.³⁶ Furthermore, prolonged technology use and screen time led 73% of the employees surveyed to agree that the longer they were on their devices, the more desire there was to have a visual break, such as taking a walk or looking out the window.³⁵ This instinctive sensibility or desire to be exposed to natural elements after long exposures to technology could indicate that people innately understand the need for nature’s ability to restore energy and focus.

Nature breaks - micro to macro

Workers need a reprieve while at the office and there are several strategies that a worker could take to combat mental fatigue. One study considered the potential benefits of “micro-breaks,” short breaks purposefully directing attention to something that is not related to work between tasks, in the form of looking out the window at a green roof in an urban environment.³⁷ The research focused on the idea that a green micro-break, with workplace nature views, could play a part in work recovery, and in so doing, improve mood and work performance.”³⁷ Comparing participants’ results after looking at a virtually simulated green roof compared to concrete roof for 40 seconds showed better performance outcomes post-views for the group looking at the green roof in both objective and subjective measures.³⁷

Wellness rooms should provide space for mind-resetting breaks to restore attention, but they should also consider biophilic elements for stress restoration. Brown, et al. demonstrated a difference in stress response before and after viewing images of nature (composed of trees, grass, fields, etc.) compared to images of the built/urban environments (consisting of man-made elements without natural characteristics). This randomized crossover study explored whether viewing different scenes prior to and after a stressor altered autonomic function during the recovery. For both scenes, there was no significant difference between secondary cardiovascular markers; however, the parasympathetic activity was much higher in recovery following the stressor in viewing scenes of nature compared to scenes of the built environment. Moreover, nature can elicit the stress recovery process after a stressor.³⁸ This indicates that it is beneficial to have views to nature; whether constructed nature, a view from a window or even art with scenes of nature throughout an office should be considered an important feature that is included in wellness room design.^{38, 37}

The ability to have views to nature and biophilic design in a workplace environment provide opportunities for workers to recover from mental fatigue and stress, but exposure to nature for overall well-being should take place out of the office as well. A large study done in 2019 demonstrated that subjective wellness markers were impacted by quantity and quality of time spent outdoors in nature.³⁹ The study found that 120 minutes is optimal

for better self-reported health outcomes. People who spent less than this amount of time reported similar results to those with almost little or no time in nature. It also turns out that over 120 minutes spent outdoors begins to show diminishing returns until 200-300 minutes, after which the results begin to flatten out. If wellness spaces in the workplace had the ability to either have access to or act as outdoor natural spaces, it would be much easier for workers to reach the optimal two hour quota of being exposed to nature.

Environmental elements of wellness: Acoustics - stimulation versus annoyance

Creating soundscapes intended to promote recovery in office environments can be an important component to a worker's ability to restore. The impact of certain environmental sounds can have a significant impact on human health and well-being. As populations grow and cities around the world become denser, the anthropogenic noise associated with urban environments will continue to increase. The United Nations Department of Economic and Social Affairs has projected that by 2050, 68% of the world's population will be living in urban areas.⁴⁰ From this, it can be inferred that our workplace environments will be surrounded by typical urban acoustic environments that will likely pervade the workplace. As a result, it is critical to understand the impact of the urban soundscape on mental and physical health as well as overall occupant satisfaction. Current information on the impact of environmental noise on human health is limited, largely due to the lack of longitudinal studies on the subject. However, in 2018, the World Health Organization (WHO) published a systematic review of the impact of environmental noise and human health. The findings suggested that there is sufficient evidence for negative health outcomes resulting from environmental noise including cognitive impairment, sleep disturbance, cardiovascular disease, metabolic diseases and a reduction in overall quality of life.⁴¹

Designing spaces specifically for wellness should allow workers to get a reprieve from exterior urban noises that signify danger in the primal centers of the brain (e.g., traffic and the potential bus barreling toward you), as well as breaks from the noise created by typical open office plans. There is some evidence to support that the background noise of an open office plan might have beneficial effects on creativity for some individuals, but often these open workplaces have a host of environmental noises that can be distracting and potentially harmful to cognition.^{42,43} Despite which specific office sounds in an indoor environment make it easier or more difficult to complete tasks, studies suggest



nature sounds could be restorative and, therefore, might be employed in wellness rooms. A study conducted in Shenyang, China in 2017 showed the different effects of experiencing three different soundscapes for 40 minutes of restoration after completing a task with directed attention for 50 minutes. All of the subjects experienced very similar visual fields of an urban park, but they were split into four groups. The first group experienced traffic sounds, another experienced machine sounds (from a lawn mower), the third group experienced a natural soundscape with sounds coming from birds, insects and occasional light traffic, while the last group did not experience a recovery period to gain a baseline for attention restoration. It should be noted that all of the soundscapes were at different pressure levels or decibels (with nature being the quietest). The group exposed to natural sounds with birds and insects had a more restorative effect compared to the other groups.⁴⁴

When designing acoustic soundscapes in a wellness space, the type of sound is important in addition to sound amplitude. Using the Stress Recovery Theory, a study in 2010 looked at the physiological response after being exposed to a period of silence, multiple periods

of stressors through a stressful mental arithmetic task, followed by a recovery period with 4 different types of soundscape: nature (a mixture of sounds from a fountain and tweeting birds) sounds (50 dB), high noise (80 dB), low noise (50 dB) and ambient noise (40 dB). It showed that the nature sounds promoted "a faster recovery of the sympathetic nervous system" compared to the other noises, particularly the high noise.^{29,45} This indicates that the type of sound is more important to stress recovery than the level of sound. There is evidence to suggest that more natural sounds from birds, insects, and water can all help in the recovery of stress and mental fatigue, but more research needs to be done to see if elements like self-selected music or other soothing soundscapes could be used in place of "natural" sounds.

Acoustics in a space can be complementary or detrimental to the restorative process, regardless of the biophilic elements that exist in the visual field. It is possible that all sensory elements when combined contribute to the power nature has on the ability for the restorative process to occur.

Environmental elements of wellness: Sensory variability

As a species, humans have spent most of their evolutionary history outdoors; therefore, evolution has made us partial to natural environments. A major difference in natural environments compared to the modern indoor environments in which most people spend a majority of their time, is the variability and unpredictability of the natural world. The African savanna, where the human brain was thought to have acquired many primal evolutionary instincts, is a space in which one can imagine many changes in environmental conditions.³⁴ When thinking of the savanna, it is easy to imagine many stimuli such as a quick breeze, expansive sunny fields mixed with trees for shade, dynamic cloud cover changing the level of brightness, changes in temperature, and sounds from animals and trees leaves rustling starting and stopping. If designing space in the workplace intended to restore and reinvigorate after sustained focused attention, it is possible that simply a noticeable change in environmental conditions could be beneficial to regaining energy and mental capacity to return to focused work.

A phenomenon known as *alliesthesia* is the ability for any stimulus to "induce a pleasant or unpleasant sensation depending on the subject's internal state."⁴⁶ As long as

the stimulus is correcting a current state to be more positive, for example if a person is feeling uncomfortably warm and a cool breeze goes over them, they perceive the sensation to be pleasurable. Furthermore, this periodic change from slightly uncomfortable to comfortable provides relief to what otherwise could produce thermal boredom.⁴⁷ The potential benefits of using alliesthesia as a tool to enhance the senses for occupants of a building, allowing a more dynamic workplace environment that stimulate occupants' mental capacity, while potentially reducing the energy demands of a building. For a dedicated space specifically designed for wellness, it can be assumed that the room will only be occupied for relatively short breaks, and a person would enjoy a change in stimulus compared to their normal working environment.

There are many studies showing the benefits of dynamic environments on a person's cognition regardless of perceived comfort. One study examined the effect of illuminance settings on visual alliesthesia and perceived comfort.⁴⁸ Gou, et al. found that performance increased with higher illuminance levels; however, subject comfort levels increased initially but then decreased as the lights grew too bright. This does not mean the more stimulation the better; there is a balance to be achieved between stimulation and over-stimulation, which might lead to distractions or cognitive decline.

Thermal milieu and thermal variability in buildings, such as thermal drift and expanded models of comfort, has potential for energy savings; however, may also have positive health and cognitive benefits.⁴⁹ Buildings are increasingly sealed up to reduce unwanted infiltration or disturb designed pressurization differentials. The ability to mechanically control indoor environments within a tight range of environmental comfort set-points is now commonplace but has fundamentally changed the human relationship with the habitat in which we evolved: natural outdoors. In a study looking at the human response to fluctuating temperatures, Miura

and Ikaga found participants had lower stress levels (measured by salivary amylase) than a similar cohort in similar an unchanging environment even though their bodies may have been considered to be put under strain due to thermoregulation.⁵⁰ The same study looked at measures of subjective fatigue to participants and found that fluctuating temperatures showed slightly lower reported levels of fatigue.⁵⁰ Exposure to heat and cold may have the potential to help with human

Exposure to heat and cold may have the potential to help with human health markers as well as cognitive performance.



health markers as well as cognitive performance. Further work by Lichtenbelt, et al. shows that “mild cold and warm environments increase metabolism, thereby targeting obesity by counterbalancing excess energy intake. Furthermore, cold environments influence glucose metabolism, significantly improving insulin sensitivity similar to an exercise regimen.”⁵¹ In on-going clinical trial research by Minson, et al. at the University of Oregon, work is being done to demonstrate if heat therapy alone, such as sauna and hot tub use, can reduce blood pressure and improve cardiovascular health as much or more than exercise.⁵²⁻⁵³ If natural ventilation or natural thermal variability in an office space isn’t achievable, the use of thermal extremes in a wellness space might have the desired positive effect on a person’s ability to refresh and lower stress levels just as an afternoon walk outside may have.

Environmental elements of wellness: Light and mood

Employee mood is a strong determinant of performance and productivity. Mood is “the core feelings of a person’s subjective state at any given moment”⁵⁴ and there are five major components of mood: anxiety, depression, hostility, positive affect and sensation seeking.⁵⁵ Mood often dictates behavior, and behavior leads to sustained performance. Throughout the day, an employee might start to feel fatigued and mood may change due to the fatigue.⁵⁶ Arousal, defined as “the continuum of state of alertness ranging from a comatose state to one of

extreme excitement”⁵⁷ leads to the dissipation of fatigue. Sustaining arousal in the workplace, in particular in sedentary work environments, is a difficult endeavor. However, there is growing research that supports the impact of illuminance, both natural and electric, on arousal, namely cortical arousal (activity in the brain) and behavioral arousal.^{56,58}

Sunlight has a strong effect on mood, with indirect daylight alleviating depression and direct sunlight reducing anxiety.⁵⁹ Daylight also provides better sustained attention and arousal and has a stimulating effect on alertness and vitality.^{59,60,61} Outdoor illuminance ranges from 2,000 lux to 100,000 lux, but the level of natural light quickly declines as it travels through a window and deeper into a space. Fluorescent indoor illuminance levels are usually around 500 lux in the horizontal plane, have considerably less light in the blue spectrum, which is considered to be the most ideal for achieving non-visual biological positive effects, and do not emulate the natural patterns of daylight.⁶²⁻⁶⁵ An ideal workspace would expose occupants to natural, low filtered daylight to better enhance mood, arousal, and overall work performance.

Increases in the illuminance levels of an environment have shown enhanced positive perceptions of space such as, more pleasant, comfortable, stimulating, friendly, and natural, but too much illuminance can lead to a decline in mood and reduced sustained attention.^{61,66,67} Mid-range illuminance levels (150 lux - 600 lux) elicit the most positive reception and occupants experience less fatigue, while illuminance level around 1000 lx has a waking effect on the central nervous system.^{57,68.}

⁶⁹ Considering that most indoor illuminance levels are around 500 lux, a general increase in the illuminance level indoors may result in more vitality and brain function.

However, sustained high illuminance can be tiring, and as the human eye adjusts to brighter lighting, the positive results of the higher illuminance may fade with time. Brief exposure to bright light promises better enhancement to brain activity that resists fatigue and timed early in the morning increases alertness and mood throughout the day.^{60,61,70,71} In the application of a short-term wellness space, inclusion of a high illuminance setting could be beneficial in restoring arousal and overall mood.

The lighting conditions of a workspace or wellness room can affect the mood, fatigue, and performance of workers. It is important to compare the advantages of increased

natural light and increased illuminance levels to the advantages of sustainability goals and cost effective design solutions.

Environmental elements of wellness: Color

Color in the workplace is often rooted in corporate branding or prevailing interior design trends. Many claims have been made that the color of a space impacts the cognitive performance or the mood of occupants.⁷²⁻⁷⁴ This research builds upon previous experiments that postulated color perception produces physiological reactions in the body which then affect mood, cognition, and motor behavior.⁷⁵⁻⁷⁷ Since then, it has been assumed that certain colors elicit certain psychological states, regardless of whether these colors are applied to a wall surface or projected from a light source. However, more recent research conducted in the last decade suggests that color, by itself, does not produce consistent emotional responses. Often, color-emotion effects are the byproduct of learned cultural conditioning and past experiences that create color associations. These associations can evoke changes in psychological behaviors and data suggests that specific dimensions of color may impact physiological pathways which can lead to certain colors eliciting feelings of relaxation or arousal regardless of past experiences.⁷⁸

Color associations, such as “blue is calming,” are learned behaviors, heavily rooted in cultural background, or shaped by individual experiences. Few colors transcend cultural divides; yellow was found to be associated with ‘joy’ across the globe. A study found that the connection of yellow with joy had a higher rate of association in countries found further away from the equator with dark, cold and rainy climates.⁷⁹ Red was also found to be a significant color across cultures and was always associated with life, energy, and excitement, which has led to the suggestion that perceived temperature of colors may explain the cross-cultural color associations.⁸⁰

Red was also found to be a significant color across cultures and was always associated with life, energy, and excitement

However, most colors have both positive and negative associations, often which are shaped by individual experiences or cultural norms. In some cultures, the color red is associated with love and romance while also connected to feelings of anger and rage. A study in the Southeastern part of the United States, found a strong connection between red and Satan or evil.⁸¹ In Chinese culture, red is associated with brides and purity while in other cultures, red is associated with oppressive and violent regimes. Another example is the color yellow.



i-18



i-19



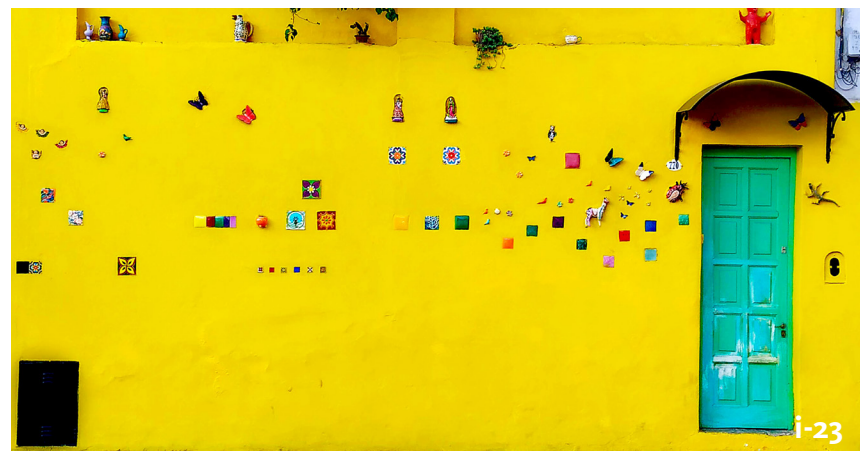
i-20



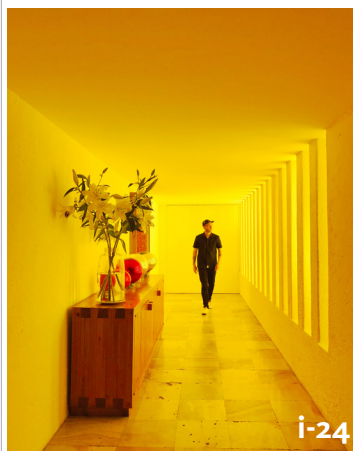
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Few colors transcend cultural divides; yellow was found to be associated with 'joy' across the globe.

In Chinese culture, it is associated with cheerfulness and royalty while in Spain it is linked with treason. In Buddhist cultures, it is synonymous with death and in Christian cultures, it is related to betrayal.⁸² Green is associated with nature, growth, fertility, and comfort while it can also be associated with poison and jealousy (“green with envy”). Blue is associated with serenity and calm, but can also be aligned with depression, sadness, and isolation (“feeling blue”). Violet is associated with royalty, sensuality, decadence, and luxury, while in other contexts it is associated with immaturity or sublimation.⁸²

Color-emotion is highly dependent on personal preference and a person’s past experiences with a particular color. For example, a western person who recently attended a funeral might associate black with grief while someone else who attended a black-tie formal gala might associate black with luxury and wealth.⁸¹ Recent research explored the “ecological valence theory” which postulates that human color preference is fundamentally adaptive and the more enjoyment or positive emotions an individual experiences with objects of a given color, the more the individual will associate positive feelings with the given color. For example, since clean water is blue and essential to an organism’s survival, there is a positive color association. The red undertone to a human’s skin is an indication of arousal and historically led to reproduction success, so it too, can create a

the connection of yellow with joy had a higher rate of association in countries found further away from the equator with dark, cold and rainy climates

positive color association.⁸³

A majority of the above research focuses on the differences in reaction and association with a change in hue. Hue is what distinguishes one color from another (e.g. “blue” or “yellow”). Recent research has begun to study the impact of all five dimensions of color: hue, chroma, colorfulness, lightness, and brightness.⁸⁴ Colorfulness is the amount of a hue in a color while chroma is the strength or vividness of a hue. Brightness is a measure of the reflectance of a color and lightness is the amount of white added to a color (also referred to as ‘value’).

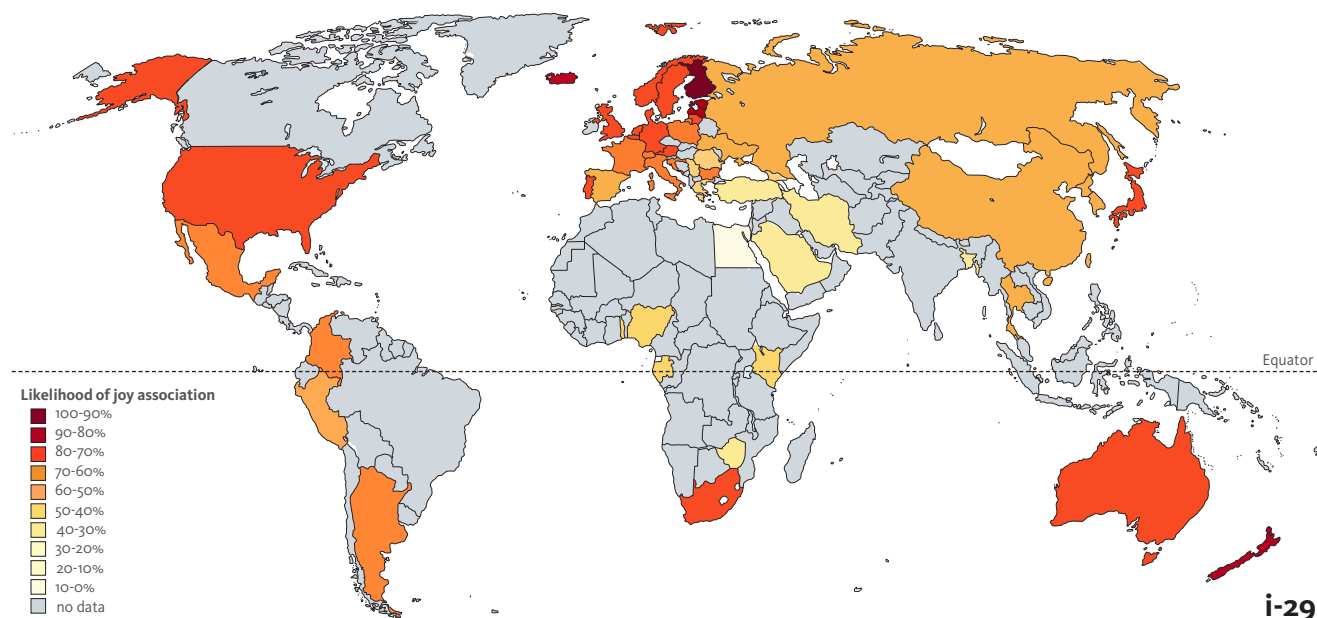
Using validated color models, such as the Munsell color system, recent research explores the relationship of chroma and value (rather than just hue) on the impact on psychological functioning and arousal.⁷⁸ A study conducted in 2017 found that calm was associated with high lightness and low chroma colors while playfulness and arousal were aligned with the high chroma colors.⁸⁵ Another study conducted in 2016 found that regardless of hue, colors with higher chroma and brightness caused significantly more skin conductance responses, accelerated heart rates, and received higher ratings of arousal and valence (attractiveness) from the subjects. It was determined that hue and brightness only affected the arousal for colors with high saturation, meaning that a change in hue had less impact on the observer’s psychological and

physiological state than the intensity of the hue.⁸⁶ This distinction is important when considering the application of color to a space to elicit an arousing or calming reaction.

Precedent studies in the use of color in relaxing and restorative environments show color being applied as a wall coating. A study in the Philippines showed that a significant reduction in stress was experienced by nursing students when they inhabited a room painted light blue and pink.⁷³ The 20 students in the study answered a pretest to determine the level of stress before entering one of three rooms (with one wall painted blue, pink, and white). After 20 minutes, the subjects answered the same questionnaire to determine if there was a reduction in stress. The results showed a reduction in stress for all participants, but there was significantly higher reduction in stress for the subjects in the colored rooms, with blue having a slightly higher rate of reduction. Another study in Italy examined the productivity and study habits of college students in different color painted break rooms. They found that the blue room had a higher rate of studying, and the green room was determined as the most calming.⁷⁴ Another study found that office worker’s overall moods were higher throughout the year for those who worked in colorful work environments.⁶⁷

However, there are claims that psychological effects do not last beyond a short duration and that painting walls for a desired result are unfounded. A study conducted in 1979 found that inmates placed in isolation rooms painted pink showed significant reduction in hostile or agitated behavior after a short 15 minutes.⁷² This led to the common belief that “pink” was a universal calming color. It was later revealed that an inmate was accidentally left in one of the painted chambers for multiple hours. The inmate had lost all composure and was trying to tear the pink off the walls and harm himself. Data suggests that a short exposure (15-20 minutes) to a painted wall may elicit a desired response, but prolonged exposure has little, to no, effect.⁸²

Other precedent examples explore the use of colored lights to induce feelings of relaxation or energy. A study in Hong Kong found that when a subject was exposed to a computer screen displaying a given color, blue elicited more relaxed feelings than red or yellow. These results were extrapolated through the subject’s reaction time.⁸⁷ Another study explored how skin conductance, heart rate, and emotional state were affected by exposure to varying hues, saturation, and brightness levels of three colors (red, blue, and green) displayed on a LED board. This study found that the brighter, more saturated colors caused significantly stronger skin conductance responses, and the use of any chromatic color (not white, black or grey) led to an increase in heart rate across the board.⁸⁶ Another study conducted in Pakistan showed a reduction in anxiety after a subject stared at a blue light.⁸⁸



Considering the varying needs of employees entering a relaxation room, it might seem like a potential strategy to incorporate color changing lights. However, it is important to note that a change in lighting can result in a change in the overall perception of a space. A change in the color of lighting impacts the perception of other colored materials. For example, a red light in a space will magnify the reflected “red” of inherently red materials. Materials that do not reflect red will appear more brown or black. The same principle applies to other colored light conditions as well. In a space that may try to deploy both colored lighting and colored materials, it is crucial to consider the effects of lighting on material.

Most lighting applications utilize white light, but with the recent advances in LED technology, designers have the opportunity to play with the spectrum of lighting. The correlated color temperature (CCT) of lighting is the change in the color of light. High CCT (> 4000K) refers to “cool” blue light. Low CCT (< 3000K) refers to “warm” red light.⁸⁹ Data suggests that light with more “blue” wavelengths enhance cognitive and physical performance.^{63,64} At the highest levels of CCT, which simulates the blue of high noon, there is a reduction of fatigue and sleepiness, and an enhancement of alertness, vitality, and mental health.⁶² These results are more evident at low illuminances.⁶⁷ On the other end of the spectrum, low illuminance and “warm” CCT light elicited feelings of comfort and overall positive feelings.⁸⁹ However, in one study, low CCT led to an increase in drowsiness.⁹⁰ Boyce found that a psychological change, as a result of the CCT of a room, is only noticeable when an occupant experiences a noticeable shift from the previous lighting condition.⁶⁶ When designing a separate space that utilizes CCT as a way to alter the mood of an occupant, it is crucial to consider how the new lighting condition differs from the existing lighting conditions of the previously inhabited workspace.

Studies have also been conducted that explore the relationship of gender and age to CCT. Knez found that females have better moods in high illuminance “warm” lighting conditions.⁹¹ Knez also found that younger adults (avg. 23 yr) exhibit a higher chance of a negative moodlet in “warm” light compared to older adults (avg. 65 yr) who exhibit a negative mood in a “cool” light condition.⁹² When considering an alteration to the color rendering and correlated color temperature of lighting conditions in an office environment, an analysis of the demographics of occupants could be beneficial.

Virtual reality and multi-sensory experiences

Physical space is costly; therefore, in many work environments real estate is optimized for production.

When dedicated space for wellness is not available, virtual space can be considered. Virtual reality (VR) technology is rapidly advancing and the visual experience is continually getting better as the cost for the hardware decreases. One study conducted by Lund University in Sweden looked at the effect that viewing a VR forest would have on stress, while incorporating nature sounds. In this case, “the virtual environment was presented using a CAVE™ system with three rear-projected walls (4 m × 3 m) and a floor projection,” instead of the more common virtual reality headset.⁹³ Three groups were examined after inducing stress; the first group took a walk in a virtual reality forest with no sound; the second group was in the VR forest with forest sounds (birds, stream, etc.); and the last group was the control who recovered from stress in an empty room with no natural

stimuli.⁹³ The results showed that the sound paired with the visual nature setting was the best for stress reduction using heart rate and cortisol biomarkers. Interestingly, the group that was in the hyper-realistic quiet forest environment had a difficult time recovering from stress and reported an unnerving feeling of being in a quiet forest.⁹³

The potential for VR to induce stress recovery is very strong. A multi-sensory virtual space replicating the experience of the natural environment could have a strong impact on recovery in the workspace. VR could be utilized in an underdeveloped existing space or new space without a lot of extra square footage for wellness rooms, be individually configurable, and offer an economically viable option for employers.



Conclusion

As human work migrated from the outdoor hunter-gatherer grounds of the savanna into the indoor workspace of the home, the *ur*-space for wellness, and into the modern workplace, our workday changed, sharply demarcating work and private time. During the industrial revolution and into the early twentieth century, hard-fought gains were secured by workers to create breaks and space for breaks in often dangerous industrial work settings, which ultimately improved productivity. Today, globalized culture and commerce have us working across time zones, once again blurring the edges of work and private life; now, coupled with a work culture and spatial environment that is often structured ostensibly for corporate profit and not individual worker wellness.

A review of the scientific literature provides a strong basis for the use of space to enhance wellness in the modern workplace. There is ample evidence on the benefits of napping to aid alertness, cognition and performance, and biophilic connections to reduce stress and improve worker wellness. Biophilic cues can be subtle and take many forms, from the visual to the unseen. Variety, flexibility and opportunities for control of one's environment are important and can be as simple as proximity to operable windows, which offer the worker the multi-sensory experience of changing diurnal and seasonal views, lighting intensity and spectrum, color shifts and thermal variation. Color, commonly used in workplaces as a branding strategy or packaged with design trends, should be reconsidered. Hue has cultural associations and very few colors globally transcend cultures; though, yellow was found to be universally associated with joy. Designers should pay attention to chroma and value, since independent of hue, high value and low chroma colors appear to be associated with calmness, while high chroma colors are more associated with playfulness and arousal.

Space dedicated for non-task-oriented workplace wellness has many productivity benefits to workers. For those workplaces fortunate enough to have proximity to outdoor natural areas, spaces inherently rich in color, thermal, auditory and lighting variety, the use of this natural resource would provide many benefits, assuming workers are given the opportunity in their day to use it. In built environments without outdoor natural space, designed space should be developed to create restorative benefits and in workplaces constrained for physical space, virtual reality even shows promising psychological results. Cultural and ideological diversity, user demographics, and other relevant spatial factors may dictate the features most beneficial to an organization; however, as the findings from the design challenge indicate, organizations can draw on scientific evidence to design creative, engaging spatial concepts for worker wellness.

... opportunities for control of one's environment are important and can be as simple as proximity to operable windows...



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Sandra Byers

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Sandy will earn her MArch degree with an emphasis in architectural technology in June. She is looking forward to putting her interests in sustainable design strategies to practice. A significant concentration of her studies has included daylighting and mass timber construction and their applications to human centric design. Much of her work as a student researcher in the Energy Studies in Buildings Laboratory at the U of O in Eugene has centered on the circadian lighting exposure of supportive living residents and how architecture may help improve the well being of this vulnerable population.



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Katherine Martin received her Bachelor of Science in Architecture from Georgia Tech in Atlanta, Georgia. She chose to come to the University of Oregon to obtain her Masters with an emphasis on sustainability in an urban setting. Her interests include passive design strategies, energy efficiency, wellness in built structures, and affordable housing.

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Lily is a Track II graduate student working towards her Master of Architecture degree. Before coming to the University of Oregon, Lily worked in private practice for three years after graduating from Temple University in Philadelphia, PA with a dual degree in Architecture and Architectural Preservation. During the start of her working career, she realized to make true strides in sustainability and resiliency, she would have to gain a deeper understanding of systems-based design from a micro to macro scale.

During her graduate studies her research in the Energy Studies and Buildings Laboratory and in the classroom has been focused on implementing natural systems into design and its effect on energy demands and a person's wellbeing, cognition and productivity as well as designing for social equity, food security, healthy building materials, and utilizing waste to create closed-loop systems. In all of these research and design endeavors, she places the emphasis on the goal of bettering the health of the planet and all of its inhabitants.



Mark Fretz

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Mark Fretz is a Research Assistant Professor and Associate Director of Outreach at the University of Oregon's Institute for Health in the Built Environment in the Department of Architecture. Prior to studying and practicing architecture, Mark spent a decade as a clinician with the U.S. Public Health Service and has transitioned from investigating oral microbiomes to building microbiomes and architectural design. As a designer, researcher and former clinician, he synthesizes this diverse background to facilitate knowledge exchange between the Institute's Build Health, research labs, external collaborators and community. His research focuses on exploring design strategies that optimize human health while reducing energy use and carbon in the built environment. An important theme in this exploration is understanding how human migration from outdoor to indoor dwelling has affected evolutionary mechanisms connected with health and how architectural design can restore these relationships.

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