Investing In People:
The Social Benefits of Sustainable Design

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ABSTRACT

This paper provides an overview of theory and research on the human benefits of building design. Identified benefits include improved health outcomes, psychological well being, reduced stress, improved cognitive performance, and improved work and life satisfaction. While many building variables affect these outcomes, there is growing evidence that the high impact design features are connection to nature, incorporation of daylight and sunlight in buildings, sensory change and variability, and improved personal control over ambient conditions.

INTRODUCTION

We think of buildings as investments in things: real estate, land, technology. Yet, we build to provide habitats for people to work, live, learn, and recover from illness.

Investing in people requires a dual approach of reducing risks and promoting positive experience. At the present time, building practices and standards focus on avoiding health and safety risk, such as illnesses and absenteeism associated with poor indoor air quality (Fisk and Rosenfeld, 1997). There are no standards, or even guidelines, on how to design to **promote** health, well being, and other positive

experiences such as engagement with place, work effectiveness, and sense of community.

This paper will focus on building design as a vehicle for promoting positive human experience and outcomes.

An Investment Framework

To explore the notion of design for positive experience, I would like to start, not with buildings but with zoos. Early zoos focused on keeping animals alive in their exhibition cages so human visitors could marvel at them. After decades of this approach, zoo keepers began to realize that many animals survived, but they did not flourish. They failed to reproduce. They often showed signs of boredom and behaved aggressively toward their fellow animals. They languished physically from lack of exercise. What was missing from their zoo habitats? What did the animals need to flourish?

To answer this question, zoos turned to field biologists who studied animals in their natural habitats and social groupings. This partnership produced a major innovation in zoo design – the ecological zoo that incorporates critical features of natural habitats. The new zoo encourages animals to explore, forage, play, build nests, and maintain social relationships that are closer to those they would experience in the wild. Construction materials, vegetation, spatial relationships, light, water features, and behavior settings are selected to provide supports and amenities for physical, psychological and social well being. Investments in the new design approach paid off. Zoo attendance and memberships increased. Animals are flourishing, and zoos are now playing a major role in animal conservation effort around the world.

What if we used the zoo approach to designing sustainable building habitats for people? This would mean starting with fundamental human needs and goals, rather than external image or prestige. It would require understanding what creates a healthy environment in the broad sense, including psychological and social factors as well as physical health. Buildings designed from this perspective would take into account the vast literature on environmental aesthetics, preferences, sense of place, and social relations.

The remainder of this paper will explore building habitability in the context of sustainable design. Much of the sustainability literature assumes that human benefits accrue automatically from improved interior environmental quality (particularly indoor air). However, research by Heerwagen and Zagreus (2005) calls this belief into question. Studies of occupant responses to LEED™ rated buildings do not show consistent positive results on a web-based survey administered by the University of California, Berkely, Center for the Built Environment (www.cbesurvey.org). Satisfaction with interior quality in the LEED buildings in the CBE database are highly varied. Furthermore, many LEED buildings score lower than non-LEED buildings on temperature, lighting, acoustics, and overall building satisfaction. The one feature on which LEED buildings performed better overall was air quality.

What Makes a Good Habitat?

Research in the behavioral sciences (Boyden, 2000; Orians and Heerwagen, 1992; Heerwagen and Orians, 1993) suggests that a good building habitat supports:

- Connection to nature
- Sense of community and belonging
- Behavioral choice and control
- Opportunity for regular exercise
- Meaningful change and sensory variability
- Privacy when desired

Table 1 identifies features and attributes of buildings that support these needs and experiences. Importantly, many of the building factors in Table 1 fall within the realm of sustainable design. This article will focus on the sustainable building features (daylight, views, connection to nature, ambient controls), but will also take into consideration other features that could be readily incorporated into sustainable building design to improve the likelihood of providing for the full range of habitat supports.

Table 1. Features and Attributes of Buildings Linked to Well Being Needs and Experiences

Experience/Need	Environmental features and attributes
Connection to nature and natural processes	Daylight; views of outdoor natural spaces; views of the sky and weather; water features; gardens; interior plantings; outdoor plazas or interior atria with daylight and vegetation; natural materials and décor.
Opportunity for regular exercise	Open interior stairways; attractive outdoor walking paths; in-house exercise facilities; skip-floor elevators to encourage stair climbing.
Sensory change and variability	Daylight; window views to the outdoors; materials selected with sensory experience in mind (touch, visual change, color, pleasant sounds and odors); spatial variability; change in lighting levels and use of highlights; moderate levels of visual complexity
	Personal control of ambient conditions (light,

Behavioral choice and control	ventilation, temperature, noise); ability to modify and adapt environments to suit personal needs and preferences; multiple behavior settings to support different activities; technology to support mobility; ability to move easily between solitude and social engagement and spaces to support both
Social support & sense of community	Multiplicity of meeting spaces, use of artifacts and symbols of culture and group identity; gathering "magnets" such as food; centrally located meeting and greeting spaces; signals of caring for the environment (maintenance, gardens, personalization, craftsmanship)
Privacy when desired	Enclosure; screening materials; ability to maintain desired distances from others; public spaces for anonymity.

HUMAN BENEFITS RESEARCH

A growing body of research in diverse fields is beginning to identify positive outcomes associated with the building features and attributes shown in Table 1. Studies show reduced adaptive load (less effort needed to adjust to an environment), reduced stress, improved emotional functioning, increased social support, reduced fatigue, and improved ability to focus attention on important activities (Heerwagen, 2000; Heerwagen et al, 2006; Ulrich, 1993; Kellert and Heerwagen, in press).

Connection to Nature

Over the past several decades, research in a variety of fields shows that contact with nature generates emotional, physiological, social, and cognitive benefits. Research on this topic has been conducted in a variety of settings including workplaces, hospitals, urban environments, and experimental laboratories. Further, the findings point consistently to the value of particular nature features such as large trees, flowers, gardens, and water. Studies also show that benefits of nature occur in many ways -- through direct contact (sitting in an outdoor garden), indirect contact (through a window view), and from simulations using nature decor (such as posters or paintings).

Ulrich's research (1984) was the first to focus on the links between nature, emotional functioning and health associated with window views. His study found that hospital

patients in rooms with views of trees had a more positive recovery from surgery than a matched group of patients whose view was a brick wall. Patients with the nature view stayed in the hospital fewer days, took fewer strong medicines, and had more positive notes from nursing staff about their recovery process. Studies in office settings have also found reduced stress associated with window views of nature (Kaplan, 1992).

Ulrich's studies have included laboratory experiments in which he has consistently found that subjects recover from stress more quickly and are in more positive moods if they are shown nature scenes or urban scenes with nature rather than urban scenes devoid of natural elements (see reviews of this research in Ulrich, 1993).

Others have shown that nature contact can be beneficial, whether it is real or simulated. For instance, a study of windowed and windowless offices by Heerwagen and Orians (1986) found that people in windowless spaces used twice as many nature elements (posters and photos especially) to decorate their office walls than those who had views to natural areas outdoors. A laboratory study of "green exercise" tested the effects of projected scenes on physiological and psychological outcomes of subjects on a treadmill (Pretty et al, 2005). They found that all subjects benefited similarly in physiological outcomes, but that subjects who viewed pleasant nature scenes (both rural and urban) scored higher in measures of self esteem than those viewing totally urban scenes or "unpleasant" rural scenes with destroyed landscapes.

In addition to the psychological benefits from nature contact, there is growing evidence of a strong linkage to cognitive functioning. For instance, Lohr et al. (1996) found that subjects working in a windowless room with plants completed a series of computerized tasks faster, had lower blood pressure readings, and felt more attentive than subjects working in the same room without plants. In study of window views, Tennessen and Cimprich (1995) found that people whose view was predominantly natural (as opposed to built) had higher scores on a survey assessing directed attention and attentional recovery. Hartig et al (1991) report similar results in a field experiment. People who went for a walk in a predominantly natural setting performed better on an editing task than those who walked in a predominantly built setting or who quietly read a magazine indoors. Performance was assessed by number of errors found in the text and corrections implemented.

In two studies of office workers, Heschong (2006) found that those with full window views, especially views of nature, performed better on a number of work tasks. One of the studies, conducted in a call center, found that workers with seated window views performed 6-7% faster (e.g., were able to handle more calls) than those without window views. The other study, a field experiment, also found positive impacts of window views on computerized memory and attention tasks. Furthermore, the quality of the view mattered. Those with full, high quality views with natural vegetation performed 10-25% better on these tasks than those with no view.

Although the mechanisms underling the links between nature and cognitive performance are not currently known, there are several hypotheses. The first, proposed by Kaplan (1995) focuses on attention. Kaplan argues that visual contact with everyday nature reduces fatigue associated with intense concentration, and thereby replenishes the attentional system enabling people to refocus easily after short nature breaks.

The other leading hypothesis, proposed by Ulrich (1993), argues that nature contact improves cognitive performance through impacts on mood. He draws heavily on research by Isen (1990). In numerous experiments, Isen's research shows that subjects in positive moods perform better on tests of creative problem solving than those who are in neutral or negative moods. Isen speculates that positive moods increase the tendency to "break set" and to see relatedness between divergent events or appearances. This is because feeling good promotes diffuse rather than focused attention and this leads people to see things differently (e.g. people notice more details) or to search more broadly for solutions and alternative interpretations. Joseph LeDoux (1996), one of the nation's leading brain researchers, cites neurological evidence to support this hypothesis. He has found that positive feelings lead to heightened activity of the right parietal brain region – the section of the brain that is associated with a more global, expansive cognitive style. Thus, positive feelings directly affect brain processes related to performance on tasks requiring creativity and novel problem solving. Daily irritants, on the other hand (such as discomfort) tend to generate high negative affect and thus are likely to interfere with higher level cognitive functioning (Clark and Watson, 1988). In contrast, daily perks – such as a window view of an outdoor landscape -- ameliorative stress.

A third mechanism for the positive impacts of nature views, suggested by Heschong (2006), is "malaise" which includes fatigue, headache, eye strain, and difficulty concentrating. In her study of office workers, Heschong found that fatigue was consistently higher among who did not have access to windows.

Outdoor Nature and Gardens

Urban nature also has benefits for health and well being. For instance, a study of public housing projects in Chicago found that large trees had a significant impact on residents' social behavior (Kweon et al, 1995; Sullivan et al, 2004). Using behavioral observations and interviews, the researchers found that housing developments with large trees attracted people to be outdoors and, once there, they talked to their neighbors and developed stronger social bonds than people in similar housing projects without green space and trees.

There is also growing evidence that both active and passive contact with gardens provides psychological, emotional and social benefits. Cooper-Marcus and Barnes (1995) found that benefits of gardens included recovery from stress, having a place to escape to, and improved moods. Benefits also occur with horticulture therapy, especially in clinical settings and nursing homes. Studies described in Morris (2003)

show that dementia and stroke patients show improved mobility and dexterity, more confidence, and improved social skills as a result of gardening activities.

Daylight and Sunlight

Benefits of daylight and sun have been studied in work and clinical settings. Sunlight in patient rooms is associated with reduced experience of pain as well as reduced stress and depression, more positive moods, and/or reduced hospital stays. In a study of patients hospitalized for severe depression, Beauchemin and Hays (1996) found that patients in sunny rooms stayed in the hospital fewer days than those in dimly lit rooms. Similar results were found for heart patients in another study (Beauchemin and Hays, 1998). Patients assigned to a sunny critical care room had lower mortality rates than those in north facing rooms lacking sunlight.

A more recent study in Pittsburgh assessed patient outcomes in bright hospital rooms compared with those in rooms in which a building wing blocked sunlight access (Walch et al, 2005). The researchers found that patients in the bright rooms, who were exposed to 46% higher light levels, experienced less perceived stress, took less analgesic medication per hour, and had 21% less pain medication costs than patients who underwent the same type of surgery but were housed in the dimmer rooms.

A recent review of the health effects of sunlight (Kiraly et al, 2006) found that physiological benefits also extend to the central nervous system through a wide range of hormonal effects. The effect of sun on bone health through the production of Vitamin D has, of course, been long known.

Both field and laboratory studies in work settings also show that interior sunlight patches improves mood.(Boubekri et al, 1991 ; Leather et al, 1998). Daylight is also perceived as important for psychological well being, physical health and for aesthetic pleasantness (Heerwagen and Heerwagen, 1986).

Sensory Change and Variability

Increasing evidence shows that people like moderate levels of sensory variability in the environment, including variation in light, sound and temperatures, (Humphrey, 1980; Platt, 1961). An environment devoid of sensory stimulation and variability can lead to boredom and passivity (Cooper, 1968; Schooler, 1984). Workplace studies show that people value daylight in the environment and highly prefer windowed spaces (Heerwagen and Orians, 1986). One of the most effective ways to achieve sensory variability is through daylight design. A study of seven energy efficient building sin the Pacific Northwest found that 66% of the occupants said they liked sunlight in their workspace and 73% said they liked the diurnal changes in daylight and sun (Heerwagen et al, 1991).

Personal Control

Personal control has assumed such a powerful place in psychology (Langer, 1983) that few question what it means or what people really want to control. Some argue

that perceived control is more important than actually control; that is, if people think they have control over environmental conditions (as with a sham thermostat), they will be satisfied. On the other hand, if people are given too much control and are asked to adjust everything, the environment may appear to be "out of control."

Given the high personal variation in ambient preferences as well as variability within a given person over time, it is likely that control over temperature, noise, air movement, and lighting are an important component of an effective work environment. The research on the advanced comfort workstation produced by Johnson Controls supports this notion (Kroner et al, 1992). The research tracked workers in an insurance company as they moved to a new building with advanced controls workstations. The study found that productivity increases of 2.8 % could be attributed to the new workstation. Interestingly, the total productivity increases associated with the move to the new building were substantially higher (16%). Although the research report does not try to link the overall productivity increase to the building features, it is evident from the pictures and from the report descriptions that the new building had a number of features that were lacking in the old building. Especially relevant is the presence of an attractive landscape with a pond, extensive windows and daylight, and a more open and spacious interior. Another key difference is the location of the workstations: in the new building, 96% of the workers with the personalized control workstations were located on the perimeter with window views. In contrast, only 30% of the workers in the old building had access to windows.

Stair Design and Exercise

Although there is little research on this topic, an increasing number of public health officials are looking at how the designed environment can reduce obesity and improve physiological functioning through stair climbing and increased walking between buildings A study currently underway of the new San Francisco Federal Building will be assessing occupant movement patterns relative to stairway and elevator design. The building uses a skip-floor elevator design for all but one elevator to encourage people to use the stairways. Rather than enclosing all stairwells in unattractive concrete, the design includes views of the city and interior gardens.

ECONOMIC VALUE OF POSITIVE BUILDING FEATURES

Although the research on the economics of social benefits of buildings is limited, the data suggest that investments pay off for both the owner/developer and the building occupants. The existing research falls into two categories: rent and property value of buildings and worker productivity.

Rental and Property Value

Many factors contribute to a building's value including general location, size, and convenience relative to shopping, restaurants, schools, and other quality of life

factors. Of particular interest for this article is the willingness of home owners and building renters to pay for amenities that have psychological and social value (or "hedonic value," as it is referred to in the economic literature). Research shows strong evidence that people are willing to pay more for good views (especially distant views, views of water, and views of large trees), high quality landscaping, and location relative to water, particularly ocean and lakes.

The Value of Landscaping and Trees

For instance, a study of building factors that influence tenants' decisions to relocate found that landscaping was highly rated and, in fact, rated more highly build out allowance, building height, convenience (relative to restaurants, banks, and shopping), age of building, and corner office space (Pittman and McIntosh, 1992). Not surprisingly, the most important factors were locational. In this study, views were rated as moderately important, but less so than landscaping.

In a study of the economic effect of trees and landscaping on office buildings in the Cleveland metropolitan area, Laverne and Winson-Geideman (2003) found that good landscaping aesthetics and large shade trees add an average of 7% to rental rates, while densely packed vegetation used as screening reduced rents by an average of 7.5%. Landscaping for noise abatement and flower beds had no measurable impact on rents.

In housing, both large trees and the landscape design quality influence price. According to a study by Henry (1994), houses with landscapes rated as "excellent" by landscape professionals were priced 4-5% higher than equivalent houses with poor landscaping. Peters (1971) found that shade trees contributed almost 19% to a 2.8 ha parcel of land in the UK. Others, (Morales, 1980; Anderson and Cordell, 1988) found that good tree cover added 3-5% to the value of a house. However, too many trees reduces hedonic price valuation

According to data derived from the sales of 2520 homes on the urban fringe of Dijon, France, the spatial arrangement of trees is an important factor in hedonic price valuation (Cavailhes et al, 2005). The researchers in this study used satellite images and a geographic information system (GIS) to create landscape views as they would be seen from a house. They found that scattered copses of trees within 70 m of the house had a positive effect on housing prices than views of forest edge or other buildings. Interestingly, trees which could not be seen from the house had no impact on price. Distant views also had little impact on housing values which the authors attribute to the fact that the views have little visual interest (no views of ocean, mountains or "emblematic" buildings. The research also took into account the extent to the house was "in view" to passersby or by occupants of nearby buildings. They described exposure to view as a "nuisance" that had a negative effect on sale price.

The findings from studies of the impact of trees on building rental and housing prices are highly consistent with research on landscape aesthetics (Heerwagen and Orians, 1993; Appleton, 1975). Studies from a variety of fields consistently show

that people prefer semi-open, savannah-like spaces with clustered trees and high visibility into the surrounding space. Such spaces provide, as Appleton describes it, the "ability to see without being seen" by enabling both visual protection and visual surveillance.

The presence of trees and landscaping may also influence consumer shopping behaviors according to a study by Wolf (2003). Using photographs of similar streets lined with small shops, but varying in tree cover and landscaping, Wolf found that people rated the shopping areas with trees and vegetation more positively, said they would be willing to spend more time in these settings, and also reported that they would be willing to pay up to 12% more for goods purchased in the retail setting with trees and good landscaping. Interestingly, business owners did not share the enthusiasm for trees due to maintenance costs and concerns that vegetation blocked a clear view of the shop.

The Value Water Views

It comes as no surprise that buildings located on waterfronts or with good views of oceans and lakes command high prices. However, not all bodies of water are equal in value nor are all water views. In a study of the hedonic value of a variety of water views in Bellingham, Washington, Benson et al (1998) found that houses with full views of Puget Sound commanded higher prices than those with partial views or with views that contained industrial buildings. Full views of the Sound added 58.9% to the property value of the house and a partial view added about 30%. Unobstructed views of a lake added 18% to the value of the house. The greatest increase in value, however, came from lakefront property which added 127% to the value of the house. (In this study, there were no ocean front properties due to the fact that a railroad runs along Puget Sound in Bellingham, restricting access to the water.) Distance from the water also had an impact on housing prices. A full ocean view added 68.3% to the value if the house was located within 0.1 miles of the water, but only 44.7% if it was located two miles away.

Worker Productivity

There is strong evidence connecting improvements in work performance to many features and attributes of the built environment (see overviews of this literature in Heerwagen, 2000; Leaman and Bordass, 2006; Loftness et al, 2005 for overviews.) Key building features associated with productivity increases include personal control of ventilation and temperatures (Kroner et al.,1992; Wyon and Wargocki, 2006a; Menzies et al, 1997), daylight (Heschong, 2006), air quality (Dorgan and Dorgan, 2006; Wyon and Wargocki, 2006b), and window views (Heschong 2006).

Surprisingly, however, this body of literature has not lead investors to "jump at the opportunity" to increase productivity by improving building practices (Mudarri, 2006). Mudarri identifies one key problem: the entity that benefits from the improvements (e.g., the organization that occupies the space) often is not the entity that provides the space (e.g., the building owner). Thus, there is no incentive to invest in something that may cost more and reap benefits for someone else. Mudarri

suggests that other incentives are needed such as reduced cost burdens from tax breaks and other methods.

However, there is another, deeper problem that has more to do with the nature of work in organizations today. The majority of research on worker productivity has focused on individual output on well defined experimental tasks or other work that is "countable", such as quality (based on error rate) or quantity produced. In contrast, work of value to organizations is knowledge based, improvisational, and often done at a group level. Knowledge work is inherently difficult to quantify because there are no absolute right or wrong answers or approaches. Knowledge work involves judgment, problem solving, problem finding, analysis, and synthesis that is difficult to evaluate except in hindsight when the "results" of such work is known.

There is clearly a disparity between what can be measured by researchers and what is of value to organizations. Because available results may not be perceived as useful to organizational decision makers, there may be little incentive on the organization's part to seek out or build facilities with features that have been identified as productivity enhancing. Researchers tend to believe that worker productivity enhancement is a general good and that business decision leaders can be convinced to invest in sustainable design if it is liked to productivity. However, this may be a misguided belief. A large scale workplace research project currently underway by the U.S. General Services Administration to re-design Federal offices shows that organizational leaders are most interested in how to use the workplace to enhance collaboration and communication, attract young workers, convey a positive image to customers, and improve staff morale (Kampschroer and Heerwagen, 2005). Productivity improvements have not been a key driver in any of the workplace projects to date. These goals are common in many private sector organizations also. This suggests that research should focus more on how sustainable building design can influence the outcomes that organizations really value.

SUMMARY AND CONCLUSIONS

The research cited above clearly shows that building design can have a significant impact on human health, well being, and work performance. There is also evidence of links to economic value, particularly building rent and housing value. The links to work performance is well reasonably well established, but the translation to economic benefits at the organizational level is not clear. A more promising, but less well understood, area of research is the link between building features, human benefits, and organizational effectiveness. Clearly more research is needed on this topic.

The high impact building variables – those that affect multiple benefits for building occupants – are daylight, sunlight, personal control of ambient conditions, and connection to nature (large trees, flowers, gardens and water). The challenge for sustainable design is how to incorporate these elements, especially nature, in urban

settings where trees, gardens, and parks are not readily available. It is evident also that improved indoor air quality reduces illness symptoms and absenteeism that can be costly to organizations. (Discussion of this literature is limited because it is viewed as a risk reduction strategy rather than a wellness and benefits promoting strategy which is the focus of this article.)

Growing interest in "biophilic design" (Keller, 2005; Heerwagen and Hase, 2001) seeks ways to incorporate nature and naturalistic design features throughout buildings, especially in urban settings. Biophilia, a term coined by E.O. Wilson (1984) refers to the strong emotional bonds between people and the natural world that evolved over the course of human existence in a biocentric world. A recent symposium, sponsored by Yale University (May, 2006), brought together social scientists, physicians, civil engineers, designers, and developers to create new design approaches that more effectively link biophilia to sustainable practices at the building, neighborhood and community levels.

The growing interest in biophilia and the human dimensions of sustainability coincide with other social changes. In the work environment, there is increasing concern about social equity and shared access to resources, daylight, and views to the outdoors. The big corner office, once monopolized by high level executives, has given way in many organizations to shared meeting spaces, with executive offices moving to the interior away from the window wall. Workstations with lower partitions and more flexible furnishings are more common as ways to support awareness and informal communication (Heerwagen et al, 2005) as well as improve access to daylight and views (Heerwagen and Zagreus, 2005).

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