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ScienceDirect

Procedia Engineering 145 (2016) 412 – 419

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Sustainable Design, Engineering and Construction

Do sustainable buildings inspire more sustainable buildings?

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Abstract

Sustainable buildings offer numerous social benefits including improved health and productivity for occupants. This study adds to this growing body of knowledge to suggest benefits extend to influence occupant consideration for sustainability. In an undergraduate civil engineering senior "capstone" course, students were given a mock request for proposal to design a new campus building. Over the course of a semester students (n=120) worked in groups of four to develop detailed drawings including documentation for Leadership Energy and Environmental Design (LEED) certification of Silver or better. Class sections were randomly selected to work within a newly constructed LEED Gold building or a 60-year-old engineering building. Among these groups, students who worked in the LEED building were more likely to achieve a higher LEED score on their final project (p=0.04). Scores were less varied, more likely to meet the Gold standard and likely to include similar features as the building they were designing within. Students' final grades were compared and found not significant (p=0.3). These results suggest working within sustainable buildings can influence design considerations for more sustainable buildings.

Peer-review under responsibility of the organizing committee of ICSDEC 2016

Keywords: Sustainable design; LEED

1. Introduction

There are many benefits to sustainable buildings that include reduced energy and water consumption [1], higher occupancy rates [2], and improved physical (e.g., reduce colds and infections) and psychological (e.g., reduce fatigue) health [3]. Sustainable design combines technological advances like high performance ventilation systems to reduce respiratory illness [4] and more nuanced opportunities like overhead or desk lighting to reduce computer glare, which is attributed to headaches [5]. Considerations for building orientation and window placement can also

Peer-review under responsibility of the organizing committee of ICSDEC 2016
doi:10.1016/j.proeng.2016.04.008

have a dramatic impact. Windows that face green space enhance occupant comfort [6] and mental focus [7]. Incorporating these numerous approaches is estimated to improve productivity rates compared to conventional buildings by more than 20 percent [8].

The interface between building systems and occupants is also a critical aspect for sustainable design. The key is to balance energy strategies with form and function. Buildings that are energy efficient may reduce carbon emissions but if these buildings are less comfortable they can lead to negative associations with sustainability from occupants [9]. Building form can also affect occupant decision processes. Variation in ceiling height correlate with consumer purchases [10] and the type of office furniture can enhance or distract from workplace collaboration [11].

Design considerations for sustainability require making complex tradeoffs between environmental concerns, comfort, and well being. To help make these decisions, designers and engineers can use rating systems, like Leadership in Energy and Environmental Design (LEED), and others, to guide project team consideration for sustainability in site programming, building layout, and identifying energy efficiency goals [12]. LEED provides a metrics to compare alternative options and justify decisions. There are also external benefits for using LEED. Buildings labeled with LEED command higher occupancy rates and higher lease prices [13]. While the LEED rating system is not comprehensive of all aspects of sustainability these higher prices suggest commercial clients, and the public, value such rating systems, which substantiates using the metrics in the decision process [14].

Whether LEED is used for external reasons (e.g., signaling sustainability to others) or internal (e.g., perceived value for occupants) [15] increasing the designers motivation to achieve a high LEED score is likely to improve building performance. LEED buildings that achieve a mediocre score can vary dramatically in energy and water use performance but highly rated LEED buildings always perform better than conventional buildings [16].

More sustainable buildings that meet a high LEED score, compared to conventional buildings, provide social, economic, and environmental benefit. To encourage more highly sustainable buildings this research investigates if engineers are influenced by the physical space during the design process. Similar to how the physical space can enhance occupant comfort and mental focus, can the physical space influence engineers' design consideration for sustainability? Answering this question can help design engineers become more aware of their design choices. Understanding how the physical space influences their design decisions, those who are interested to incorporate or reach higher levels of sustainability can intentionally seek out these positive benefits of sustainable buildings.

1.1 Leadership in Energy and Environmental Design

In this study, the use of LEED buildings is to inspire occupants, in this case, engineers to consider more sustainable design when planning a new commercial building. LEED is used because of its wide application in industry. LEED awards points in five categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. The Sustainable Sites (SS) category rewards decisions that integrate local and regional systems, that includes transportation services and natural systems for biodiversity. The Water Efficiency (WE) category addresses indoor and outdoor water use with increasing points for reducing consumption. The Energy and Atmosphere (EA) category approaches energy from both efficient design methods and renewable energy sources. The Materials and Resources (MR) category focuses on the life cycle of products awarding points for minimizing extraction, processing, transport, and disposal of building and construction materials. And Indoor Environmental Quality (IEQ) category rewards buildings that improve air quality and thermal and visual comfort.

2. Hypothesis

The hypothesis is the physical space during the design process will significantly impact engineers' consideration for sustainability. Designing a new building inside a highly rated LEED building will encourage engineering design teams to reach for similarly higher levels of performance. The null hypothesis is the physical space will have no measured affect on engineering design for sustainability. Sustainability is quantitatively measured using the LEED rating system for New Construction v3. An engineering team that reaches a higher LEED score is considered to have met a higher level of sustainability for the purposes of the study. Statistical significance is set to an alpha of less than 0.05.

Control and intervention groups of engineering students were chosen at random. The tested hypothesis is the physical space during design influences decision making and consideration for sustainability. The control group