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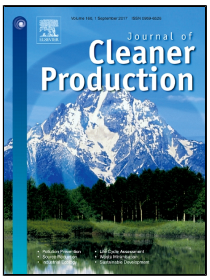

Measuring the impact of dynamic life cycle performance feedback on conceptual building design

John P. Basbagill, Forest Flager, Michael Lepech

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John P. Basbagill[a], Forest Flager[b], Michael Lepech[c]

[a] Corresponding author. Department of Civil and Environmental Engineering, Stanford University, 473 Via Ortega, Stanford, CA USA, e–mail: basbagil@stanford.edu, phone: (847) 912-3850.
[b] Department of Civil and Environmental Engineering, Stanford University, 473 Via Ortega, Stanford, CA USA, e–mail: forest@stanford.edu
[c] Department of Civil and Environmental Engineering, Stanford University, 473 Via Ortega, Stanford, CA USA, e–mail: mlepech@stanford.edu

ABSTRACT

Decisions made in the early design stages critically determine a building's life cycle environmental impacts and costs. Dynamic building performance feedback has the potential to improve design decision making, but the best means of providing such feedback is not well understood. This paper evaluates the effectiveness of three visualization tools in helping designers make sustainable building design decisions. A charrette was conducted in which participants were tasked with minimizing carbon emissions and cost of an office building based on feedback from a scatterplot, histogram, and tornado diagram. Results demonstrate that designers achieved significant improvements in solution quality when feedback was present, with the scatterplot achieving a 20% improvement over conventional methods. The research quantifies the effectiveness of various visualization methods in helping designers create low-carbon, high-performing buildings and suggests that quantity and type of feedback should be carefully considered during the early stages of the sustainable design process.

KEYWORDS

life cycle assessment; life cycle cost; environmental impact feedback; energy efficient buildings; sustainable building design

1. Introduction

Buildings have significant economic, environmental, and social impacts. The gross output of the US construction market was $1.35 trillion in 2015 (Bureau of Economic Analysis, 2015) and accounted for 7% of total employment globally (Khasreen et al., 2009). Buildings account for nearly 40% of primary energy consumption (United States Energy Information Administration, 2016) and associated greenhouse gas emissions (United States Energy Information Administration, 2011). Evidence suggests that greenhouse gas (GHG) emissions from buildings are a significant contributor to the observed increase in the Earth's surface temperature (United States National Research Council, 2010) as well as smog and ozone pollution, which decreases human life expectancy (Anenberg et al., 2010, Anenberg et al., 2011). Further, GHG emissions have been shown to reduce crop yields by 2-15% (Avnery et al., 2013). A significant portion of the environmental and economic impacts of buildings is decided upon in the early phases of the design of these facilities (Wood and Agogino, 2005). Understanding how design decisions impact a building's life cycle performance, therefore, is a critical step towards creating a more sustainable built environment.