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Putting the green into corrections: Improving energy conservation, building function, safety and occupant well-being in an American correctional facility

Jennifer Eileen Cross[a,*], Tara O'Conner Shelley[b], Adam P. Mayer[c]

[a] Institute for the Built Environment & Department of Sociology, Colorado State University, Campus Delivery 1784, Fort Collins, CO 80523-1784, United States
[b] School of Criminology, Criminal Justice, and Strategic Studies, Tarleton State University, Fort Worth, TX 76116, United States
[c] Human Dimensions of Natural Resources, Colorado State University, Fort Collins, CO 80523-1784, United States

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ABSTRACT

Correctional facilities are some of the most energy intensive buildings and therefore offer a great opportunity for savings from high performance design. We ask the question, can integrative design positively affect building energy consumption, function, safety, and occupant well-being in a corrections building? From 2011–2015, we utilized mixed methods including: document analysis, social network analysis, interviews, focus groups, and surveys to study one correctional facility through the process of design, construction, and operations. We found that adhering to the principles of integrative design resulted in the design of a high performance building that reduced energy consumption, improved building function, increased staff productivity, increased safety and occupant well-being for both staff and offenders. We also found that the design flaws in the building were the direct result of excluding a key building occupant group, offenders. This case illustrates the potential and necessity of integrative design processes to achieve aggressive performance standards.

1. Introduction

The built environment is the largest single source of resource consumption, energy use, and greenhouse gas emissions, making the built environment a critical target for conservation efforts. In the United States (U.S.), buildings are responsible for 40% of energy use, 72% of electricity consumption, 30% of raw material use, 39% of greenhouse gas emissions, 12% of water consumption, and 30% of solid waste creation [1]. Buildings also have substantial impacts on human health and well-being (e.g., asthma, depression, stress, productivity) because people spend 90% of their time inside buildings [1]. The green building movement has brought attention to the impacts of buildings on human and environmental health; however, in 2010, LEED certified, green buildings accounted for only about 0.1% of global building stock, and 25% of new construction projects [2–4]. More importantly, while many green buildings have improved energy efficiency, indoor air quality, these benefits are not universal [5,6]. Many designed-to-be-green buildings have failed to live up to their potential for reduced energy consumption, lowered GHG emissions, and improved occupant well-being [7–9].

In response, under the Bush administration, the U.S. government put into place Executive Orders and Mandates for improving the federally owned buildings and being a resource to improve buildings across the United States. In 2005, the Energy Policy Act of 2005 (Public Law 109-058) defined high performance buildings as, "buildings that integrate and optimize all major high-performance building attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity" [10]. The primary barriers that have obstructed the adoption of green building[1] practices are not technical but cultural, social and psychological [11,12]. Meeting the challenge to design and operate green buildings requires transfer of knowledge across numerous specialized groups, which is best facilitated by the intentional use of integrative design practices and large and diverse teams [5,12–16].

Despite the fact that integrated design processes and integrated teams have been established as an effective strategy for avoiding the barriers to design of high performance buildings [10,17,18], integrated processes while widely known, are not the standard process [5,15,19]. In an effort to encourage greater adoption of integrated design practices, technical assistance programs have been established by federal, state and local governments as well as utility companies, and certification programs have begun to include points for using an integrated design process [12,20,21]. Recent literature in this field encourages use

* Corresponding author.
E-mail addresses: Jeni.Cross@colostate.edu (J.E. Cross), Tarashelley1@icloud.com (T.O. Shelley), apmayer@rams.colostate.edu (A.P. Mayer).

[1] In the construction industry the terms sustainable buildings, green buildings, and high-performance buildings are all used synonymously to describe buildings that focus on balancing impacts on the planet, society, and economy. Sustainable or green design focuses on reducing resource use (energy, water, raw materials), selecting materials that support human and environmental health, and creating buildings that are comfortable, safe, and productive.

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of the term Integrative Design Process, where integrative suggests more of an ongoing and iterative process than integrated, which implies an activity that has a clear beginning an ending [13].

Research on green and high-performance buildings has examined building performance related to occupants with myriad measures from occupant comfort to health to productivity. One of the barriers to adoption of green building processes are false assumptions that green building costs more or that green building sacrifices occupant comfort and well-being [11]. Studies of green buildings have found that occupant performance is enhanced by reducing absenteeism [22–24] and that improving indoor air quality (ventilation, CO_2, and VOCs) dramatically improves cognitive function [25]. Research on indoor environmental quality (thermal comfort, lighting, and acoustics) has produced mixed results when comparing green to traditional buildings. In some studies, green building occupants have higher comfort levels [26], but this has not been consistently documented in the literature [27–30]. Thatcher and Milner [31] argued that the inconsistency in the positive impact(s) of green buildings on occupant productivity and wellbeing suggest that future studies ought to focus on examining specific design features that are associated with occupant productivity, comfort, and wellbeing. Others have suggested that the inconsistency in outcomes from green buildings can best be addressed through the Integrative Design Process [5,12,14]. This transdisciplinary case study takes a mixed-method approach to studying the design process, design decisions, building features, and their impacts on building performance and occupant wellbeing.

The definition of high-performance buildings explicitly focuses on building performance holistically, including all major systems. The design objectives for high performance buildings include several objectives. Some definitions of high performance buildings focus on integration of systems, life-cycle costs, reducing energy and resource use, and improving indoor air and environmental quality [12], while others encourage examination of a larger set of concerns, like the “whole building framework”, which defines eight high performance objectives—accessibility, aesthetics, cost-effectiveness, functionality, historic preservation, productivity, security and safety, and sustainability [10]. This study will examine five design objectives, each defined here utilizing Prowler and Vierra’s (2008) definitions. First, cost-effectiveness refers to the selection of design choices and building elements based on both initial costs and life-cycle costs. Second, functionality pertains to programming of the building to meet the spatial needs of various building users and purposes as well as durability and maintenance of building elements. Third, productivity focuses specifically on occupant well-being, considering physical and psychological comfort including air quality, and environmental quality—lighting, acoustics, thermal comfort, work space and technology. Fourth, security and safety is relevant in all buildings and especially in correctional facilities as it concerns protection of all building occupants and assets from man-made, technological, and natural hazards. Finally, sustainability pertains specifically to the environmental performance of the building regarding energy and resource consumption.

The Integrative Design Process is a departure from traditional design because it asks all stakeholders of the building community to participate in integrative sessions where they consider all the project objectives, building functions, systems, materials, and energy performance from a holistic systems perspective [10,13]. In contrast, during traditional design many stakeholders are never consulted and the typical planning and design process relies on the expertise of specialists who often work in an isolated fashion making decisions and design choices in a linear versus integrated manner. In addition, the Integrative Design Process is also unique because it focuses on the relationships between stakeholders, building trust, collaboration, communication across the design process, risk management and efficient decision-making [5,12–14]. The inclusion of all building project stakeholders requires early engagement, and a strategy for maintaining feedback between the core decision-making team and building occupants across the construction process as roles shift during each phase [12–14].

Correctional facilities, in particular, can benefit from the Integrative Design Process to improve building performance [32]. The energy use and costs associated with correctional buildings are significantly higher than most facilities due to the sheer number of individuals under supervision 24 h per day. In effect, they are true “energy hogs”, typically using twice as much energy (kBtu/SqFt/year) than office buildings or schools [33]. Correctional facilities are also complex operationally, requiring designs that simultaneously provide the opportunity for visibility, safety, supervision, and privacy. The green building movement has spread into the correctional building sector, but few studies have examined how the integrative process can improve the building performance for correctional facilities [32,34]. This study documented the impact of using the Integrative Design Process for the construction of a new community corrections facility, specifically examining five aspects of building performance—cost-effectiveness, sustainability (energy conservation), functionality, security and safety, and productivity (occupant well-being).

We asked the following research questions:

- How thoroughly was the Integrative Design Process used in the design and construction of the Alternative Sentencing Building (ASB) in Larimer County? How did this process influence costs of construction?
- How does the ASB’s energy consumption, utility costs, and GHG consumption compare to their goals defined during the design process?
- How well did the ASB improve building function through the use of Integrative Design Process?
- How well did Integrative Design Process address of safety and security concerns for correctional staff and offenders?
- What changes in occupant well-being can be associated with the Integrative Design Process in this case?

2. Case selection

Larimer County implemented the Alternative Sentencing program (and eventually designed a purpose-built facility, the ASB) to avoid the most costly incarceration and jail time for low risk offenders [35,36]. Community corrections programs, which house low-risk offenders an allow them to leave the facility for work, have two primary benefits: (1) they costs less per night per offender and (2) they allow offenders to maintain ties to the community and employment. The ASB is a compelling case for in-depth study as it represents a community driven research initiative on an understudied type of building (i.e., correctional facilities) in the integrated design and high performance building literature. More specifically, the Director of Facilities with Larimer County along with the County Criminal Justice Coordinator asked us to conduct a study to ascertain the effect of the Integrative Design Process on building performance (e.g., energy use, GHG emissions) and function (e.g., privacy, space, storage) as well as occupant wellbeing (e.g., ability to relax). The design process utilized for this building typified the process advocated by both researchers and the Colorado Governor’s Energy Office’s High Performance Building Program[2] that provided financial support for the Integrative Design Process. Additionally, county and university funds supplemented various aspects associated with this project.

The selection of this case was also timely as we were able to design our the methodology to correspond with the Integrative Design Process. Assessing the impacts of the design process requires conducting

[2] The State of Colorado has changed this program to the High Performance Certification Program. https://www.colorado.gov/pacific/dola/high-performance-certification-program.