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The purpose of this study was to look at occupant satisfaction with Kelley Engineering Center, a LEED registered building. Results from a post-occupancy evaluation of Kelley conducted in spring 2006 were compared to those from a pre-occupancy survey of occupants in non-green buildings disseminated in spring 2005. The results showed that respondents were more satisfied overall with Kelley than with their previous buildings. When analyzed at the next level, the data revealed that occupants of Kelley were satisfied overall with the lighting, indoor air quality, space, and furnishings and that their levels of satisfaction increased from the responses reported in the pre-occupancy survey. However, many occupants expressed dissatisfaction with the thermal comfort and acoustics in Kelley, and had been more satisfied with these aspects in their previous non-green buildings.

Occupant Satisfaction in a LEED Registered Building

by
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Amy A. Anderson, Author

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## DEDICATION

*Tomorrow's Child*

Without a name; an unseen face
and knowing not your time nor place
Tomorrow's Child, though yet unborn,
I met you first last Tuesday morn.

A wise friend introduced us two,
and through his shining point of view
I saw a day which you would see;
A day for you, and not for me.

Knowing you has changed my thinking
for I never had an inkling
That perhaps the things I do
might someday, somehow, threaten you.

Tomorrow's Child, my daughter-son
I'm afraid I've just begun
To think of you and of your good,
Though always having known I should.

Begin I will to weigh the cost
of what I squander; what is lost
If ever I forget that you
will someday come to live here too.

Glenn Thomas, © 1996

Occupant Satisfaction in a LEED Registered Building

# CHAPTER I

# INTRODUCTION

In 1962 Rachel Carson called attention to environmental awareness through her book *Silent Spring*. Carson provided readers with evidence that man-made technologies, developed to ease burdens on humans, negatively impact nature, destroy the environment, and ultimately harm humankind.

> We now stand where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed but at its end lies disaster. The other fork of the road—the one 'less traveled by'—offers our last, our only chance to reach a destination that assures preservation of our earth. (Carson, 1962, p. 244)

Carson challenged her readers and the world to stop and take notice of the death and destruction of the environment resulting from technology and to reclaim the clean pure air, water, and soil for future generations. Carson's publication is credited with jump-starting the "innovators" in the area of sustainability (Anderson, 1998; Hawken, 1993).

Environmental concern takes many forms, and solutions are applied in many disciplines. The built environment is a vital area in which solutions such as sustainable design principles continue to be developed and increasingly adopted by government, corporations, and individuals.

> Sustainable design is not a new building style. Instead, it represents a revolution in how we think about, design, construct, and operate buildings. The primary goal of sustainable design is to lessen the harm poorly designed buildings cause by using the best of ancient building approaches in logical combination with the best of new technological advances. Its ultimate goal is to make possible offices…that are net producers of energy, food, clean water and air, beauty, and healthy human and biological communities. (Barnett and Browning, 2004, p. 4)

*Justification for the Study*

Studies (Finnegan & Pickering, 1986; Heerwagen, 2003; Heerwagen, 2005; Samet, 2003) have shown the benefits of sustainable buildings on human health and the environment, but few assess the satisfaction of the occupants of green buildings or buildings designed using sustainable practices. Some research assumes that occupants are more satisfied, healthier and more productive in green buildings (Boubekri, Hulliv & Boyer, 1991; Clements-Croome & Baizhan, 2000; Fisk, 2002; Heerwagen 2001; Leaman & Bordass, 2005; Sundstrom, Town, Rice, Osborn & Brill, 1994; Wineman, 1986; Wyon, 2004). More case studies and empirical evidence "on building occupants' health, satisfaction, and productivity in a wide range of buildings would help strengthen the business case" (U.S. Department of Energy, 2003, p. 5-4).

The relative "newness" of green building has contributed to the limited research available in this area. Satisfaction is not tangible or easily quantifiable and is often overlooked when evaluating buildings. Economic and environmental impacts and costs can usually be easily measured, however, social value, ranging from satisfaction of an individual through morale and corporate image, is difficult to enumerate.

According to Clements-Croome and Baizhan (2000) more occupants report a greater impact on productivity from dissatisfaction with their physical work environment than from job dissatisfaction or job stress. Organizations with satisfied employees typically have higher employee retention, higher productivity, lower operating costs, and lower ongoing capital costs (Corps, 2005). Occupant satisfaction with the built environment is of great interest and value to organizations, from the building owner to the employee (Heerwagen, 2003). Occupants provide valuable feedback on indoor environmental quality and how it impacts their satisfaction, comfort, and productivity (Zagreus, Huizenga, Arens, & Lehrer, 2004).

### *Kelley Engineering Center*

Kelley Engineering Center (Kelley) on the campus of Oregon State University (OSU) located in Corvallis, Oregon is home to the School of Electrical Engineering and Computer Science. The Kelley building houses laboratories, classrooms, seminar rooms, and offices for more than 360 faculty, staff members, and graduate students, as well as a small café (College of Engineering, 2005).

Completed in August 2005, Kelley Engineering Center was built to Leadership in Energy and Environmental Design (LEED) Gold standards for sustainability. At four-stories, 153,000 square feet, and a cost of $45 million, Kelley Engineering Center will be the "greenest" academic engineering building in the United States once it is commissioned and certified LEED Gold by the United States Green Building Council (USGBC) (College of Engineering, 2005). The facility was designed and built to meet a specified level of certification by the USGBC (Gold, detailed in Chapter II). Kelley is currently registered with the USGBC as a project that was built to Gold standards with the goal of obtaining certification. All required paperwork has been submitted to the USGBC for review, and the certification for Kelley is expected in 2006.

Green features of the Kelley Engineering Center include natural ventilation, energy efficient heating, ventilation and air conditioning (HVAC) systems, daylighting, earth-friendly concrete, bio-planters that recycle rainwater runoff, ample bicycle parking and showers, local construction materials, low-toxicity materials and finishes, and recycling of original on-site materials. The design of the facility using these construction principles and materials make Kelley eligible for LEED Gold certification. Kelley will stand as an educational tool about sustainability and renewable energy issues for students, faculty, staff, visitors, and the community into the future.

## *Purpose of the Study*

The purpose of this study is to examine occupant satisfaction with Kelley Engineering Center. A pre-occupancy study captured occupant satisfaction with non-green buildings and expectations of Kelley prior to moving into the new facility. A post-occupancy evaluation captured occupant satisfaction with Kelley and whether expectations of the new building were met. The following elements of buildings that contribute to occupant satisfaction were explored: acoustics, thermal comfort, indoor air quality (IAQ), lighting, and space.

Satisfaction levels of occupants in a new green building were studied. Satisfaction as well as expectation theories were applied to the research to understand the occupants' anticipated reactions to their new building and if those expectations were met. In addition, the occupants' levels of satisfaction with various aspects of their new environment including acoustics, lighting, thermal comfort, and space were analyzed.

### *Research Questions*

This study addressed the following research questions:

1. Is overall occupant satisfaction higher in a LEED registered building than in a non-green building?
2. Is occupant satisfaction with lighting higher in a LEED registered building than in a non-green building?
3. Is occupant satisfaction with thermal comfort higher in a building constructed to LEED standards than a on-green facility?
4. Is occupant satisfaction with acoustics higher in a LEED registered building than in a non-green facility?

5. Is occupant satisfaction with indoor air quality higher in a LEED registered building than in a non-green building?
6. Is occupant perceived productivity higher in a LEED registered building than in a non-green building?

### *Assumptions*

This study was developed under the assumptions that the potential participants use email regularly, will complete the survey in their office, and that all respondents have a similar interpretation of satisfaction levels used in the Likert scale (e.g. satisfied, dissatisfied, etc.). Limitations of the study are addressed in the Results section of this paper.

### *Definitions*

*Built Environment* – buildings, spaces, and products created by people.

*Cradle-to-cradle* – a design philosophy in which products are made to be used and then reused in the same or another way, nothing is discarded, and the products are not 'down-cycled' into a lesser product (McDonough & Braungart, 2002).

*Daylighting* – the lighting of space using natural light, through the use of windows, skylights, and doors (Wilson, et al., 1998).

*Gold, LEED* – a level of green building certification based on a specified number of points (United States Green Building Council, 2005).

*Green Building or Development* – construction using practices that reduce the impact on the earth's resources compared to traditional building practices (Barnett & Browning, 2004, p. 100).

*Greenwashing* – "to falsely claim a product is environmentally sound" (Wilson, et al., 1998, p. 496).

*Indoor Air Quality (IAQ)* – "the health effects of air in a building…influenced by building materials and ventilation" (Wilson, et al., 1998, p. 496).

*Leadership in Energy and Environmental Design (LEED)* – "a voluntary, consensus-based national standard for developing high-performance, sustainable buildings" (United States Green Building Council, 2005, p. 1).

*Life Cycle* – "the consecutive, interlinked stages of a product" from raw material to manufacture, construction, use and destruction (Wilson, et al., 1998, p. 497).

*Off-gas* – "Emission of chemical compounds from a newly painted, finished, carpeted, or furnished room into the air" (Wilson, et al., 1998, p. 497).

*Post-Occupancy Evaluation (POE)* – the collection of information about buildings and the occupants via survey at least six months *after* occupancy (Heerwagen, 2001).

*Pre-Occupancy Evaluation* – the collection of information about buildings and the occupants via survey at least three months *prior* to leaving old space (Heerwagen, 2001).

*Satisfaction* – a consumer's response to perceived expectations and whether those expectations have been met; with the evaluative process being an integral part of the outcome (Yi, 1990, p. 69).

*Sustainability* – "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Barnett & Browning, 2004, p. 101).

*United States Green Building Council (USGBC)* – an organization designed to promote the design of buildings that minimize environmental impacts while maximizing performance and creating healthy places for people to live and work (United States Green Building Council, 2005).

*Volatile Organic Compounds (VOC)* – chemical compounds that can cause negative health effects (e.g. headaches, nausea, etc.); VOCs can be emitted by paints, finishes, and construction materials (Wilson, et al., 1998).

# CHAPTER II

# LITERATURE REVIEW

This chapter begins with an overview of the conceptual framework used in understanding occupant behavior and satisfaction. This is followed by a brief chronological account of the adoption of sustainable building practices in contemporary history, an overview of the research regarding a building's impact on the environment, and an explanation of a standard by which green buildings are measured. The chapter ends with a review of components of the built environment examined in this study and how they affect occupants.

Literature on sustainable building practices focuses on cost, not value, thus leading to a quantitative approach to evaluating the benefits of utilizing sustainable practices (Corps, 2005; Heerwagen, 2003). However, evaluation should go beyond cost and consider the value of buildings—the social value as well as economic value. Ferguson and Weisman (1986) found a significant correlation between job satisfaction and satisfaction with the built environment.

## *Satisfaction Theory*

Satisfaction theory is a business-based marketing theory that focuses on delivery of satisfaction to consumers, business, or society. Satisfaction theory provides a conceptual framework for measuring how occupant satisfaction is measured. A number of definitions for consumer satisfaction have been posited in the literature throughout the research in this area. Typically satisfaction is viewed as an emotional or cognitive response, but also as a combination of both, or as an evaluative response (e.g., attitude about the product's advertisement) (Giese & Cote, 2002; Tse & Wilton, 1988, Veenhoven, 1996; Yi, 1990). In evaluating satisfaction, a consumer's response to their perceived expectations is reviewed along with whether those expectations have been met, the actual process of evaluation is an integral part of the outcome (Yi, 1990).

One of the most frequently studied aspects of consumer satisfaction research is the expectation paradigm. For example, researchers examining the expectancy-disconfirmation paradigm generally agree that satisfaction or dissatisfaction in post-evaluation "is determined by the consumer's evaluation of the discrepancy between prior expectation and the actual perceived product performance after usage" (Chiou, 1999, p. 81).

Researchers, in measuring occupant satisfaction with a built environment, have evaluated the adaptation theory, a component of environmental psychology, to look at various levels of satisfaction with the built environment, to include health, well-being, and ability to complete objectives (Bechtel & Churchman, 2002; Bell, Greene, Fisher, & Baum, 1996). Adaptation theory permits evaluation of occupant perception from an adaptive perspective (Saegert & Winkel, p. 446). This theory helps to explain occupants' adaptation to various aspects of the indoor ambient conditions and how occupant behavior may change over time to accommodate various situations (e.g., an occupant will bring a space heater to work if the thermal comfort level is not satisfactory for that individual) (Bechtel & Churchman, 2002). Not only is human satisfaction with the built environment important, but occupant satisfaction in a green building is valuable. Green buildings are inarguably better for the natural environment and better for human health and well being than traditional buildings. This argument alone supports the future construction of green buildings. But to ensure the future successes of these new green buildings occupants must be satisfied with their indoor environment ambient conditions, their thermal comfort levels should be considered, indoor air quality should be controlled, and appropriate lighting, acoustical treatments, and furnishings should be designed into the space.

### *Sustainability in Contemporary History*

Sustainable practices in architecture and interior design in the United States increased during the last quarter of the twentieth century, an increase that continues though today. A pioneer in the integration of green design principles in architecture and design, William McDonough, AIA, "designed and built the first solar-heated house in Ireland in 1977 and designed the first 'green office' in the U.S. for the Environmental Defense Fund in 1985" (McDonough, 2005). He was an early adopter of sustainable practices and continues to have global impacts in urban planning, architecture, design, and manufacturing processes. Clients include Ford Motor Company, China Housing Industry Association, the White House, and a number of interior design product and materials manufacturers (McDonough, 2005). In 1992 McDonough, along with business partner Michael Braungart, developed the Hannover Principles for the 2000 World's Fair in Hannover, Germany (McDonough & Braungart, 2003). These principles were designed to provide a framework for sustainable design in all facets of society, integrating industry and ecology. The Principles include concepts regarding the interdependence of humans and nature, responsibility for new technologies and designs and their impacts on nature and future generations, utilization of natural energy and elimination of waste, acceptance of limitations of design, and constant learning, understanding and communication of knowledge. *The Hannover Principles* was designed to be a living document, eternally evolving with new understanding and knowledge of the world (McDonough & Braungart, 2003). These principles were not only adopted for the 2000 World's Fair but have been published into a manifesto that is in use around the world.

As the environmental movement began to capture the attention of more and more people, forward-thinking business leaders began to consider sustainability in the corporate world. In 1993 Paul Hawken published *The Ecology of Commerce: A Declaration of Sustainability*. Hawken is considered a leading business philosopher in sustainability, and in his book he describes an approach to business unlike any other previously presented. He does not succumb to the corporate philosophy that businesses must continue to grow or else die, or the ecological philosophy that if businesses continue to grow the world around them will be destroyed. Instead Hawken introduces an approach whereby businesses adopt sustainable and restorative processes but continue to use effective operational and marketing techniques. Hawken argues that businesses can drive the change to sustainable practices themselves, for "no other institution in the modern world is powerful enough to foster the changes necessary" (Hawken, 1993, p. 17 ).

*The Ecology of Commerce* impacted businesses and business leaders alike. Ray Anderson, founder, Chairman and CEO of Interface Corporation, a global leader in commercial carpet, was inspired to make changes in his company's operations and processes after reading Hawken's book. In *Mid-Course Correction, Toward a Sustainable Enterprise: The Interface Model* (1998), Anderson details the arduous steps taken to transform his company into a leader in the sustainability market, a company that was part of a notoriously environmentally un-friendly industry (manufacturing of carpet and textiles). Anderson, in the book, reveals not only the successes of Interface today but the journey it took to get there and the bumps along the way. He shows other organizations that while transforming the way they do business may not be the easiest route; it is by far the best. Anderson coins the phrase "doing well by doing good," succinctly capturing the success of Interface by doing the right thing for the environment and future generations (Anderson, 1998).

Anderson continues to expand his commitment to the environment and doing the right thing with ambitious corporate goals. Interface operates under a sustainable business model, manufacturing sustainable products using sustainable processes. They are a leader in sustainability because they not only impact other business leaders and organizations but also consumers who chose an Interface product. Contractors who specify Interface products, designers who recommend their products, and building owners who purchase their products (in many cases as part of LEED certification goals) are all choosing sustainable products manufactured by an environmentally responsible organization. But Interface faces their toughest challenge yet, set forth by executives of the company in a corporate vision: "To be the first company that, by its deeds, shows the entire industrial world what sustainability is in all its dimensions: people, process, product, place and profits - by 2020 - and in doing so we will become restorative through the power of influence" (Interface, Inc., 2004).

As businesses began to adopt sustainable models, William McDonough and Michael Braungart recognized a need for a new design philosophy, one that could be readily embraced and adopted by manufacturing facilities as well as individuals. And in 2002 they introduced another book, *Cradle to Cradle: Remaking the Way We Make Things*. It made the world stop and think about how things are made and the destructive cycles in which industry is caught up (Herman Miller, 2005). Cradle-to-cradle refers to a design philosophy in which products are made to be used and then reused in the same or another way, nothing is discarded, and the products are not 'down-cycled' into a lesser product (McDonough & Braungart, 2002). This concept evolved from the cradle-to-grave concept assumed by many manufacturers of products created since the Industrial Revolution. A product in this category is developed, manufactured, used, and then disposed of, usually into a landfill, or "down-cycled" into a lesser product (McDonough & Braungart, 2002).

In a 2004 documentary, entitled *The Corporation* (Achbar), Ray Anderson, among other high profile global business and social leaders, speaks about corporate responsibility. Anderson specifically addresses environmental responsibility and puts a face on a company that once participated in the destruction of the earth through cheaper, but environmentally more expensive, manufacturing processes. He walks his audience through his revelation of wrongdoing, his strategies to correct the problems, and the struggle to get where the company is today.

The rise in popularity of implementing sustainable practices has permeated many facets of society, from daily activities of consumers to strategic planning by corporations and governments. An evolution of sustainable thinking has taken place over the past 45 years, most notably marked by the publication of *Silent Spring* in 1962 (Carson). An evolution that continues, with organizations and individuals sharing knowledge, ideas, triumphs and defeats, communicating that the road to travel may not be an easy one, but it's the right one.

*Environmental Impacts of Buildings*

From site selection to materials, construction, and the life of a building, the environment is impacted by the choices made at each step. It is a carefully planned combination of components that create a truly green building.

Through proper selection of materials and systems and evaluation at each level, the change can be made from traditional building construction to green building, thus affecting the building occupants, the community, and the environment.

*Site.* Site assessment is the initial step in the development of a building and an important step in its sustainability (Barnett & Browning, 2004). This assessment involves an evaluation of land use, ecology, water, energy use, and pollution. In designing a green building, there are guidelines to preserve landscape patterns whenever possible or reestablish appropriate landscape patterns, reinforce the natural infrastructure, conserve resources, restore and promote ecological health, create solutions based on natural processes, support biodiversity through the use of indigenous landscapes, and restore and reuse lands before destroying new land (Barnett & Browning,. 2004; Thomas, 1999; Wilson, et al., 1998).

Site selection is important to the environment. If the new structure will be replacing an existing building or infrastructure, careful consideration should be paid to the destruction and removal of debris, reuse of original materials, and recycling whenever possible. If building on open land, an evaluation of the species of plants and animals that will be displaced is essential in preserving the ecological integrity of the land (Wilson, et al., 1998).

Site selection also considers the location and orientation on the site for placement of the new structure. Evaluation of the site includes available sunlight to make use of solar heat and daylight, views for occupants, wind, noise, and air quality—all of which can be improved with proper vegetation, for proper placement of a building for maximum efficiency (Barnett & Browning, 2004; Thomas, 1999).

*Materials.* Selection of the materials used in the construction of a building, as well as the furnishings and finishes used in the interior, is one of the most visible and influential components in green design. Many attributes of materials must be evaluated, including the manufacturing processes used to produce the building materials, transportation of materials to the construction site, installation process, Volatile Organic Compound (VOC) levels, and end-of-life and recycling issues (Thomas, 1999).

Sustainable manufacturing and recycling practices ensure the most efficient use of materials and energy. Manufacturing processes utilizing sustainable practices will produce little or no pollution, produce minimal waste while maximizing recycling, operate with energy efficiency, and have no negative health impacts for manufacturing workers. Using regional (within 500 miles) or local materials supports local economies and minimizes environmental transportation impacts including use of fossil fuels and exhaust pollution. Proper selection of paints, finishes and adhesives with low or no off-gassing helps to maintain healthy indoor air quality (Thomas, 1999; Wilson, et al., 1998).

*Energy.* (HVAC systems, water usage, lighting) Designing a building for resource efficiency is another component of green design. This means using water, energy and materials efficiently, often resulting in lower operating costs as well as creating a healthy work environment (Frumkin, 2003). Examples of energy efficient use of resources and systems include low-flow toilets, daylighting and energy efficient electric lighting, motion or light sensors, gray water reuse, Energy Star$^{TM}$ appliances, and natural ventilation (Wilson, et al., 1998).

HVAC are systems in buildings that are used to heat and cool the space and ventilate the air within the space. Green buildings are typically designed in such a way that HVAC systems are smaller than those in traditional buildings. With natural ventilation and solar heating and cooling, green buildings require less mechanical heating and cooling. Water conservation can occur through the use of water-efficient landscaping, rainwater collection and reuse, wastewater management, and water-saving plumbing fixtures (Barnett & Browning, 2004). Maximizing daylighting and energy-efficient light fixtures will reduce energy costs. Energy efficient buildings also help to minimize HVAC pollutants (particles, fibers, mists, molds, bacteria, and gases), thereby improving internal and external air quality (Thomas, 1999).

*Construction and construction waste.* Construction waste can take up as much as 40% of landfills in the United States (Wilson, et al., 1998, p. 299). Construction waste consists of all materials cleared from a site when a location is selected for building (e.g., concrete from existing sidewalks) and all excess materials used in construction (e.g., lumber, nails, steel, etc.). But there are cost effective alternatives to disposing of construction waste, including recycling and materials exchange. As the green building movement continues to grow, there are regulatory pressures in some areas requiring "recycling of wood, metals, and cardboard for all construction projects over $25,000 in size" (Wilson, et al., 1998, p. 300).

To encourage construction of green buildings, the city of Seattle implemented a policy that sets a goal of LEED Silver for all city-funded projects over 5,000 square feet, which includes proper management of construction waste (City of Seattle, 2000). Chicago offers a variety of financial incentives for building green, from tax credits to hundreds of thousands of dollars in grants (City of Chicago, 2004).

*Life cycle.* The life cycle of a building includes the environmental impacts of the construction of the facility, the life of the structure, and end-of-life considerations. Energy, materials, operation, and maintenance over the life of the building are all considered when evaluating the life cycle of a building, as well as future use of the space, including possible destruction (Wilson, et al., 1998). The life cycle of a new building must be considered during the design phase, addressing such questions as: What could the building be used for in the future? What is the life expectancy of the materials being used (are they durable)? Could it be easily disassembled for reuse in other structures? These questions help determine the sustainability of the structure and exemplify William McDonough's cradle-to-cradle philosophy in which products may be used, recycled, and used again without losing any material quality. Historically, the end-of-life of a building was not a major consideration in the construction of a new structure.

*Benefits of Building Green*

In making educated choices about site, materials, construction, and use of a building, owners, occupants, businesses, and communities reap benefits far into the future. One example is the C.K. Choi Building at the University of British Columbia (UBC) in Vancouver, Canada completed in 1996. Measuring 29,321 square feet and accommodating 100 full-time occupants, the Choi Building was constructed using the same original construction budget as a conventional (non-green) building. This green building had a positive impact on enrollment and reputation of UBC. New staff members "have come to work there because of the buildings" (Corps, 2005). By incorporating sustainable features, the C.K. Choi Building has changed people's concepts of green buildings, both on and around campus. In addition, UBC realized an annual savings of 191,603 kWh of electricity per year (Corps, 2005).

Another example is the Pennsylvania Department of Environmental Protection's Cambria Office Building that received energy-efficient windows for a $15,000 increase in cost. This additional spending that incorporated sustainable practices resulted in $30,000 in savings by eliminating a heat zone that was no longer needed to heat the perimeter (the new windows would provide solar heating), downsizing heat pumps, and increasing the floor space which could be translated into additional rent (made possible by using smaller heating equipment and ducts) (U.S. Department of Energy, 2003, p. vi).

*Environment.* When buildings are designed using sustainable practices the natural environment benefits through recycling, energy efficiency, less pollution, and better air quality. (Barnett & Browning, 2004) The environmental impacts of a green building are far fewer than those of traditional structures. With proper site selection, plant and animal species are not displaced, buildings utilize solar energy and vegetation to reduce the use of HVAC systems thereby reducing energy needs and the use of fossil fuels, and minimal construction waste is created.

Throughout the construction process, reuse of original site materials and recycling reduce landfill usage. The materials used in construction of a facility impact the environment from manufacture through installation. By selecting materials that are easily and quickly replenished (e.g., bamboo), responsibly manufactured (e.g., with no air pollutants and minimal waste), and installed properly (e.g., no harmful chemicals in adhesives and finishes), the ecology of the earth is being protected. Energy systems selected to operate the building should be efficient in their operation, reusing water whenever possible, minimizing electric power, and maximizing solar. (U.S. Department of Energy, 2003)

*Health and Safety.* Human health is positively affected with views of nature, with daylighting, and with indoor and outdoor landscaping (Heerwagen, 2004). Occupants report greater satisfaction when the physical environment includes operable windows and views outside and individual ventilation controls (Leaman & Bordass, 2001). In terms of construction materials, the use of sustainable woods helps minimize deforestation, which impacts global climate change (Frumkin, 2003). And local products benefit the community through increased jobs and decreased use of fossil fuels for transportation.

*Economic.* Green building often has a comparable capital cost to that of traditional building methods. In cases where the initial capital outlay for green buildings is higher than those of traditional buildings, energy savings over the life of the building typically mitigate that cost (Corps, 2005). Energy-efficient designs used in green buildings not only reduce energy costs but can increase human productivity. Lockheed commissioned a new $2 million 600,000 square foot commercial office building located in California and incorporated daylighting for energy efficiency. The result was a $500,000 per year energy savings with a 15% increase in production and 15% decrease in employee absences (Romm & Browning, 1998, p. 13). ING Bank spent $700,000 on energy systems for a new 538,000 square foot office building, including daylighting. The organization has realized approximately $2.6 million in energy savings per year. In addition employee absenteeism was down 15%, and the company gained a new socially responsible corporate image (Romm & Browning, 1998, p. 13).

*Productivity.* Although often difficult to measure, productivity may be positively impacted by the use of sustainable design practices in built structures. Occupants who are satisfied with their workspace tend to be more productive employees, with fewer absences (Romm & Browning, 1998). West Bend Mutual Insurance Company constructed a 150,000 square foot commercial office space that incorporated individual controls as one component of a new green building.

The West Bend Mutual Insurance Company realized a 16% increase in the number of insurance claims processed (Romm & Browning, 1998).

Productivity is usually seen as an economic measure within an organization and associated with percentages or dollars. However, occupant-perceived productivity is equally important but is captured in a qualitative fashion. Studies show that occupant satisfaction (including thermal comfort, lighting, and acoustics) is affected by occupants' ability to control their environment, and that there is a link between comfort and productivity (Leaman & Bordass, 2005). Satisfied occupants feel more productive.

*Community.* Community pride appears to be strengthened through sustainable design. "Occupants who experience increased job satisfaction, health, and productivity will carry those experiences back to their families and friends in the community, thus influencing overall well-being" (U.S. Department of Energy, 2003, p. 3-9). Green design principles applied in the workplace can influence individual use of sustainable practices at home and in the community, through purchase of green products, recycling, or using energy efficient appliances. Sustainable construction practices tend to produce less pollution, noise, dust, and traffic congestion, all leading to improved community safety, public health, and well-being. These same practices also promote recycling, reduced construction waste, and efficient energy and water use, thereby reducing demand on landfills, electric utilities, and wastewater treatment plants. Utilization of locally manufactured and produced building materials supports the local economy and community employment, as well as reducing transportation costs, energy usage, and pollution through vehicle emissions (U.S. Department of Energy, 2003, p. 3-9).

*A Measurement Tool ... What is LEED?*

As the sustainability trend began to emerge in the mainstream of the design and construction industries, more and more businesses attempted to join a small, but growing, circle of "green" manufacturers. Companies began to profit from claims of sustainable products, though most claims went unsubstantiated. This practice became known as "greenwashing" (Wilson, et al., 1998).

In early 2000, the Leadership in Energy and Environmental Design (LEED) Green Building Rating System was introduced, partly in response to growing evidence of "greenwashing." LEED was developed by the United States Green Building Council (USGBC) members as a rating system by which to measure the sustainability of buildings. The USGBC was formed in 1993 to promote green building, and LEED was developed as a next step in helping to realize this mission. The LEED rating system takes into account human health, energy efficiency, design, construction, maintenance, and life cycle of the structure. LEED certification is a voluntary program that offers validation to building owners, occupants, industry, and community that a building is green (United States Green Building Council, 2005). As of 2005 there were 2,758 new construction buildings in the United States were LEED registered, as compared with 624 buildings in 2002 (United States Green Building Council, 2005).

*Areas*

The LEED rating system addresses different areas in order to fairly assess the performance, features, and processes of buildings. The following are current areas the USGBC considers for LEED certification.

- *New construction and Major Renovations* (LEED-NC) is a green building rating system that was designed to evaluate high-performance commercial and institutional projects, with a focus on office buildings (United States Green Building Council, 2005).
- *Existing buildings* (LEED-EB) maximizes operational efficiency while minimizing environmental impacts in existing built structures. It provides a recognized, performance-based benchmark for building owners and operators to measure operations, improvements and maintenance on a consistent scale. LEED-EB is a road map for delivering economically profitable, environmentally responsible, healthy, productive places to live and work (United States Green Building Council, 2005).
- *Commercial Interiors* (LEED-CI) was developed for the tenant improvement market. LEED-CI provides the opportunity to make sustainable choices for tenants and designers, who do not always have

control over whole building operations. LEED-CI is the recognized standard for certifying high-performance green interiors that are healthy, productive places to work, are less costly to operate and maintain, and reduce environmental footprint (United States Green Building Council, 2005).

- *Core & shell development* (LEED-CS) is for designers, builders, developers, and new building owners who address sustainable design for new core and shell construction. Broadly defined, core and shell construction covers base building elements, such as the structure, envelope and building-level systems, such as central HVAC, and so forth. The CS product recognizes that the division between owner and tenant responsibility for certain elements of the building varies between markets (United States Green Building Council, 2005).
- *Neighborhood development* (LEED-ND) is currently under development and will integrate the principles of smart growth, urbanism, and green building into the first national standard for neighborhood design (United States Green Building Council, 2005).
- *Homes* (LEED-H) is being tested by the USGBC with input from local and national stakeholder groups. It is a voluntary initiative promoting the transformation of the mainstream home building industry towards more sustainable practices. It will provide a much-needed tool for homebuilders, homeowners, and local governments for building

environmentally sound, healthy, and resource-efficient places to live (United States Green Building Council, 2005).

*Categories*

Points are awarded for accomplishments in six overall categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design process. The six areas are listed below and the components for which LEED credits can be awarded are listed below (United States Green Building Council, 2005).

- *Sustainable sites* – the selection of the location for the new building, how the site is developed or redeveloped, the availability of alternative transportation to and from site, the design of stormwater management, how much heat is absorbed (or reflected) by the roof of the building (referred to as the 'Heat Island Effect' where the increased heat leads to the need for an increase use of air conditioning and therefore an increase in pollution and decrease in energy efficiency), and the reduction of pollution (United States Green Building Council, 2005).
- *Water efficiency* – water efficient landscaping, water use reduction (i.e., through the use of energy efficient plumbing fixtures), and the use of any innovative wastewater technologies (United States Green Building Council, 2005).

- *Energy and Atmosphere* – meeting specified minimum energy performance requirements, optimizing energy performance, utilizing renewable energy (United States Green Building Council, 2005).
- *Materials and Resources* – storing and collecting recyclable materials, building reuse, construction waste management, reuse of materials, using materials with recycled content, purchasing local or regional materials, using rapidly renewable materials and certified wood (United States Green Building Council, 2005).
- *Indoor Environmental Quality* – meeting minimum indoor air quality performance, controlling tobacco smoke, increased ventilation, materials with low off-gassing (i.e., sealants, paints, carpet, wood, etc.), control of lighting and thermal comfort, and daylight and views (United States Green Building Council, 2005).
- Innovation and Design Process – any new innovation in design used in the project (United States Green Building Council, 2005).

A complete checklist of LEED categories is provided in Appendix A.

*Levels*

Based on the number of points earned in each of the categories above, a building is eligible to receive certification at one of four levels, Certified, Silver, Gold, or Platinum (United States Green Building Council, 2005). Platinum is the highest level of certification and requires a maximum number of points (52-69) (United States Green Building Council, 2005).

*Process*

LEED certification requires the completion of a three-step process. Upon satisfaction of all requirements, a building is certified, and the building owner receives the benefits of a USGBC certified green building which include an official certification, a plaque, and marketing exposure through USGBC. The process is as follows:

(1) register project with USGBC - tools and support are provided by USGBC for project certification. There are fees associated with this process.

(2) Throughout the process of development and construction, USGBC offers technical support in the form of the LEED Reference Guide, customer support, and formal credit interpretation requests (CIRs) (help from the USGBC in applying a LEED prerequisite or credit to a specific project).

(3) The final step in the process is building certification. Documentation of the project is submitted to the USGBC for technical review. This step in the process typically takes three months (United States Green Building Council, 2005).

*Benefits of LEED*

According to the USGBC,

> LEED certified buildings have lower operating costs, higher lease rates, and happier and healthier occupants than conventionally constructed structures. Certification under LEED validates to the market that your building is green, as well as setting standards and measures for the building's performance (United States Green Building Council, 2005, p. 2).

LEED certification provides a standard upon which to measure and compare buildings. And this certification is an asset to organizations and building owners, representing corporate and social responsibility.

*Drawbacks of LEED*

While the LEED rating system is a good step in the right direction and has its supporters, it also has its critics. Supporters of the cradle-to-cradle philosophy argue that the LEED system is not stringent enough, that meeting LEED standards does not guarantee an energy-efficient building (Eijadi, Vaidya, Reinertsen & Kumar, 2002). In addition, although participating in the LEED certification process is voluntary, the expense often makes it cost-prohibitive for organizations. In addition to registration fees to USGBC which vary depending on the size of the project (up to $7,500), a large expense comes from energy modeling and commissioning, which are required as proof of meeting certain milestones to earn points toward certification (in the tens of thousands of dollars) (Nieminen, 2006).

### *Design Features of the Built Environment*

Occupant satisfaction with the physical environment is important because it is a main factor affecting worker productivity (Clements-Broome & Baizhan, 2000). Occupants experience effects from a number of factors associated with the structure, design, materials, and layout of the building, each factor present in both green and non-green buildings. Choices made in the design of a building, its location, the selection of materials, its construction, and maintenance can all be done using sustainable practices. This section will describe the areas of the built environment being considered for this study and how each can be applied using sustainable practices.

#### *Acoustics*

Acoustical issues in the workplace include noise from HVAC systems, office equipment, co-workers, visitors, and so forth. Studies have shown this factor to affect occupant satisfaction. Productivity and mental tasks are often interrupted by very low noise levels (Lawrence, 1989).

Three methods are used in determining satisfactory sound levels in buildings: "(1) prevention of noise-induced hearing loss, (2) ease of speech communication, and (3) prevention of noise annoyance" (Lawrence, 1989, p. 117). In a typical office or institutional facility noise at levels that may cause hearing loss are not a concern, nor is the prevention of noise annoyance, which is of concern when speech communication is not a main requirement of the space (e.g., bedroom). However, speech privacy is an important factor. To address speech privacy issues, designers must consider space layout (e.g., cubicles or offices, adjoining spaces), materials used in design and construction (e.g., noise reflective surfaces like concrete or absorbent surfaces like carpet or acoustical wall treatments), and activity within the space. Studies have indicated that occupant satisfaction with their physical environment is inversely proportionate to noise from co-workers, including those talking on telephones (Sundstrom, Town, Rice, Osborn & Brill, 1994).

Energy-efficient green buildings are typically quieter spaces, due to smaller HVAC systems. And while operable windows may allow unwanted noise into the space, landscaping used throughout the site can help mitigate this noise. Through these and other techniques, green buildings can incorporate a variety of sustainable practices that result in occupants who are satisfied with their acoustic environment (Barnett & Browning, 2004).

*Thermal Comfort*

Thermal comfort is the "condition of mind which expresses satisfaction with the thermal environment" (Baskin & Vineyard, 2003, p. 1). Thermal comfort includes air temperature of a space, humidity, speed of air hitting the occupant, temperature of solid surfaces in the space, and solar heat (as through windows). Opitz (2006) and Clements-Croome and Baizhan (2000) claim that thermal comfort is one of the top reasons cited by occupants for unsatisfactory environments and building occupants who are thermally comfortable tend to be happier, healthier, and more productive. Being able to control individual temperature within five degrees can increase work performance by 3-7% (Wyon, 2004). According to a study by Fisk (2002), improving thermal comfort for U.S. office workers can result in potential U.S. annual savings or productivity gains between $20 billion and $160 billion (in 1996 U.S. dollars). Designers can maximize the potential for occupant satisfaction by providing user control, allowing occupants to manage the ventilation in their own work space (Thomas, 1999). Operable windows, circulation of fresh air, individually controlled ventilation, and solar heating and cooling are all examples of sustainable approaches to thermal comfort.

*Indoor Air Quality (IAQ)*

IAQ is the condition of the air inside a space that affects the health and well-being of the occupants. According to Wyon (2004, p. 100) "poor indoor air quality can reduce the performance of office work by 6-9%." Indoor air pollution is also often associated with increased sick leave and therefore decreased productivity.

Poor IAQ can lead to a variety of health issues including headaches, lethargy, and nasal and mucous membrane symptoms. A study compared buildings with mechanical ventilation to those with or without humidification and those that were naturally ventilated (Finnegan & Pickering, 1986). The results indicated that there were significantly more occupants who reported headaches, lethargy, and nasal and mucous membrane issues in artificially ventilated buildings than in naturally ventilated buildings. In humidified buildings occupants reported more eye-related problems, tight chest, and dry skin than those in naturally ventilated buildings. The occupant dissatisfaction attributed to these symptoms was high and affected the employees' ability to work (Finnegan & Pickering, 1986).

Air quality can be improved through:

- the use of low or no-VOC paints, adhesives, and other materials
- no formaldehyde used in wood products and finishes
- limited use of vinyl
- proper ventilation (e.g., copy rooms where harmful emissions are present)
- monitoring carbon dioxide levels
- using chlorine-free cleaning solutions and utilizing filters for vacuum cleaners
- regularly monitoring IAQ levels.

All of these components combine to create an environmentally-friendly, as well as enjoyable, place to work (Wilson, et al., 1998).

*Daylighting*

Daylighting, which is the lighting of space using natural light, through the use of windows, skylights, and doors is thought to make occupants happier, healthier and more productive (Loveland, 2002). Studies indicate that occupant moods improve with daylight, provided the sun does not create too much warmth or glare (Boubekri, Hulliv, & Boyer, 1991; Leather, Pyrgas, Beale, & Lawrence, 1998). Usually daylighting offers views to the outside, visually connecting occupants with nature, another psychological factor contributing to occupant satisfaction (Laouadi, 2005; Menzies & Wherrett, 2004). According to Heschong (2002) and Wilson (2000) occupants tend to be more productive in daylit buildings compared to non-daylit buildings.

"Office workers strongly believe that lighting conditions are an extremely important aspect of their workspace environment...daylighting is of particular importance" (Abdou, 1997, p. 124). "The biophilia hypothesis states that humans have an innate need to be in contact with nature; one of the most positive aspects of windows does appear to be the ability to see the outside world, including such things as information about weather conditions" (Menzies & Wherrett, 2004, p. 624). Another aspect of the use of windows in the workplace is the occupants' ability to open their windows and control ventilation.

Daylighting, when used without controls, can result in glare, reflections on computer monitors, shadows, and excessive heat. Therefore, it is important to combine daylighting, proper architectural elements such as solar shading, and energy efficient electric lighting when developing lighting strategies.

When high-performance windows are chosen and oriented properly in buildings, they can play a major role in the energy efficiency of a building by controlling summer heat and winter cold (Menzies & Wherrett, 2004 and Loveland, 2002).

*Space*

When evaluating occupants' work space, the amount of space, function, and support of work tasks are usually considered. Occupant satisfaction is often dependent upon personal space as well as shared and public space throughout the building (Heerwagen, 2004). Boyden (1971), a biologist, provides a list of well being needs around which space should be organized (Heerwagen, 2004). This list includes the following: ability to interact spontaneously, freedom to move between groups (i.e., small to large, public to private), opportunity for self-expression, sound levels similar to those found in nature, sensory variability, and aesthetic interest. Daylight permeating the work space, views of nature, natural comfort provided through individual ventilation control within a space, and comfortable noise levels are all components of an occupants' work space that can be incorporated in green buildings to promote satisfaction (Heerwagen, 2004).

## *Measuring Occupant Satisfaction*

Post-occupancy evaluations (POE) of built environments provide builders, designers, and owners with data necessary to determine whether the goals of the design have been met. Not meeting objectives may result in occupant dissatisfaction and negative economic impacts for the client (Marans and

Spreckelmeyer, 1981 and Vischer, 2001). POEs are conducted in a systematic fashion after the building has been occupied for some time, usually a minimum of six months (Preiser, 2001 and Heerwagen, 2001).

POEs can provide valuable feedback on occupant satisfaction and building performance, information that can be beneficial to the designers, builders, and owners. POE studies are useful tools for improving structures and increasing occupant satisfaction (Vischer, 2001).

### *Summary*

Research shows that green buildings are beneficial to the environment and human health. In addition, scholars indicate that satisfied healthy occupants are more productive in green buildings. The researcher examined the built environment and the discrepancy between occupant satisfaction with non-green buildings and expectations for their new physical environment and their satisfaction with the green environment after they occupied the space for a period of time. The pre- and post-occupancy surveys captured occupants' satisfaction with a variety of components of the built environment of Kelley Engineering Center, including acoustics, thermal comfort, indoor air quality, daylighting, and space. A comparison was made between these satisfaction levels and the satisfaction levels collected from the same population of occupants when their workspaces were located in non-green buildings, as well as between the occupants' expectations of Kelley and their actual satisfaction. This study provides additional research needed on building occupant satisfaction to help strengthen the business case for green buildings.

# CHAPTER III

# METHOD

The purpose of this study was to examine occupant satisfaction with Kelley Engineering Center. An existing pre-occupancy study captured occupant satisfaction with non-green buildings and expectations of Kelley, prior to moving into the new facility. A post-occupancy evaluation captured occupant satisfaction with Kelley and whether occupant expectations of the new building were met. The following elements of buildings that contribute to occupant satisfaction were explored: acoustics, thermal comfort, indoor air quality (IAQ), lighting, and space.

## *Research Design*

In development of a post-occupancy questionnaire, Sanoff (2001) recommended a rating scale in the evaluation of overall satisfaction with various aspects of quality in buildings. The overall approach for conducting the research for this study followed an approach recommended by Marans and Spreckelmeyer (1981). This was a behavioral approach to evaluating the built environment and was an effective approach in studying occupant satisfaction. The evaluation included the following steps:

- Gathered background data on facility (Kelley Engineering Center).
- Designed research, where the method of data collection was established.
- Collected data, including dissemination of instrument and capturing of data.

- Documented, analyzed, and disseminated; this included coding data, performing data analysis using statistical computer software, and reporting results.

This study utilized an existing data set (pre-occupancy survey) to which comparisons were made with the post-occupancy evaluation (POE) data.

The existing data set consisted of a pre-occupancy evaluation conducted in June 2005 to use as a comparison group with the data collected from the post-occupancy survey (Heerwagen, 2001). This evaluation was conducted 3 months prior to the move to the new building (Kelley). The post-occupancy evaluation was conducted six months after project completion and occupancy allowing occupants time to adjust to their new environment. This time delay helped mitigate the "settling in" period associated with new buildings when problems are most evident and aspects of the building may need to be fine-tuned; it also helped to reduce the "halo" effect that is often seen when occupants move to a new or renovated space (Heerwagen, 2001, p. 85).

*Population*

The population of this study was 70 faculty and staff members at Oregon State University in the School of Electrical Engineering and Computer Science, the entire population of faculty and staff for the school. Graduate students were not included in the population due to the transient nature of college students (e.g., graduation, leave of absence, different assistantship positions, etc.). The participants occupied office spaces in four existing (non-green) buildings on the campus of Oregon State University during the 2004-2005 academic year (Batcheller, CH2M Hill Alumni Center, Dearborn, and Owen) and moved their offices into the new (green) Kelley Engineering Center in September of 2005. The researcher examined aspects of occupant satisfaction in the previous offices during academic year 2004-2005 and the new offices in the LEED-registered building in 2005-2006.

*Pre-occupancy Sample*

The pre-occupancy data were collected during Spring Term 2005. The sample consisted of 18 faculty and 12 staff members of Oregon State University occupying the following non-green buildings on the campus of OSU: Batcheller, CH2M Hill Alumni Center, Dearborn, and Owen. The participants were 43% of the population of 70. Participants were volunteers.

*Post-occupancy Sample*

Post-occupancy data were collected during Spring Term 2006. The sample consisted of the 22 participants, 16 faculty and 6 staff, 31% of the entire population (70) of faculty and staff of the School of Electrical Engineering and Computer Science at Oregon State University occupying Kelley Engineering Center. The participants were volunteers.

### *Procedure*

A web-based survey was used for the collection of data for the pre-occupancy evaluation. Email was selected as the method by which to disseminate the survey for its ease of implementation, minimal expense, and higher potential for response when compared to letters. All email correspondence to subjects was sent through the Operations Manager for the School of Electrical Engineering and Computer Science in order to show departmental support of the questionnaire and possibly increase participation. After IRB acceptance of the procedure and materials, the introduction email was sent to all potential participants. The introduction email detailed the purpose of study and the timeframe, stating that the study would remain open for two weeks upon receipt of the web link. One week later the invitation email, containing a web link to the survey, was forwarded to all potential participants. One week later a reminder of survey closure date was emailed to potential participants. At the end of the two week timeframe the survey was closed and when potential participants clicked on the web link they received a message on the screen indicating that the survey was closed. A two week timeframe was chosen as a reasonable time within which to capture the data as the participants were faculty and staff members with busy schedules during the end of spring term.

Responses were collected via the Internet using Zoomerang. Zoomerang is an online survey tool, created in 1999 to provide organizations with a cost effective way to conduct surveys with minimal effort. The tool allowed the manager of the survey to easily input new questionnaires, modify layout, and launch surveys without requiring the additional computer hardware to support the application. More than 100 million surveys have been sent through Zoomerang since its inception in 1999 (Zoomerang, 2005). Data are captured and stored in a secure online database housed with Zoomerang. Responses are anonymous to protect the confidentiality of the participants.

The link included in the invitation email (as well as in the reminder email sent one week later) took participants to the Zoomerang website where they first saw a "Welcome" screen introducing them to the survey and thanking participants for their time. The survey began immediately following this screen when the participant chose to "Take Survey" by clicking on the link. Participants could choose to record some responses and return later to complete the remainder of the study or could opt to not complete the survey. A reminder email with the end date of the survey was sent to subjects one week prior to the close of the survey. The survey remained active on the website for two weeks. Upon closure of the survey the link sent to participants in the invitation and reminder emails took them to a screen that showed "Survey Closed." Upon completion of the survey a "Thank you" message appeared on the screen. Only fully completed surveys were used. Partially completed surveys were discarded to eliminate possibly skewed statistical data.

The same dissemination procedure was be used for the post-occupancy survey. IRB approval and post-occupancy questionnaire used in the online survey are included in Appendices C and D.

### *Instruments*

Data were collected using an online survey consisting of 53 questions. Thirty-seven questions were in the form of a 5-point Likert rating scale, with 1 being very dissatisfied and 5 being very satisfied and 3 as a neutral option. A 5-point Likert scale was chosen as a simple bipolar response format with a neutral option, and it was believed to be sensitive enough to measure satisfaction. Three open-ended questions were also included to capture additional feedback. The survey included sections about office layout, office furnishings, thermal comfort, air quality, lighting, and acoustics.

Prior to dissemination of the pre-occupancy questionnaire, feedback was solicited from members of the university community. The proposed survey was sent to the Dean of the Graduate School for review, an expert on satisfaction research and creating surveys using Likert scales, as well as her role on the editorial review board for the *Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behavior*. In addition, the survey was provided to a faculty member of the College of Business at Oregon State University (an assistant professor and Director of the Austin Entrepreneurship Program) with a strong research background and experience with surveys in business. Feedback from both individuals was positive and supported a decision to move forward with the questionnaire.

Questions for the pre- and post-occupancy surveys were adapted from the Center for the Built Environment (CBE) web-based occupant survey, a survey designed specifically to compare the performance of LEED versus non-LEED certified buildings (Center for the Built Environment, 2000). The Center for the Built Environment is a National Science Foundation Industry / University Cooperative Research Center at the University of California, Berkeley created to research and communicate objective information on new building technologies and designs (Center for the Built Environment, 2000). Additional questions adapted from the satisfaction literature were also added to those adapted from the CBE survey. These questions were used to capture information specific to Kelley Engineering Center and Oregon State University. All questions on the pre-occupancy survey were included in the post-occupancy questionnaire with only verb tense modifications.

### *Data Analysis*

Analysis of the data was performed using the online survey tool Zoomerang in conjunction with the statistical package S-Plus. Using S-Plus the means and standard deviations for specific individual questions were obtained. An inter-item reliability analysis (Cronbach's alpha) was performed in S-Plus to test the reliability of all questions contained within one category. The results of the inter-item reliability analysis were 0.8. This allowed the researcher to summarize the information of several items in the questionnaires. After successful completion of the reliability analysis, overall results in the categories of lighting, acoustics, thermal comfort, indoor air quality, and space could be reported. Cross tabulation tables were created in Zoomerang and analyzed for specific categories to identify relationships between cross tabulated variables. This analysis provided insight into the relationships between areas of dissatisfaction and type of workspace as well as its location within the building.

# CHAPTER IV

# RESULTS

The purpose of this study was to examine occupant satisfaction with Kelley Engineering Center. A survey designed to capture occupant satisfaction with certain indoor environmental factors was disseminated to faculty and staff of Oregon State University, School of Electrical Engineering and Computer Science. These employees were administered a post-occupancy survey in Spring 2006. Existing data from a sample of this same population prior to moving into the Kelley Engineering Center, collected in Spring 2005, were used as a comparison (Appendix E). Thirty employees completed the pre-occupancy survey and twenty-two completed the post-occupancy survey. The survey contained questions regarding the following ambient conditions of the indoor environment: lighting, thermal comfort, acoustics, indoor air quality, space, and furnishings. This chapter describes the answers to the research questions posed in chapter one as well as satisfaction results per category and correlation analysis.

## *Scope of Inference*

The population for this study consisted of the faculty and staff of Oregon State University, School of Electrical Engineering and Computer Science all of whom moved their offices from several buildings on campus into Kelley Engineering Center in the fall of 2005. The whole population (70) was solicited via email to participate. However only thirty (43%) participated in the pre-occupancy survey and twenty-two (32%) participated in the post-occupancy survey. This was not a random sample. The participants were volunteers. Neither causal inferences nor population inferences can be drawn because selection of units from the population was not random nor was the allocation of units to groups. Inferences about the sample can be drawn, and it may be possible to draw inferences to similar groups.

## *Research Questions*

The following research questions were addressed, comparing results from the pre-occupancy survey with those of the post-occupancy evaluation.

### *Ambient Conditions*

1. Is overall occupant satisfaction higher in this LEED registered building than in a non-green building?

Overall occupant satisfaction with Kelley Engineering Center was 59%, up from 37% satisfaction of occupants in the non-green facilities. Occupants were asked about their overall level of satisfaction with Kelley. On average they were satisfied with the building (Mean: 3.34 SD: 1.05).

2. Is occupant satisfaction with lighting higher in this LEED registered building than in a non-green building?

Over 50% of occupants were satisfied with the amount of lighting and visual comfort in their workspaces. This was up slightly from satisfaction levels with lighting in the non-green buildings. Respondents were asked questions regarding ability to control aspects of lighting, amount of lighting in a workspace, the level of visual comfort of the lighting, and whether lighting interfered with or enhanced their ability to complete their tasks. The pre-occupancy results showed that occupants were satisfied with their lighting (Mean: 3.24), the post-occupancy results show an increase in satisfaction with their lighting (Mean: 3.44). Figure 1 shows the differing results between lighting amount and visual comfort. Occupants were slightly more satisfied with lighting amount (Mean: 3.68) than with visual comfort (Mean: 3.36).

Write-in responses to lighting (Table 1) showed evidence of dissatisfaction with levels of thermal comfort. These results suggest the possibility of poor design or lack of understanding by the occupants of the operation of the HVAC system and any connection to the lights.

*Table 1.* Selected occupant write-in responses about lighting from the post-occupancy survey

| | |
|---|---|
| Lighting | • Lights are too bright for me when I'm on the computer, but if I turn them off, I get no heat. And, I'd like to dim them at least, but I can't.<br>• Lights must be on to have heat. The "auto" selection for the lights provides light that is not overly-bright (preferred). At present, the lights cycle on and off if I use that setting and stay on with the "Normal" setting. Right now, the lights are too bright for comfort.<br>• The lights cycle on and off, and that's a pain. |

The researcher further analyzed the occupant satisfaction with lighting by looking at office location, including floor, area of the building, and relation to windows. Although overall occupants were satisfied with lighting, this cross tabulation was performed to determine whether windows or amount of sunlight during work hours interfered with or enhanced occupants' ability to complete their tasks. Results indicate that 100% of participants with offices on the south and west sides of the building felt that the lighting in their workspaces enhanced their ability to complete tasks (Table 2). Since south-facing offices receive the most daylight, this suggests that the solar shading feature included in the design of the building was successful.

*Table 2.* Relationships between satisfaction with lighting quality and office location

| In which area of the building is your area located?: | | | | | | |
|---|---|---|---|---|---|---|
| | Total | Overall, does the lighting quality interfere with or enhance your ability to get your job done?: | | | | |
| | | Interferes | 2 | 3 | 4 | Enhances |
| Total | 22 | 2 | 4 | 5 | 8 | 3 |
| North | 13 | 1 | 3 | 2 | 5 | 2 |
| South | 3 | 0 | 0 | 0 | 3 | 0 |
| East | 5 | 1 | 1 | 3 | 0 | 0 |
| West | 1 | 0 | 0 | 0 | 0 | 1 |

3. Is occupant satisfaction with thermal comfort higher in this building constructed to LEED standards than a non-green facility?

Thermal comfort scored the lowest in the LEED registered building at 9% of respondents rating satisfied, compared with 37% satisfaction with temperature for occupants in non-green buildings. Participants were asked to rate their satisfaction with the temperature in their workspace and whether their thermal comfort interfered with or enhanced their ability to get their job done. In the pre-occupancy questionnaire respondents felt slightly satisfied about their thermal comfort levels (Mean: 3.07). The post-occupancy survey revealed that occupants were not satisfied with their thermal comfort in their workspaces (Mean 2.44).

The lack of occupant with thermal comfort in Kelley Engineering Center, as reflected in the above figures, is captured in written responses to open-ended questions provided by some of the participants. These responses offer reasons for the decreased level of satisfaction with thermal comfort in Kelley. The main complaints with these areas are shown in Table 3 (the complete list of post-occupancy survey comments can be found in Appendix F).

Only 9% of respondents were satisfied with the thermal comfort in their workspaces. Write-in responses provided some insight into possible causes for dissatisfaction. Lack of operational understanding by the occupant of the HVAC system may be a possible reason.

*Table 3.* Selected occupant write-in responses about thermal comfort from the post-occupancy survey.

| | |
|---|---|
| Thermal Comfort | • The heat cuts off after 5pm and you can freeze by 8pm. I have a space heater in my office. Some others do too. So much for saving energy.<br>• The heating issue has not been entirely resolved and my office was freezing during the winter.<br>• Nobody understands even yet how the heating works. |

An analysis of thermal comfort revealed that 0% of respondents on the second, third, fourth floors were satisfied with the temperature of their workspace and only 20% of those on the first floor were satisfied. Of those participants with workspaces on the south, east, or west sides of the building, 0% were satisfied with their thermal comfort, and only 15% of those on the north side were satisfied. Of occupants with workspaces not near an exterior wall or window (within 15 feet) 0% reported satisfaction with temperatures in their workspaces. And of those near exterior walls or windows, only 11% were satisfied (Table 4).

*Table 4.* Relationships between satisfaction with thermal comfort and location

On which floor is your office located?:

| | Total | How satisfied are you with the temperature in your workspace?: Not at all satisfied | 2 | 3 | 4 | Very satisfied |
|---|---|---|---|---|---|---|
| Total | 22 | 4 | 4 | 12 | 2 | 0 |
| 1st floor | 10 | 2 | 0 | 6 | 2 | 0 |
| 2nd floor | 5 | 1 | 2 | 2 | 0 | 0 |
| 3rd floor | 6 | 1 | 2 | 3 | 0 | 0 |
| 4th floor | 1 | 0 | 0 | 1 | 0 | 0 |

In which area of the building is your area located?:

| | Total | How satisfied are you with the temperature in your workspace?: Not at all satisfied | 2 | 3 | 4 | Very satisfied |
|---|---|---|---|---|---|---|
| Total | 22 | 4 | 4 | 12 | 2 | 0 |
| North | 13 | 3 | 3 | 5 | 2 | 0 |
| South | 3 | 0 | 1 | 2 | 0 | 0 |
| East | 5 | 0 | 0 | 5 | 0 | 0 |
| West | 1 | 1 | 0 | 0 | 0 | 0 |

Is your office near an exterior wall (within 15 feet)? :

| | Total | How satisfied are you with the temperature in your workspace?: Not at all satisfied | 2 | 3 | 4 | Very satisfied |
|---|---|---|---|---|---|---|
| Total | 22 | 4 | 4 | 12 | 2 | 0 |
| Yes | 18 | 3 | 4 | 9 | 2 | 0 |
| No | 4 | 1 | 0 | 3 | 0 | 0 |

Is your office near a window (within 15 feet)? :

| | Total | How satisfied are you with the temperature in your workspace?: Not at all satisfied | 2 | 3 | 4 | Very satisfied |
|---|---|---|---|---|---|---|
| Total | 22 | 4 | 4 | 12 | 2 | 0 |
| Yes | 18 | 3 | 4 | 9 | 2 | 0 |
| No | 4 | 1 | 0 | 3 | 0 | 0 |

4. Is occupant satisfaction with acoustics higher in this LEED registered building than in a non-green facility?

Acoustics also scored extremely low in Kelley Engineering Center, with 32% of the occupants satisfied with noise levels compared with 36% satisfied in their previous non-green offices. Sound privacy scored even lower in the LEED registered building with only 4% of the occupants satisfied compared with 30% satisfaction in the previous facilities. In order to assess the occupants' level of satisfaction with acoustics, the researcher asked questions pertaining to noise level in their workspace, sound privacy, and whether acoustic qualities in their workspace interfered with or enhanced their ability to get their jobs done. Respondents for the pre-occupancy survey were not satisfied with the acoustic qualities of their workspaces (Mean: 2.82). The post-occupancy survey results show that occupants were even less satisfied with acoustics in the LEED registered building (Mean: 2.36).

Occupant dissatisfaction with acoustics in Kelley Engineering Center, as reflected in the above figures, is captured in written responses to open-ended questions provided by some of the participants. These responses offer reasons for the decreased level of satisfaction with acoustics in Kelley. The main complaints with these areas are shown in Table 5 (the complete list of post-occupancy survey comments can be found in Appendix F).

The write-in responses provided by the participants on acoustics support the quantitative evidence that only 4% of occupants were satisfied with sound privacy in Kelley. This qualitative data shows that design of the facility concerned with acoustics may have been an issue.

*Table 5.* Selected occupant write-in responses about acoustics from the post-occupancy survey.

| | |
|---|---|
| Acoustics | • The sound proofing between offices is nearly non-existant. When my neighbors phone rings, I think its mine. We can hear each other talk, cough, sneeze, drop things, etc.<br>• Very noisy sound carries and hard to focus or hear on the phone<br>• Sound proofing would have been a great idea in this day and age.<br>• There is little or no sound absorption in the building. It's almost impossible to have a confidential conversation. Things are so loud in my office, that it is sometimes hard to have a conversation on the phone -- with my office door SHUT.<br>• Sound is a major problem, since there are many situations in which private and/or confidential items must be discussed (e.g., advising students).<br>• NOISE!!!!!!!!!!!!<br>• Walls are paper-thin. No privacy with respect to noise. THIS IS HORRIBLE!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!! |

The analysis of acoustical quality and its interference or enhancement of an occupants' ability to complete tasks was compared with type of office, location within the building, and distance to nearest window. The results indicate that 67% and 100% of participants with workspaces on the third and fourth floors, respectively, reported that the acoustics interfered with their ability to complete tasks. In addition, 100% of respondents with workspaces located on both the south and east sides of the building reported that the acoustic quality interfered with their ability to complete tasks (Table 6). In terms of type of office, 100% of participants with cubicle workspaces (administrative staff) were affected by noise as were 55% of those with enclosed private offices.

*Table 6.* Relationships between satisfaction with acoustical quality and office type and location

**On which floor is your office located?:**

| | Total | Overall, does the acoustic quality in your workspace interfere with or enhance your ability to get your job done?: Interferes | 2 | 3 | 4 | Enhances |
|---|---|---|---|---|---|---|
| Total | 22 | 9 | 4 | 5 | 1 | 3 |
| 1st floor | 10 | 4 | 1 | 2 | 1 | 2 |
| 2nd floor | 5 | 1 | 2 | 1 | 0 | 1 |
| 3rd floor | 6 | 3 | 1 | 2 | 0 | 0 |
| 4th floor | 1 | 1 | 0 | 0 | 0 | 0 |

**In which area of the building is your area located?:**

| | Total | Overall, does the acoustic quality in your workspace interfere with or enhance your ability to get your job done?: Interferes | 2 | 3 | 4 | Enhances |
|---|---|---|---|---|---|---|
| Total | 22 | 9 | 4 | 5 | 1 | 3 |
| North | 13 | 4 | 2 | 4 | 1 | 2 |
| South | 3 | 2 | 0 | 0 | 0 | 1 |
| East | 5 | 3 | 2 | 0 | 0 | 0 |
| West | 1 | 0 | 0 | 1 | 0 | 0 |

**Which of the following best describes your office (select one)::**

| | Total | Overall, does the acoustic quality in your workspace interfere with or enhance your ability to get your job done?: Interferes | 2 | 3 | 4 | Enhances |
|---|---|---|---|---|---|---|
| Total | 22 | 9 | 4 | 5 | 1 | 3 |
| Enclosed office, private | 20 | 7 | 4 | 5 | 1 | 3 |
| Enclosed office, shared with other people | 0 | 0 | 0 | 0 | 0 | 0 |
| Cubicles with partitions above standing eye level | 1 | 1 | 0 | 0 | 0 | 0 |
| Cubicles with partitions below standing eye level | 1 | 1 | 0 | 0 | 0 | 0 |
| Workspace in an open office with no partitions | 0 | 0 | 0 | 0 | 0 | 0 |
| Other, Please Specify | 0 | 0 | 0 | 0 | 0 | 0 |

5. Is occupant satisfaction with indoor air quality higher in this LEED registered building than in a non-green building?

Occupant satisfaction with indoor air quality increased in Kelley Engineering Center, as compared to that in the existing non-green buildings, with 41% occupant satisfaction in Kelley up from 37%. In order to address satisfaction levels with indoor air quality, the researcher asked the respondents about air quality in their workspaces, to include stuffy/stale air, drafts, odors, and whether the indoor air quality interfered with or enhanced their ability to get their jobs done. Participants in the pre-occupancy survey revealed that they were neutral (Mean: 3.00) about indoor air quality, while respondents to the post-occupancy survey indicated that they were satisfied with their indoor air quality (Mean: 3.41).

*Perceived Productivity*

6. Is occupant perceived productivity higher in this LEED registered building than in a non-green building?

Respondents in both questionnaires were asked about perceived productivity. Participants in the pre-occupancy questionnaire were asked to what extent they expected that working in an energy efficient building would improve their work. Forty percent responded that it would affect their work significantly. The post-occupancy evaluation asked respondents to rate the extent to which working in Kelley Engineering Center has improved their work; only 19% indicated that their work improved significantly. In this question the Likert scale rating went from one (1), "not at all," to five (5), "significantly."

An overview of the results from the research questions is presented in Figure 1.

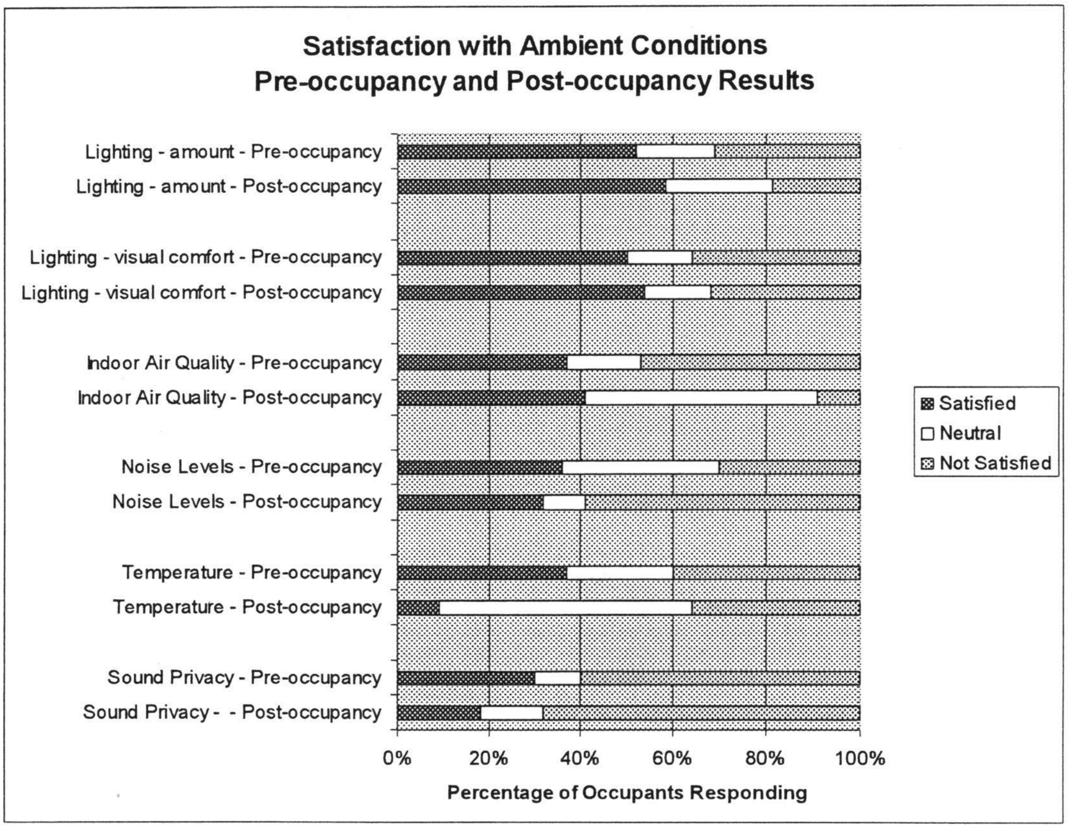


*Figure 1.* Satisfaction levels per indoor ambient condition for both pre- and post-occupancy surveys.

*Satisfaction Levels*

The following chart (Table 7) shows the average rating for each of the core ambient condition areas evaluated in this survey (lighting, thermal comfort, acoustics, indoor air quality, space, and furnishings). The rating system ranged from one, not at all satisfied, to five, very satisfied with three being the neutral rating. As shown below, occupant satisfaction increased for all indoor ambient conditions except thermal comfort and acoustics. The complete set of raw data can be found in Appendix E.

*Table 7.* Average scores per category per survey and difference between the results.

| | Pre-occupancy | Post-occupancy | Differences |
|---|---|---|---|
| Space | 3.296360154 | 3.6002886 | **0.303928** |
| Furnishings | 3.133333333 | 3.465909091 | **0.332576** |
| IAQ | 3 | 3.40909091 | **0.409091** |
| Thermal Comfort | 3.066666667 | 2.439393939 | -0.62727 |
| Lighting | 3.237547893 | 3.43939394 | **0.201846** |
| Acoustics | 2.822222222 | 2.363636364 | -0.45859 |
| Maintenance | 2.739846743 | 2.742424242 | **0.002577** |
| Building | 3.066666667 | 3.636363636 | **0.569697** |

The following charts provide a graphical representation of the data shown above. Figure 2 shows the results of the pre-occupancy survey and Figure 3 shows those of the post-occupancy questionnaire. These visual representations show the clear increases and decreases in reported satisfaction with the selected indoor ambient conditions between non-green and green buildings.

Pre-occupancy Results

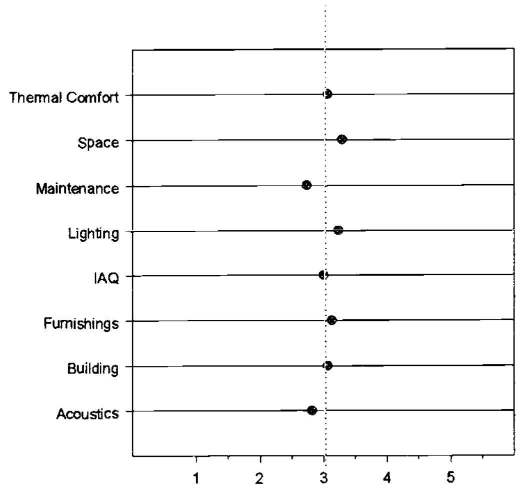


*Figure 2.* Mean response score per indoor ambient condition category for the pre-occupancy survey.

Post-occupancy Results

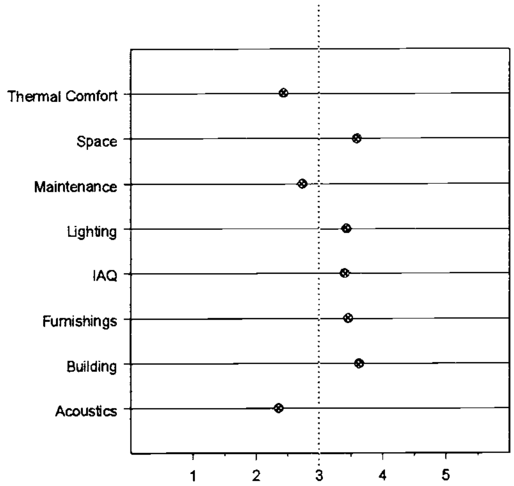


*Figure 3.* Mean response score per indoor ambient condition category for the post-occupancy survey.

## *Additional Findings*

### *Space and Furnishings*

Participants in both the pre-occupancy and post-occupancy questionnaires were asked about their type of workspace, private space available for work and storage, and the level of visual privacy in their workspace. In addition, participants responded to questions regarding comfort and adjustability of office furnishings, and colors used for flooring, furniture, and surface finishes. The results of the pre-occupancy survey show that occupants were satisfied overall with their workspace as well as their furnishings (Mean: 3.30, Mean: 3.13 respectively). However, when asked whether their workspace and furnishings interfered with or enhanced their ability to get their jobs done, the responses show that occupants felt that these components slightly interfered (Mean: 2.97, SD: 1.07 and Mean: 2.93, SD: 0.94 respectively).

The results of the post-occupancy survey show that occupants were overall satisfied with their workspace as well as their furnishings (Mean: 3.60, Mean: 3.47 respectively). When asked whether their workspace and furnishings interfered with or enhanced their ability to get their jobs done, the responses show that occupants felt that these components slightly enhanced (Mean: 3.41, SD: 1.18 and Mean: 3.41, SD: 1.14 respectively).

*Sustainability Knowledge*

Sixty-six percent of respondents in the pre-occupancy survey felt they had no knowledge of LEED certified or green buildings compared with 50% of those responding to the post-occupancy questionnaire. Of occupants participating in the post-occupancy survey only 41% felt satisfied with the amount of information they were provided on Kelley Engineering Center's green features.

## *Demographic Data*

Demographic data was captured in the pre- and post-occupancy surveys; however, demographic comparisons were not made. This research did not intend to look at the correlation between occupant satisfaction and demographic data. The pre-occupancy sample was comprised of 16 males and 13 females, the post-occupancy group consisted of 11 males and 10 females. Seventy-seven percent of the pre-occupancy sample was between the ages of 26 and 55, 82% of the post-occupancy group was in this range. The total population surveyed was 70 faculty and staff in the School of Electrical Engineering and Computer Science. The pre-occupancy sample consisted of 30 volunteers and the post-occupancy sample was comprised of 22 volunteers.

The following charts show the distribution of faculty and staff among the respondents in the pre- and post-occupancy surveys (Table 8), the building in which occupants resided prior to moving into Kelley Engineering Center (Table 9), and the number of years occupants have been employed at Oregon State University (Table 10).

*Table 8.* Number of faculty and staff responses per survey.

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Faculty | 18 | 16 |
| Staff | 12 | 6 |
| | **30** | **22** |

*Table 9.* Number of respondents who worked in each building per survey.

In which building is your office located?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Dearborn Hall | 17 | 0 |
| Batcheller Hall | 2 | 0 |
| CH2M Hill Alumni Center | 3 | 0 |
| Owen Hall | 7 | 0 |
| Kelley Engineering Center | 0 | 22 |
| | **29** | **22** |

*Table 10.* Number of years respondents have been employed at Oregon State University per survey.

For how many years have you worked at Oregon State University?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Less than 1 | 9 | 4 |
| 1 – 2 | 6 | 4 |
| 3 – 5 | 6 | 2 |
| More than 5 | 9 | 12 |
| | **30** | **22** |

*Summary*

Occupant satisfaction, overall, increased from the previous non-green buildings to the building constructed using sustainable design practices. The overall building satisfaction rating for Kelley Engineering Center, as reported by respondents, was 3.64, the highest mean rating of all categories. However, when specific indoor environment areas were further analyzed for level of satisfaction, it was revealed that thermal comfort and acoustics in Kelley Engineering Center were unacceptable to many occupants. In many of those cases, a closer look at specific data for each question revealed that responses were scattered across the continuum between not at all satisfied and very satisfied. The cross tabulation tables show that location of an occupants' workspace within the building may have an impact on their levels of satisfaction with thermal comfort and acoustics.

# CHAPTER V

# CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to look at occupant satisfaction with Kelley Engineering Center, a LEED registered building. Results from a post-occupancy evaluation of Kelley conducted in spring 2006 were compared to those from a pre-occupancy survey of occupants in non-green buildings disseminated in spring 2005. The results showed that respondents were more satisfied overall with Kelley than with their previous buildings. When analyzed at the next level, the data revealed that occupants of Kelley were satisfied overall with the lighting, indoor air quality, space, and furnishings and that their levels of satisfaction increased from the responses reported in the pre-occupancy survey. However, many occupants expressed dissatisfaction with the thermal comfort and acoustics in Kelley, and had been more satisfied with these aspects in their previous non-green buildings.

## *Implications of Findings*

The results of this study provide another case study addressing occupant satisfaction in green buildings. Through this study the researcher addressed the need for more case studies and empirical evidence "on building occupants'…satisfaction, and productivity in a wide range of buildings [to] help strengthen the business case" for constructing green buildings (U.S. Department of

Energy, 2003, p. 5-4). It also provides valuable information on occupant satisfaction with the built environment, which is of great interest and value to organizations, from building owners to employees (Heerwagen, 2003).

Constructing a facility using sustainable building practices and materials is, without question, less harmful to the environment than using traditional construction methods and materials. Studies indicate that these buildings provide healthier indoor environments for occupants and in some cases improve productivity and satisfaction (Boubekri, Hulliv & Boyer, 1991; Clements-Croome & Baizhan, 2000; Fisk, 2002; Heerwagen 2001; Leaman & Bordass, 2005; Sundstrom, Town, Rice, Osborn & Brill, 1994; Wineman, 1986; Wyon, 2004).

*Satisfaction*

This study has shown that occupants' overall levels of satisfaction increased between the non-green buildings and the green facility, Kelley. However, looking at the overall satisfaction levels does not provide a clear picture or an accurate assessment of occupant satisfaction with the green facility. Further analysis was needed to determine if all environmental ambient conditions were found satisfactory by respondents or a select few. When examining individual ambient conditions, the researcher found that occupants were not satisfied with thermal comfort and acoustics in Kelley.

Upon further investigation into the areas of dissatisfaction, it appeared that low levels of occupant satisfaction with specific indoor ambient conditions in

Kelley were not related to the use of sustainable building practices or materials. Instead, these complaints were more likely a result of poor design decisions made by the architects and engineers or the selection of inappropriate materials.

*Acoustics.* Analysis of relationships between acoustics and respondents' office type as well as office location indicated that the third and fourth floors of Kelley, and the south and east areas were least desirable based on levels of satisfaction with acoustics. A possible explanation for this is the layout of those floors (see Appendix B). The third floor contains conference rooms, furnished alcoves, and numerous laboratories. The fourth floor houses fewer laboratories but incorporates a lounge. The interactive nature of the meetings in these spaces combined with their locations in relation to office spaces may be a cause of noise problems. The areas designed for collaboration (coded as Alcoves on the floor plans found in Appendix B) are close to offices and may also be contributing to occupants' dissatisfaction with acoustics. In addition, hard materials used in the design of atrium of the facility, such as steel, brick, and glass, may be a contributing factor to acoustic dissatisfaction (see Appendix B).

*Thermal Comfort.* Respondents indicated dissatisfaction with thermal comfort in Kelley. An analysis between thermal comfort and office type and location was performed and revealed that no respondents on the second, third, fourth floors were satisfied with the temperature of their workspace and of those participants with workspaces on the south, east, or west sides of the building, none were satisfied with their thermal comfort. For those with offices on the first floor or north side of the building only one-fifth of participants were satisfied with the temperature. For occupants with workspaces not near an exterior wall or window (within 15 feet) 0% reported satisfaction with temperatures in their workspaces. An analysis of workspace locations revealed that respondents not satisfied with thermal comfort are located throughout all areas of the building and possibly signals that the HVAC system was not operating efficiently or correctly.

Entries contained in a log of issues kept for Kelley Engineering Center by the project manager at Oregon State University includes information on thermal comfort for perimeter offices (J. Gremmels, personal communication, April 19, 2006). This log details the adjustments and issues with building systems and details the issue and steps taken to resolve them. The details show that an understanding of the HVAC system as well as occupant training were important components to correcting the issues. The log indicated that "occupants need to be trained" (J. Gremmels, personal communication, April 19, 2006).

*Lighting.* In evaluating the amount of daylighting in Kelley and the impact on perceived productivity, the researcher found that 50% of respondents felt that lighting quality in Kelley enhanced their ability to complete tasks. In addition, 100% of participants with offices on the south and west sides of the building felt that the lighting in their workspaces enhanced their ability to complete tasks. Occupants appear satisfied with the sustainable component of daylighting used throughout the Kelley based on these findings.

*Indoor Air Quality.* Only 9% of respondents reported they were not satisfied with the indoor air quality in Kelley. Occupants appear satisfied with the air exchange system designed into the facility and the operable windows that allow fresh air into the space based on these findings.

It does not appear that occupant dissatisfaction with acoustics or thermal comfort in Kelley Engineering Center is a result of the sustainability of components used in construction. However, it does appear as though occupant satisfaction in the areas of lighting and indoor air quality can be associated with the sustainable practices and materials used. The use of daylighting throughout the facility and the combination of daylighting and electric lighting are sustainable designs that may have led to higher levels of occupant satisfaction. The constant air exchange system implemented in Kelley may have contributed to occupant satisfaction with indoor air quality.

*LEED and Post-occupancy Evaluations (POE)*

When designing a building to meet LEED criteria architects are ideally concerned with meeting environmental standards without compromising on the aesthetic quality of the facility. Although this is an obvious and rational approach, one additional step in the process should be considered. That is ensuring the satisfaction of the occupants.

The sustainability of the systems and materials specified for Kelley do not appear to be the source of occupants' dissatisfaction. The HVAC system, which affects thermal comfort, used in the design of the facility was not the cause of the dissatisfaction. Instead, the dissatisfaction appears to be a result of poor building layout, inappropriate systems configuration, and lack of understanding by the end users of how the system works in order to maximize occupant comfort. It was the application of a post-occupancy evaluation that gathered that data on the satisfaction in these areas.

A building that meets any level of LEED certification cannot necessarily be said to improve overall occupant satisfaction or to provide high levels of satisfaction. Architects are able to design and construct buildings to meet LEED certification without satisfying the occupants with the ambient conditions of the facility. This possibly creates a scenario whereby a cost-effective, energy-efficient, environmentally friendly facility is actually costing the owner or occupier more. Occupants who are dissatisfied with their built environment may be less productive employees (Clements-Croome & Baizhan, 2000), less concerned with supporting the sustainability aspects of the facility (e.g., recycling, turning off lights when not in use), and possibly more apt to seek employment elsewhere. This indicates that another level of evaluation must be conducted to assess the comfort and satisfaction of the individuals occupying these spaces.

One suggestion is to add another level to a LEED certification application. This component of the certification process would be completed after twelve months of occupancy and submitted with energy performance measures (currently, a required step in the process). The data would be gathered in the form of a POE.

The architect would be required to administer the POE and submit the results with the application. The architect would also be required to share this information with their client. Adding this step to the LEED certification process would not only help to maximize occupant satisfaction but would also encourage architects to work closely with clients even after the building is completed.

Post-occupancy evaluations were originally developed to evaluate the performance of a building after it has been completed and occupied for a period of time. The POE focuses on occupant requirements, such as health, safety, functional, efficiency, psychological comfort, and satisfaction. "Ideally, the information gained through POEs is captured in lessons-learned programs and used in the planning, programming, and design processes for new facilities to build on successes and avoid repeating mistakes" (Learning from our Buildings, 2001, p. 1). Post occupancy evaluations were created based on the concept that better spaces can be designed by asking if expectations had been met and how satisfied users of the building are with the environment (Learning from our Buildings, 2001).

The design of POEs, such as the one used in this study, does not distinguish between traditional building construction methods and sustainable design principles. Therefore, they do not capture occupant's knowledge of the sustainable aspects of the building and if they are satisfied with those specific areas. Questions are not designed to address satisfaction with sustainable design issues. The development of a POE designed specifically for facilities built using sustainable construction principles would assist in gathering more data regarding satisfaction of green buildings.

It is important for architecture firms to return to projects and conduct post-occupancy evaluations. This step in the maintenance phase of project management offers the architect insight into successes and failures of a particular design with regard to ambient conditions including lighting, acoustics, indoor air quality, thermal comfort, and space. With this insight architects can modify designs that didn't work as intended and replicate those that did in future designs. Successes stand as testaments to the architect's talents and attract new clients as well as encourage referrals and repeat business. And failures provide an opportunity for architects to learn from an imperfect design or material, to make corrections to an existing structure, and to make future designs even stronger.

From a building owner or occupant perspective, the POE provides information on ambient conditions, perceived productivity, and psychological comfort. Including POEs as an essential component to any construction project conveys to clients that their relationship with the architect does not end after the structure is completed. In addition to the reputation, past successes, and costs associated with hiring an architecture firm, clients should also look for the POE component in project management plans when searching for an architect. It builds a level confidence and trust that should not be underestimated.

*Limitations*

Limitations of this study that were beyond the control of the researcher included the inconsistent nature of satisfaction research and the timing of the dissemination of the post-occupancy survey. Satisfaction research attempts to capture the level of consumer satisfaction within a particular context. However, confounding variables such as emotions, health, life events, and so forth, often affect participants' responses (e.g., bad mood). This component of the research must be acknowledged.

Timing of the post-occupancy survey met the minimal recommended timeline of six months, but twelve months would have been optimal. The six month time delay helps mitigate the "settling in" period associated with new buildings when problems are most evident as well reducing the "halo" effect that is often seen when occupants move to a new or renovated space (Heerwagen, 2001, p. 85). By waiting twelve months prior to disseminating the post-occupancy questionnaire, most major maintenance adjustments in the building could be completed and occupants would have experienced the building during all four seasons. In addition, the post-occupancy questionnaire was distributed in the first few weeks of spring term, so occupants' busy schedules may have prevented them from participating. Finally, sample sizes in both the pre- and post-occupancy surveys were small, larger sample size would have yielded more reliable data.

The researcher was in control of many other factors of this research and found the following limitations. Different methods beyond the online nature of the survey used would make it possible to clarify any questions for participants. Additional research methods to be used might include face-to-face interviews, group discussion, and observation. The length of the survey was kept to fewer than 60 questions and an estimated 15 minutes to complete. However, this may have been too much time for some potential participants. Identifying data were not captured in the pre-occupancy survey and therefore the researcher was unable to pair them with the post-occupancy data. This had an impact on the applications of statistical testing because pairing could not be established. Independence could not be confirmed and significance tests and confidence intervals could not be found.

### *Suggestions for Future Research*

Future research might include another survey conducted after the twelve month occupancy time period which would allow for corrections of facility issues and would encompass occupancy during the full spring and summer months. Since one of the areas of dissatisfaction for occupants in Kelley was thermal comfort, the warmer weather in the spring and summer months would probably affect the results in a twelve-month survey.

A measure of productivity, including sick days, reported health issues, and employee retention, would be valuable data to capture in a post-occupancy survey. This information could be used to determine if a move into a green facility improved the results in any of these areas. Due to the sensitive nature of human resources data, personal information could not be collected for the present study.

However, a future study obtaining anonymous data from both pre- and post-occupancy groups regarding productivity could be compared to determine whether green buildings have an impact on amount and quality of work.

Success or failure in specific areas of green building design should be evaluated in-depth. For example, this study revealed dissatisfaction with acoustics. A future study could delve solely into the acoustical components of the building, examining the design, materials, and occupant satisfaction. This research should include personal interviews to capture more information on specific reasons behind the dissatisfaction, interviews with the architect or designer, research on the specific materials used, and researcher observations of the specific area and issues.

A future study should be conducted looking at actual energy performance of Kelley Engineering center. Through write-in responses occupants have shared the adaptive behaviors they acquired in order to be comfortable in their workspaces. These include such things as using portable space heaters and bypassing occupancy sensors on lights, behaviors that may be less energy efficient than intended but necessary for personal comfort. As part of LEED certification, energy models and commissioning must be submitted to demonstrate the building has met certain milestones to earn LEED credits. However, this does not guarantee that the system is working properly or most efficiently, as was evident in write-in responses for this survey. An additional study looking at occupant adaptive behaviors and more in-depth dissatisfaction with certain areas would provide information needed to take steps toward maximum energy-efficiency.

*Concluding Comments*

The whole is not always greater than the sum of its parts. In the case of Kelley Engineering Center, occupants were satisfied with the overall building, and they were more satisfied with Kelley than they were with their previous buildings. However, it would be inaccurate to translate the respondents' overall satisfaction with the building into a conclusion that occupants were satisfied with all aspects of their indoor ambient conditions. Results indicated that occupants were not satisfied with acoustics or thermal comfort. In addition, the researcher could not conclude that the sustainable aspects of Kelley led to occupant satisfaction. The method used in this research did not capture data to support this. However, the data does support the conclusion that occupant dissatisfaction reported in specific areas was not a result of using sustainable construction practices or materials.

This evaluation of the satisfaction of occupants in a LEED registered building needs to be clearly understood. While there was dissatisfaction with select areas of the indoor built environment, there is no evidence to support the conclusion that this level of dissatisfaction was a result of using sustainable building practices or materials. Instead it appears that participants were satisfied with sustainable aspects, including indoor air quality and amount of daylighting.

By investing in occupant satisfaction through the use of POEs, training, and education on the green aspects of the building, architects can help occupants and owners embrace green buildings. Sustainable building principles should be the design and construction standard of the future. And by addressing the satisfaction of the occupants in those buildings, architects and engineers can help encourage decision-making that considers not only a building's impact on an organization's bottom line, but also its impact on the environment.

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# APPENDICES

# APPENDIX A

LEED-NC

## LEED-NC Version 2.2 Registered Project Checklist

<< enter project name >>
<< enter city, state, other details >>

| Yes | ? | No | Sustainable Sites | | 14 Points |
|---|---|---|---|---|---|
| Y | | | Prereq 1 | **Construction Activity Pollution Prevention** | Required |
| | | | Credit 1 | **Site Selection** | 1 |
| | | | Credit 2 | **Development Density & Community Connectivity** | 1 |
| | | | Credit 3 | **Brownfield Redevelopment** | 1 |
| | | | Credit 4.1 | **Alternative Transportation**, Public Transportation Access | 1 |
| | | | Credit 4.2 | **Alternative Transportation**, Bicycle Storage & Changing Rooms | 1 |
| | | | Credit 4.3 | **Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles | 1 |
| | | | Credit 4.4 | **Alternative Transportation**, Parking Capacity | 1 |
| | | | Credit 5.1 | **Site Development,** Protect of Restore Habitat | 1 |
| | | | Credit 5.2 | **Site Development,** Maximize Open Space | 1 |
| | | | Credit 6.1 | **Stormwater Design,** Quantity Control | 1 |
| | | | Credit 6.2 | **Stormwater Design,** Quality Control | 1 |
| | | | Credit 7.1 | **Heat Island Effect,** Non-Roof | 1 |
| | | | Credit 7.2 | **Heat Island Effect,** Roof | 1 |
| | | | Credit 8 | **Light Pollution Reduction** | 1 |

| Yes | ? | No | Water Efficiency | | 5 Points |
|---|---|---|---|---|---|
| | | | Credit 1.1 | **Water Efficient Landscaping**, Reduce by 50% | 1 |
| | | | Credit 1.2 | **Water Efficient Landscaping**, No Potable Use or No Irrigation | 1 |
| | | | Credit 2 | **Innovative Wastewater Technologies** | 1 |
| | | | Credit 3.1 | **Water Use Reduction**, 20% Reduction | 1 |
| | | | Credit 3.2 | **Water Use Reduction**, 30% Reduction | 1 |

| Yes | ? | No | Energy & Atmosphere | | 17 Points |
|---|---|---|---|---|---|
| Y | | | Prereq 1 | **Fundamental Commissioning of the Building Energy Systems** | Required |
| Y | | | Prereq 2 | **Minimum Energy Performance** | Required |
| Y | | | Prereq 3 | **Fundamental Refrigerant Management** | Required |
| | | | Credit 1 | **Optimize Energy Performance** | 1 to 10 |
| | | | Credit 2 | **On-Site Renewable Energy** | 1 to 3 |
| | | | Credit 3 | **Enhanced Commissioning** | 1 |
| | | | Credit 4 | **Enhanced Refrigerant Management** | 1 |
| | | | Credit 5 | **Measurement & Verification** | 1 |
| | | | Credit 6 | **Green Power** | 1 |

continued...

## Materials & Resources — 13 Points

| Yes | ? | No | | | Points |
|---|---|---|---|---|---|
| Y | | | Prereq 1 | **Storage & Collection of Recyclables** | Required |
| | | | Credit 1.1 | **Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof | 1 |
| | | | Credit 1.2 | **Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof | 1 |
| | | | Credit 1.3 | **Building Reuse**, Maintain 50% of Interior Non-Structural Elements | 1 |
| | | | Credit 2.1 | **Construction Waste Management**, Divert 50% from Disposal | 1 |
| | | | Credit 2.2 | **Construction Waste Management**, Divert 75% from Disposal | 1 |
| | | | Credit 3.1 | **Materials Reuse**, 5% | 1 |
| | | | Credit 3.2 | **Materials Reuse**,10% | 1 |
| | | | Credit 4.1 | **Recycled Content**, 10% (post-consumer + ½ pre-consumer) | 1 |
| | | | Credit 4.2 | **Recycled Content**, 20% (post-consumer + ½ pre-consumer) | 1 |
| | | | Credit 5.1 | **Regional Materials**, 10% Extracted, Processed & Manufactured Regio | 1 |
| | | | Credit 5.2 | **Regional Materials**, 20% Extracted, Processed & Manufactured Regio | 1 |
| | | | Credit 6 | **Rapidly Renewable Materials** | 1 |
| | | | Credit 7 | **Certified Wood** | 1 |

## Indoor Environmental Quality — 15 Points

| Yes | ? | No | | | Points |
|---|---|---|---|---|---|
| Y | | | Prereq 1 | **Minimum IAQ Performance** | Required |
| Y | | | Prereq 2 | **Environmental Tobacco Smoke** (ETS) **Control** | Required |
| | | | Credit 1 | **Outdoor Air Delivery Monitoring** | 1 |
| | | | Credit 2 | **Increased Ventilation** | 1 |
| | | | Credit 3.1 | **Construction IAQ Management Plan**, During Construction | 1 |
| | | | Credit 3.2 | **Construction IAQ Management Plan**, Before Occupancy | 1 |
| | | | Credit 4.1 | **Low-Emitting Materials**, Adhesives & Sealants | 1 |
| | | | Credit 4.2 | **Low-Emitting Materials**, Paints & Coatings | 1 |
| | | | Credit 4.3 | **Low-Emitting Materials**, Carpet Systems | 1 |
| | | | Credit 4.4 | **Low-Emitting Materials**, Composite Wood & Agrifiber Products | 1 |
| | | | Credit 5 | **Indoor Chemical & Pollutant Source Control** | 1 |
| | | | Credit 6.1 | **Controllability of Systems**, Lighting | 1 |
| | | | Credit 6.2 | **Controllability of Systems**, Thermal Comfort | 1 |
| | | | Credit 7.1 | **Thermal Comfort**, Design | 1 |
| | | | Credit 7.2 | **Thermal Comfort**, Verification | 1 |
| | | | Credit 8.1 | **Daylight & Views**, Daylight 75% of Spaces | 1 |
| | | | Credit 8.2 | **Daylight & Views**, Views for 90% of Spaces | 1 |

## Innovation & Design Process — 5 Points

| Yes | ? | No | | | Points |
|---|---|---|---|---|---|
| | | | Credit 1.1 | **Innovation in Design**: Provide Specific Title | 1 |
| | | | Credit 1.2 | **Innovation in Design**: Provide Specific Title | 1 |
| | | | Credit 1.3 | **Innovation in Design**: Provide Specific Title | 1 |
| | | | Credit 1.4 | **Innovation in Design**: Provide Specific Title | 1 |
| | | | Credit 2 | **LEED® Accredited Professional** | 1 |

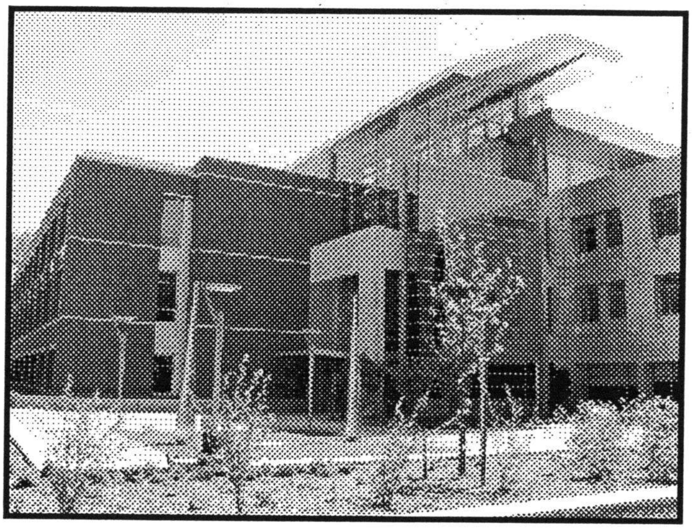
## Project Totals (pre-certification estimates) — 69 Points

| Yes | ? | No |
|---|---|---|
| | | |

**Certified** 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

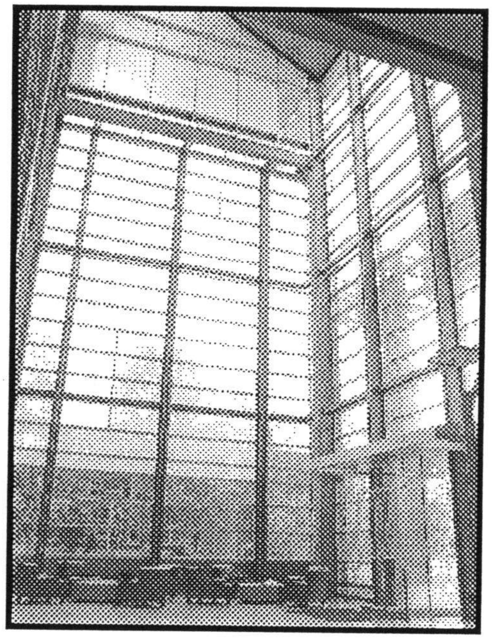
# APPENDIX B

*Photos and Floorplans of Kelley Engineering Center*

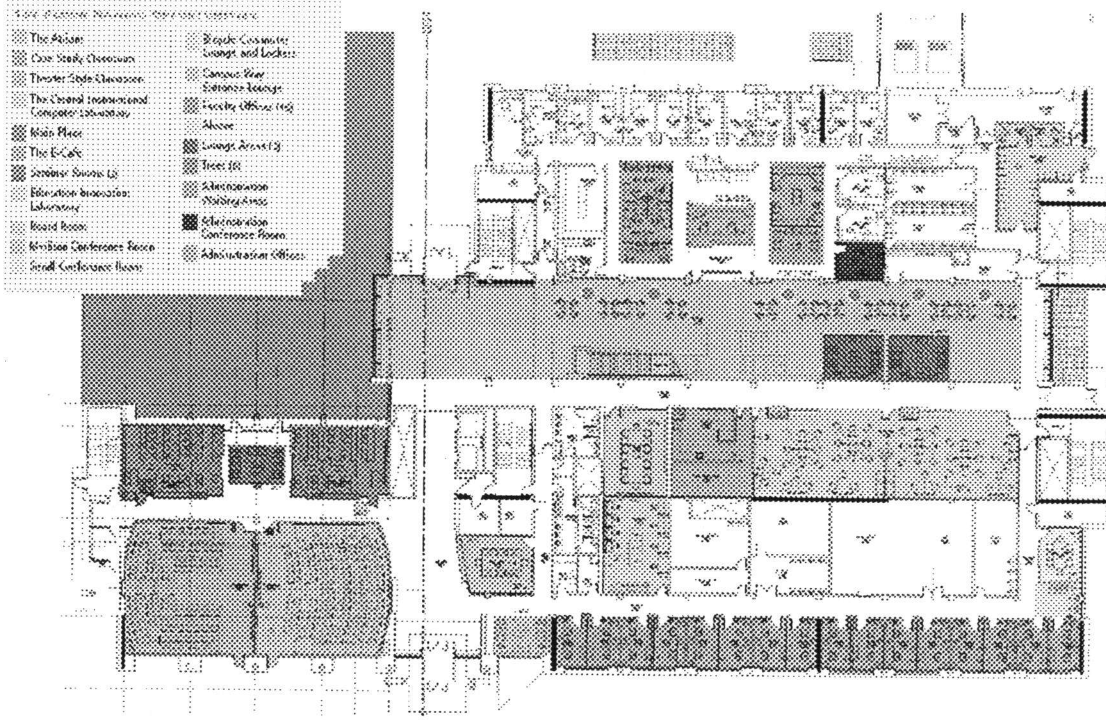


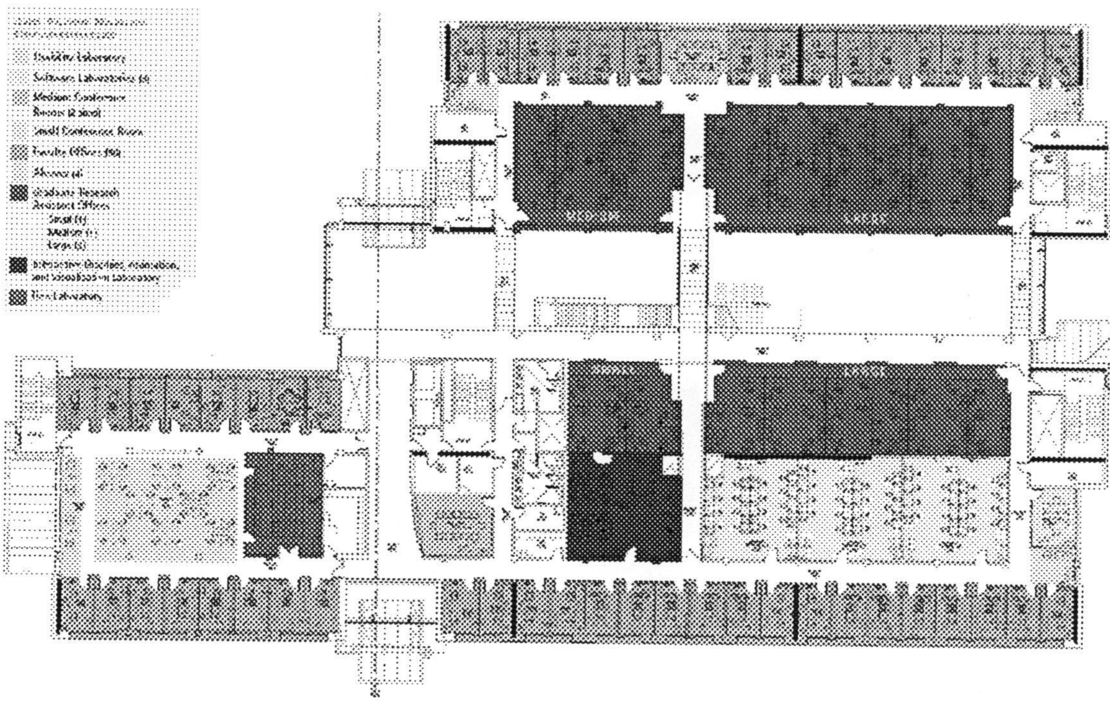
Exterior north side view of Kelley Engineering Center with glass atrium

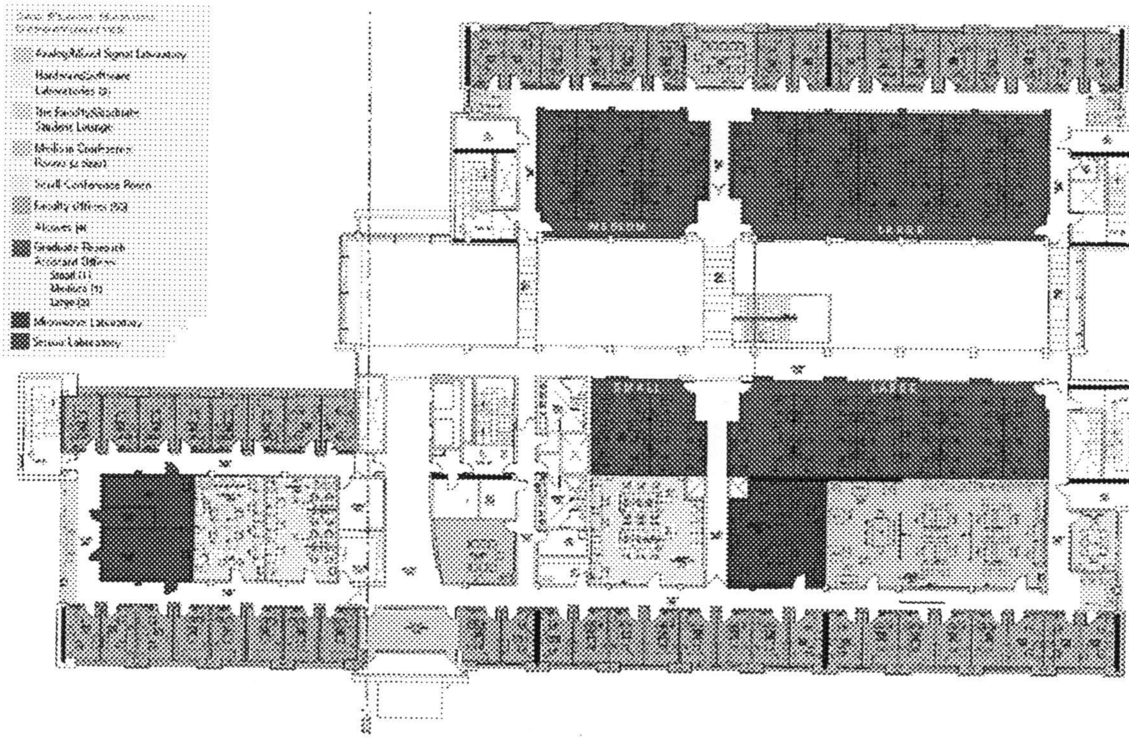
Interior view of atrium facing east

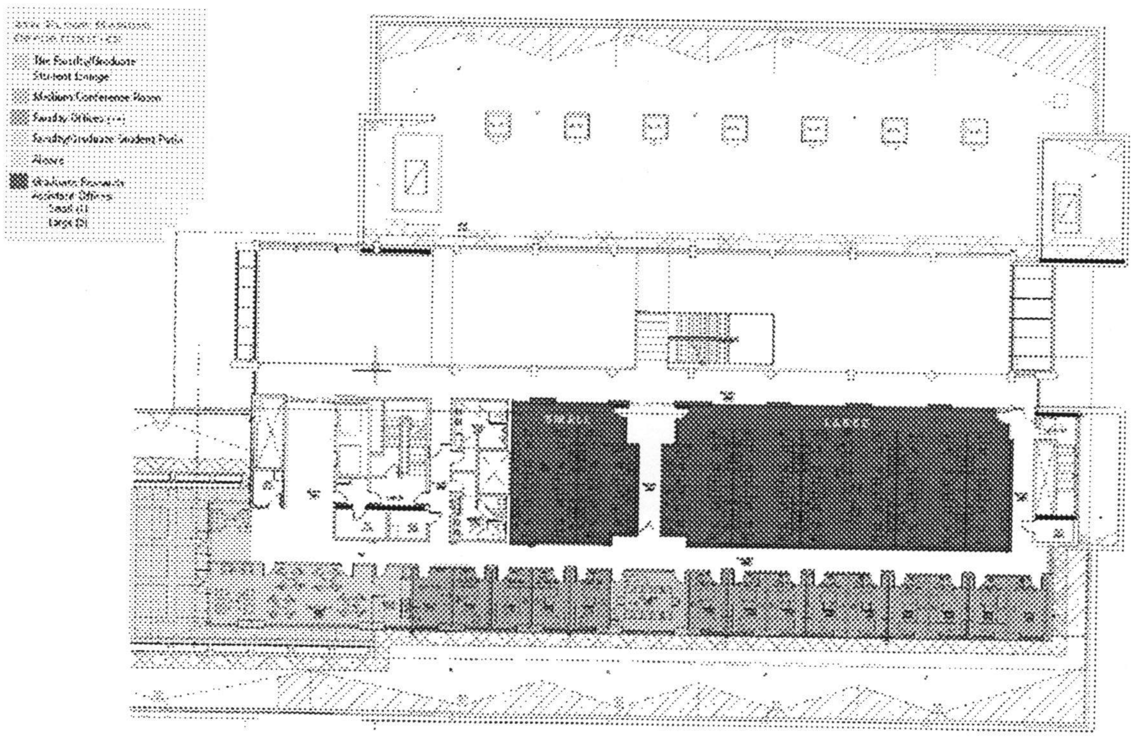


Interior view of atrium facing west









Floorplans of Kelley Engineering Center, first through fourth floors.

From *Kelley Engineering Center at Oregon State University College of Engineering* [Brochure], (p. 5-8), by College of Engineering Oregon State University, Oregon.

# APPENDIX C

## *IRB Approval Letter for Post-occupancy Survey*

OSU
Oregon State
UNIVERSITY

**Institutional Review Board • Office of Sponsored Programs and Research Compliance**
**Oregon State University, 312 Kerr Administration Building, Corvallis, Oregon 97331-2140**
**Tel 541-737-8008 | Fax 541-737-3093 | http://oregonstate.edu/research/osprc/rc/humansubjects.htm**
IRB@oregonstate.edu

TO: Carol Caughey,
DHE

RE: Occupant Satisfaction with a LEED Registered Building
(Student Researcher: Amy vanCadsand)

IRB Application No. 3237

Level of Review: Exempt from Full Board – Category 2

Expiration Date: 3/24/2007

Approved Number of Participants: 70

The referenced project was reviewed under the guidelines of Oregon State University's Institutional Review Board (IRB). The IRB has **approved** the **new** request with a waiver of documented informed consent under §45CFR46.117(c)(2). A copy of this information will be provided to the full IRB committee.

Enclosed is the informed consent information for this project, which has received the IRB stamp. All participants must receive the IRB-stamped informed consent language.

- **MODIFICATION REQUEST:** Any proposed changes to the approved protocol (e.g. protocol, informed consent form(s), testing instrument(s), research staff, recruitment material, or increase in the number of participants) must be submitted for approval before implementation.
- **ADVERSE EVENT:** Adverse Events must be reported within three days of occurrence. This includes any outcome that is not expected and routine and that results in bodily injury and/or psychological, emotional, or physical harm or stress.
- **CONTINUING REVIEW:** Before the expiration date noted above, a notice will be sent to remind researchers to complete the continuing review form to renew this project. It is imperative that the Continuing Review is completed and submitted by the due date in the notice or approval will lapse, resulting in a suspension of all activity.

Forms and additional information can be found at the IRB web site at:
http://oregonstate.edu/research/osprc/rc/humansubjects.htm.

If you have any questions, please contact the IRB Human Protections Administrator at IRB@oregonstate.edu or by phone at (541) 737-8008.

Elisa Espinoza Fallows — Date: 3/25/06

Elisa Espinoza Fallows
IRB Human Protections Administrator

pc: 3237 file

## APPENDIX D

*Post-Occupancy Evaluation Questionnaire*

1. For how many years have you worked for Oregon State University?
   __ Less than 1
   __ 1 – 2
   __ 3 – 5
   __ More than 5

2. In a typical week, how many hours do you spend in your office?
   __ 10 or less
   __ 11 – 30
   __ More than 30

3. On which floor is your office located?
   __ 1st
   __ 2nd
   __ 3rd
   __ 4th

4. In which area of the building is your area located?
   __ North
   __ South
   __ East
   __ West

5. Is your office near an exterior wall (within 15 feet)? Y/N

6. Is your office near a window (within 15 feet)? Y/N

7. Which of the following best describes your office (check one):
   __ Enclosed office, private
   __ Enclosed office, shared with other people
   __ Cubicles with partitions above standing eye level
   __ Cubicles with partitions below standing eye level
   __ Workspace in an open office with no partitions
   __ Other

8. How satisfied are you with the amount of private space available for your work?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

9. How satisfied are you with the amount of private space available for storage?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

10. How satisfied are you with the level of visual privacy?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

11. How satisfied are you with opportunities for interaction with co-workers?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

12. Overall, does the office layout interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

13. Overall, does the layout of the building interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

14. Please describe any other issues related to office or building layout that are important to you.

15. How satisfied are you with the comfort of your office furnishings and equipment (chair, desk, guest chairs, computer, equipment, bookcases)?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

16. How satisfied are you with your ability to adjust your furnishings to meet your needs?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

17. How satisfied are you with the colors of flooring, furniture and surface finishes?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

18. To what extent do your office furnishings and equipment interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

19. Please identify any other issues related to office furnishings and equipment that are important to you.

20. Which of the following do you personally adjust or control in your workspace? (Check all that apply)

__ Window blinds/shades
__ Operable window
__ Thermostat

__ Portable heater
__ Permanent heater
__ Room air conditioning unit
__ Portable fan
__ Ceiling fan
__ Adjustable air vent in wall/ceiling
__ Door to interior space
__ Door to exterior space
__ None of the above
__ Other

21. How satisfied are you with the temperature in your workspace?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

22. Overall, does the thermal comfort in your workspace interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

23. How satisfied are you with the air quality in your workspace (i.e. stuffy/stale air, drafty, odors)?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

24.Overall, does the air quality in your workspace interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

25. Which aspects of lighting are you able to control? (check all that apply):
__ Light switch
__ Light dimmer
__ Window blinds/shades
__ Desk (task) light
__ None of the above
__ Other (please explain) ______________________________

26. How satisfied are you with the amount of light in your workspace?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

27. How satisfied are you with the visual comfort of the lighting (i.e. glare, reflections, contrast)?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

28. Overall, does the lighting quality interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

29. How satisfied are you with the noise level in your workspace?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

30. How satisfied are you with the sound privacy in your workspace (ability to have a conversation without you neighbors overhearing and vice versa)?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

31. Overall, does the acoustic quality in your workspace interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

32. How satisfied are you with the cleaning services provided for your workspace?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

33. How satisfied are you with the general maintenance of the building?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

34. Does the cleanliness and maintenance of this building interfere with or enhance your ability to get your job done?
(Interferes) 1 2 3 4 5 (Enhances)

35. I think that the appearance of my office conveys a message to others who see it.(Circle one) Yes/No

36. Overall, how satisfied are you with your personal workspace?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

37. How satisfied are you with the building overall?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

38. Please list additional comments / recommendations about your personal workspace or the building overall?

39. I feel that the appearance of my office affects my success at work.
(Not at all) 1 2 3 4 5 (Significantly)

40. How would you rate your knowledge of LEED certified or green buildings?
(No Knowledge) 1 2 3 4 5 (Great deal of knowledge)

41. How satisfied are you with the amount of information you have been provided on Kelley Engineering Center's green features?
(Not at all satisfied) 1 2 3 4 5 (Very satisfied)

42. The Kelley Engineering Center was built to be energy efficient. To what extent do you think that working there has improved your work?
(Not at all) 1 2 3 4 5 (Significantly)

43. Do you think that the sustainability aspects of Kelley Engineering Center is improving the recruitment/retention of faculty?
(Not at all) 1 2 3 4 5 (Significantly)

Of graduate students?
(Not at all) 1 2 3 4 5 (Significantly)

Of undergraduate students?
(Not at all) 1 2 3 4 5 (Significantly)

44. Do you believe that the sustainability aspects of Kelley Engineering Center academically enriches students?
(Not at all) 1 2 3 4 5 (Significantly)

45. Do you believe the sustainability aspects of Kelley Engineering Center has changed the level of pride and loyalty of:
Alumni
(Not at all) 1 2 3 4 5 (Significantly)

Donors
(Not at all) 1 2 3 4 5 (Significantly)

Faculty
(Not at all) 1 2 3 4 5 (Significantly)

Students
(Not at all) 1 2 3 4 5 (Significantly)

46. Do you believe the sustainability aspects of Kelley Engineering Center have raised the national and international visibility of OSU?
(Not at all) 1 2 3 4 5 (Significantly)

47. Do you believe the sustainability aspects of Kelley Engineering Center have raised the national and international visibility of the College of Engineering?
(Not at all) 1 2 3 4 5 (Significantly)

48. To what extent do you think that you are a socially responsible citizen?
(Not at all) 1 2 3 4 5 (Very)

49. To what extent do you think you will feel more socially responsible working in Kelley Engineering Center?
(Not at all) 1 2 3 4 5 (Very)

50. You are:
__ Male
__ Female

51. How many years have you been employed with Oregon State University?
____ Years

52. Are you:
__ Faculty
__ Staff

53. On your last birthday you were:
__ 20 – 25
__ 26 – 35
__ 36 – 45
__ 46 – 55
__ 56+

# APPENDIX E

*Results of the Post-occupancy Questionnaire*

## DEMOGRAPHICS

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Male | 16 | 11 |
| Female | 13 | 10 |
| | **29** | **21** |

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Faculty | 18 | 16 |
| Staff | 12 | 6 |
| | **30** | **22** |

On your last birthday you were:

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| 20 - 25 years old | 2 | 1 |
| 26 - 35 years old | 8 | 7 |
| 36 - 45 years old | 7 | 3 |
| 46 - 55 years old | 8 | 8 |
| 56+ years old | 5 | 3 |
| | **30** | **22** |

In which building is your office located?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Dearborn | 17 | 0 |
| Batchelor | 2 | 0 |
| CH2M Hill Alumni Center | 3 | 0 |
| Owen | 7 | 0 |
| Kelley | 0 | 22 |
| | **29** | **22** |

For how many years have you worked at Oregon State University?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Less than 1 | 9 | 4 |
| 1 - 2 | 6 | 4 |
| 3 - 5 | 6 | 2 |
| More than 5 | 9 | 12 |
| | **30** | **22** |

## OFFICE

In a typical week, how many hours do you spend in your office?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| 10 or less | 1 | 1 |
| 11 - 30 | 6 | 5 |
| More than 30 | 23 | 16 |
| | **30** | **22** |

On which floor is your office located?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Basement | 0 | 0 |
| 1st | 6 | 10 |
| 2nd | 17 | 5 |
| 3rd | 7 | 6 |
| 4th | 0 | 1 |
| | **30** | **22** |

In which area of the building is your area located?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| North | 7 | 13 |
| South | 9 | 3 |
| East | 2 | 5 |
| West | 11 | 1 |
| | **29** | **22** |

Is your office near an exterior wall (within 15 feet)?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Yes | 24 | 18 |
| No | 6 | 4 |
| | **30** | **22** |

Is your office near a window (within 15 feet)?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Yes | 24 | 18 |
| No | 6 | 4 |
| | **30** | **22** |

Which of the following best describes your office:

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Enclosed office, private | 17 | 20 |
| Enclosed office, shared with other people | 1 | 0 |
| Cubicles with partitions above standing eye level | 3 | 1 |
| Cubicles with partitions below standing eye level | 5 | 1 |
| Workspace in an open office with no partitions | 2 | 0 |
| Other | 2 | 0 |
| | **30** | **22** |

## SPACE

How satisfied are you with the amount of private space available for your work?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 5 | 2 |
| | 6 | 1 |
| | 4 | 2 |
| | 1 | 9 |
| Very satisfied | 14 | 8 |
| | **30** | **22** |

How satisfied are you with the amount of private space available for storage?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 4 | 2 |
| | 5 | 2 |
| | 10 | 6 |
| | 6 | 6 |
| Very satisfied | 4 | 6 |
| | **29** | **22** |

How satisfied are you with the level of visual privacy?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 5 | 2 |
| | 6 | 0 |
| | 3 | 3 |
| | 5 | 6 |
| Very satisfied | 10 | 11 |
| | **29** | **22** |

How satisfied are you with opportunities for interaction with co-workers?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 1 | 2 |
| | 6 | 4 |
| | 2 | 6 |
| | 11 | 5 |
| Very satisfied | 10 | 4 |
| | 30 | 21 |

Overall, does the office layout interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 2 | 2 |
| | 6 | 2 |
| | 10 | 7 |
| | 6 | 7 |
| Enhances | 6 | 4 |
| | **30** | **22** |

Overall, does the layout of the building interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 4 | 2 |
| | 3 | 3 |
| | 15 | 5 |
| | 6 | 8 |
| Enhances | 2 | 4 |
| | **30** | **22** |

Overall, how satisfied are you with your personal workspace?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 1 | 1 |
| | 11 | 2 |
| | 6 | 6 |
| | 7 | 10 |
| Very satisfied | 5 | 3 |
| | **30** | **22** |

How satisfied are you with the building overall?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 1 | 0 |
| | 10 | 4 |
| | 8 | 5 |
| | 8 | 8 |
| Very satisfied | 3 | 5 |
| | **30** | **22** |

I think that the appearance of my office conveys a message to others who see it.

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Yes | 30 | 21 |
| No | 0 | 1 |
| | **30** | **22** |

I feel that the appearance of my office affects my success at work.

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 0 | 0 |
| | 3 | 6 |
| | 12 | 8 |
| | 10 | 4 |
| Significantly | 5 | 4 |
| | **30** | **22** |

## FURNISHINGS

How satisfied are you with the comfort of your office fumishings and equipment (chair, desk, guest chairs, computer, equipment, bookcases)?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 2 | 1 |
| | 7 | 3 |
| | 6 | 4 |
| | 9 | 8 |
| Very satisfied | 6 | 6 |
| | **30** | **22** |

How satisfied are you with your ability to adjust your fumishings to meet your needs?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 3 | 2 |
| | 8 | 8 |
| | 11 | 4 |
| | 3 | 4 |
| Very satisfied | 5 | 4 |
| | **30** | **22** |

How satisfied are you with the colors of flooring, furniture and surface finishes?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 3 | 0 |
| | 2 | 1 |
| | 14 | 9 |
| | 5 | 6 |
| Very satisfied | 6 | 6 |
| | **30** | **22** |

To what extent do your office furnishings and equipment interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 2 | 2 |
| | 6 | 2 |
| | 16 | 6 |
| | 4 | 9 |
| Enhances | 2 | 3 |
| | **30** | **22** |

## THERMAL COMFORT

Which of the following do you personally adjust or control in your workspace?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Window blinds/shades | 20 | 14 |
| Operable window | 13 | 17 |
| Thermostat | 2 | 8 |
| Portable heater | 4 | 7 |
| Permanent heater | 1 | 1 |
| Room air conditioning unit | 8 | 1 |
| Portable fan | 4 | 2 |
| Ceiling fan | 0 | 0 |
| Adjustable air vent in wall/ceiling | 0 | 0 |
| Door to interior space | 12 | 8 |
| Door to exterior space | 3 | 4 |
| None of the above | 3 | 1 |
| Other | 1 | 3 |

How satisfied are you with the temperature in your workspace?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 1 | 4 |
| | 11 | 4 |
| | 7 | 12 |
| | 8 | 2 |
| Very satisfied | 3 | 0 |
| | **30** | **22** |

Overall, does the thermal comfort in your workspace interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 4 | 2 |
| | 8 | 10 |
| | 5 | 9 |
| | 7 | 0 |
| Enhances | 6 | 0 |
| | **30** | **21** |

**INDOOR AIR QUALITY (IAQ)**

How satisfied are you with the air quality in your workspace (i.e. stuffy/stale air, drafty, odors)?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 3 | 0 |
| | 11 | 2 |
| | 5 | 11 |
| | 6 | 6 |
| Very satisfied | 5 | 3 |
| | **30** | **22** |

Overall, does the air quality in your workspace interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 3 | 0 |
| | 8 | 2 |
| | 9 | 12 |
| | 5 | 6 |
| Enhances | 5 | 2 |
| | 30 | 22 |

## LIGHTING

Which aspects of lighting are you able to control?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Light switch | 22 | 18 |
| Light dimmer | 1 | 6 |
| Window blinds/shades | 20 | 16 |
| Desk (task) light | 9 | 17 |
| None of the above | 1 | 0 |
| Other | 3 | 3 |

How satisfied are you with the amount of light in your workspace?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 3 | 1 |
| | 6 | 3 |
| | 5 | 5 |
| | 7 | 6 |
| Very satisfied | 8 | 7 |
| | **29** | **22** |

How satisfied are you with the visual comfort of the lighting (i.e. glare, reflections, contrast)?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 4 | 3 |
| | 7 | 4 |
| | 4 | 3 |
| | 9 | 6 |
| Very satisfied | 6 | 6 |
| | **30** | **22** |

Overall, does the lighting quality interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 4 | 2 |
| | 8 | 4 |
| | 6 | 5 |
| | 4 | 8 |
| Enhances | 8 | 3 |
| | **30** | **22** |

## ACOUSTICS

How satisfied are you with the noise level in your workspace?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 4 | 8 |
| | 5 | 5 |
| | 10 | 2 |
| | 7 | 2 |
| Very satisfied | 4 | 5 |
| | **30** | **22** |

How satisfied are you with the sound privacy in your workspace (ability to have a conversation without your neighbors overhearing and vice versa)?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 8 | 10 |
| | 10 | 5 |
| | 3 | 3 |
| | 5 | 1 |
| Very satisfied | 4 | 3 |
| | **30** | **22** |

Overall, does the acoustic quality in your workspace interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 5 | 9 |
| | 10 | 4 |
| | 5 | 5 |
| | 5 | 1 |
| Enhances | 5 | 3 |
| | **30** | **22** |

## MAINTENANCE

How satisfied are you with the cleaning services provided for your workspace?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 4 | 3 |
| | 11 | 6 |
| | 9 | 10 |
| | 3 | 3 |
| Very satisfied | 2 | 0 |
| | **29** | **22** |

How satisfied are you with the general maintenance of the building?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | 5 | 1 |
| | 9 | 5 |
| | 9 | 15 |
| | 6 | 1 |
| Very satisfied | 1 | 0 |
| | **30** | **22** |

Does the cleanliness and maintenance of this building interfere with or enhance your ability to get your job done?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Interferes | 2 | 0 |
| | 7 | 4 |
| | 13 | 16 |
| | 5 | 2 |
| Enhances | 3 | 0 |
| | **30** | **22** |

## SUSTAINABILITY ASPECTS

How would you rate your knowledge of LEED certified or green buildings?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| No knowledge | 19 | 3 |
| | 1 | 8 |
| | 7 | 10 |
| | 3 | 1 |
| Great deal of knowledge | 0 | 0 |
| | **30** | **22** |

How satisfied are you with the amount of information you have been provided on Kelley Engineering Center's green features?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all satisfied | - | 1 |
| | - | 2 |
| | - | 10 |
| | - | 7 |
| Very satisfied | - | 2 |
| | | **22** |

The Kelley Engineering Center is being built to be energy efficient. To what extent do you expect that working there will improve/has improved your work?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 4 | 4 |
| | 1 | 4 |
| | 13 | 10 |
| | 9 | 3 |
| Significantly | 3 | 1 |
| | **30** | **22** |

Do you expect that the sustainability aspects of Kelley Engineering Center will improve the recruitment/retention of faculty?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 7 | 4 |
| | 5 | 6 |
| | 8 | 4 |
| | 6 | 5 |
| Significantly | 4 | 2 |
| | **30** | **21** |

Of graduate students?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 8 | 3 |
| | 3 | 6 |
| | 9 | 6 |
| | 7 | 4 |
| Significantly | 3 | 2 |
| | **30** | **21** |

Of undergraduate students?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 7 | 3 |
| | 4 | 5 |
| | 10 | 9 |
| | 6 | 3 |
| Significantly | 3 | 2 |
| | **30** | **22** |

Do you believe that the sustainability aspects of Kelley Engineering Center will academically enrich students?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 5 | 4 |
| | 7 | 4 |
| | 11 | 7 |
| | 4 | 4 |
| Significantly | 3 | 3 |
| | **30** | **22** |

Do you believe the sustainability aspects of Kelley Engineering Center will change the level of pride and loyalty of Alumni?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 6 | 2 |
| | 2 | 1 |
| | 5 | 7 |
| | 12 | 10 |
| Significantly | 5 | 2 |
| | **30** | **22** |

Of donors?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 4 | 1 |

| | | |
|---|---|---|
| | 2 | 2 |
| | 8 | 7 |
| | 11 | 9 |
| Significantly | 4 | 3 |
| | **29** | **22** |

Of faculty?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 5 | 3 |
| | 1 | 0 |
| | 9 | 9 |
| | 9 | 8 |
| Significantly | 6 | 2 |
| | **30** | **22** |

Of students?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 5 | 2 |
| | 2 | 3 |
| | 11 | 8 |
| | 8 | 6 |
| Significantly | 4 | 2 |
| | **30** | **21** |

Do you believe the sustainability aspects of Kelley Engineering Center will raise the national and international visibility of OSU?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 6 | 3 |
| | 5 | 2 |
| | 7 | 5 |
| | 9 | 10 |
| Significantly | 3 | 2 |
| | **30** | **22** |

Do you believe the sustainability aspects of Kelley Engineering Center will raise the national and international visibility of the College of Engineering?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 7 | 3 |
| | 4 | 4 |
| | 9 | 3 |
| | 7 | 10 |
| Significantly | 3 | 2 |
| | **30** | **22** |

To what extent do you think that you are a socially responsible citizen?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 0 | 0 |
| | 0 | 0 |
| | 9 | 3 |
| | 11 | 12 |
| Very | 10 | 6 |
| | **30** | **21** |

To what extent do you think you will feel more socially responsible working in Kelley Engineering Center?

| | Pre-occupancy | Post-occupancy |
|---|---|---|
| Not at all | 5 | 5 |
| | 3 | 5 |
| | 7 | 5 |
| | 11 | 5 |
| Very | 4 | 2 |
| | **30** | **22** |

# APPENDIX F

*Responses to the Post-occupancy Questionnaire Open-ended Questions*

*Question 14.* Please describe any other issues related to office or building layout that are important to you.

1 There are a lack of bathrooms on the first floor. Due to the e-cafe and the additional traffic it brings in it causes the first floor restrooms to be over burdened.

2 Walls are paper-thin. No privacy with respect to noise. THIS IS HORRIBLE!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

3 There is little or no sound absorption in the building. It's almost impossible to have a confidential conversation. Things are so loud in my office, that it is sometimes hard to have a conversation on the phone -- with my office door SHUT.

4 I love it here! In my 45 years of working in various office and cubicles, this is by far the best!

5 location of mail room, breakroom/kitchen, restrooms less than convenient

6 Whiteboard is in an awful location (file cabinet gets in the way but I can't move the file cabinet because there is no where to move it to)

7 The location and style of the mailboxes is very bad design and location (i.e. labeling wasn't thought of ahead of time). The location of the mailbox area should not have been next to the director's office. The heating system in [Kelley] has not been worked out yet so our offices were very cold during the winter. I had to plug in a portable heater.

8 1 or 2 more chairs in the office would improve meetings

9 We all seem very isolated here with little interaction in comparison with Owen Hall. The alcoves at the end of the hall don't work for those who have offices here. We have no common space or bullpen (watering hole) to go to. The atrium is nice but is very cold and sterile even with the couches and vegetation. The polished marble and excessive glass and metal all gives a hostile, cold, un-homey feeling. When the double doors open on the North side of the building, those in the nice chairs get blasted with artic winds. The sound proofing between offices is nearly non-existent. When my neighbors phone rings, I think its mine. We can hear each other talk, cough, sneeze, drop things, etc. The heat cuts off after 5pm and you can freeze by 8pm. I have a space heater in my office. Some others do too. So much for a saving energy. The white boards in the office were unusable as they were partially blocked by the file cabinets. Totally stupid design. I'd love to have my full size whiteboard from Owen. The desks are nice. There...one nice comment!

10 very noisy sound carries and hard to focus or hear on the phone

11 Because of lack of storage, my office is still full of boxes. Because it is full of boxes,

there is no room to meet with colleagues and students.

12 The lights cycle on and off, and that's a pain. The temperature problems have been fixed now. The atrium is wonderful! and the e-cafe is very convenient. It would be nice to have info about faculty locations posted all on the first floor, so you know which floor to go to.

13 sound proofing would have been a great idea in this day and age.

14 Copy machine is some distance from my office.

*Question 19.* Please identify any other issues related to office furnishings and equipment that are important to you.

1 Everythings works well. At times, it does seem cold and I am tempted to bring in a heater. It would be nice to be able to regulate the heat in my office. The only other problem I have had was having a place to hang my coat and this was fixed quite nicely by the door hook that was installed.

2 more time and money given to equip offices

3 Thermostat is tricky to operate

4 the ventilation slots in the floor impact chair movement significantly

5 Give me a whiteboard bigger than a postage stamp and a place to put it.

6 less desk space to work on than before

7 The switches and controls on the wall made it impossible to put in a big white board. The small white board is unusable and too high.

8 RSI concerns, desk height (if the chair is raised then feet do not rest comfortably) chair seat and back do not fit a small person like my self

9 Office furniture is not acceptable when visitors are in the office and has not been modified despite many requests.

*Question 38.* Please list additional comments / recommendations about your personal workspace or the building overall.

1 Gorgeous building that brings in a lot of natural light.

2 NOISE!!!!!!!!!!!!

3 Usability problem: mixing lights with temp -- that's silly. What if I want to turn off the lights but still be warm? Usability problem: can't close inside window without also closing outside window. eg, what if I want fresh air but also to block out hallway noise? Usability problem: Lights are too bright for me when I'm on the computer, but

if I turn them off, I get no heat. And, I'd like to dim them at least, but I can't. Usability problem: What kind of new building has a leaky roof? Usability problem: Nobody understands even yet how the heating works. Usability problem: In fact, nobody really understands how anything works! Energy efficient? We can't turn off hte lights, so every night every office has to be lit an extra 30 minutes after we go home so that we don't lose our heat. Bike room: There are many bikes that don't work in the kind of racks we were provided. There should be some at least a few conventional racks for incumbents, shorter bikes, female bikes, etc.

4 Need to fix Park Terrace - this road is the first thing many visitors see and it is awful! Like living in New Jersey (sorry!) -- I can say that because I have family there...

5 My trash rarely gets cleaned and it is right in visual view once you open the door.

6 I listed some of these in the previous area but of course in Kelley the heating issue has not been entirely resolved and my office was freezing during the winter.

7 more chairs would be nice the inability to control heating/cooling is very annoying

8 Toliets are a joke. Four flushes usually do the job. Way worse than the bad ones we are have to use in our homes. Too many locks. Good grief, there seem to be locks on every door. I am so tried of this. And why oh why don't they have a card key lock on the North side door. Most all of us who come in after hours would use that door, but no, we have to walk half way around the building to get in. Amazingly stupid. What where the architects thinking. They were too focused on visual impact to think about important issues like entering the building on a rainy dark nigh.

9 sound levels carry - nothing private

10 Sound is a major problem, since there are many situations in which private and/or confidential items must be discussed (e.g., advising students).

11 Lights must be on to have heat. The "auto" selection for the lights provides light that is not overly-bright (preferred). At present, the lights cycle on and off if I use that setting and stay on with the "Normal" setting. Right now, the lights are too bright for confort.

12 Used towel collectors in Men's rooms need to be at least twice their current size.