EMPLOYEES' SATISFACTION WITH INDOOR ENVIRONMENT QUALITY ASSOCIATED WITH PRIMARY AND ALTERNATIVE WORKSPACES IN OFFICE ENVIRONMENTS

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DENISE A. GUERIN, PHD, ADVISER

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Getting 'educated' does not pay well. Frozen pizza on paper plates does not create cherished memories when substituted for holiday meals. A suitcase full of library books packed for family vacations does not provide companionship to others or even serve as a good book. Staying up all night researching and writing under bright lights and a quiet flow of music does not make for a peaceful night for others. All of this and more was a constant in our family life. I am grateful for my mother who has been waiting for me (to be present in the moment) and for my son's help with – with just about everything that I couldn't do - and for not reminding me of what I didn't do. It was his turn anyway. I am grateful for the friends that remained supportive and stayed on track as friends when I might not have been very friendly with my head attached to my laptop.

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ABSTRACT

The purpose of this study was to address employees' satisfaction with indoor environment quality (IEQ) associated with alternative workspaces (AWSp) and primary workspaces (PWSp). Specific IEQ criteria of interest included acoustics, appearance (aesthetics), daylighting, electric lighting, function, furnishings, indoor air quality, thermal conditions, vibration and movement, and view.

A post-occupancy evaluation (POE) was conducted with employees (faculty, staff and students) who had workspace in a facility designed and developed referencing sustainable design guidelines. Hanson Hall was selected for this study as it was developed referencing the B3 Guidelines (formerly known as the Minnesota Sustainability Guidelines or MSBG). Hanson Hall is a five-level, classroom and office building located on the West Bank of the University of Minnesota Twin Cities campus and includes approximately 25,400 square feet of space dedicated to primary workspaces (PWSp) and 23,900 square feet of space allocated to alternative workspaces (AWSp).

The Sustainable Post-Occupancy Evaluation Survey (SPOES) was used for this study and modified to include questions for an Alternative Workspace Module. Affordance theory served as the theoretical framework for this research, and a model was developed to illustrate employees' (observing/perceiving) satisfaction with the IEQ criteria in the designed environment, natural environment, and social environment.

Employees responded to an online survey to rate their satisfaction with the overall facility (site, building and interior) [F (SBI)], their PWSp, and their AWSp. They also rated their satisfaction with IEQ criteria associated with their PWSp and self-identified AWSp. Satisfaction was rated on a 1-7 Likert-type scale, and data were analyzed using descriptive and inferential statistics.

An IEQ satisfaction score was developed from the weighted means of the 11 IEQ criteria resulting in an overall composite IEQ score of 5.32 for the PWSp and 5.29 for the AWSp. The IEQ criterion affording the highest level of satisfaction with PWSp was function, and the lowest level of satisfaction was view. The IEQ criterion affording the highest level of satisfaction for the AWSp was function and the lowest level of satisfaction was view. ANOVA results of the overall satisfaction with the F (SBI), PWSp, and AWSp revealed statistically significant differences among the three IEQ scores.

Previous research on employees' satisfaction with IEQ criteria was associated only with the overall F (SBI) and the PWSp. This study addressed the increasing use of AWSp to accommodate employees' work modes with the goal to develop a more comprehensive understanding of employees' satisfaction with IEQ criteria across all workplace settings. This research served as a pilot study and is considered limited in scope and in sample size (N=26). However, much was learned about AWSp and the process used to evaluate employees' satisfaction with their AWSp.

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CHAPTER ONE INTRODUCTION

Purpose

The purpose of this study is to examine employees' satisfaction with indoor environmental quality (IEQ) in alternative workspaces (AWSp), primary workspaces (PWSp), and the overall facility (site, building, and interior) [F (SBI)] in a building developed referencing sustainable design guidelines. Sustainable building guidelines provide building owners, facility managers, and design practitioners with strategies, rating systems, and evaluation processes to design, build, and operate high performance buildings. Sustainable design strategies focus on conditions related to the site or community, the use of natural resources (energy and water consumption), material by-products entering the waste stream, indoor environment quality criteria, and occupants' (employees') perceptions of their satisfaction, performance, and health. Rating systems provide guidelines to follow for different sustainable initiatives. The guidelines define prerequisite conditions, performance criteria, operational procedures, and prescriptive related goals. Sustainable design rating systems can encompass both national and regional priorities such as those associated with the Leadership in Energy and Environmental Design (LEED)® (United States Green Building Council, n.d.) and the B3 Guidelines (formerly known as the Minnesota Sustainable Building Design Guidelines (MSBG) – Buildings Benchmarks Beyond) (Center for Sustainable Building Research, n.d.a). Further, rating systems provide vested stakeholders with an opportunity to track and quantify building performance and economic, environmental, and human outcomes in projects (B3 Guidelines, n.d.a).

Indoor Environment Quality and Employees' Satisfaction

IEQ criteria are associated with different aspects of the physical environment that influence employees' satisfaction such as acoustic conditions, appearance (aesthetics), cleaning and maintenance, daylighting conditions, electric lighting conditions, function, furnishings, indoor air quality, personal adjustability, privacy, technology, thermal conditions, vibration and movement, and view conditions. The impact of IEQ criteria on building occupants can be examined through physical measurements to assess compliance with performance benchmarks, interviewing employees through focus groups, and administering occupant surveys (Driza & Parks, 2014; Freihoeffer, 2012).

To understand the relationship between IEQ criteria and employees' satisfaction, researchers frequently conduct post-occupancy evaluations (POEs) after the building project is complete and occupied for a period of time (Hadjri & Crozier, 2009; Preiser, 1995). Preiser, Rabinowitz, and White (1988) define POEs as "the process of systematically comparing actual building performance, i.e., performance measures, with explicitly stated performance criteria" (Preiser, 1995, p. 19). Thus, POEs are commonly used to measure the impact of IEQ criteria and employees' satisfaction and perceptions of their work performance and health in workplace environments (Abbaszadeh, Zagreus, Lehrer, & Huizenga, 2006; Lee & Guerin, 2009; Veitch, Charles, Farley, & Newsham

2007). The results of POEs can also reveal problems in the environment by isolating IEQ criteria that contribute to negative perceptions of workplace environments (Nasrollahi, Knight, & Jones, 2008; Newsham, Veitch, & Charles, 2008). Both positive and negative responses to IEQ conditions provide important feedback on how well the building is performing from the employees' perspective.

Several POE studies have examined employees' satisfaction with IEQ criteria at the level of the overall workplace environments (site, building, and interior) (Choi, 2011; Freihoeffer, 2012; Guerin, Kulman-Brigham, Kim, Choi, & Scott, 2012; Heerwagen & Zagreus 2005; Jensen, Arens, & Zagreus, 2005; Lai & Yik, 2007; Lee & Guerin, 2009; Malmqvist, 2008; Peretti, Schiavon, Goins, Arens, & De Carli, 2010; Peretti & Schiavon, 2011; Zagreus, Huizenga, Arens, & Lehrer, 2004) and at the level of the primary workspace (PWSp), e.g., desks, workstations, cubicles, private offices.. There is little to no research that systematically examines employees' satisfaction with IEQ in other types of workplaces, referred to in this study as alternative work spaces (AWSp) e.g., unassigned spaces, meeting rooms, team rooms, lounges, etc.

Research into sustainable design criteria identifies real outcomes and feedback important to the design of workplace environments and organizational success. For example, employees' satisfaction with IEQ criteria at the level of the PWSp is associated with employees' satisfaction with the overall workplace environment and job satisfaction

(Veitch, Charles, Farley, & Newsham 2007). Further, employees' satisfaction is associated with employees' retention and organizational success (O'Neil, 2013). These studies reveal an important connection between the physical environment and employees' satisfaction with their workplace environment that bears further discussion.

Workplace Environments

Today's workplace environment is more likely seen with work areas that are designed to support new ways of working (Knoll, 2013; Johnson & Hargis, 2011; Paron-Wildes, 2012; O'Neil, & Wymer, 2011; O'Neil, 2013). Advancements in communication and network technology have untethered employees from their PWSp and allowed them to work from several areas distributed throughout the office environment.

Sociologist Oldenburg (1989; 2002) was the first to identify different places for work as the first place (the home environment), the second place (the office), and the third place (social amenity spaces such as coffee shops). Following this lead, Florida (2010) identified the fourth place as a location where work activities occur in informal settings or mini-offices – specifically designed to accommodate entrepreneurs, consultants, and independent contractors. As social places grew into destinations for work activities, the line between work and socializing became blurred. Leaders in workplace design quickly responded by integrating third places (social amenity space) into offices, thus allowing workers to meet, work, socialize, interact, and dine in a variety of locations (Steelcase, n.d.a). Today, office environments are seen as spaces more likely to serve as a “hub for learning and working, rather than a container for people” (Heerwagen, Anderson, & Porter, 2012, p. 26).

Traditionally, organizations provided employees with a PWSp (private office, workstation, or desk) associated with their position, title, and/or work responsibilities. PWSp provides employees with a place to ‘put their stuff’ and to serve as a home base from which to operate (Johnson & Hargis, 2011). PWSp can be assigned, reserved, shared, or solely occupied. Typically, PWSp functions serve as a place for concentration (head down or focus work), collaboration (where guest seating is provided), and in some cases, connection (informal or causal exchanges) (Knoll, 2013).

PWSp is frequently linked to office standards that reflect employees’ positions or hierarchy in the organization. These standards are associated with specific physical features such as size of space and wall or panel enclosures and often appear to share the same or similar design attributes (materials, finishes, and furnishings). PWSp designed as private offices are typically arranged contiguously along a corridor or window wall. Those that are designed as cubicles or workstations are typically located in open spaces and clustered together in a grid like pattern.

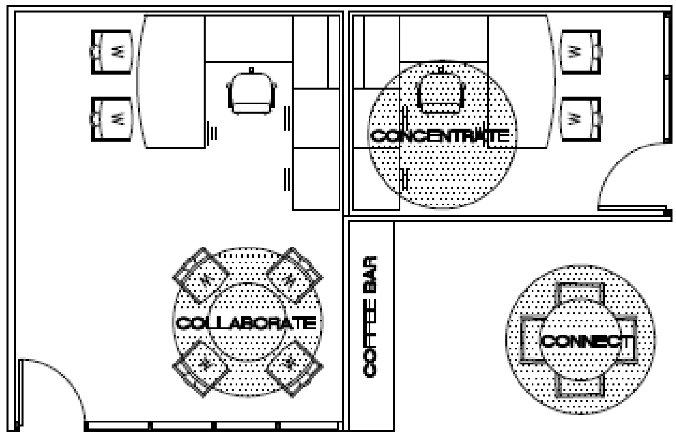


Figure 1 shows how private offices serve as PWSp and accommodate different types of work activities (collaborate and concentrate) as noted in shaded areas. *Figure* 2 shows how PWSp in workstation or cubicle layouts accommodate different types of work activities (collaborate and concentrate) as noted in shaded areas. Connection spaces are identified on the plans that serve as typical AWSp adjacent to PWSp.

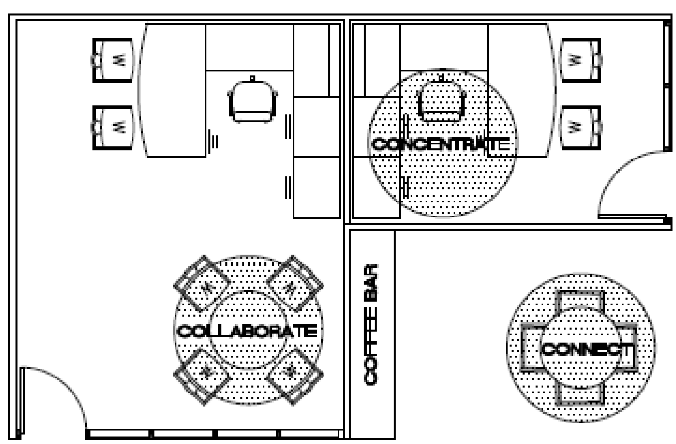


Figure 1. PWSp (private office) and work activities (collaborate and concentrate) (Drawn by T. Bauer, 2013)

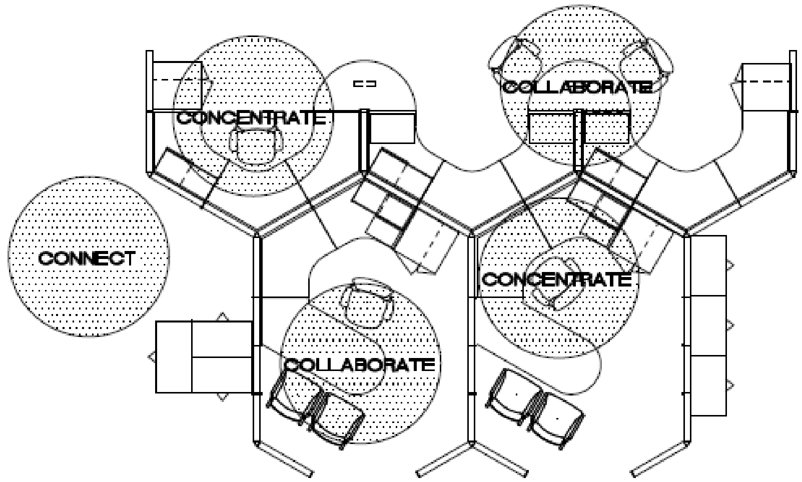


Figure 2. PWSp (workstations) and work activities (collaborate, concentrate, and connect) (Drawn by T. Bauer, 2013)

AWSp are 'go to spaces' used for work and distributed throughout the office environment. They are generally used by individuals for concentration activities, project teams for collaboration activities, and as connection spaces for informal sharing or social activities (Knoll, 2013). *Figure* 1 and *Figure* 2 illustrate AWSp near PWSp (file areas or coffee bars) where employees come together and connect for brief, informal moments.

Traditionally, AWSp are associated with conference rooms, meeting rooms, training rooms, resource rooms, and libraries. Today, AWSp are more likely to be referred to as enclaves, hives, hubs, huddles, hotels, pods, team rooms, focus-booths, scrum rooms, and more (Knoll, 2013; Langhoff, 2007; New South Wales Government Workplace Guidelines, 2005; Steelcase, n.d.b; Venezia, 2007; Voss, 2010). Collectively, *Figures* 3 - 6 illustrate examples of AWSp located in the workplace environment of

Steelcase Global Headquarters and Steelcase University in Grand Rapids Michigan. In these illustrations, AWSp are associated with coffee bars, work cafés, and small meet up areas that are used for connection activities. They are also depicted as enclosed team meeting areas used for collaboration activities and enclosed enclaves and quiet spaces used for concentration activities (Steelcase, n.d.c; Steelcase, n.d.d).

Figure 3. Coffee bar and assorted meet-up spaces (connection activities) at Steelcase University (Steelcase, n.d.c, p. 76)

Figure 4. Private enclaves (concentration activities) and team spaces (collaboration activities) at Steelcase University (Steelcase, n.d.c, p. 80)

Figure 5. Work café and quiet areas (connection and concentration activities), Steelcase Headquarters, Grand Rapids, MI (Steelcase, n.d.c, p. 82)

Figure 6. Work café and meet up spaces (connection and collaboration activities) Steelcase Headquarters, Grand Rapids, MI (Adapted from Steelcase, n.d.d, p. 52)

AWSp are associated with changes in architectural features such as dropped or raised ceilings, variations in floor heights, unique finishes and materials, or specialized furniture groupings in open areas. AWSp can also be centralized in a convenient area for all employees or distributed throughout the area to fit work and team requirements. AWSp provide employees with greater choice and freedom to accomplish work-related activities in locations that best suit their work mode.

Gensler's 2013 workplace study suggests that "enabling choice with the right alignment of tools, policies, and spaces is an opportunity for companies to create a climate in which autonomous, engaged employees can make meaningful decisions to maximize their individual job performance" (Gensler, 2013, p. 14). Workers come to the workplace with new expectations around flexibility and connections with others and the outside world. Organizations offering employees a choice of when, where, and how to work have 12% more satisfied employees and see their workplace as innovative (Gensler, 2013).

In response to organizations' change in work modes, systems furniture manufacturers developed new office layouts to demonstrate how PWSp and AWSp accommodated new ways of working. *Figure* 7 and *Figu*re 8 are prototypical plans that show how PWSp and AWSp are distributed throughout the workplace environment and located in both open areas and enclosed rooms. *Figure* 7 is a floor plan developed by Allsteel and distinguishes AWSp from PWSp as shaded areas (Allsteel, 2011). *Figu*re 8 is a floor plan developed by Knoll (2012) that illustrates PWSp in gray shaded areas and AWSp in different colors associated with different types of work activities.

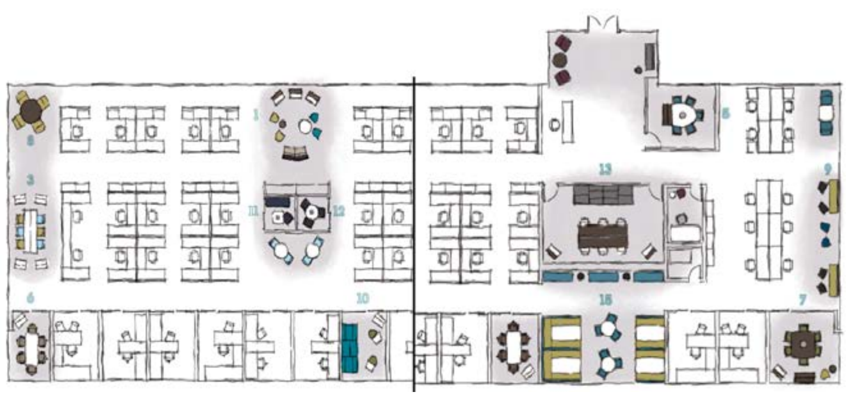
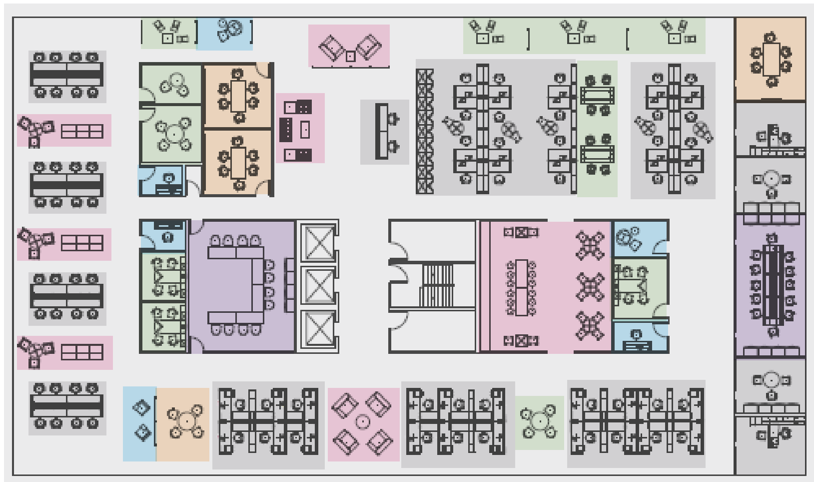


Figure 7. Floor plan depicting PWSp areas and AWSp as gray-shaded area (Adapted from Allsteel, 2011, pp. 10-11)



*Figu*re 8. Floor plan depicting PWSp and AWSp (Knoll, 2012, p. 3)

Steelcase Inc., a major innovator and manufacturer of systems furniture, incorporated several key concepts related to PWSp and AWSp in the layout of their headquarters located in Grand Rapids, Michigan. Based on their own workplace research and witness of changing work practices, they developed a workplace model that reflects a 'palette of places' with different layers of ownership (Steelcase, n.d.a). *Figure* 9 illustrates the Steelcase workplace model reflecting the four sectors of ownership and the use associated with each space. The Steelcase model associates I/Owned spaces with resident workstations and private offices. I/Shared spaces are associated with touchdown spaces and enclaves. We/Owned spaces are associated with training rooms, collaborate spaces, or café' spaces. We/Shared are associated with project team spaces and shared project space.

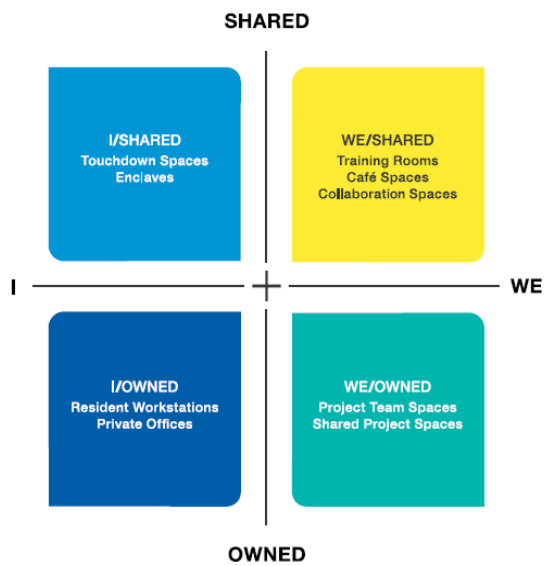


Figure 9. Layers of ownership in the workplace (Steelcase, n.d.a, p. 27)

Further, the floor plan illustrates how the choice associated with a ‘palate of places’ provides employees with the ability to align their work task (collaborate, concentrate, or connect) with a space that best fits their need (Steelcase, n.d.a). *Figure* 10 illustrates color coded areas relating to the space type and layers of ownership as follows: I/Owned space are associated with resident workstations and private offices in dark blue; I/Shared spaces are associated with touchdown spaces and enclaves in light blue; We/Owned spaces are associated with training rooms, collaborate spaces, or café’ spaces in turquoise; and We/Shared are associated with project team spaces and shared project space in yellow.

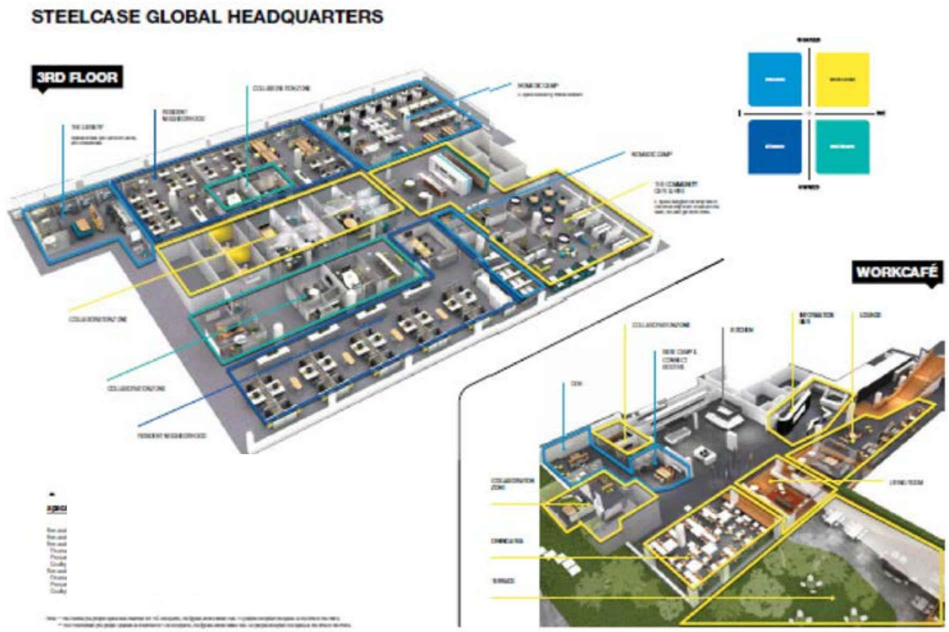


Figure 10. Mapping layers of ownership (Adapted from Steelcase, n.d.a., p. 27)

Finally, changes in workplace strategies have affected the amount of space allocated to PWSp and AWSp as well as the time employees spend in each type of workspace. Space allocation reports indicate that the overall PWSp size has decreased, and the amount of space allocated for AWSp has increased (Barber, Laing, & Simeone, 2005; Deloitte, 2009; Gensler, 2013; Gillen, 2006; Haworth, n.d.c; Knoll, 2013; Langhoff, 2007; O'Neil, 2011). Previously, the ratio of PWSp to alternative workspace was approximately 70% PWSp to 30% AWSp. Today, many commercial office environments and higher education institutions are approaching a ratio of 50% PWSp to 50% AWSp (Knoll, 2012; Knoll, 2013).

The time employees spend in their PWSp and other locations in the office has also shifted. Gensler's workplace study found that employees spend approximately 74% of their time in the office, and of that time, 72% is spent at the PWSp (Gensler, 2006). O'Neil and Wymer (2011) indicated that workers are spending almost 50% of their time outside of the PWSp, of which 23% is spent at other locations in the office. Herman Miller's Space Utilization Studies have also noted a shift in where time is spent in and out of the office. In their findings, researchers found that private office space was vacant 77% of the time, and workstations were vacant 60% of the time (Herman Miller, n.d.a). With some variation based on industry type, Steelcase reported that primary workstations stood empty 40% - 60% of the time (Steelcase, n.d.e). Knoll (2013) workplace researchers found that, "half of their [employees'] work time is spent outside of individual assigned workspaces in places other than the central offices and in new kinds of spaces" (p. 1).

It is important to note that work activities and layers of ownership are not the focus of this study, but they are related to the changes transforming the workplace and how space is allocated and used. Just as social media and workplace researchers characterize AWSp differently, work activities are also characterized using different terms. In addition, research on employees' satisfaction with IEQ conditions in the PWSp or the AWSp rarely associates employees' satisfaction with IEQ conditions during specific work activities such as collaboration, connection, or concentration in PWSp or AWSp.

Rationale for the Study

> Our workplace-making industry is acutely aware of the tumultuous change going on. The way we think about, plan, and use the physical work environment is shifting in several fundamental ways. Work is no longer where you go, but what you do. The nature of work continues to become more complex and more collaborative. Space is no longer an entitlement but a resource. Technology has enabled us to work anytime and anywhere, changing both the notion of "going to the office" and what happens at "the office" – whatever and wherever the office might be. (Heerwagen et al., 2012, p. 2)

This research study responds to strategic shifts in workplace design and how AWSp are used to accommodate new ways of working in office environments. Previous POE research has focused on employees' satisfaction with IEQ conditions at the level of the PWSp. Very little information is known about employees' satisfaction with IEQ criteria associated with AWSp, therefore a potentially large and important portion of the workspace has not been investigated. This may be due, in part, to a lack of recognition of presence of AWSp in the overall workplace, a lack of understanding of where employees spend their time in the workplace environment, a lack of valid and reliable research instruments that systematically evaluate employees' satisfaction with IEQ criteria associated with AWSp, or, simply, the shift of the employee work efforts from assigned (PWSp) to unassigned (AWSp).

Therefore, this research intends to address this gap in knowledge by examining AWSp within workplace environments, first by examining overall satisfaction with and the F (SBI), PWSp, and AWSp, and secondly, through specific attention directed at employees' satisfaction with IEQ conditions associated with PWSp and AWSp. This study is exploratory in nature with a goal to include a more comprehensive view of employees' satisfaction with workplace environments. It responds to changes occurring due to the increased AWSp in office environments and shifts in employee work modes.

Summary

Concern for employees' satisfaction, performance, and health has led to the development of sustainable IEQ design guidelines that address built environment conditions known to influence occupants in their workplace settings. POE studies provide stakeholders with information on how well a building meets the needs of employees (satisfaction, performance, and health). POE studies have previously focused on the employees' satisfaction with the overall workplace environment and job satisfaction (Veitch et al., 2007), but rarely investigated AWSp, missing a large portion of the work environment. However, satisfied employees are associated with employee recruitment, retention, and organizational success (O'Neil, 2013). Therefore, employees' satisfaction with the whole workplace environment needs to be investigated.

PWSp provides a 'home base' where employees put their stuff and AWSp are 'go to spaces' distributed throughout the workplace environment. Both PWSp and AWSp accommodate different work styles (e.g., collaboration, concentration, and connections) and are associated with different layers of ownership (I/owned, I/shared, We/owned, We/shared). Most importantly, they are defined by attributes of the physical environment (furnishings and architectural features) associated with IEQ criteria that influence employees' satisfaction with their workplaces. The results of this study will provide a more comprehensive understanding of employees' satisfaction with individual IEQ criteria associated with both PWSp and AWSp and the relationship of employees' satisfaction with these spaces and the overall workplace environment.

CHAPTER TWO LITERATURE REVIEW

Introduction

This chapter begins with a brief reflection on 20^{th}- and 21^{st}-century office environments leading up to the current trends and factors impacting the design of office spaces today. Employees' satisfaction, workplace environments, and the role of interior designers in creating sustainable design workplaces are reviewed. The Building, Benchmark and Beyond (B3) Guidelines and indoor environment quality (IEQ) criteria [acoustics, appearance (aesthetics), daylighting, electric lighting, function, furnishings, indoor air quality, privacy, thermal, vibration and movement, and view] selected for this study are introduced. Lastly, the Affordance Theory is presented as the research framework guiding the investigation of employees' satisfaction with Indoor Environment Quality (IEQ) criteria in workplace environments.

Office Environments – Then and Now

> Offices are not a modern invention. Long ago, commerce, religious groups, armies, government bureaucracies created the need for clerical workers, record keepers, file managers, and other "pencil pushers" to deal with the information and paper documents that accompany such organizations. This need dates back thousands of years, even before paper was invented. From papyrus scrolls to clay tablets, data management – not to mention filing and storage – created process and problems that

> influenced the space in which such activities took place. (Long, 2004, p.13)

Workplace environments have undergone a significant change in the course of a century. Laing (2006) suggests that “Knowing where we have come from is essential to understanding where we are today and what our options are moving forward” (p. 29). Major shifts in building materials, communication technologies, and cultural awareness continue to shape workplace conditions for employees today.

20th-Century Office Environments

> The goal of the capitalist is net gain; net gain is at a minimum without economy; the motif of engineering is economy; and the life of economy is efficiency…. The first thought of the capitalist should be to keep his employees, his human machines, in prime condition. (Darrach, 1906, p. 42)

At the turn of the 20th-century, office buildings were constructed using basic materials such as masonry, stone, cast iron, heavy timbers, terracotta, and wood floors. Building amenities and communication technologies included the passenger elevator, gas light, electric light, voice tubes, and the telegraph (Pile, 2005). *Figure* 11 depicts a private office in the early 1900s, equipped with electric light and voice tube technology. As economies expanded, the demand for basic typing skills, accounting services, and information processing rose. To meet growing business and industrial goals, office employees worked long hours, often in dark interiors filled with rigid furnishings. Despite the perceived improvements in interior workplace conditions of the time, workers in clerical positions expressed anxiety over optic nerve strain and the dread of desk disease thought to cause “giddiness, liver problems, bladder and urinary infections, a swimming of the head, deafness, stomach and bowel disorders, piles, and strictures” (Zakim, 2006, p. 574).

Figure 11. Workers in a private office, voice tubes communication technologies, c. 1903. Photo courtesy of: www.officemuseum.com (office museum, n.d.a)

As new building materials continued to evolve (e.g., structural steel and glass curtain walls) and elevator service expanded upward, building heights increased leading to the birth of the iconic image of a skyscraper. Inspired by advancements in factory assembly lines, office work became much more mechanized and driven by performance and profit. Working as a management consultant, Frederick Taylor (1911) focused on workplace conditions with the goal to capture greater efficiencies in employees' performance and business processes. He established the Principles of Scientific Management, comprised of a strict set of laws, rules, and practices geared to maximize prosperity for both employers and employees. Industrial psychologists, Frank and Lillian Gilbreth, followed Taylor's research with a focus on workplace productivity, human fatigue, and employee well-being (Perkins, 1997; Price, 1990). Architects were quick to respond to these new workplace processes and designed large open offices to reflect factory-like settings, with desks and typewriter assemblies in rigid, synchronized rows where employees work habits could be easily observed by management (Knight & Haslam, 2010). *Figure* 12 illustrates office environments for clerical workers and arrangements of desks in tight rows. The Smithsonian Museum described this work culture:

> Standardization made it easy for managers to keep a close eye on all workers and work flow, counting the typists' strokes or the number of letters opened per hour. Offices were often open spaces, without partitions, where desks could easily be watched. Workers were kept to their jobs, which they pursued in silence. They were not allowed to talk

because conversation cut down work time. (Smithsonian Museum, n.d.)

Figure 12. Sears headquarters office environments, c. 1913. Photo courtesy of: www.officemuseum.com (Office museum, n.d.b)

By mid-century, a German consulting firm challenged the prevalence of the rigid open office plan designed to reflect the hierarchy of an organization from worker to manager (Zalesny & Farace, 1987). Instead of the cell-like desks surrounded by observation platforms, the Quickborner team approached office layout with an egalitarian perspective (non-hierarchical approach). They looked specifically at patterns of communication in the organization and developed a spatial layout to enhance collaboration among all workers. The design solution, referred to as Bürolandschaft or Brolandschaft, appeared more random, haphazard in nature, and spread out across the office landscape (Christensen, n.d.; Knight & Haslam, 2010; Zalesny & Farace, 1987).

This new approach received a great deal of criticism, the merits of which are still debated today. *Figure 13* shows the random appearance of workspaces in an open office landscape plan. Private offices disappeared, and service areas were more evenly distributed or placed on the periphery of the open office (Vivian, 2012).

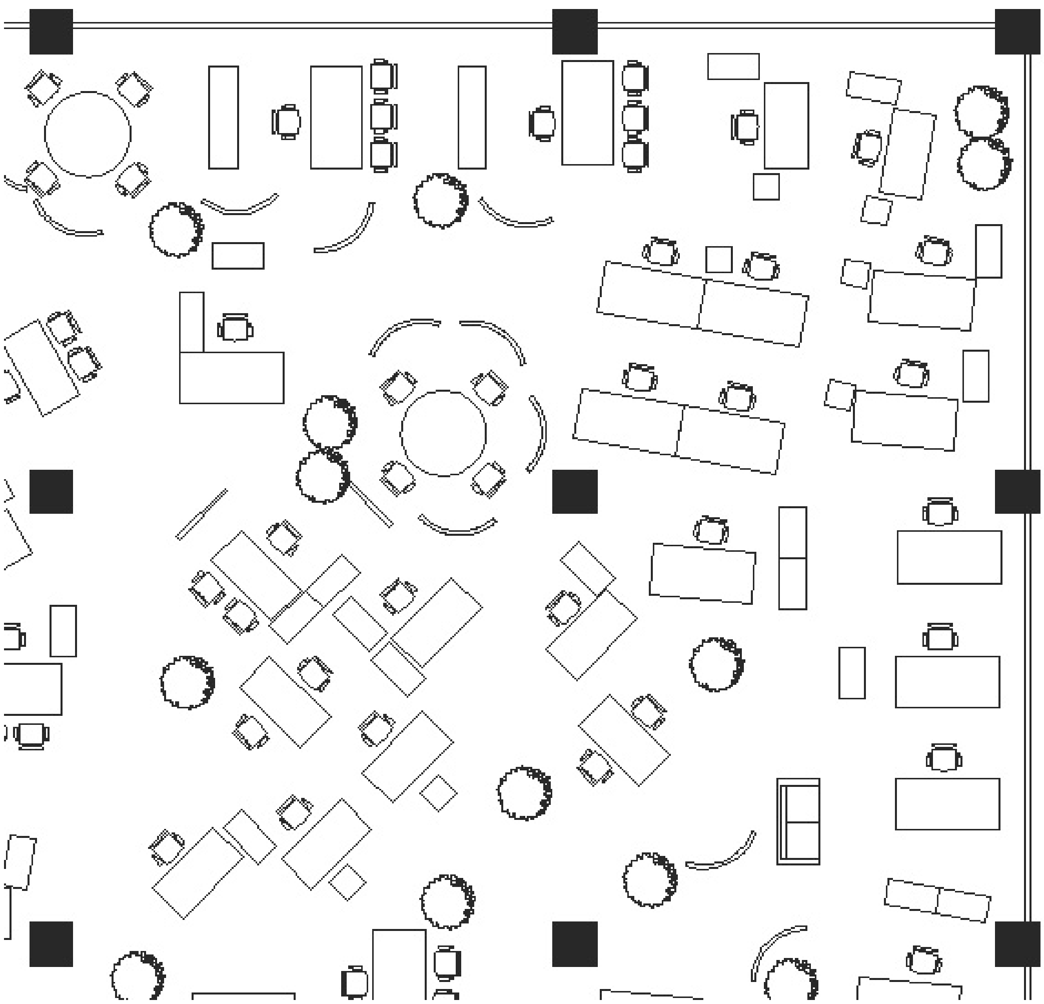


Figure 13. Brolandschaft open office landscape planning (Wikipedia, n.d.a)

As working conditions continued to progress, organizational psychologists shifted their attention away from rigid performance driven aspects of work to factors contributing to the health and well-being of employees that supported their productivity. Several studies linked the indoor environment (e.g., acoustics, indoor air quality, and lighting) to problems associated with worker health (Davis, Leach, & Clegg, 2011; Harris, 2006; Hedge, 1988; Mendell et al., 2002; Rashid & Zimring, 2008). For example, poor lighting conditions (too little or too much) were associated with eye-strain (Boyce, 1998;Vincent, Spierings, & Messinger,1989); loud, reoccurring noises interfered with worker concentration (Sundstrom, Town, Rice, Osborn, & Brill, 1994); and indoor air quality was associated with employee respiratory illness, referred to as Sick Building Syndrome (SBS) (Hedge, Burge, Robertson, Wilson, & Harris-Bass, 1989).

Industrial designers also turned their focus to the design of equipment, tools, and furnishings and the fit with human comfort and functional use (Dawis, 2002; Miles & Perrew É, 2011). Human factor (or ergonomic) researchers examined the design of objects and repetitive task movement thought to contribute to work-related musculoskeletal disorder risk (WRMDR) and employee-absenteeism (Chatterjee, 1987; Miles & Perrew É, 2011; Nugent, 2012; Sprigg & Jackson, 2006). *Figure* 14 illustrates early human factor (ergonomic) research involved with user interactions between task and workspace (e.g., typing task, body position and suggested configuration of the chair, keyboard, visual display terminals, and viewing angles). After 10 years of research into human task analysis and posture and body morphology, an industrial and environmental designer, Bill Stumpf, developed the first ergonomic task chair for Herman Miller, a leading manufacturer of office furniture. The introduction of the Ergon Chair revolutionized the design of task seating for its adjustability, aesthetics, comfort, and improvements associated with worker health (Herman Miller, n.d.b).

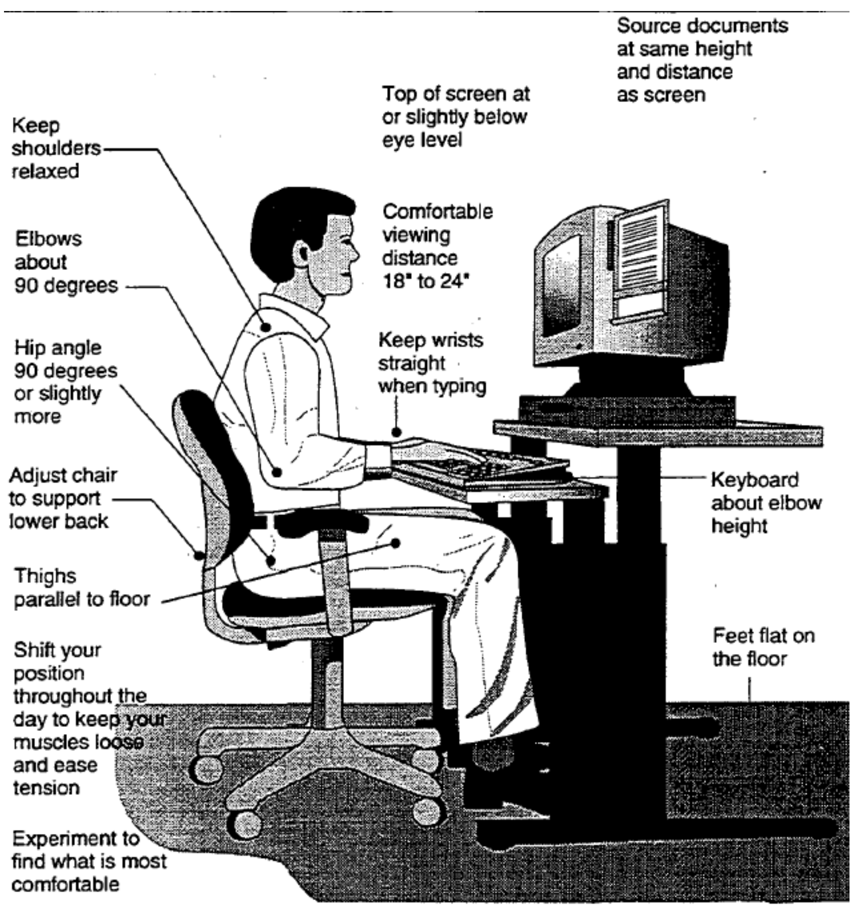


Figure 14. Physical ergonomics: the science of designing user interaction with equipment and workplaces to fit the user (Soni, R, n.d.)

Committed to innovation in workplace design, Herman Miller introduced the first modular furniture system called Action Office (Herman Miller, n.d.c). *Figure* 15 illustrates the design and configuration of a new type of workspace referred to as a workstation and cubicle in office environments. Designed by Robert Propst, the traditional office desk, typewriter return, and credenza were converted into a new workspace and assembled from a modular kit of parts, consisting of panels, work surfaces, vertical storage units, and several finish options. In 1985, the World Design Congress recognized the Action Office furniture system as the most significant industrial design introduction to workplace environments (Herman Miller, n.d.c).

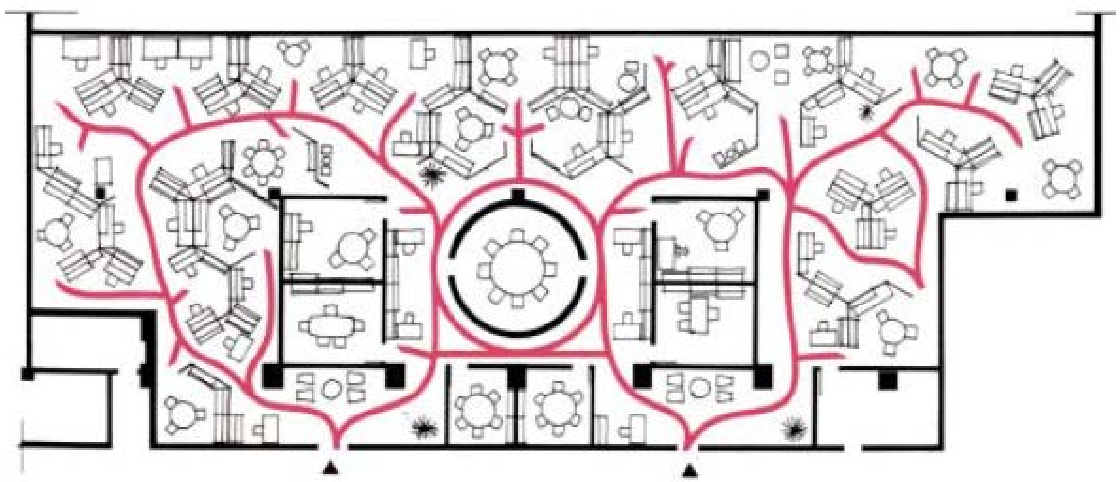


Figure 15 Action Office 2 Brochure: open office landscape and nonlinear workspace hierarchy designed by R. Probst, 1973, (Herman Miller, n.d.c)

By the end of the 20th-century, desktop computers replaced the typewriter and electronic mail provided an immediate exchange of information and documents over postal mail. From this time forward, workers were connected in the office, at home, and around the world (Gillies & Cailliau, 2000; Kluver, 2000; Masuda, 1982; Wershler-Henry, 2005). Workers found new ways to work, places to work from, and access to business opportunities near and far.

21st-Century Office Environments

> Workplace performance exists not only in conjunction with business success but with the character, form, and success of our cities. Increasingly, the workplace is not the sole location for work, but is a vital connection among myriad locations in which work happens. Today's knowledge work happens not just at the scale of people and offices, but at the scale of buildings, cities, and ultimately the globe. (Gensler, 2013, p. 5)

Several new trends related to changes in worker populations and business focus emerged at the beginning of the 21st-century resulting in a new set of challenges for organizations. The mobile worker population expanded due to advancements in technology, and employees could work anywhere and everywhere and still get their jobs done (Alberts & Papp, 1997; Davis et al., 2011; Haworth, n.d.a; Heerwagen et al., 2012; O'Neil, 2009; Ouye, 2011). Changes in the population demographics brought four generations into the workplace, and organizations were challenged to manage four unique sets of values and expectations in the workplace (O'Neil, 2009; O'Neill, 2010).

Technology advancements expanded business opportunities around the world and catered to a work culture that was ‘always on.’ Workers could hold virtual meetings with employees in attendance from all over the world and time zones (Blum, 2006; Heerwagen et al., 2012; O’Neil, 2009). Inspired by Taylor’s *Scientific Principles of Management Knowledge*, Drucker (1959) termed the concept ‘knowledge economy,’ and this subsequently became associated with the information age and development of artificial intelligent. The knowledge worker was a catalyst for organizations to look for new ways of working (collaboration, concentration, and connection) and new workspaces to work in (Augustin & Brand, n.d.; Davenport, 2005; Drucker, 1959; O’Neil, 2009; Ouye, 2011).

The growing awareness of the effect of industrial practices on the earth and depletion of natural resources resulted in new areas of concern for the environment (Fuller, 1963; Heinberg, 2010; Mollison, 2012). Beyond the responsibilities related to the care of the people, organizations were now challenged with the care of the earth and responded with a new set of sustainable ethics in their business practices (Nahikian, n.d.; O’Neil, 2009). In a study by MIT Sloan Management Review and the Boston Consulting Group, two-thirds of the 2,800 corporate leaders studied viewed sustainable programs as vital to marketplace competition, 30% of which felt that the goals transfer directly to their bottom line (Gale, 2012). Forward thinking organizations committed “to act ethically, support its employees, and respect the environment to be viable in this new era” (Gensler, 2008, p. 23).

To establish a comprehensive approach to business success, John Elkington, identified the 'people, planet, profit' and 'triple bottom line' (TBL) to address a broader scale of costs and responsibilities as the economy, society, and the environment (Elkington, 1997). Kang and Guerin (2009) noted a similar approach in the following:

> The environmentalists and ecologists emphasize sustainable interactions with natural systems. Economists tend to emphasize the economic standard of living and sustainable economic development. Sociologists and anthropologists give greater emphasis to social and cultural factors and quality of life issues. (p. 171)

Corporate strategies adopting sustainable initiatives add to the value of their brand and corporate citizenship for the good of the people, planet, and their profitability. For example, increased employee "productivity represents an annual payback of around $3 per square-foot, while the energy efficiency gains that are typical of green buildings today generate about a sixth of that, around 50 cents per square-foot" (Reid, 2008, p. 31). To achieve these savings, organizations have to consider numerous interrelated factors associated with the IEQ in workplace environments (e.g., acoustics, ergonomics, indoor climate, lighting conditions, space planning, technology, etc.) along with concern for improve productivity and profitability (Steelcase, n.d.f).

The beginning of the 21st-century reflected several changes in the way work was done, who was doing the work, and where the work was being conducted (Bonda &

Sosnowchik, 2007; Davis et al., 2011; Heerwagen et al., 2012; O'Neil, 2009; Ouye, 2011). The trends most significant to this study include the increased concern for the employee experience and the environment (sustainable design initiatives). A discussion of employees' experience (e.g., employees' satisfaction, overall environment satisfaction, and job satisfaction), the context of workplace in research studies, the role of interior designers in creating sustainable design workplaces and sustainable design guidelines are presented next. Specific attention is directed at the B3 guidelines and the 11 IEQ variables investigated in this research.

Employees' Satisfaction, Job Satisfaction, and Environment Satisfaction

Employees represent the largest expenditure in an organization, followed by costs associated with real estate functions (Brill, Margulis, & Konar, 1984; Cohen, 2007; Guerin et al., 2012; Harter, Schmidt, & Keyer, 2002; McCoy, 2005; Veale, 1989). In addition to hard costs, employees comprise the intellectual capital of the organization – and as such, represent an intangible asset, a resource of knowledge, creativity, and invention that leaves the premises at the end of the day (Voss, 2010). Therefore, attracting and retaining the best talent has been a major focus for organizations and considered essential to business success (Gensler, 2006). The following section discusses employees' overall environmental and job satisfaction as a way to attract and retain employees; an explanation of employees' satisfaction is presented as well.

Employees' Satisfaction

Post-occupancy evaluations (POE) typically discuss survey results in terms of employees' or occupants' satisfaction, workplace satisfaction, job satisfaction, overall environment satisfaction, and / or overall building satisfaction - all of which leads to confusion for the reader. In a study of occupants' satisfaction in workplace settings, Frontczak et al., (2012) noted several inconsistencies in how satisfaction was used in the scope of 10 different studies (Astolfi & Pellerey, 2008; Bluyssen, Pries, & van Dommelen, 2011; Cao, Ouyang, Zhu, Huang, Hu, & Deng, 2012; Choi, Aziz, & Loftness, 2009; Humphreys, 2005; Lai, Mui, Wong, & Law 2009; Marans & Yan, 1989; Schakib-Ekbatan, Wagner, & Lussac, 2010; Veitch et al., 2007; Wong, Mui, & Hui, 2008). Frontczak et al. (2012) concluded that occupants' satisfaction was most frequently associated with "satisfaction/comfort with indoor environmental quality or satisfaction/comfort with the workspace" (p. 119).

In a POE study of Leadership in Energy & Environmental Design (LEED) and green buildings examining IEQ criteria in the workplace environment, Lee and Guerin (2009) define satisfaction as 'a user's evaluative response to expectations for each IEQ criterion' (p. 294). In a separate study, employees' satisfaction was associated with workers' expectations and influenced by individual experiences that evolve over time (Matzler & Renzl, 2007; Oliver, 1997).

Kano (1984) makes a distinction that satisfaction has core attributes, secondary attributes, and bonus attributes that relate to overall satisfaction. Huang and Sarigöllü, (2008) identified core attributes or proportional factors as those that directly influence overall satisfaction. Secondary attributes or basic factors are considered essential to the satisfaction experience; they do not necessarily determine overall satisfaction but will contribute to overall dissatisfaction. Bonus attributes or factors are those that add unexpected value and that lend themselves to maintaining existing levels of satisfaction (Huang & Sarigöllü, 2008; Kano, 1984). *Figure* 16 depicts the relationship between the basic factors, proportional factors, and bonus factors and illustrates the high and low values of performance and satisfaction.

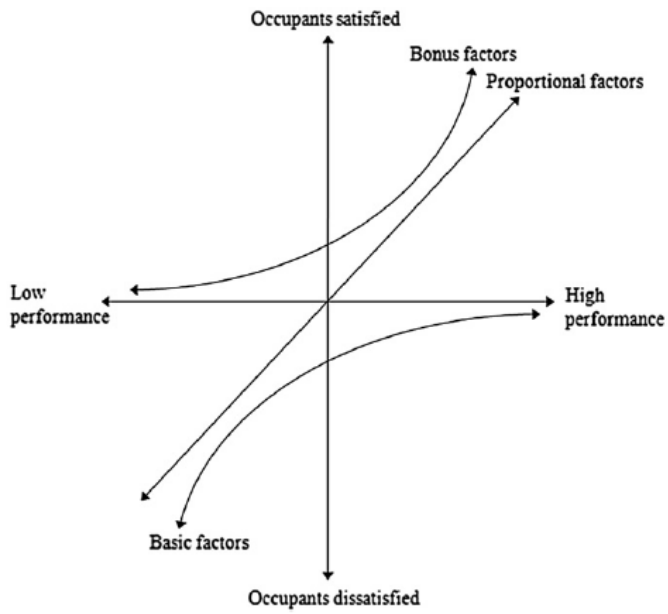


Figure 16. Kano's Satisfaction Model (1984) (cited in Kim & de Dear, 2012)

Attributes or factors related to occupants' satisfaction in the workplace environment are presented in the following example. A work surface, chair, and a small amount of space are considered to be an essential component or expectation (secondary attributes or basic factor) to meet essential work activities in an office environment. Workers expect minimal accommodations and do not perceive the work surface, chair, and small space as 'given' and do not lead to satisfaction. If the work surface, chair, and space were not available, the absence of these items would more likely lead to dissatisfaction. If the chair was rigid, inflexible, and led to back pain; the work surface was dirty, marred, and hard to reach; and the occupant was located next to a mechanical room with a constant hum – these conditions could lead to dissatisfaction with the workplace (core attribute or proportional factor). If the chair had mechanisms to optimize ergonomics; the work surface was clean, appropriately sized, and adjustable; and the worker was seated in a room with a view of a natural landscape, these conditions could go beyond expected levels necessary for a satisfying experience (bonus factors).

Overall Environment Satisfaction

To understand the relationship between individual IEQ criteria and occupant satisfaction with the overall workplace, Kim and de Dear (2012) applied Kano's Satisfaction Model to the Center for the Built Environment's (CBE) occupant survey database and examined symmetrical and asymmetrical relationships between 15 individual IEQ criteria and overall workplace satisfaction. The results identified two categories as ‘basic’ and ‘proportional.’ The IEQ factors yielding a predominantly negative impact on occupants’ overall satisfaction were considered ‘basic’ [e.g., temperature, noise, space, visual privacy, adjustability in furnishings, finishes (colors and textures), and workplace cleanliness]. The basic factors demonstrated a nonlinear relationship with overall satisfaction. The ‘proportional’ IEQ factors included air quality, amount of light, visual comfort, building cleanliness, and building maintenance and demonstrated a predominantly linear relationship with overall satisfaction (Kim & de Dear, 2012).

The results demonstrated that overall occupants’ satisfaction does not ‘correspond uniformly to improvements of individual IEQ factors,’ suggesting a wider range of explanations or situational factors that account for overall satisfaction with the building (Kim & de Dear, 2012, p. 33). Similar results were demonstrated by Spreckelmeyer (1993) who “found that unsatisfactory ratings of a specific design feature have a great impact on the overall rating of the environment, although the same feature is less important for the overall assessment, when rated satisfactory” (cited in Schwede, Davies, & Purdey, 2008, p. 275).

Job Satisfaction

Newsham et al. (2009) developed a conceptual model of the relationship between individual IEQ criteria, overall environment satisfaction, job satisfaction, and well-being. The POE study linked employees' overall satisfaction with their workstations and job satisfaction along with other mediating variables related to the organizational culture and compensation. With some variation in research scope, focus, and mediating variables, the link between overall environment satisfaction and job satisfaction was also demonstrated in studies by; Kamarulzaman, Saleh, Hashim, and Hashim (2011); Veitch et al., (2007); and Wells (2000). *Figure* 17 depicts the role of the physical conditions contributing to environmental satisfaction and job satisfaction along with other contributing factors to such as stress, physical symptoms, and organization factors (compensation, management).

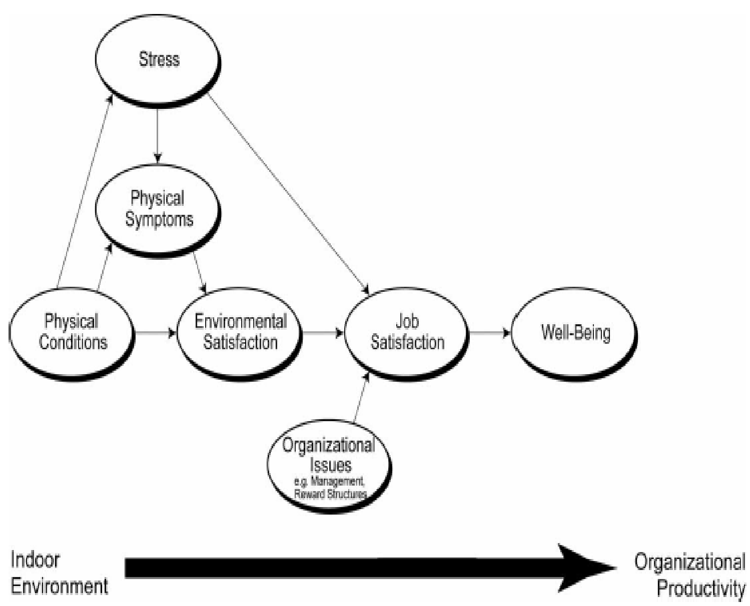


Figure 17. Conceptual model of linkages between indoor environment and outcomes important to organizational productivity (Newsham et al., 2009)

Job satisfaction refers to a “pleasurable or positive emotional state, resulting from the appraisal of one’s experiences” (Locke, 1976, p. 1300, cited in Danielsson & Bodin, 2008). Broadly speaking, job satisfaction is a reflection of employees’ attitudes, personality traits, and the perception of the job itself (Saari & Judge, 2004). As a part of employees’ work experience, researchers linked higher levels of satisfaction with the work environment to job satisfaction (Lee & Guerin, 2009; Kamarulzaman et al., 2011; Newsham et al., 2009; Veitch et al., 2007).

To date, there has been a plethora of research examining occupants’ satisfaction and the physical environment (Matzler & Renzl, 2007). The results of these studies vary based on the research focus, population, building of interest, IEQ criteria of interest, and more. Regardless, there is growing evidence that demonstrates employees’ satisfaction with selected IEQ criteria at the level of the workstation, the overall environment, and work (job) satisfaction. These studies contribute to the body of knowledge surrounding employees’ satisfaction with the built environment and suggest areas for improvement in sustainable environments.

Workplaces and Workspaces

In addition to different references to employees’ satisfaction, Frontczak et al., (2012) noted that there is a lack of clarity around the terms used in describing specific areas of office environments that are referred to in research studies. In some studies, the term ‘workstation’ is used to identify the primary workspace. In other studies, satisfaction with the office environment includes “not only the workstation area but also corridors and common areas like meeting rooms, copying rooms, and restrooms” (Frontczak et al., 2012, p. 128). Sundstrom and Sundstrom (1986) define the physical work environment (PWE) as ‘the interior architectural surroundings of an entire organization, encompassing appearance; arrangement of spaces (work areas, meeting areas, circulation, social spaces, and other support and service spaces); furniture, furnishings, equipment, and accessories; and conditions associated with (light, sound, temperature, air)’ (cited in Vithayathawornwong, Danko, & Tolbert, 2003, p. 6). This study refers to employees’ satisfaction with the overall office with specific attention to the overall facility (site, building, and interior) [F (SBI)], the primary workspace (PWSp), and the alternative workspace (AWSp) and IEQ conditions associated with the PWSp and the AWSp.

Environmentally Responsible Interior Design

L. Jones (2008) defines sustainable design in the workplace as a macro perspective that focuses on the “protection of the health and welfare of global ecosystems” whereas green design is a micro perspective focusing on “the health and welfare of people in the built environment” (p. 3). Environmentally responsible interior design (ERID) is an approach that combines both of these goals to support life for all generations now and in the future (L. Jones, 2008).

ERID is practiced by interior designers that “plan, specify, and execute interior environments that reflect their concerns for the user’s quality of life and the world’s ecology” (L. Jones, 2008, p. 86). For example, interior designers embody these concerns by specifying furnishings made from renewable resources, contain low volatile organic compounds (VOC), are derived from regional resources, and give credence to how packaging materials are recycled following the installation as well as the end-of-life recycling contributions.

Sustainable Workplace Environments

Buildings are responsible for the consumption of at least 40% of electric energy across the world (Nahikian, 2012) and 25% of the global greenhouse gas emissions (Levin, 2008). Developing an organizational purpose to support sustainable work practices has become just ‘smart’ business in today’s global community (Nahikian, 2012; O’Neil, 2009). Organizations stepped up to meet this challenge with at least 90% of the Fortune 500 companies adopting a triple bottom line (concern for the economy, society, and environment) into their own organizational goals (Steelcase, n.d.f).

The Role of the Interior Designer, Workplace Design and Sustainable Practices

Interior design is a multi-faceted profession in which creative and technical solutions are applied within a structure to achieve a built interior

> environment. These solutions are functional, enhance the quality of life and culture of the occupants, and are aesthetically attractive. Designs are created in response to and coordinated with the building shell and acknowledge the physical location and social context of the project. Designs must adhere to code and regulatory requirements and encourage the principles of environmental sustainability. (National Council for Interior Design Qualifications, n.d.)

Interior designers play a major role in the planning and specification of IEQ conditions, e.g., furnishings, materials, finishes, and the spatial layout of workplace environments. During the 1970s, concern for energy consumption, ecological systems, and building design led to a new concept in design referred to in popular press as 'eco-design.' Buildings were large consumers of energy and material resources, making them easy targets for eco-criticism and opportunities for more energy-efficient design solutions. Interior design educators advocated that interior practitioners needed "to re-examine their design philosophies, and as a profession, be recognized for supporting an energy ethic in their design practices" (Ellison, 1978, p. 36). With appropriate education and training, interior designers were charged with the responsibility as leaders to promote healthy environments and support the ecological balance of the earth (Ellison, 1978).

Today, interior designers are expected to understand and apply design strategies that address natural and electrical lighting systems (luminaires and light sources), acoustic design (speech privacy and sound distribution), thermal and indoor air mechanical systems, and more (Council for Interior Design Accreditation, 2014). Kang and Guerin (2009) suggest that interior designers have the ability to “minimize the negative impacts and maximize the positive impacts on environment, economic, and social systems over the life cycle of the interior components of a building” (p. 171). The importance of this responsibility is noted in the following goal statement for designers working with emerging trends in workplace environments.

> Buildings also have what might be called a “performative” purpose. In addition to fulfilling a practical function …buildings are also expected to accomplish a result or goal, such as encouraging innovation, promoting healing, creating community, enhancing socialization, or providing a unique interactive experience. In addition, there are higher standards for the things buildings must NOT do, such as waste water and energy, contaminate the air, or prohibit access to persons with disabilities. It is no longer enough for buildings to be and to mean; today’s buildings must matter. (Berens, 2013)

To meet ongoing developments in sustainable design practices, interior design professionals obtain additional training by completing continuing education units (CEU’s). They attend seminars, workshops, and other types of classes offered through professional organizations such as International Interior Design Association (IIDA), American Society of Interior Designers (ASID), Interior Designers of Canada (IDC), the Interior Design Educators Council (IDEC), and the United States Green Building Council (USGBC). Accreditation as a LEED professional provides interior designers with an additional opportunity to complement their knowledge about sustainable design initiatives affecting interior environments.

Interior designers share the responsibility for sustainable design practices with other project stakeholders, e.g., architects, building officials, property managers, building owners, manufacturers, contractors, and installers. Interdisciplinary project teams are assembled with individuals having the ability to execute decisions appropriate for the selected design strategies, oversee testing conditions for evaluation, and document regulatory compliance as required by design sustainable guidelines (USGBC, n.d.).

In summary, the workplace environment that employees experience is one that interior designers have essential responsibility for in the specification of furnishings, finishes and materials, and the overall organization of the space. Therefore, knowledge of IEQ criteria and their relationship to occupant satisfaction, productivity, safety, and well-being are essential to the practice of good design.

Sustainable Design Guidelines

The development of sustainable guidelines was a game changer for manufacturers, architects, interior designers, general contractors, and building managers alike. Several related, but uniquely positioned, sustainable design strategies emerged throughout the world to provide a common system to guide, monitor, and examine the design of building projects. Similar to the triple bottom line, design guidelines were developed to reflect economic, environmental, and social concerns. Building environments needed to be created and constructed that were durable and flexible, conserving of resources; and conducive to human health and productivity (Minnesota Pollution Control Agency. (n.d.). Design guidelines are commonly associated with rating systems comprised of both required and selected strategies and associated with credits or points. Performance objectives, strategies, and goals are identified early in the process and evaluated against measurable outcomes. The General Services Administration (GSA) elaborates on rating systems as:

> …tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings. For a rating system to add value to the sustainable design and/or operation of a building, it must offer a credible, consistent basis for comparison, evaluate relevant technical aspects of sustainable design, and not be over-burdensome to implement and communicate. (Fowler & Rauch, p.1)

The B3 Guidelines – Goals and Real Outcomes

Minnesota was tasked to develop regionally-specific sustainable design guidelines that were compatible with LEED guidelines and reflected state objectives and regulations. The Building, Benchmarks, and Beyond – Minnesota Sustainability Building Guidelines (B3-MSBG) were enacted in 2000 at the direction of the Minnesota State Legislature (CSBR, n.d.a). The B3 Guidelines were established to provide prescriptive and performance criteria to guide the design and development of selected state-funded projects and to work in concert with local building guidelines and LEED sustainable guidelines (CSBR, n.d.b). The B3 Guidelines address building projects with several key areas in Performance Management Overview; Site & Water Overview; Energy & Atmosphere Overview; Indoor Environmental Quality Overview, and Materials & Waste Overview (B3 Guidelines, n.d.b).

The guidelines were developed by the Center of Sustainable Building Research (CSBR) at the University of Minnesota and referred to as Minnesota Sustainable Design Version 1.1. In 2006, the guidelines advanced to Version 2.1 and Version 2.2 in 2014. The B3-MSBG guidelines charged with the responsibility "to reduce energy; enhance health, well-being, and productivity of the building occupants; and improve the quality of the natural environment" (CSBR, n.d.b). Building projects receiving funds appropriated through Minnesota legislative action and meeting size and scope of work criteria are required to comply with the B3 guidelines. Projects are enrolled in the B3 tracking program and follow an established set of protocols beginning with the agency planning phase stage through the correction period. Completed projects are tracked and evaluated against the initial design goals projected, e.g., resource consumption (water, energy, and carbon footprint) and actual building performance metrics.

One of the key requirements of the guidelines is to demonstrate real outcomes related to project lifecycle costs; human impact; related costs (health and well-being, productivity, absenteeism, employee turnover, and health care costs); environmental impacts; and community impacts and associated cost. To meet the state legislated objectives, a multi-discipline team of researchers with the Center of Sustainable Building Research (CSBR) developed a post-occupancy evaluation consistent with the initiatives associated with the B3 guidelines (B3 Guidelines, n.d.c).

The Sustainable Post Occupancy Survey (SPOES) Version 1.1 was developed as an online, web-based survey instrument and tested for validity and reliability. SPOES Version 2.2 was advanced in 2014 to meet corresponding changes in the B3 guidelines. The survey collects feedback on employees' satisfaction perceptions of their work performance and health associated with the F (SBI) and the PWSp, satisfaction with IEQ conditions with the PWSp, levels of physical activity, and commuting practices.

Buildings in the B3 project tracking system that meet specific survey criteria (e.g., number of occupants, size, building type, etc.) are required to participate in the survey at 9 and 18months post-occupancy. The SPOES team works with onsite survey coordinators to forward the survey link to employees. Results are summarized in research reports and published on the B3 case study website, along with other building performance metrics (B3, n.d.d).

The B3 Guidelines – SPOES and IEQ Criteria

As previously stated, the SPOES questionnaire first asks employees to rate their overall satisfaction with and perceptions of their health and work performance with the F (SBI) and their PWSp. Next, employees rate their overall satisfaction with 15 different IEQ criteria with their PWSp at the category and attribute level. Category level IEQ criteria examine overall conditions and in some cases, include attributes that have more distinct properties associated with a particular category. For example, thermal conditions is an overall category level with three distinct attributes: temperature (hot or cold), air velocity (drafty or stagnant), and humidity (dry or moist) (B3, n.d.e). Not all IEQ criteria are specifically defined by the B3 Guidelines or represented by performance requirements but are generally regarded to reflect important aspects related to IEQ conditions of workplace environments (e.g., aesthetics, function and privacy).

Some category level IEQ criteria have attributes and some do not. A few of the category level criteria have attributes that are also category level IEQ criteria. For example, the category level IEQ criteria for privacy include attributes of sound (acoustic conditions) and visual (view conditions). Each one of these attributes is also a category level IEQ criterion with their own unique attributes. Acoustic conditions have attributes that address employees' ability to hear desired sounds and to limit undesired sounds.

Electric lighting conditions and daylighting conditions (also associated with natural lighting) falls under the general category of overall lighting conditions as both of these IEQ criteria contribute to the overall illumination requirements for interior environments. Electric lighting and daylighting are also considered to be category level criteria, and each one has attribute properties associated with the amount light and the ability to adjust desired aspects of light.

Category Level IEQ Criteria Included in this Study

The following discussion reviews the definitions and standards associated with the IEQ criteria included in this study and employees' satisfaction as it relates to the overall F (SBI), PWSp, and the AWSp. The eleven category level IEQ criteria included in this study are: acoustic conditions (ACC), appearance (aesthetics) (APP), daylighting (DAY), electric lighting (ELE), function (FUN), furnishings (FUR), indoor air quality (IAQ), privacy (PRI), thermal conditions (THE), vibration and movement (VIB), and view conditions (VIE).

The literature review represents case studies, experimental designs, POE studies, and literature surveys focused on specific areas of interest. It is important to note a few considerations that impact conclusions obtained in the research. In particular, POE studies often asked employees to respond to several conditions in the workplace environment or several aspects around isolated variables of interest. Fransson, Vastfjall, and Skoog (2007) point out that the evaluation processes typically involve subjective and objective responses and that different results are obtained through different methods and approaches. In a study of three variables of interest, Huang, Zhu, Ouyang, and Cao, (2012), noted that “physical environmental parameters are all interrelated, and the feeling of comfort is a composite state involving an occupant’s sensations of all these factors” (p. 305). Frontzcal and Wargocki (2011) found that other factors, e.g., “characteristics of building occupants, building-related factors, and outdoor climate including seasonal changes” contribute to evaluation of human comfort of the workplace environment (p. 922).

Finally not all research included in this review differentiates between the physical environment of the F (SBI) and the physical environment of the PWSp. Very little attention has been directed at the physical environment supporting IEQ conditions in AWSp. Given this, the discussion will review research associated with both the F (SBI) and the PWSp together and research regarding AWSp separately.

IEQ Criterion – Acoustic Conditions

Definitions and Standards Related to Acoustic Conditions (ACC))

The B3 guidelines address acoustic conditions under section 1.7 Effective Acoustics. The intention of the guideline is to provide:

> …a positive soundscape acceptable to occupants and appropriate to their tasks. The benefits are avoiding exposure to: unhealthy noise levels, the

> elevated stress which accompanies higher background noise levels and noise distraction impacts on mental work. Effective acoustics allow for effective speech communications at normal speaking voice and still accommodates local speech privacy. (B3, n.d.f)

Specific requirements for compliance and reference materials are directed at preventing reoccurring internal and external sources of noise from over 70 decibels (dBA); exceeding a noise curve (NC) over 50 dBA in continuously occupied interior spaces; exceeding a noise curve (NC) over 45 dBA in classroom spaces; achieving reverberation rates no greater than 0.2 sec and .08 sec based on a 500 Hz octave (excluding concert halls and similar environments). Recommended performance criteria identify an articulation index no greater than 0.20 for open offices "where a low level of speech intelligibility is required' and 'greater than 0.70 for enclosed offices where a high level of speech intelligibility is required" (B3, n.d.f). A variety of reference and web resources are provided by B3 to design teams involved with the acoustic design of office spaces and other special conditions.

The term 'acoustics' refers to "a science that deals with the production, control, transmission, reception, and effects of sound" (Acoustics, def.1, n.d.). Sound itself is a vibration or wavelike energy that is audible in the ranges of 20 to 20,000 hertz (Hz) and travels through gases, liquids, and solids. Sound is perceptible through the skin audibly and as vibrations (Leeds, 2001). Three general measurements contribute to the effect of sound on humans: “Sound Pressure Level (SPL), Event Exposure Level (Lex), and Multiple-Event Sound Equivalent Level (Leq), all of which define decibel” (Kryter, 1985, as cited in Navai & Veitch 2003, p. 5).

Acoustic conditions can produce pleasant and desirable sounds (satisfactory conditions) or unpleasant and undesirable sounds (unsatisfactory conditions). Poor acoustics is often associated with unwanted noise and speech privacy issues in commercial office settings and can serve as a source of annoyance and stress for workers. Acoustic satisfaction has been defined as “a state of contentment with acoustic conditions; it is inclusive of annoyance, loudness, and distraction - all concepts used by one or another researcher in this area to assess subjective experiences associated with the acoustic environment in offices” (Navai & Veitch, 2003, p. 2).

Distractions, noise, and lack of audible privacy in open-office settings are frequent topics for theoretical explanations and workplace research. The growth in the diversity of workstyles and knowledge worker population has fueled this concern primarily because of the conflicting requirements needed to support both collaboration and concentration activities in the same area (Roper & Juneja, 2008). Distracting sounds arising from unexpected stimuli will remove attention away from the work being performed, resulting in additional stress on workers, which may affect their productivity (Mawson, n.d.a). Workers vary on distraction trigger factors, coping ability, capacity to concentrate, and the time it takes to re-engage focus. Researchers have found that workers take upwards of 15 minutes to regain a level of concentration for full effectiveness, and with each successive interruption, productivity is diminished (DeMarco & Lister, 1999). Over the course of a day, continuous distractions spread across various team members in an organization, generates a loss in overall productivity and potential revenues (Mawson, n.d.a).

The Sustainable Post Occupancy Evaluation Survey Version 2 + Alternative Workspace Module (SPOES V2 + AWSp Module) includes a category level question that asks employees to rate their satisfaction on the overall acoustic quality in their PWSp. Two attribute level questions ask employees to rate their ability to hear desired sounds in their PWSp and their ability to limit desired sounds in their PWSp. While the two attribute level questions are outside of the scope of this study, they are typically referred to in research regarding to acoustic conditions in workplace environments.

Employees' Satisfaction with Acoustic Conditions in the F (SBI) and PWSp

Several research studies point to problems with acoustic conditions in open office environments (Abbaszadeh et al., 2006; Lee & Guerin, 2009; Jensen et al., 2005; Wargocki et al., 2012). In a study using CBE survey data, 142 buildings and over 23,000 occupants, acoustic problems were found to be a function of both noise and speech privacy (Jensen et al., 2005). Results from this study indicated that occupants were more dissatisfied with aspects of speech privacy in comparison to noise levels; occupants residing in private offices were more satisfied with the acoustic conditions than individuals working from workstations. Dissatisfaction triggers associated with open office environments include ‘overhearing private conversations’ and ‘talking within the surrounding office,’ both of which have been found to interfere with workers’ ability to get their work done (Jensen et al., 2005; Sundstrom et al., 1994).

CBE researchers comparing non-sustainable buildings to those developed using LEED sustainable guidelines noted that both types of building environments contributed to occupants’ dissatisfaction with acoustic conditions (Abbaszadeh et al., 2006). The survey results indicated “a grouping of LEED rated green buildings in the bottom of the percentile rank charts” raising questions as to why deliberate efforts made to accommodate improved acoustic conditions resulted in dissatisfaction with the office environment (Abbaszadeh et al., 2006, p. 368). Researchers concluded that higher levels of dissatisfaction in open office environments had to do with lower partitions on cubicles, thus allowing sound to travel more freely throughout the space (Abbaszadeh et al., 2006). Although lower panels (maximum height of 42”) are recommended to allow seated occupants perimeter gazing, they also allow sound to travel more freely throughout the open office environment (USGBC, 2006).

Lee and Guerin (2009) also found similar levels of dissatisfaction with acoustic conditions. Results of a study on a LEED certified buildings with 3,769 workers indicated "acoustic quality showed the lowest satisfaction percentage (34%) and the highest dissatisfaction percentage (48%)" (p. 294). Sundstrom, Herbert, and Brown (1982) suggest that the inclusion of "masking sound systems, carpeting, and sound-absorbing materials may not create enough privacy for people in managerial jobs" (p. 391).

Although several of the studies have suggested problems with the acoustic conditions in workplace environments, a study referencing ten years of CBE survey data, 351 office buildings, and over 52,000 workers, found occupants were satisfied with their overall workspace environment and IEQ components related to noise level in workspace (Frontczak et al., 2012).

Employees' Satisfaction with Acoustic Conditions in the AWSp

Studies involving AWSp and acoustic conditions are limited. Those that do exist address the topic through related studies of social interaction with others, desired levels of privacy, or location of spaces producing higher levels of noise in areas adjacent to PWSp where focus work is interrupted.

Brager et al., (2000) surveyed 238 workers in the knowledge worker profession to assess social interaction and the physical environment. Respondents "rated acoustic privacy as more important than visual privacy" in team spaces and expressed more dissatisfaction with acoustic conditions than visual privacy conditions (Brager et al., 2000, p. 11). Acoustic privacy concerns were expressed over the proximity of private offices to team spaces. Several respondents complained about the noise and lack of privacy as they “can hear conversations next door” and “noise distractions from people in team spaces” (Brager et al., 2000, p. 23). Interestingly, the goal to accommodate social interaction conflicted with the need to manage private conversations and unwanted noise.

In another study focusing on organizational support and collaborative space layout, workers expressed similar concerns regarding acoustic distractions from shared amenity spaces or alternative work areas (kitchens, copy centers, mail rooms) located near the vicinity of primary assigned work environments (Hua, Loftness, Heerwagen, & Powell , 2011). These findings are similar to cases studies that examined speech privacy issues in commercial office environments (Salter, Powell, Begault, & Alvarado, 2003). The research focused on several sizes of meeting rooms adjacent to private offices that shared the same method of construction. The researchers (Salter et al., 2003) noted that improvements to meeting rooms adjacent to private office space could have been treated to ‘minimizing sound leaks’ and ‘cross talk’ between conference rooms and adjacent spaces (p. 22). They recommended that appropriate design specifications (including sound absorbing wall treatments and upgraded ceilings), be made at the onset of a project to minimize the reverberation and build-up of sound within the rooms (Salter et al., 2003).

IEQ Criterion – Appearance (Aesthetic) Conditions

Definitions and Standards Related to Appearance (Aesthetic) Conditions (APP)

The B3 Guidelines do not include any requirements or recommendations for the category level criterion, IEQ Appearance (Aesthetics). However, the B3 guidelines support the specification of building-related products that contribute to the appearance of an interior setting. The B3 guidelines that impact sustainable goals and therefore the 'appearance' of the building and interior environment include M.1 Life Cycle Assessment of Building Assemblies, M.2 Environmentally Preferable Materials, and I.2 Specify Low-emitting Materials such as furnishings and finishes (B3 Guidelines, n.d.g; B3 Guidelines, n.d.h; B3 Guidelines, n.d.i). These guidelines relate more specifically to the IEQ criterion on furnishing conditions and will be discussed more fully in that section.

The term 'appearance' or 'aesthetics' is a multi-faceted phenomenon and has several different meanings and interpretations. For some, it can be vague and ambiguous. The following discussion addresses design considerations often associated with the overall appearance (aesthetics) of environments arising out of design goals, material specification, style, cleanliness, and ambiance.

Design programs identify goals related to the context, function, form, spatial, and aesthetic qualities of the building and interior environment. Sustainable design guidelines serve this process by first addressing site considerations, building orientation, and structural materials and integrating these goals into an over-arching design concept. Lee (2011) makes note of this process and the impact on building aesthetics in the following:

> …structural, material and spatial qualities… an aesthetic is supposed to emerge from, as well as be embodied in, the order that ties them together as an indivisible whole. Therefore, in short, if a building or an environment is designed and built to be sustainable, it should inform how it was conceived and situated, and what makes it be so under what kind of conditions. And in the presence of such a work, it should be perceivable and/or understandable that it serves and fits such purpose. (p. 11)

Interiors that are designed and developed referencing sustainable guidelines frequently address materials, products, and furnishings associated with rapidly-renewable resources, regional materials, and recycle content. Bamboo is a rapidly renewable wood product that is commonly specified for wall, floor, and cabinetry applications in sustainably designed environments. Materials obtained from regional areas (e.g., limestone from a local quarry) contribute to vernacular images associated with the appearance of building interiors and exteriors. Repurposed products divert discarded products from the waste stream and lend themselves to novel and unique applications in sustainably designed environments. For example, large wood doors have been repurposed as conference tables, barn siding has been repurposed as a wood wall paneling material, and bottle glass has been recycled and incorporated into countertop materials. All of these products come together to create an ‘aesthetic’ or appearance associated with sustainably designed interior environments.

Interior design education often associates the visual image or appearance (aesthetics) of an interior environment with the design elements and principles. Design elements provide the basic components on an interior environment e.g., line, shape, form (volume/mass), color / value, light, texture (visual/pattern and tactile), space, and time. Design principles provide the techniques on how design elements are used or applied to the interior project, e.g., balance (formal, informal, radial, crystallographic); contrast; emphasis; proportion (size); and harmony/unity/variety; and repetition (rhythm, movement). Not all authors and educators agree on the terminology related to the design elements and principles, but there is general agreement that the design elements and principles are useful in the production and evaluation of good design.

The appearance of an interior environment is also associated with features that reflect the prevailing material culture, social norms, capital resources, historical time periods, styles and trends, building type, function, and/or the organizational brand or image. Appearance relates to the state or condition of a building (e.g., old or new, dirty or clean) and a general ambiance of the workplace environment (e.g., warm or cold, open or crowded, dull or vibrant, sophisticated or silly).

Appearance (aesthetic) conditions also involve subjective responses or individual ‘taste’ and other considerations associated with place attachment, meaning, symbolism, status, etc. In a study of office interiors, appearance (aesthetics) was evaluated along with symbolism and instrumentality (function). The researchers found that they “could not unravel relationships among the three dimensions,” suggesting a complex relationship in the assessment of appearance (aesthetics) (Vilnai-Yavetz, Rafaeli, & Yaacov- Schneider, 2005, p. 547). Kayode, Ojo, and Sheba (2008) refer to design and the aesthetics of the built environment as “a human territory that is physically transformed and seasoned with modern amenities and good living conditions” (p. 288).

As previously discussed, appearance is not represented in the B3 guidelines under any required or recommended performance criteria. None-the-less, appearance (aesthetics) creates a lasting visual impression of the building experience, and therefore it is included as an IEQ criterion in the evaluation of built environments. The SPOES V2 + AWSp Module asks employees to rate their satisfaction on the overall appearance (aesthetics) of their primary workspace.

Employees’ Satisfaction with Appearance (Aesthetic) Conditions: F (SBI) and PWSp

Research on conditions associated with appearance (aesthetics) in workplace environments has several different areas of focus. For example, Miller, Erickson, and Yust (2001) conducted a study on the physical workplace environment, employee job satisfaction, and motivation with a focus on the role of objects in creating a sense-of-place. The researchers developed a sense-of-place index for the workplace consisting of "physical comfort, feelings of comfort, control of noise and privacy, control of selection and arrangement of work area furnishings, level of noise present in work area, perception of privacy, presence of work related objects, and presence of personal objects" (pp. 41). The results indicated a significant correlation between the sense-of-place index and employee motivation (r=.170 p=<.OS) and job satisfaction (r=.219 p=c.05). Further, "the ability to select one's office furnishings and to arrange them as desired showed a significant relationship to motivation and job satisfaction" (Siler, 2009, p. 42)

In a study by Siler (2009) on the importance of aesthetics in workplace environments, 21 employees were interviewed and responded to questions in response to what they 'liked most about their office' and what they 'liked least about their office.' The interview sessions were transcribed and categorized based on the following terms: aesthetics (ambiance, comfort, and style), symbolic (identity), instrumental (function, fit), emotional (personalization), and overall (fit to purpose and environment). The data identified four overall factors characterizing employees' workplace environment as: 'positive' (an avenue of self-expression or an extension of themselves; 'negative' (coping behaviors and disappointment based on lack of function or fit); 'distressful' (not representative of the quality of their organization), and 'indifferent' (the building reflected the organization and its setting). In a concluding remark, the author noted that 'beauty' associated with office environments "allows people to express their identities at work, and allows them to integrate their personal and professional lives. Its absence leads to emotional distress and attempts to diminish its importance compared to other aspects like functionality" (Siler, 2009, p.77).

Satisfaction with Appearance (Aesthetic) Conditions: AWSp

Studies involving AWSp and conditions associated with appearances are limited. Those that do exist address the topic through related studies of satisfaction with AWSp (e.g., the overall openness of the spaces in relationship to the overall workplace environment). In a POE relocation study, Shepley, Zimmerman, Boggess, and Lee (2009) examined employees' satisfaction with their new workplace environment (PWSp and AWSp) using the concept of openness (view of space, density, and accessibility to others), community (social integration and recognition of others), and flexibility (multipurpose attributes and relocation adjustability). The survey, administered one year following relocation, was distributed to 174 staff members and received a 40% response rate, with a total of 70 employees responding. The open-ended results indicated that employees' satisfaction was most significant with AWSp associated with the living room (38 comments), the kitchen (35 comments), and corner space (9 comments) and least satisfied with team spaces (8 comments) and workstations (6 comments). In addition, employees indicated higher levels of satisfaction associated with the openness of their new environment as it facilitated the ability to communicate with other employees more easily.

IEQ Criterion – Daylighting Conditions

Definitions and Standards Related to Daylighting Conditions (DAY)

The B3 guidelines address this category level criterion under the section 1.9 Daylight. This guideline was developed with the intent to utilize daylight as a source of ambient illumination known to provide physiological and psychological benefits to building occupants. Further, the B3 identifies important qualities of daylighting through "its inherent variation, power spectrum (color), and the predominantly horizontal component of its illumination vector (direction of illumination)" (B3 Guidelines, n.d.j).

Daylight is a term frequently used synonymously with natural light and sunlight. In the sustainable building community – it represents a free source of illumination that can be used to offset electric lighting energy consumption. Therefore, sustainable design guidelines reference daylight as a source of natural light that contributes to the overall illumination requirements of interior spaces. Daylighting conditions are typically facilitated through windows that are often associated with the category level IEQ criteria, View Conditions. Sustainable design guidelines are directed at maximizing potential sources of natural light and view conditions for the well-being of office workers while limiting negative effects (glare, excess light, and passive solar heat gain).

Performance criteria for new buildings require that at least 75% of the area meet minimum lighting requirements at the floor level and at 30" above the floor; to meet uniform lighting ratios for at least 10:1 in continuously occupied daylit spaces; and to provide lighting controls that direct solar penetration away from work surfaces. Further, electric lighting controls should be automatic and allow lights to be adjusted to accommodate contributions from daylighting sources. Window to Floor Area Ratio's (WFAR) should not exceed 25% to minimize excess energy use (used to balance heating and cooling cycles) and to prevent excess glare. The B3 guidelines provide an online form that allows data to generate probable lighting levels in a given area of the interior space.

The SPOES V2 + AWSp Module addresses daylighting – along with electric lighting –first as an attribute of the overall lighting IEQ category. Both lighting sources (daylighting and electric lighting) contribute to overall illumination goals for interior environments and are also considered as a category level IEQ criterion with their own attributes (e.g., amount and adjustability).

Daylight is an electromagnetic radiation source that exhibits a full color spectrum. It is associated with a color rendering index (CRI) near 100 (high noon on a clear, sunny day), which varies throughout the day, season, and climatic conditions in the sky. To this end, people and interior colors viewed in daylight are thought to be more true and representative than those viewed in electric light sources (Boyce, Hunter, & Howlett, 2003).

As a system, lighting design strategies are developed to capture desired daylight, reduce dependence on energy consuming electric lighting systems, minimize solar heat gain, and control excess light resulting in glare hitting the work surface. Effective daylighting approaches involve the strategic placement of window openings, skylights, and other light harvesting mechanisms. The guidelines do not provide any additional information on window sizes, configuration, orientation, or quantity beyond the previously stated requirements to harvest daylighting conditions; however, they do provide guidelines to capture view, which is discussed separately under the section on IEQ View Conditions.

Effective daylighting approaches also involve a well-designed control system (manual and automatic) to regulate the amount of available daylight or electric light based on the climatic, building requirements, and occupant preferences (Lighting Research Center, n.d.a). There are many types of lighting control options available, for example, occupancy sensors, photosensors, automatic (computer programmed), and manual or occupant controlled (Lighting Research Center, n.d.b). Lighting controls also encompasses shading devices to provide occupants with the opportunity to shield or direct unwanted light, e.g., window blinds, louvers, or shades.

Daylighting calculations and modeling strategies are used to approximate design intentions. Daylighting – along with electric lighting contribution, is typically studied and refined through complex computer modeling programs and or calculations to approximate the amount of light falling throughout the interior space based on the time of day, seasonal variations, location (latitude and longitude), and more.

Daylight is conveyed into interior spaces through a variety of mechanisms, e.g., glass curtain walls, window openings, clerestory openings, skylights, light tubes, etc. Besides daylight, the windows or openings also provide views to the external environment that provide occupants with temporal information on the time of the day (e.g., morning, afternoon, night) and climatic conditions (e.g., sunny, cloudy, rainy, snowy, etc.). Daylight entering into the interior environment also leaves patterns (sun patches) reflecting the location of the sun that move throughout the interior environment based on the time of day. Therefore, it is possible to have a generally well-balanced luminous environment in one period of the day and glare (excess brightness) in another period of the day.

Employees' Satisfaction with Daylighting Conditions: F (SBI) and PWSp

Employees' satisfaction with the daylighting conditions is often studied in association with lighting quality (the psychological and physiological responses related to exposure to daylighting conditions), window openings, views, and controls. It is important to note that although Electric Lighting Conditions and View Conditions are separate IEQ category level criteria discussed separately, several studies reported here examine daylight, electric light, window openings, and views together. For example, in a literature review of over 60 studies on daylighting preferences in the workplace, overall, employees indicated that "working by daylighting results in less stress and discomfort than working by electric light" (Galasiu & Veitch, 2006). Further, in a study reported by Cuttle (1983) of 471 office workers, 99% felt that offices should have windows and 86% of the workers consider daylighting as a preferred source of lighting (Galasiu & Veitch, 2006). In a POE study of a university building designed with sustainable guidelines in place, occupants indicated high levels of satisfaction with daylighting conditions but also expressed concerns with the integration of artificial (electric) lighting and control of those systems (Hau, Oswald, &Yang, 2011).

Boyce (1998) defined lighting quality as one that eliminates distractions, "provides appropriate conditions for the context, and also adds an aesthetic element that lifts the spirit" (cited in Heerwagen, 2000, p. 361). In a study on daylighting and workspace locations, employees indicated a preference for workspaces 'near a window to experience the psychological and physiological benefits associated with daylight (Heerwagen & Orians 1986, p. 361). Daylight, as an electromagnetic stimulant to the human visual system, has been found to facilitate visual task performance due to its enhanced color rendering qualities associated with the spectrum distribution (Boyce, et al., 2003). The visual spectrum of daylight produces a high-output of short-wavelengths that impacts the melatonin uptake and circadian rhythms in the human body (Brainard, 2002; Leslie, 2003; Rea, Figueiro, & Bullough, 2002). Through a complex set of interactions of the visual system, Hanifin and Brainard (2007) note “that the biological sensitivity for different wavelengths of light is quite different from the visual sensitivity” (p. 462).

There is a long history of researchers who have examined window size, placement, and proximity in the office environment with various findings in preferences and behaviors (Butler & Biner, 1989; Butler & Steuerwald, 1991; Cetegen, Veitch, & Newsham, 2008; Farley & Veitch, 2001; Wang & Boubekri, 2010; Yildirim, Akalin-Baskaya, & Celebi, 2007). Butler and Steuerwald, (1991) conducted a study on window size preferences in a scale model. Research subjects were asked to rate window size preferences in a small and medium size office space. The results indicated that window preferences were affected by room size and yet the preferred window size was not a constant proportion of wall size. Further, smaller windows were preferred for computer work, and larger windows were preferred when beautiful scenery was available.

Boubekri, Hull, and Boyer (1991) examined employees’ satisfaction with window size and sunlight penetration in a standard size, private office space. Occupants were asked to rate their satisfaction and indicate their affective mood. Results indicated that window size did not significantly affect occupant satisfaction, but sunlight patterns falling on the floor (sun patches) produced feelings of relaxation when sitting adjacent to the window. The researchers noted that the benefits associated with daylight also implied potential problems with excess light, solar heat gain resulting in the need for window (shading) controls.

A few studies have examined daylight, window location, sun patches with preferences in seating location, seasonal variation, and office type (private, shared or open). In an experimental, multi-method study by Wang and Boubekri (2010), researchers assessed satisfaction, mood, and seating preferences based on 10 locations exposed to shifting sun patches and overall luminous qualities under simulated task performance. Results of the research led to the development of an optimal zone in seating location for different room configurations (private, shared and open), noting conditions related to view (external and door entrance), and seasonal variation on luminous qualities. The optimal seating location preference was identified near the window (sideways) to capture view but away from locations where direct glare minimized task performance. In a separate article, from this same study, the authors further articulate the disturbance of sun patches on the overall luminous quality of an interior space and the unknown environmental factors (changes in sun patch location) and behavior / performance responses. Additional considerations were given to view of the exterior, view of door entrance, and ability to control access to view with privacy as a mediating consideration (Wang & Boubekri, 2010).

Employees' Satisfaction with Daylighting Lighting Conditions: AWSp

None of the preceding studies addressed the IEQ Daylighting Conditions criterion and employees' satisfaction with AWSp (conference rooms, meeting rooms, or any type of shared workspace). In a somewhat related study of windows in different types of spaces (classrooms, dormitories, residential homes, etc.), different sizes (small, medium and large), with different degrees of transparency, and 18 factors (access to views, privacy, sunlight, etc.), 150 students rated these according to their preference. The results of this study indicated that room function mediated size of window, and that factors influencing selection of window size for each space indicated that access to sunlight and view of outside were the top two factors. The researchers concluded that preference for windows is not consistent with all types of spaces and that more research is needed to determine window type, style, and opacity is needed for windows incorporated into each space type (Butler & Biner, 1989).

IEQ Criterion – Electric Lighting Conditions

Definitions and Standards Related to Electric Lighting Conditions (ELE)

The B3 Guidelines address electric lighting conditions in section 1.6 Quality Lighting, with the "intent to supplement and support the use of daylight as a primary source of light for visual tasks" (B3 Guidelines, n.d.k). The B3 goal is to specify products and conditions that will simulate qualities associated with daylighting, e.g., spectral distribution, natural color, satisfying visual illuminance, and ability to adjust for glare conditions. To a lesser extent, the B3 Guidelines address electric lighting and plug loads (task lighting) under Energy and Atmosphere 1.1 with the goal of identifying energy paths to drive efficiencies through the systems and fixtures specified.

Building performance requirements seek to integrate electrical lighting systems that are responsive to daylight conditions with automatic or manual operable control systems. The system needs to respond to services needed in different spaces, e.g., media projection areas from general work areas with controls that are easily operated.

In addition to the required building performance criteria, the B3 guidelines provide recommended performance criteria for general illumination requirements (35-50 foot-candles), contrast ratios (no greater than 10:1 between view and task levels), and CRI levels. The Illuminating Engineering Society of North America (IESNA) provides recommendations for illumination requirements and CRI levels for space and activity types.

The B3 recommends different methods, processes, and resources to support the design process. The first is to conduct a point-by-point analysis of the horizontal illumination of the work surface in each light mode and space. The second method suggests a computer program be used to identify performance characteristics for the proposed lighting system in each primary space. Analysis of light falling on vertical plans in task or work areas is important to the success of this method. Several references are available to guide and the design and specification of lighting systems such as the *IESNA Lighting Handbook, Ninth Edition*, specification and cut sheets available from source and luminaire manufacturers, and modeling programs used to illustrate overall lighting goals.

The SPOES V2 + AWSp Module asks employees to rate their satisfaction first as an attribute of overall lighting conditions, next as an overall electric lighting condition, followed by attributes associated with amount of electric lighting and adjustability of electric lighting. Daylighting is also considered an attribute of overall lighting conditions as both lighting sources contribute to overall lighting conditions in an interior environment.

The driving force behind the development of sustainable design guidelines was, in part, due to the recognition of the detrimental effects on the environments' carbon footprint and the rising cost of energy. In the early 1990s, lighting was found to be associated with 20-25% of the annual consumption of the overall electricity consumed in the United States (Energy Resource Center, 1995). Further, 30% to 40% of energy consumed in the United States contributed to one-quarter of the total carbon emissions (Augenbroe, Pearce, Guy, & Kibert, 1998).

Lighting design is guided by goals originating out of science, art (aesthetics), technology, and economics (energy consumption). At their basic level, the design guidelines reflect local building codes, standards, minimum requirements for illumination, and/or energy conservation goals where applicable. Lighting design also is guided by illumination requirements related to the tasks being performed, conditions related to the user (aging eye conditions), physical attributes of the space (e.g., ceiling height, finishes, textures), and desired ambiance or mood.

Design strategies address lighting goals through several layers of the interior environment. The general ambient lighting layer provides minimum requirements for wayfinding and overall illumination of the interior space. The task lighting layer puts the light at the level and location where needed (e.g., an adjustable luminaire used to illuminate the work surface).The architectural or accent layer is associated with built-in, form-enhancing effects (grazing or sculpting), or feature-enhancing effects (art objects). Finally, the decorative lighting layer showcases the expressive aesthetic qualities of the luminaires (e.g., sparkle, accent, artistic, or novel characteristics). Different lighting effects are achieved when light is pushed upward (indirect), downward (direct), or any combination in the distribution approaches. Further, different types of lens (e.g., louvers, prisms, shields, etc.) are used to modify and direct the light into the volume of space or toward a surface area. The IEQ criteria that are impacted most significantly by layers are appearance (aesthetics) and function, and to a lesser extent, acoustic conditions (ballast noises) and thermal conditions (excess heat build-up).

Effective lighting design involves the specification of luminaires (e.g., recessed, pendant, track, flush mount lighting fixtures), sources (e.g., fluorescent, metal halide, incandescent, mercury, light-emitting diode (LED) (lamps or bulbs), and switching and controls (e.g., manual, automatic, photo-sensors, occupancy sensors, etc.). Of these, the quality of light emitted is affected mostly by the light source (lamp or bulb) and its color properties, e.g., the CRI, the Kelvin temperature, the correlated color temperature (CCT), and or gamut area index (GAI). Lighting sources falling into the warm color range are associated with incandescent lights and fall in the 3000K range, and cool colors are associated with fluorescent light and fall in the 4100K range. Daylight or natural light fall in the 5000K range and has a CRI of 100 under a clear sky at high noon (Winchip, 2005). The light source or lamp specified has a large impact on the color rending of material objects, finishes, and people. As previously stated, the B3 recommend light sources with CRI levels on a space-by-space breakdown. IESNA also provides recommendations for lighting levels stated as a footcandle (fc) (the amount of light falling on a surface) based on space type and tasks performed (Benya, 2003; Winchip, 2005).

Advancements in lighting technology, luminaires, lamps, controls, and switching mechanisms continue to flood the market place with new opportunities to conserve energy and capture daylight. Benya (2003) confers that lighting design decisions often involve selections based on overall costs, which “tend to favor less efficient, less appealing, and higher maintenance solutions; life cycle cost analysis tends to favor energy efficient, low maintenance solutions, and that human needs tend to favor more expensive, more appealing solutions"(p. 19). Today, overall lighting design strategies need to balance human needs while considering the impact of economic and energy costs associated with sophisticated control systems, building materials and fixtures, passive solar heat gain that impacts heating and cooling cycles against the cost of new lighting design technologies that deliver improved, cost efficient lighting solutions

Employees' Satisfaction with Electric Lighting Condition: F (SBI) and PWSp

Lighting research gathers important feedback from employees' perceptions of satisfaction, preference, performance, and health under varying lighting conditions. Satisfaction with lighting conditions leads to satisfaction with other IEQ criteria (e.g., appearance, daylighting), along with employees' satisfaction and workplace satisfaction. For example, in an experimental study involving 118 subjects, Veitch, Stokkermans, and Newsham (2013), investigated lighting conditions (employees' appraisal of lighting and room appearance) and workplace satisfaction. Results indicated that employees with favorable appraisals of the lighting conditions led to favorable appraisals of the interior space and favorable prediction regarding workplace satisfaction.

Veitch and Newsham (2000) note the difficulty involved in establishing research of employees and their satisfaction with luminous conditions in workspace environments involving individual variability in preferences, inconsistencies in luminous conditions, changes in worker expectations over time, and differences in measurement and reporting approaches by researchers. Lighting research methods utilize experimental conditions, mock-up simulations, opinion polls, examining physical measurements, computer modelling, POE survey methods, and more. As noted with daylighting conditions, examination of electrical lighting conditions often occurs with other related variables of interest (e.g., lighting quality, comfort, visual quality, control, adjustability, glare, daylighting, and more). *Figure* 18 illustrates the complexities of how the volume of interior space can be divided into horizontal bands or zones to determine luminous qualities affecting each area (Loe, Mansfield, & Rowlands, 1994). The circles designate an "angular subtense 20° (C20) and 40° (C40) and horizontal band widths of 20° (B20) and 40° (B40)" in the conference room space (p. 121). Taken together, these aspects represent the most central point of view in this interior space and provide an opportunity to analyze specific layers, features of interest and work areas.

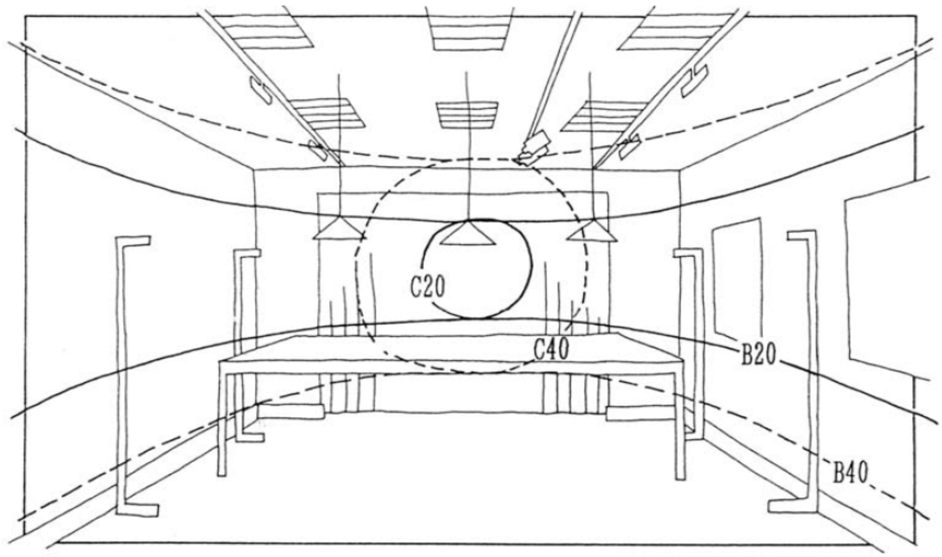


Figure 18. Identifying attributes of luminous qualities in office spaces: areas of investigation (Loe et al., 1994, p. 123)

Building projects developed around code and economic considerations are often designed to accommodate minimum lighting levels. Under these conditions, lighting quality and actual task performance can be compromised (Leslie, 2003). Furthermore, although building codes set minimum performance standards, researchers have found that measurements of site conditions fail to meet sustainable design guidelines. On one hand, it is possible to satisfy minimum industry standards and on another, fail to meet more qualitative goals associated with sustainable design practices (Freihoeffer, Guerin, Martin, Kim & Kulman Brigham, 2013). Discrepancies between design intentions and actual conditions, human responses to poor lighting conditions (e.g., eye fatigue, glare, distractions due to low-frequency lamp flickers, or poor posture to accommodate areas light distribution patterns), and problematic visual conditions (e.g., poor color renditions, excessive brightness) provide an ongoing source of interest in achieving qualitative lighting solutions in workplace environments.

Over time, lighting quality has been hard to define and measure. Veitch and Newsham (1996) conducted a literature review on lighting conditions in workplace environments and found little to no agreement on what constituted the attributes of lighting quality. They proposed a behavioral-based definition to evaluate how well the luminous environment supported people in the following modes 1) visual performance; 2) task performance; 3) social interaction and communication; 4) mood, e.g., satisfaction and performance; 5) health and safety; and 6) aesthetic judgments. Using this approach, specific luminance conditions (illumination, luminance, luminance distribution, uniformity, glare control, flicker rate, and spectral power distribution) could be examined against each behavioral response (Veitch & Newsham, 1996). Lighting conditions in the work environment are better served by focusing on the desired qualities of the luminous environment as opposed to the falling back to the minimum conditions that are associated with economics, codes, and energy-driven objectives.

Early studies examined lighting quality using the CSP index (Comfort, Satisfaction, and Performance) to measure effective lighting installation in workspace environments (Bear & Bell, 1992). Comfort was associated with attributes of brightness, size, location of light source, and contrast with background. Satisfaction was associated with the appearance of people, objects, the spatial volume, and brightness. The performance aspects related to the spectral quality and the flux density distributed over the work task area. To confirm the use of the CSP index as an evaluation tool, a survey was administered to 471 workers in 26 offices, who were asked to evaluate lighting conditions (e.g., glare, brightness, color, uniformity, etc.) using a semantic differential scale using terms as ‘good,’ ‘bad,’ ‘adequate,’ or ‘poor.’ The final CSP index provided a systematic method to develop initial benchmarks defining satisfaction at an 80% level when the index of evaluated attributes reached a score of at least 35. CSP index scores above 65 were indicative of 95% satisfaction with lighting quality in the workplace environment.

Lee and Guerin (2010) defined lighting quality as that which could be measured by an ‘occupants’ environmental satisfaction with the amount of light and the visual comfort of the lighting and job performance affected by lighting quality in their personal workspace’ (p. 1106). In a study of involving 15 LEED certified buildings, 3,550 subjects, and five different types of PWSp, lighting quality was found to be the highest for enclosed shared offices, followed by bullpen workspaces, enclosed private offices, cubicles with low partitions, and lastly, cubicles with high partitions. Performance with lighting quality was the highest in bullpen workspaces, while the lowest score was associated with cubicles with high partitions. The authors concluded that lowering partition heights or using more transparent materials near the top of partitions over five feet in height could lead to improvements in the overall lighting quality in the workspace.

Illuminance levels play an important role in visual comfort, task performance, and ambiance contributing to employees' satisfaction with electric lighting conditions. Boyce et al. (2006) conducted two field experimental studies to examine interconnected 'linked mechanisms' between different luminaires (combinations of direct lighting and indirect lighting effects), non-task surface finishes (different reflectance and colors), and control options (dimming or switching) on worker behavior. Wyon (1996) defined the concept of 'linked mechanism' as variables of interest that are thought to have a causal relationship. *Figure* 19 illustrates the linked mechanism map used to look at aspects of personal control, luminous conditions, and non-task surface brightness and demonstrates the complexity associated with conditions contributing to lighting satisfaction.

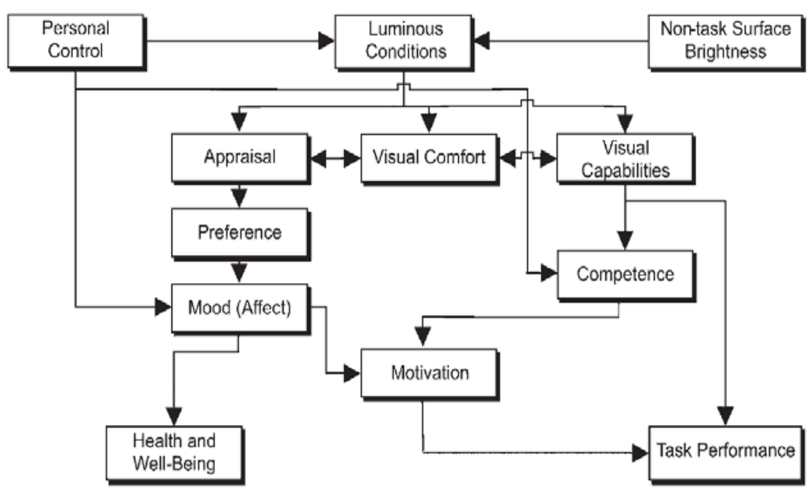


Figure 19. Linked mechanisms map hypothesized to link luminous conditions with health, well-being, and performance (Boyce et al., 2006, p.192)

The research team subsequently identified several linked mechanisms useful to their experiment, e.g., “luminous conditions that cause visual discomfort or distraction will, over time, affect visual capability and the appraisal of the conditions” and “visual comfort has an indirect effect on mood and, through mood, an effect on feelings of health and well-being although it could also be considered a form of well-being” (Boyce et al. 2006, p. 192). Results of the study revealed greater levels of participant comfort with direct/indirect luminance systems over direct luminance systems. There were no central determinants defining lighting quality; however the study determined that task performance was affected by task visibility, practice, and fatigue over time. Individuals were able to adjust lighting levels to fit a visual task, and thus accommodate their own visual comfort or minimize unnecessary lighting based on room brightness or occupancy.

Oi (2002) associates lighting quality and visual comfort with the physiological and psychological condition of the visual system (e.g., visual stress, fatigue, concentration, or mood); the visibility for object discrimination, task performance, safety, and security; and the meaning of the environment (e.g. conditions supporting meaning, survival, well-being, and uplifting). Oi (2002) further links light quality with the meaning of the environment by examining the lighting conditions and the features of the surroundings, such as their shapes, spatial arrangements, and other attributes. In this approach, the researcher supports the unique lighting conditions associated with the meaning, identity of specialized spaces in the office environment.

Lee and Guerin (2010) found employees in enclosed and shared offices used wall switches to control their personal lighting needs while individuals in cubicles and bullpen workspaces used task lighting most frequently. In a POE survey of lighting conditions in a workspace environment, results indicated closed or private office environments yielded higher levels of employees' satisfaction with adjustability of lighting controls over employees located in workstations in open office environments (Freihoeffer, 2012). Freihoeffer noted that "occupants in closed workspaces had more controllability over their lighting/illumination sources, particularly their ceiling lighting" and "occupants in open workspaces only used ceiling lighting for illumination, lighting that they could not control (adjust illumination levels or turn on/off)" (pp. 173-174). Both closed or private office environments and workstations in open areas provided alternative options for lighting (task, undercabinet, and /or floor lighting), however, only individuals in closed PWSp were able to control overhead (ambient or general) lighting. In another workplace study investigating lighting controls and employee performance, Ihle (2010) found that only 42% of the employees indicated they could control the light at their workstations and expressed a need for greater amounts of lighting on the desk, in particular, undercabinet lighting.

Lighting controls allow employees to lower their workspace luminance levels as well, thereby minimizing energy and costly expenditures (Moore, Carter, & Slater, 2002). Boyce et al. (2006) found that individually controllable lighting conditions were rated as more comfortable by a larger percentage of people than conventional fixed conditions. Although the research points to several advantages with lighting controls, it is important to note that not all studies identify the type of control and the layer of light that is affected by the control mechanism. For example, control switches for ambient lighting in large open office spaces are generally located at the area entrance/exit and are typically ganged together effecting large areas of workspaces. Individuals attempting to control light in their workspace would affect other workspaces within that ambient light range. Individuals located in private offices or closed workspaces have much greater control over that space and thereby can control ambient light (general illumination) without affecting the luminous environment of employees in other spaces.

Employees' Satisfaction with Electric Lighting Conditions: AWSp

None of the preceding studies addressed the IEQ Electric Lighting Conditions criterion and employees' satisfaction with AWSp (conference rooms, meeting rooms, or any type of shared workspace). There is some agreement in the research that considers specialized spaces, e.g., conference rooms, break rooms, and lounges, to involve slightly different goals than those associated with the overall F (SBI) and PWSp (Escuyer & Fontoynont, 2001). This may be due to unique program goals (e.g., lighting to support presentations in conference rooms); breakrooms (e.g., lighting to support food preparation); lounge spaces (e.g., lighting to support behaviors involving rest or relaxation); and reception lounges and atrium spaces (e.g., lighting highlight architectural features).

IEQ Criterion – Function Conditions

Definitions and Standards Related to Function (FUN)

The B3 Guidelines do not include any requirements or recommendations for the IEQ category level criterion function. Regardless, how an interior environment functions, with all of its accouterments (space, furnishings, objects, equipment, finishes, colors, textures, or other materiality), has several implications for employees' satisfaction. The SPOES V2 + AWSp Module simply asks employees to rate their satisfaction with the overall function of their primary workspace. On a fundamental level, function could be related to how well something works, in principal, in comparison to how it was designed to work or how it functions for the individual employee. However, this provincial approach does not consider the role of appearance (aesthetic), instrumentality, symbolism, architectural features, functional features, affordances, serviceability, or adjustability (control) that impacts the PWSp. The following discussion provides a background to illustrate some of the ambiguity with employees' satisfaction related to conditions supporting the IEQ function criterion.

Function refers to "the action for which a person or thing is specially fitted or used or for which a thing exists" (Function, Def. 2, n.d.). As a fundamental design objective, students are introduced early in their educational process to an infamous quote from Louis Sullivan's writing that 'form follows function'- a reduction of the original reference to "form ever follows function, and this is the law" (Sullivan, 1896, p. 408). For some designers (architects, industrialists, and interior designers), ornamentation and beauty are unnecessary excess. To others, ornamentation and beauty were adopted as a function of the form. Kayode, Ojo, and Sheba (2008) articulate the need for integrity in the built environment in the following,

> …values of concern for prudence, morality and sincerity in the application of materials for design forms and functions, believing that in a created environment, physical features that were produced and modified by man to serve his needs should be governed by 'social conscience.' This basic concept is still relevant to contemporary design. It is imperative for the artist/designer, artisan, architect, and planner to consider the matter of integrity in each of its separate applications: to materials, form, function, and ornamentation. (p. 283)

In a literature review of employees' perceptions and the physical aspects of their office environments, Vilnai-Yavetz, et al. (2005) found that offices embodied characteristics related to instrumentality, aesthetics, and symbolism. For example, the office environment supports many functions; instrumentality facilitates task performance; proper aesthetics provide an appealing space to work in, and symbolism suggests status and employees roles within the organization. Further, Vilnai-Yavetz, et al. (2005) suggest that each characteristic is regarded separately.

Marans and Spreckelmeyer (1982) developed similar conclusions on a POE study of employees' perceptions of their workplaces where workers considered the ambience of their workplace "as having both aesthetic components and functional components" suggesting linkages exist in the minds of occupants between aesthetic and non-aesthetic components (p. 652).

Using a Q methodological approach (Siler, 2009; Van Exel & Graaf, 2005), interviewed 21 individuals about the physical aspects of their workplace. Van Exel and Graaf (2005) identify Q methodology as a systematic study of subjectivity, whereas respondents (referred to as a P-set) "asked to rank-order the statements from their individual point of view, according to some preference, judgment, or feeling about them" (referred to as Q-set) (p. 1).

Statements reflecting the employees' subjective preferences, points of view, and feelings about their workplace aesthetic were collected and sorted by instrumentality, aesthetics, and symbolism. Siler (2009) indicated that although "the model was extremely helpful in organizing the study; the results do not fall so neatly into these categories" (p. 68). She found that employees' statements could be assigned to two or more categories and determining which category was primary was related to the overall context of the discussion. Marans and Spreckelmeyer (1982) developed similar conclusions on a POE study of employees' perceptions of their workplaces where workers considered the ambience of their workplace “as having both aesthetic components and functional components” suggesting linkages exist in the minds of occupants between aesthetic and non-aesthetic components (p. 652).

The concept of function has also been associated with the organization of interior space or design of the PWSp. Danielsson and Bodin (2009) conducted a workplace study to determine employees’ satisfaction based on office type. The study identified seven different office types based on their architectural and functional features as follows: cell-office, shared-room office, small open-plan office, medium open-plan office, large open-plan office, flex-office, and combi-office. Architectural features included spatial layout, and functional features were related to the types of activities or types of work performed. The authors concluded that the “office environment is complex, and each unique office type contains not one single environmental factor but several different factors that interact and influence the individual” (p. 244). *Figure* 20 illustrates office types based on architectural and functional features moving from open office spaces with workstation (upper left and right) to enclosed offices (lower left and right) depicted as private office spaces.

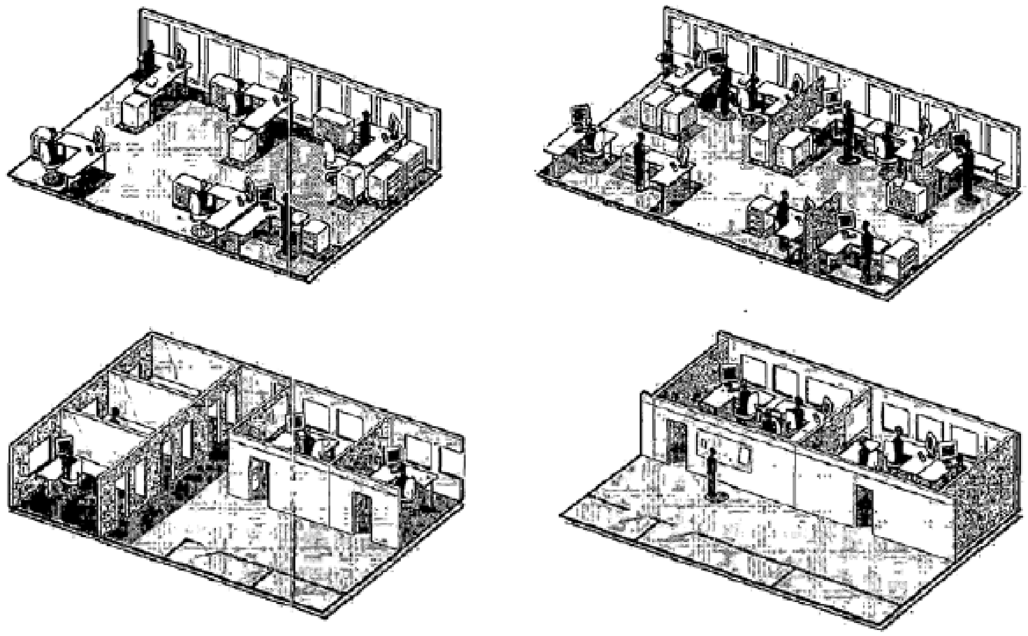


Figure 20. Office type based on architectural and functional features (Danielsson & Bodin, 2009, p. 244)

Function has also been tied to features related to the design of objects, furnishings, and spaces. Using the Affordance-Based Design (ABD) methodology developed by Maier and Fadel (2009), Kim, Lim, and Park (2009) proposed a design evaluation framework that suggests that structural elements inform users on how an object, tool, or space can be used. Functional Affordance Features (FAF) reveal physical properties of an object or space; Ergonomics Affordance Features (EAF) relate to the physical usability of an object or space; and Information Affordance Features (IAF) display properties to inform users on how an object or space is to be used. The FAF/EAF/IAF framework provides designers with an opportunity to deconstruct an object or space in such a manner that all implicit and latent functions or potential uses can be identified. Affordance Theory serves as the theoretical framework for this research and will be discussed in greater detail at the end of this chapter.

As a primary workspace, the question of function also relates to serviceability. For example, how well does it serve as a resource to facilitate an employee's work responsibilities? Is it in working order? Does it provide flexibility to accommodate a range of work positions? Does it work for collaboration, concentration, and connection activities if needed? Is the space configured efficiently, or are there impediments that employees need to work around? These are just a few examples that relate to the function conditions of the PWSp.

Employees' Satisfaction with Function Conditions: F (SBI) and PWSp

Given the wide range of terms and concepts associated with function, there is little research that supports employees' satisfaction with functional conditions in the PWSp only. Research that does exist focuses on aspects of the workspace design as a whole and does not differentiate the facility from the primary from the alternative. Danielsson and Bodin (2009) examined employees' satisfaction with different office types based on architectural (physical characteristics) and functional features (work activities). They found substantial differences in satisfaction levels between office types. Private cell-office provided the greatest amount of buffer for work activities involving concentration but lower satisfaction scores with connection activities, in particular, those supporting affinity with others. Open-plan offices had lower levels of satisfaction with work activities due to noise (acoustic conditions) and privacy. The researchers attributed these scores to the architectural and functional features associated with the office type. In a related study, Danielsson and Bodin (2008) examined employees' job satisfaction across the different office types. Result of this study indicated greater levels of job satisfaction with flex offices, cell offices, and shared offices and less levels of job satisfaction with combi offices, medium-size offices, and large open offices. Again, researchers associated job satisfaction levels with the architectural and functional features of the different office types.

Employees' Satisfaction with Function Conditions: AWSp

Research involving functional conditions in AWSp tends to focus on work spaces designed to accommodate a unique set of organizational objectives related to work activities. For example, workplace research by Knoll (2012) has identified specialized workspaces referred to as activity spaces (e.g., refuge, enclave, team meeting, assembly, community) and space catering to a specific function (e.g., privacy/focus, sanctuary/small group, strategy/project team, assembly/large group, and community/serendipitous interaction). Recommendations for design layout, furnishings, technology, size, and other amenities supporting each work function are provided.

A great deal of research interest in AWSp is attributed to the type of functional activities associated with collaboration and interaction with others. Fayard and Weeks (2007) conducted a two-year qualitative study in three offices looking at patterns of informal interaction occurring in the office environment. Informal interactions allow employees to share information about themselves and their work that does not take place in formal meetings or in their PWSp. The researchers utilized affordance theory to examine how the physical features of the designed environment (enclosure, size, spatial layout, location, etc.); human behaviors; and social relationships in copy rooms, kitchens, and water-cooler locations where employees gathered. From interviews and observations conducted weekly, the researchers contended that "settings such as photocopier rooms afford informal interaction to the extent that they bring people into contact with each other (propinquity), allow people to control the boundaries of their conversation (privacy), and provide legitimate rationalizations for people to stay and talk to each other (social designation)" (Fayard & Weeks, 2007, p. 625).

In another study of AWSp functional activities involving employees' interactions, Oseland, Marmot, Swaffer, and Ceneda (2011) conducted a two-year field study in eight different workplace environments with 12,700 participants using a multi-method approach consisting of observation, survey, interviews, site assessment, and more. The goal of the study was to identify environmental conditions that supported the interaction-to-innovation cycle associated with knowledge-workers. *Figure* 21 illustrates the interaction-to-innovation cycle and at what intersections functional activities move from a singular event to a shared event.

Figure 21. The Interaction-Innovation cycle, moving from singular to shared events (Oseland et al., 2011, p. 52)

As seen in the illustration, conditions for interaction include proximity, accessibility, privacy, legitimacy, and functionality. Conditions supporting function included the layout and style of the furniture, accessibility of equipment (such as audio-visual), appropriate environmental conditions (temperature control, air quality, light), and the availability services provided (catering, AV support, room set-up). Results of the study found that offices with greater numbers of meeting rooms also had more meetings; utilization of formal meeting spaces was 37% and informal meeting areas were at 21%; meeting rooms were frequently used for informal sharing; knowledge sharing was higher for teams that were co-located colleagues; spaces supporting team functions and social ties reported higher levels of satisfaction; and the office environment could benefit from having a balance of AWSp types (formal and informal).

In a related study on collaboration activities in the workplace, Heerwagen, Kampschroer, Powell, and Loftness (2004) conducted a literature review to identify how the physical environment influences behaviors. The authors provide several key findings. First, knowledge work is associated with both highly cognitive conditions and social activity, thus workers need to move efficiently between private zones and social interaction areas. Second, to encourage interaction, work teams should be located near each other to maintain high levels of visibility and remain connected by a strong central path. Third, locate informal collaboration spaces near teams and provide adequate levels of privacy, furnishings, and technology requirements.

IEQ Criterion – Furnishing Conditions

Definitions and Standards Related to Furnishing Conditions (FUR)

The B3 Guidelines do not include any requirements or recommendations for the category level criterion, IEQ Furnishing Conditions. Sustainable guidelines address furnishing conditions through related categories by examining material components, manufacturing processes, distribution pathways, life cycle assessment (LCA), durability, function, ergonomics, aesthetics, and end-of-life reclamation or recyclability.

The B3 Guidelines that affect office furnishings include the following: 1.2 Specify low-emitting materials (B3 Guidelines, n.d.j); M.1 Life Cycle Assessment of Materials (B3 Guidelines, n.d.g); M.2 Environmentally Preferable Materials (B3 Guidelines, n.d.h); and to a lesser extent, the M.3 Waste Reduction and Management (B3 Guidelines, n.d.1). The guidelines summarize the consumer impact of building materials and office furnishings used in the office setting in the following:

> The building industry consumes over three billion tons of raw materials annually—around 40 percent of the total material flow in the global economy—the need to reduce the effects of building material extraction, processing, delivery, use, and disposal has become imperative to improving the health of the economy and the environment. (B3 Guidelines, n.d.m)

There are several product categories, e.g., systems furniture (wall hung, free-standing panels); seating (task, guest, lounge, conference; case goods (desks, returns, bridges and credenzas); storage components (bookcases, files, wardrobes); and tables (conference, break out tables and occasional tables). Office furniture can be free-standing or built-in (assembled and attached to a constructed wall). The USGBC (2006) refers to systems furniture as "a panel-based system workstation comprised of modular interconnecting panels, hang-on components and drawer/filing components or a free-standing grouping of furniture items and their components have been designed to work in concert" (p. 326). Further, furniture components assembled in a millwork shop and installed onsite (e.g., laminate top or core top) are subjected to IEQ standards that address indoor air quality (IAQ) and low-emitting materials (comprised of composite wood and laminate adhesives).

To comply with sustainable goals, independent, non-government, and third-party organizations set standards to guide and direct manufacturing processes, appropriate use of natural resources, durability standards, and other end-of-life reclamation or recycling processes. More specifically, sustainable goals related to furnishings conditions focus on products reflecting low-emitting materials (to reduce indoor air quality related concerns), products developed for durability and long-term performance (life cycle costing), products developed from environmentally preferred materials (regionally available or rapidly renewable materials), and products that are shipped and boxed to reduce packing materials contributing to the waste stream.

The B3 Guidelines address off-gassing and other indoor air quality (IAQ) issues under the section 1.2 Specify Low-Emitting Materials. The intent of this guideline is to "reduce indoor chemical pollution in a building by choosing low-emitting materials and furnishings during construction, operation, and maintenance" (B3 Guidelines, n.d.j). Office furnishings have been previously associated with material emissions that impact IAQ. With few exceptions, furnishing specifications must comply with the IAQ portion of California Section 01350 standard. In addition, modular office furnishings (cubicles and workstations) must comply with the State of California's Modular Office Furniture Specification, supported by documentation from the furniture manufacture within one year of delivered project. Projects seeking LEED credit for low-emitting furniture must comply with Greenguard Indoor Air Quality Certification methods (a third party certification program) to ensure that manufacturing process adhere to strict chemical emission limits (USGBC, 2006).

In a related effort to determine appropriate VOC levels in office environments based on typical installation sites, the Business and Institutional Furniture Manufacturing Association (BIFMA), the GSA, and other stakeholders worked in concert with researchers to develop a standard size and volume of space for the PWSp. Carter and Zhang (2007) analyzed over 30 floor plans representing seven leading furniture manufacture's office furnishings to determine the average size and volume of private office space and a smaller workstation space, both occurring within systems furniture. The results were developed as 'worst case scenarios' to reflect occupant exposure conditions. The researchers concluded that "a standard open plan office environment for a single workstation system is defined as 5.94 m^2 (64 ft^2) floor area by 2.74 m (9 ft) high (576 ft3 or 16.3 m3)" and a "standard private office environment for a single workstation system is defined as 23.78 m^2 (256 ft^2) floor area by 2.74 m (9 ft) high (2304 ft^3 or 65.2 m^3)" (p. 466). Both PWSp conditions took into consideration the related spatial requirements associated with shared file areas, meeting areas, and egress aisles. *Figure*

22 shows a typical workspace layout that includes open plan workstations, private offices, egress paths, and shared spaces used to calculate the workspace sizes.

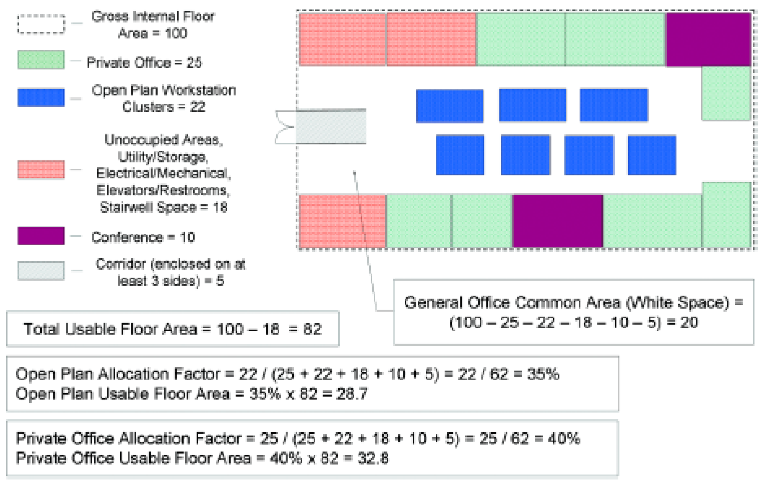


Figure 22. Typical office environments with PWSp, shared work areas, etc. (Carter & Zhang, p. 469)

The B3 addresses the durability and performance of furnishings under the M.1 Life Cycle Assessment of Building Assemblies section. The intent of this guideline is to set a “modest benchmark of performance and inform early building assembly material choices using life cycle assessment of alternatives” (B3 Guidelines, n.d.g). Specification of materials and furniture components are associated with global warming conditions, air and water contamination, and energy consumption. Required performance criteria include the development of a custom benchmark measure against the total global warming potential and conduct a life cycle analysis of assemblies that meets the custom benchmark. The guideline provides additional resources to confirm specifications using the Athena EcoCalculator, The Environment Impact Estimator, or the Building for Environment or the Economic Software (BEES).

The B3 guidelines address other aspects in furnishing components under the B3 section M.2. Environmentally Preferable Materials with the intent to "to encourage the use of materials and products that have specific properties intended to improve life cycle performance" (B3 Guidelines, n.d.h). The required performance criteria include the use of recycled, salvaged, or reused materials to meet a minimum level of 5% for reuse or salvaged and 10% of recycled materials. Specific percentages of furniture and components are measured by weight or value and also consider the pre-consumer and post-consumer recycle content.

Additional considerations include components produced using rapidly renewable or bio-based resources, and aspects of durability. For example, the Forest Stewardship Council (FSC®) promotes the use of renewable wood products through their forest management programs and certifies a 'chain-of-custody' exchange for their products that verifies the materials and processes meet environmental goals throughout the supply chain (Forest Stewardship Council, n.d.). In addition, the Association for Contract Textiles (ACT®) identifies fabrics used in furniture products that meet the Fact ™ eco-label standards related to fiber sourcing, material safety, manufactured processes and embodied energy, water conservation and recycling practices, life-cycle assessment (durability), and social accountability (Association for Contract Textiles, n.d.).

The B3 performance requirements include the use of local or indigenous materials obtained within 250 miles of the project site or manufactured in the State of Minnesota or from approved state-funded recycling programs. The final requirement is use of “materials that are reusable, recyclable or biodegradable at the end of their use in the project” (B3 Guidelines, n.d.h). Additional considerations are made to the breakdown and intended life recyclability of products specified.

Lastly, sustainable guidelines also address furniture packaging under the B3 Guideline, M.3 Waste Reduction and Management. The intent of this guideline is to “minimize use of resources and negative environmental impacts through careful reduction and management of wastes generated during the construction process and building occupancy” (B3 Guidelines, n.d.1). A substantial amount of the required performance criteria is directed at minimizing construction waste and diverting building operation materials from the waste stream. All packaging materials (construction and furnishings) are subject to a reuse or return of 50% of the materials (by weight) to the originating supplier or manufacturer plant. Packing materials that are made from recycled content are also encouraged.

The specification of office furniture also involves consideration of ergonomic fit, adjustability, personal control, operational consistencies, durability, life cycle costing, and aesthetics. These are important considerations for occupant comfort; however, they are currently not an IEQ category level criterion. The SPOES V2 + AWSp Module asks employs to rate their satisfaction with their overall furnishing of the PWSp.

Employees' Satisfaction with Furnishing Conditions: F (SBI) and PWSp

Guerin et al. (2012) conducted a POE case study with 238 workers in a new building developed according to LEED sustainability criteria and examined employees' satisfaction with selected IEQ criteria in the F (SBI) and the PWSp. Employees were generally satisfied with the overall F (SBI). Employees moving from private offices into workstations and those staying in workstations both expressed significantly less satisfaction with their furnishings, adjustability, and finishes than with the F (SBI). The researchers concluded "that workstations type is a major intervening factor that may affect employees' satisfaction" (p. 96).

In a CBE study involving over 52,000 occupants, researchers (Frontczak et al., 2012) reported that occupants with higher cubicle partitions had slightly higher levels of satisfaction with the furniture comfort than occupants with lower cubicles. Newsham (2009) examined occupants' satisfaction and found that occupants were satisfied with workstation furnishings and equipment and satisfied with the overall environment. This study also linked environmental satisfaction to job satisfaction (Newsham, et al., 2009).

Researchers (Kim & de Dear, 2012) examined linear and non-linear IEQ variables related to occupants' satisfaction to determine the impact of 15 IEQ criteria on occupants' overall satisfaction. Analysis of the data identified visual privacy, adjustability of furniture, and amount of space as Basic Factors (those that enhance overall satisfaction but lead to dissatisfaction when unfilled) and 'ease of interaction' and 'comfort of furniture' as a Proportional Factor (those having noticeable impact on satisfaction or dissatisfaction). The researchers concluded "the six IEQ factors impacting occupants' satisfaction were related to office layout and furnishing issues. Usually, thermal comfort, air quality, acoustic quality, and visual quality (lighting) are featured prominently in the IEQ research literature, but office layout or furnishing issues rarely rate a mention" (Kim & de Dear, 2012, p. 8).

Although research has indicated a primarily positive association with occupants' satisfaction with furnishings, there is a lack of robust discussion regarding the contribution of layout and furnishing to overall occupants' satisfaction (Kim & de Dear, 2012). This may in part be due to the inconsistent manner in which furnishings conditions are measured at the workstation or overall workspace, with few exceptions (Guerin et al., 2012). POE studies also lack any meaningful discussion on systems furniture specified with low-emitting materials and the impact on IAQ.

Employees' Satisfaction with Furnishing Conditions: AWSp

In the previous discussion of employees' satisfaction with furnishings and overall satisfaction, AWSp (conference rooms, meeting rooms, or any type of shared space) were not discussed in any of the research results. In a somewhat related area of interest, researchers are beginning to look at project teams and their furnishings.

In a study of teams and team environments and the AWSp used, Brager et al. (2000) looked at four features of the physical space that supported team activities: physical layout, furniture, writing surfaces, and equipment. Results assessed occupants' satisfaction and found that writing surfaces (white boards) were the 'most satisfying' whereas the lowest satisfaction was with equipment. Further, researchers concluded that difficulty in operating equipment due to lack of computers and phones contributed to occupants' dissatisfaction. Furniture and layout were not significant contributors to occupants' satisfaction.

IEQ Criterion - Indoor Air Quality Conditions

Definitions and Standards Related to Indoor Air Quality Conditions (IAQ)

The B3 guidelines address IAQ under section 1.2 Specifying Low-Emitting Materials, 1.1 Restrictive Environment Tobacco Smoke, and 1.4 Ventilation Design (B3 Guidelines, n.d.i; B3 Guidelines n.d.n; B3 Guidelines n.d.o). Conditions related to performance requirements for the specification of low-emitting materials were presented with the discussion on Definitions and Standards Related to Furnishing Conditions. Additional considerations address the installation of new materials, finishes, and products used in their installation (e.g., floorcovering, paints, acoustic ceilings, gypsum board, cabinetry, sealants, and furnishings). These materials need to be certified and or comply with the most current IAQ portion of California Section 01350 Standard (B3 Guidelines, n.d.i).

The B3 Guideline 1.2 Ventilation Design addresses IAQ conditions by reducing "indoor pollutants by eliminating environmental tobacco smoke (ETS) from occupied areas of the building" (B3 Guidelines, n.d.n). Required performance criteria focus on the role of the organization and the goal to establish no smoking policies within the entire building and separating exterior smoking areas away from the building entrance as a means of preventing external smoke from entering the building.

Both LEED (USGBC, 2006) and the B3 ventilation guidelines require compliance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.1-2004. More specifically, the intent behind B3 Guideline 1.4 Ventilation Design is to "promote good indoor air quality by requiring a ventilation baseline based on the general procedures and information contained in the latest approved version of ASHRAE Standard 62" (B3 Guidelines n.d.o). ASHRAE 62 requires buildings or projects to meet minimum ventilation rates for the satisfaction of 80% or more occupants exposed to building conditions and to minimize adverse health effects by careful management of known contaminants (ASHRAE, 2004a). Protocols for compliance begin with site evaluation and extend through the final phase of construction and installation.

Radon also serves as a potential source of contamination to air quality. Radon is a naturally occurring radioactive gas that is a by-product of decaying radium found in soils. As a heavy and inert gas, it enters building environments through small cracks in foundation level materials. *Figure* 23 shows how radon emerging from the soil enters the built environment and is distributed into the indoor air that occupants breathe. It is colorless, odorless and without any residual taste. Radon is regarded as a determent to healthy IAQ and contributing factor to lung cancer. The National Academy of Sciences considers radon to be a contributing cause in the lung cancer-related deaths of 15,000 to 22,000 individuals annually (EPA, n.d.b).

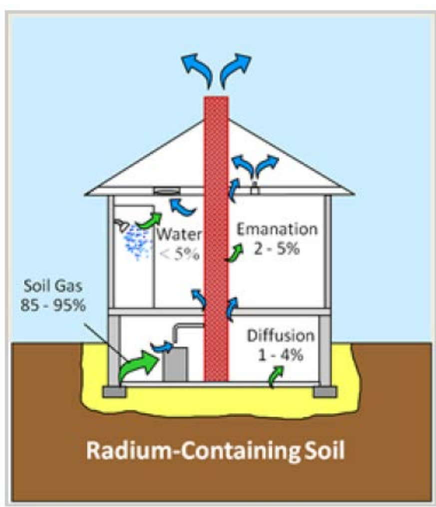


Figure 23. Radon as a source of unhealthy IAQ in built environments (EPA, n.d.b)

Depending on the project type (new construction or major remodeling), performance criteria are geared to the prevention level rather than ventilation design. In Minnesota, counties located in 'Zone 1' must follow a document published by the United States Environmental Policy Agency (hereafter, referred to as the EPA) referred to as the *Radon Prevention in the Design and Construction of Schools and other Large Buildings* (United States Environmental Policy Agency, 1994).

Additional performance guidelines require compliance with ASHRAE ventilation standard 62.1. Recommended performance guidelines involve monitoring of CO^2 concentrations in continuously occupied spaces following occupancy and every year following initial occupancy. Occupied 'breathing spaces' are defined as the volume between 3 and 72 inches above the floor and 2 feet or greater distance from walls) [and] shall not exceed 450 ppm above outdoor concentrations" (B3 Guidelines, n.d.n).

The SPOES V2 + AWSp Module asks employees to rate their overall IAQ (free of odors, staleness, chemicals, or irritants) of their PWSp. IAQ is an overall category level criterion There are no additional IAQ attribute level questions (free of odors, staleness, chemicals, or irritants) on the survey.

The EPA refers to IAQ as "the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants" (US_EPA, n.d.b). In 1984, the World Health Organization Committee reported that indoor air complaints were associated with up to 30% of buildings worldwide (US_EPA, 1991). As health complaints grew, so did reactive responses from health and building officials. Sick building syndrome (SBS) was subsequently named for the acute health conditions occupants experience based on the time spent in a particular room within a building or the entire building (US_EPA, 1991). Building related illness (BRI) referred to occupant health conditions directly linked to airborne building contaminants in a specific building (US_EPA, 1991; Mendell, 2003). Multiple chemical sensitivity (MCS) is associated with individuals' health problems arising out of exposure to specific chemicals and other irritants, often found in low levels of concentration (Nussbaumer, 2008).

It is widely recognized that people spend upwards of 90% of their time indoors. Given this, concern for IAQ and the consequence on human health and performance is paramount to the goal of designing buildings to protect the occupants (Jørgensen, Hanssen, Bakke, & Jensen, 2009). Indoor air can be affected by unhealthy accumulations of mold, bacteria, particulates, dust mites, viruses, gases (CO2, radon), secondhand smoke, emissions, fumes, and chemicals associated with off-gassing materials (Jones, L., 2008). Occupants exposed to poor IAQ experience health symptoms such as runny noses, headaches, allergies, asthma, bronchitis, and pneumonia, lung cancer, and Legionnaires' disease (Mendell, 2003; Nussbaumer, 2008). On a global level, Sundell (2004) reports that "indoor unvented burning of biomass for cooking is the cause of at least 2,000,000 deaths a year, mainly women and children" (p. 51).

IAQ is affected by the presence of offending pollutant sources as well as the process to remove them. For example, in an experimental study involving a simulated office setting, researchers examined the effect of pollutant sources (3-month old personal computers or PCs) on occupant perceptions of air quality, SBS illnesses complaints, and office productivity. Following the removal of the PCs from occupant view, occupants reported improved perceptions of air quality, a reduction in the severity of headaches, and improved typing performance (Bakó-Biró, Wargocki, Weschlerb, & Fanger, 2004). In a more detailed investigation of the potential pollutant sources, researchers were unable to identify any significant chemicals in sufficient concentrations that could be responsible for the negative experiences, leading to the notion that stealth chemicals may add to negative occupant experiences (Bakó-Biró et al., 2004). In similar studies in Denmark and Sweden, the removal of a pollutant source (old carpet previously installed in a building associated with SBS complaints) resulted in an improved subjective assessments of perceived air quality (Wargocki, et al, 2002).

Employees' Satisfaction with Indoor Air Quality Conditions: F (SBI) and PWSp

Studies examining occupants' satisfaction with IAQ criterion at the workstation level and the overall workplace vary – possibly due to sample sizes, building type, number of criteria assessed, and length of exposure to site conditions. Researchers found that occupants of 21 LEED-rated or sustainably developed buildings reported greater levels of satisfaction with IAQ conditions over occupants located in 160 non-sustainable buildings (Abbaszadeh et al., 2006). In a study using CBE survey data of 15 LEED-certified office buildings and 3769 office workers, IAQ was ranked among the highest level of satisfaction of seven individual IEQ criteria. In a pre-and post-survey of 200 office workers moving from an older building (baseline) to a new building outfitted with floor diffusers, respondents were significantly more satisfied with air quality in the new building over the old building (Zagreus et al., 2004).

In contrast, CBE survey results acquired over a 10-year period representing over 50,000 occupants, IAQ ranked among the highest level of dissatisfaction with the indoor environment (Wargocki, et al., 2012). Lastly, in the study assessing IEQ factors on Kano's satisfaction model, IAQ was identified as a proportional factor, meaning that occupants' satisfaction was directly related to overall satisfaction.

Employees' Satisfaction with Indoor Air Quality Conditions: AWSp

In the preceding studies, none of these studies addressed IAQ conditions and employees' satisfaction with alternative workspaces (conference rooms, meeting rooms, or any type of shared space). In addition to these studies, occupants' satisfaction and the IAQ conditions were not identified in any other studies on areas associated with alternative workspaces.

IEQ Criterion – Privacy Conditions

Definitions and Standards Related to the Privacy Conditions (PRI)

The B3 Guidelines do not have any guidelines related to privacy conditions, yet research continues to demonstrate this as an important aspect to employees' working environments. Privacy conditions are a category level criterion that is addressed in part through acoustics and visual conditions in the work environment. The B3 Guidelines do address acoustic conditions under 1.7 Effective Acoustics (B3 Guideline, n.d.f) without specific regard to acoustic privacy. However, it is addressed through studies of employees' satisfaction with acoustic conditions in the work environment. Visual privacy is somewhat related to view conditions, which is addressed in the B3 guidelines under section 1.10 View Space and Window Access (B3 Guidelines, n.d.p). Conditions involving 'view' will be addressed under the IEQ View Conditions section. The SPOES V2 + AWSp Module asks employees to rate their satisfaction with the overall privacy (sound and visual privacy) conditions of their PWSp.

Newell (1994) defines privacy as a multi-faceted perspective related to phenomenological state of an individual or a physical condition that is afforded by the ability to regulate or control environmental features. Sundstrom, Burt, and Kamp (1980) suggest that privacy is a psychological concept that involves a "sense of control over access to oneself or one's group" (p. 102). It is the goal and desire to regulate information or contact with others, whereas architectural privacy is achieved through features that regulate isolation or openness of an environment.

Employees' Satisfaction with Privacy Conditions: F (SBI) and PWSp

Workplace environments typically include PWSp with varying degrees of enclosure (e.g., walls, panels and ceiling) with both private offices and workstations located in open areas. PWSp can be equipped with doors or window blinds, acoustic panels or insulation, or be located in areas to promote or minimize interaction with others. Studies involving open offices, workstations placed in close proximity to each other, and a large number of workers are associated with higher levels of noise, distractions from others, a sense of crowding, and thus, less privacy (Sundstrom et al., 1980; Sundstrom et al, 1982).

As trends in workplace environments moved towards open office environments, filled with workstations, research on employees' satisfaction in these settings with mixed results between satisfaction and dissatisfaction. Open offices environments provide conditions for interaction that, on one hand, provide a source for visual distractions and connections between employees. Rashid, Wineman, and Zimmring (2009) conducted a study of 35 people relocated to a new office to determine employees' perception of privacy and job satisfaction in an open office environment. The results indicated that the open office environment provided better visibility, accessibility, and face-to-face interaction in their new space, leading to perceptions of improved privacy and job satisfaction. In another study involving relocated employees and changes in PWSp type, employees were found to be more dissatisfied with privacy conditions in open-office workstations (cubicles) regardless of the type of PWSp (private office or open office) they had before relocating into a new space (Guerin et al., 2012). Further, privacy conditions with acoustic conditions in the open office environment yielded greater levels of dissatisfaction that privacy with visual conditions.

Lee (2010) conducted a similar study on cubicles in open office environments to examine employees' satisfaction with privacy based on the type of enclosure provide by partitions. Results indicated that employees were satisfied with aspects of privacy, interaction, and acoustic conditions in cubicles having both low and high panel heights. Privacy conditions associated with workplace environments show different levels of satisfaction and dissatisfaction, presumably due to other factors related to employees' expectations, role, job function, and habituation with conditions that suggest the need for additional consideration and research. Finally, in a study of workstation features, Sutton and Rafaeli (1987) found employees' satisfaction with visual privacy with the PWSp but also noted that satisfaction with the workspace did not reflect satisfaction with their work.

Employees' satisfaction with Privacy Conditions: AWSp

In a study by Peterson and Beard (2004) involving individual and group work, the researchers examined employees' satisfaction with a new work space design referred to as 'cave' and 'common.' *Figure* 24 depicts the Personal Harbor Workspace developed by Steelcase and used by 15 knowledge workers involved in the study. Employees responded to several survey instruments and interviews geared to examine work modes involving concentration and collaboration. Results indicated that the employees were generally satisfied with their visual privacy and task performance with their PWSp but less satisfied with their audio privacy. Post-hoc interviews revealed workplace behaviors described as ‘prairie dogging’ that occurred when one employee would poke their head out of the hub to interact with another team member in an adjacent hub, only to have the interaction spill into other employees’ workspace. Visual privacy in team space was also considered less satisfying. Post-hoc interviews and analysis revealed that employees felt group work displayed in common areas was compromising given that “individuals who rate their competence had free access to this [visual] information” (p. 170).

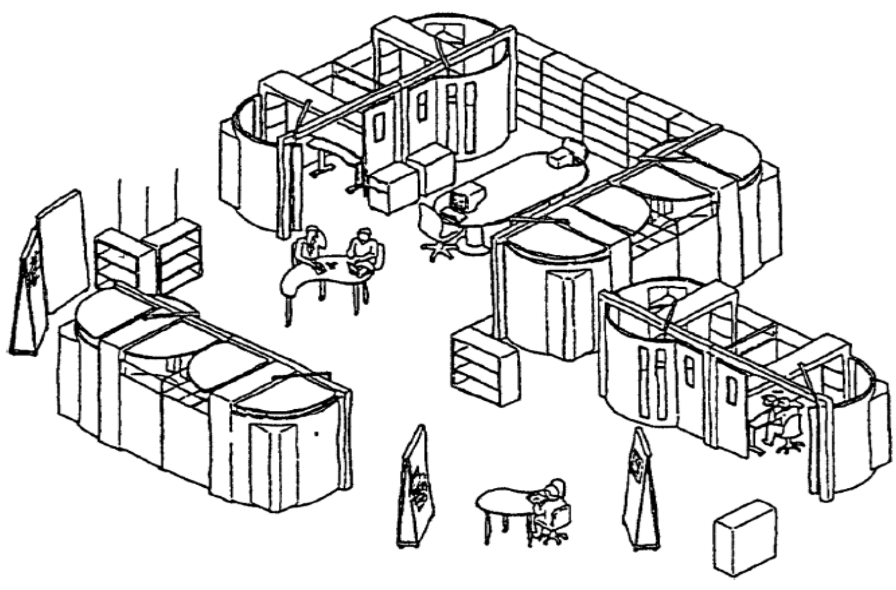


Figure 24. Personal harbor workspaces (Perterson & Beard, 2004, p. 169)

IEQ Criterion – Thermal Conditions

Definitions and Standards Related to the Thermal Conditions (THE)

The B3 Guidelines address thermal conditions under 1.5 Thermal Comfort with the intent to "provide for occupant thermal comfort through control of ambient temperature, and operative temperature, which includes wet bulb, dry bulb and globe temperatures, relative humidity (RH), mean radiant temperature (MRT), and air velocity" (B3 Guideline, n.d.q). Thermal comfort is an overall category level IEQ criterion with attributes of temperature, air velocity, and humidity. The SPOES V2 + AWSp Module asks employees first to rate their overall satisfaction with thermal conditions in their PWSp, followed by questions associated with each of the following attribute level criteria: temperature (hot or cold), air velocity (drafty or stagnant), and humidity (dry or moist).

There are several approaches used to define thermal conditions. L. Jones (2008) defines thermal comfort as the "appropriate combination of temperature (i.e., air is warmed or cooled), airflow, and humidity that allows an individual to be comfortable within the confines of a building" (p. 387). ASHRAE Standard 55-2004, *Thermal Environmental Conditions for Human Occupancy* for compliance or credit (USGBC, 2006). ASHRAE identifies thermal comfort as "the state of mind that expresses satisfaction with the thermal environment" (ASHRAE, 2004b). Accordingly, the ANSI/ASHRAE Standard 55, states that "if 80% of the occupants are satisfied with a thermal environment of a building at any given time, the thermal condition of that environment is considered reasonably comfortable" (ASHRAE, 2004b). There are six factors that known to contribute to thermal comfort humidity, temperature, radiation, air speed, personal factors such as level of activity (sedentary to strenuous), and clothing (ASHRAE, 2004b; Cheng, Niu, & Gao, 2012).

Thermal comfort is difficult to achieve for all occupants, therefore the condition that only 80% must be satisfied. For example, buildings are known to vary seasonally due to humidity levels, temperatures taken at different height levels will read differently, and air circulation will vary in naturally vented buildings as opposed to mechanically vented buildings (ASHRAE, 2004b).

Energy consumption of buildings' heating, ventilating, and air conditioning (HVAC) mechanical operations are expected to grow by 50%. There is a strong push in sustainable design guidelines to minimize the impact of this growth by reducing energy consumption in buildings themselves. To meet and comply with AIA 2030 goals, the B3 Sustainable Building 2030 Energy Standards have been established to reduce energy consumption in projects built after 2010 at 60% or below that of an average building, until 2015, when "the standard becomes 70 percent better and so on until net zero energy is reached in 2030" (B3 Guidelines, n.d.r). These standards are currently in place for all projects receiving bond funding in the State of Minnesota and are applicable for projects seeking voluntary compliance.

Thermal comfort is subjective and varies individually, both psychologically and physiologically. To achieve greater levels of satisfaction across larger groups, ISO 7730:2005, Ergonomics of the Thermal Environment, was developed as a separate standard used to examine thermal satisfaction using a predicted mean vote (PMV) and a predicted percentage dissatisfied (PPI) (International Society Organization, 2005). This standard addresses the insular value clothing plays in adjusting to fluctuating thermal building environment conditions and how heat is transferred from the human body to the near environment. The indices associated with the standard help to minimize occupants' dissatisfaction from conditions associated with excessive hot or cold thermal discomfort by adjusting the layers of clothing and to maximize higher levels of satisfaction across group satisfaction (Frontczak & Wargocki, 2011).

Employees' Satisfaction with Thermal Comfort Conditions: F (SBI) and PWSp

In a study examining employees' satisfaction with thermal conditions in open and closed office environments, Freihoeffer (2012) found that satisfaction with the attributes of temperature, air velocity, and humidity contributed to overall satisfaction with thermal conditions in the workplace environment. The study showed that measurements of thermal conditions in the workplace environment were found to be consistent with the B3-MSGB guidelines, however employees' satisfaction levels varied significantly between open and closed PWSp.

In an experimental field test of three IEQ variables (thermal, acoustic, and visual conditions), Huang, et al (2012) found that thermal comfort was associated with higher importance for the office environment over visual or acoustic conditions and led to higher levels of overall satisfaction with the office environment. Frontczak and Wargocki (2011) found similar results in a literature review of factors contributing to human comfort in building environments. More specifically, “the studies surveyed showed that building users consider thermal comfort to be the most important parameter influencing overall satisfaction with IEQ” (p. 935). The studies also noted that although acceptable thermal conditions varied across climate and seasonal conditions, control of temperature, air movement, and air quality in the winter were associated with higher levels of satisfaction. The researchers added that aesthetic conditions or appearance (room decoration and color of light) were not associated with higher levels of satisfaction with thermal conditions (Frontczak & Wargocki, 2011).

POEs report satisfaction or dissatisfaction across different projects, building types, and compliance with sustainable guidelines. For example, researchers found that occupants in 21 LEED-rated or sustainably developed buildings reported greater levels of satisfaction with thermal comfort conditions over occupants located in 160 non-sustainable buildings (Abbaszadeh et al., 2006). In another study, CBE survey data representing 320 buildings and over 47,000 respondents, more occupants were dissatisfied (42%) than satisfied (39%) with their workplace thermal comfort conditions (Arens, 2007). Additionally, when plotted in frequency distributions across buildings, only 11% of the buildings recorded occupants' satisfaction at 80% with temperature levels in the workplace. These findings lead researchers to conclude that occupants in this survey were reporting a much higher rate of thermal dissatisfaction in the buildings they occupied (Arens, 2007).

In a study by Frontczak et al., (2012), referencing the CBE data base of over 52,000 occupants in 351 buildings, occupants were more dissatisfied with thermal conditions than satisfied. In another study, Lee and Guerin (2009) found similar results of occupant dissatisfaction with thermal comfort in data in 15 LEED certified buildings and 3,769 office workers.

Employees' Satisfaction with Thermal Conditions: AWSp

In the preceding studies, none of these studies include any results on thermal conditions in alternative workspaces (conference rooms, meeting rooms, or any type of shared space). In addition to these studies, occupants' satisfaction with thermal comfort conditions were not identified in any other studies of alternative workspaces.

IEQ Criterion – Vibration and Movement Conditions

Definitions and Standards Related to Vibration and Movement Conditions (VIB)

The B3 guidelines address the conditions related to vibration and movement under section I.8 Reduce Vibration in Buildings. This is a required scope of action for all new buildings following the B3 guidelines and recommended for building renovation projects where structural remodeling is involved. The intent of this guideline is to eliminate conditions that create “harmful vibration effects that are created by wind sway and transmitted outdoor sources, indoor machinery (especially HVAC), and foot traffic” (B3 Guidelines, n.d.s). Protracted exposure leads to an unhealthy source of stress and disruption to working conditions in the PWSp. In addition, elimination of wind sway in the upper floors of a building increases employees’ satisfaction, perceptions of well-being, and enhances the value of the building (Kwok, Hitchcock, & Burton, 2009).

The B3 guidelines require performance as it relates to the structural integrity of the building components (e.g., steel, wood, or concrete); method of construction (e.g., Joist-Concrete Slab Floors); and floor deflection for wood and concrete construction. Recommendations address building conditions in structures over seven stories in height, and require floor vibration resonant rates compatible with the human body in all continuously and intermittently occupied areas. Additional resources are provided, e.g., *The American Institute of Steel Construction Inc. (AISC) AISC Design Guide 11*, to assist with specification and design criteria.

The design and specification of IEQ conditions related to vibration and movement are under the direction of licensed structural engineers, architects, and other officials. To assist with this process, the B3 provides several compliance tools and resources to access appropriate engineering data in the design process. Space planners and interior designers have responsibilities for planning workplace environments and knowing where excess dead loads would compromise structural integrity. For example, locating high-density filling systems or fire-safe files in offices, particularly in upper floors, requires special attention and or consultation with a structural engineer.

Vibrations are associated with both natural and intentional forces. Thalheimer (1996) states that “all real objects, including of course human beings, are made of real materials characterized by some degree of mass (weight), stiffness (spring-like), and damping (energy-absorbing)” (p. 6). Objects can vibrate internally (natural frequencies) and externally. Natural frequencies are fairly stable due to its mass and stiffness, but when an action event occurs, vibrations will move in all three directions (X, Y, and Z). Vibrations are generally stronger in the vertical (Z) direction as typically less constrained than those at ground level. Vibrations arise in objects due to external forces such as wind (sway), seismic conditions, and mechanical movement. The magnitude of a vibration is expressed by the amount, intensity, or inherent vibrational energy present. Vibrational displacement, velocity, and acceleration are quantified in magnitude metrics.

Vibrations can be transferred (transmitted) or absorbed by the human body and are perceived on a logarithmic basis. Whole-body vibration research focuses on the whole-body physiological and biological effects related to “muscular activity and maintenance posture, cardiovascular system effects, cardiopulmonary effects, metabolic and endocrinological effects, central nervous system effects, gastrointestinal system effects, and motion sickness effects” (Thalheimer, 1996. p. 3). Research shows that long-term excess vibration exposure can affect individuals in the lower back region resulting in injuries from restricted range of motion, damage to spinal discs, numbing and loss of digits, and more.

Office environments are susceptible to vibration and movement through HVAC systems, lighting systems, mechanical systems, office equipment, and people walking in the area. Vibration and movement can also be accompanied by acoustic issues, e.g., HVAC equipment running, deflection cracks in the floor, photocopier sounds, and more. Excessive floor vibration in office environments affects the serviceability conditions in workplace environments, produce stress in employees, and affect employee comfort and productivity (Hicks, 2004). Excess building sway in tall buildings due to wind conditions can interfere with employees’ daily well-being and performance activities and create a sense of fear. The following discussion addresses employees’ satisfaction with conditions specific to planning of the interior workplace environment.

Employees' Satisfaction with Vibration and Movement Condition: F (SBI) and PWSp

As an IEQ criterion, vibration and movement is largely overlooked or underreported in POE studies relating to employees' satisfaction in the workplace. Researchers examining human comfort in response to vibration and movement frequently focus on floor vibrations and wind-induced building movement.

Hanagan and Murray (1997) noted various problems where vibration amplitudes spanning large open office floors resulted in employees' disruptions and reduced efficiency in employees, and in more extreme cases, abandoned structures. Hanagan, (2005) conducted case-studies in offices on walking-induced floor vibrations and employees' complaints. Hanagan (2005) noted that the shift away from cellular, hard-walled offices to open plan workspaces with small, lightweight partition-type workspaces have a significant impact on the behavior of the floor system. Further, hard-walled offices constructed from light-weight metal studs and gypsum board "provide both support and damping to the floor framing, making it less susceptible to objectionable levels of vibration" (p. 14-15). The result of this change has led to a dramatic increase in employees' vibration complaints.

In a case study involving complaints about floor vibrations in an office building with multiple floors, the researchers noted that the tenants in the floor beneath the studied office had made several changes in the office layout, removing several cellular offices, large storage files, and paper supplies. The remodeled plan contained an open office environment with partition-like cubicles and less paper storage due to the increased use of electronic storage of the previous paper files. Following the completion of the interior remodeling, employees on the floor above note several problems with floor vibration. An on-site field investigation noted problems with walking and the resonance frequency of the floor system. Pernica (1990) noted that walking produces considerable harmonic occurring in multiples of a walking pace. Hanagan's case-study revealed acceleration amplitudes associated with walking behaviors were above recommended limits (.005g) noted in the ACSI guidelines. *Figure* 25 illustrates the results of the vibrational testing reflecting small waves associated with the normal pace of walking and higher peaks associated two times the normal walking pace. The results of this investigation revealed that "the largest harmonic force is created at the frequency of the walking pace, the smaller amplitude harmonic force present at 4.7 hertz (Hz) is causing the largest floor response associated with the resonance with the fundamental frequency of the floor system" (Hanagan, 2005, p. 15). A hertz is a measure defined by the International System of Units (SI) and represents one cycle occurring per second.

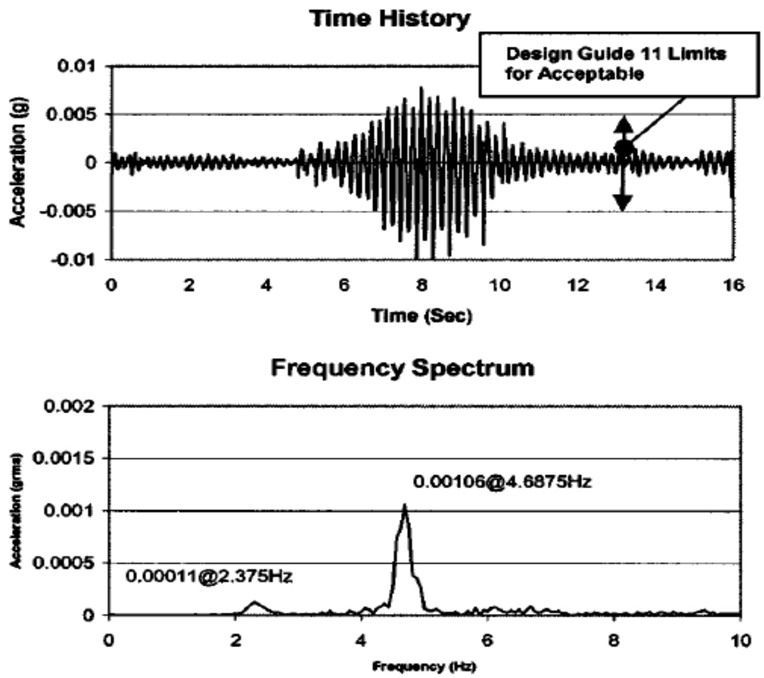


Figure 25. Floor vibration depicting walking behavior; regular pace and double pace (Hanagan, 2005, p. 16)

Vibration and movement complaints also arise in tall buildings where wind-induced vibration occurs. Taller, more slender buildings are made more possible today due to the use of high strength building materials and stiffer structural systems. Kwok, Hitchcock, and Burton (2009) note that "these increasingly wind-sensitive buildings possess low natural frequencies of vibration, which positions the buildings within an operating range susceptible to enhanced wind excitations such as along wind turbulence buffeting and crosswind vortex-induced excitation, particularly for buildings in regions of high wind speeds" (p. 368).

Studies on human perception of vibration in wind-induced buildings are associated with three research approaches, human response to motion simulation and shake table experiments, field experiments of artificial buildings, and field experiments and occupant surveys in wind-excited buildings. Employees have different perceptual responses to vibration and movement. Buildings experiencing high winds often sway and move in a manner that generates annoying acoustic creaking sounds, e.g., glass doors or windows fit into metal frames or porcelain wall and floor tile move against each other in bathrooms. These sounds serve as reminders to workers that the building is moving and in some cases, creates unnecessary alarm and fear.

Kwok, et al. (2009) research on human comfort and wind-induced vibrational complaints, found that several of the vibration perception tests were related to conditions based on sinusoidal vibration and task distraction. Studies examining perceptions of building vibration and cognitive task performance were most mostly inclusive. Most studies involved a subjective assessment of vibrational conditions where comfort and well-being varied notably. Kwok et al. (2009) suggest that vibration and movement practices lack a "universally accepted occupant comfort serviceability criterion" to guide and establish acceptable levels of wind-induced vibration in tall buildings (p. 377). The researchers summarize human responses to vibration and movement conditions in the following observation:

> Since human perception and tolerance of wind-induced tall building vibration are essentially a subjective assessment, there are significant

> differences and uncertainties in the building vibration accept-ability and occupant comfort criteria and the assessment methodology currently in use. Prior experience, vibration expectation, habituation, personality and even job satisfaction also play an important role, which makes predicting an individual's reaction to building vibration a complex task. (Kwok et al., 2009, p. 377)

Employees' Satisfaction with Vibration and Movement Condition: AWSp

The preceding studies did not include any discussion on employees' satisfaction with vibration and movement in AWSp (conference rooms, meeting rooms, or any type of shared space). There were no additional studies found on employees' satisfaction with vibration and movement conditions in AWSp.

IEQ Criterion – View Conditions

Definitions and Standards Related to View Conditions (VIE)

The B3 Guidelines address conditions related to view conditions under I.10 View Space and Window and the goal to provide access to views of exterior spaces. This guideline suggests "the benefits of providing this visual access are the ability for focal rest to avoid eyestrain, and access to visual information about changing outside conditions. A 'view amenity' also aids varying attention cycles and relieves the stress of mental work" (B3 Guidelines, n.d.p). The recommendations also identify 'high-performance' views, e.g., clouds, trees, natural water features, and other types of horizontal landscapes.

View conditions are considered “from every assigned and continuously occupied workstation position at seated eye height of 48 inches there shall be visual access to a view space that is at least 20 feet away” (B3 Guidelines, n.d.p). Details regarding access to view, clear view space, and human factors around ergonomic view positions are included in *Figure* 26. The side elevation view illustrates vertical view angles and distance from view opening, and the plan view illustrates the horizontal angle opening from a seated position. Access to view and view opening can be calculated using analytical software or plan evaluations.

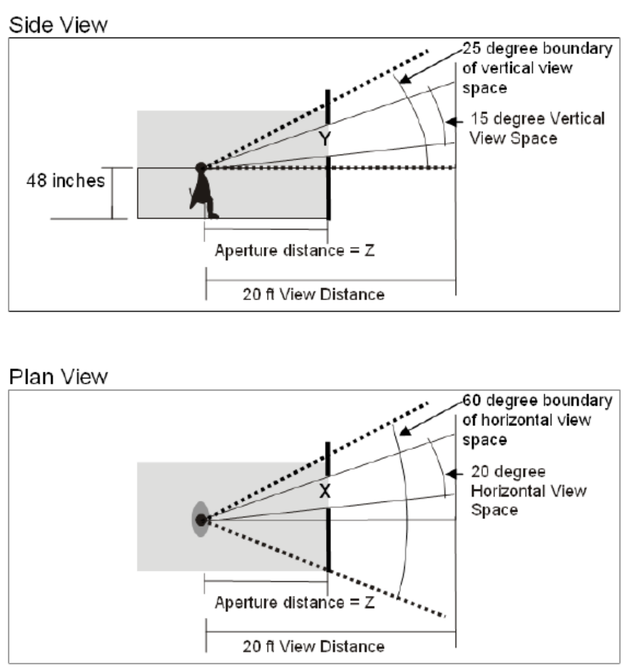


Figure 26. Plan and side elevation illustrating recommended view conditions (B3 Guidelines, n.d.t)

As previously addressed, view conditions are facilitated by windows and other architectural openings. They enhance the opportunity to capture natural light and views of external environments and also provide a potential source for heat loss or gain. The use of low partitions in work environments with cubicles requires additional concern for acoustic and visual privacy yet maintaining view for employees.

The SPOES V2 + AWSp Module asks employees to rate their satisfaction with the overall view conditions (outdoor or distant interior views) from their PWSp. The question on view conditions is considered to be a category level question contributing to the IEQ of the PWSp.

Employees' Satisfaction with View Conditions: F (SBI) and PWSp

As indicated in the SPOES V2 survey question, 'views' can be both outdoor and distant interior space. Research on employees' satisfaction with views in office environments is frequently associated with windows or openings that provide views of natural settings, views of urban settings, views of inner office (atrium) environments, and the lack of views that are associated with windowless environments.

Windows in offices are favored over windowless workplace settings as they provide a connection to the outside environment, daylight, natural light, and the potential for fresh air (Heerwagen & Orians, 1986). In a study of open-plan offices, proximity to windows and partition height has demonstrated higher levels of employees' satisfaction with closer proximity and with areas of lower partition heights. Results indicated that access to a window view provided greater satisfaction in employees from those who had less proximity to a window view. Access to views was considered as a compensating effect over potential loss of privacy in open office environments (Yildirim, Akalin-Baskaya, & Celebi, 2007).

The positive benefits of a view of nature through windows have been documented in healthcare (Ulrich, 1984) environments and office environments (Ulrich, 1979) and as such, are considered to be high-performance features as defined in the B3 guidelines. Attention Restoration Theory, developed by (Kaplan & Kaplan, 1989), arose out of a 20-year study that examined human mental attention and fatigue and rates of restoration that took place after exposed to views of nature (Kaplan, 1992; Kaplan, 1995).

The impact of views of nature and employees' satisfaction in office settings has been noted in several studies. Leather, Pyrgas, Beale, and Lawrence (1998) found that "a view of natural elements (i.e., trees, vegetation, plants, and foliage) was found to buffer the negative impact of job stress on intention to quit" (p. 739). In a similar study on job satisfaction (Lottrup, Stigsdotter, Meilby, & Claudi, 2013), views of natural elements (green outdoor environments) were related to high levels of job satisfaction and deemed an important element contributing to the workplace environment. Employees' satisfaction with views of nature was preferred over views of live plants in interior settings (Dravigne

& Waliczek, 2008). Views of natural environments, e.g., forests, are also considered to have a positive impact on job satisfaction and a decrease of job-related stress (Sop Shin, 2007).

In a study examining the aesthetic qualities and complexities of views associated with both the natural environments and urban environments, Ulrich (1979; 1984) found subjects to prefer the aesthetic qualities of natural environments over urban environments. Kaplan (2007) examined employees' satisfaction on the qualitative aspects related to urban views, e.g., tree-lined spaces, prairie grass-like ground cover, groomed lawns, and parking areas. Results indicated that employees preferred views of natural settings more than views of major buildings or parking areas. Employees' preference for natural environments over built or urban views has been demonstrated in several other studies (Aries, Veitch, & Newsham, 2010; Herzog, Colleen, Maguire, & Nebel, 2003; Tennessen & Cimprich, 1995).

Views of interior spaces obtained through intervening open offices or atrium areas are cited less frequently in research reports than views involving exterior spaces. Buildings designed referencing sustainable guidelines are more likely to incorporate design features that facilitate views both inside and outside the workplace environment. For example, an office building in a Midwestern city pursing LEED certification was designed to incorporate "extensive daylighting design including atriums, high exterior windows, interior windows for borrowed light, light interior finishes for reflectivity, low cubicle partitions (for light and view access), dimming daylighting controls, and extensive access to views" (Guerin, et al., 2012, p. 88). A POE study was conducted on this building with over 200 employees. Researchers found a moderate level of satisfaction with 'overall views,' mediated over concerns for loss of privacy in offices with large glass walls. Concern over privacy in open office environments with high internal visibility (open stairways, low partition walls, larger walkways with activity nodes) were also noted in the Philip Merrill Environmental building, the first LEED Platinum building developed referencing LEED sustainable guidelines in the Unites States (Heerwagen & Zageus, 2005; Heerwagen et al., 2004). High internal visibility facilitates improved communication and information, yet these types of workplace settings also create "difficulties for complex cognitive tasks that characterize high value knowledge work" (Heerwagen & Zageus, 2005, p. 23).

Lastly, research on the 'lack of views' in windowless workplace environments has received a considerable amount of investigation primarily due to compensatory aids used to replace views and potential sources for daylight. In a study conducted at the University of Washington, researchers examined the décor of 75 windowless offices to examine thematic content of visual images used on walls. Researchers found that twice as many visual images were used in windowless offices than offices with windows, and further, the visual images were dominated by nature themes and landscapes (Heerwagen &

Orians, 1986). In a study of 385 employees in windowless environments, it was found that employees in windowless environments were five times as likely to bring plants into their workspaces and three times more likely to bring in landscape images in comparison to employees having windows and views to exterior environments (Biner, Butler, & Winsted, 1991). Further, plants and visual images are considered to serve as compensatory elements for individuals working in windowless environments.

Employees' Satisfaction with View Conditions: AWSp

The preceding studies did not include any discussion on employees' satisfaction with view conditions in AWSp (conference rooms, meeting rooms, or any type of shared space). There were no additional studies found on employees' satisfaction with view conditions in AWSp.

Summary - IEQ Criteria and Workplace Environments

The literature review identified definitions and standards for 11 IEQ conditions included in this study. Research involving employees' satisfaction with all IEQ criteria associated with the F (SBI) and the PWSp was presented and reviewed. Research involving employees' satisfaction with all IEQ criteria for AWSp was far less supported. Two of the eleven IEQ criteria were supported by discussion of employees' satisfaction with IEQ conditions in AWSp, and they include function and privacy. Five of the IEQ criteria associated with AWSp included only limited or related aspects of employees' satisfaction with acoustic conditions, appearance conditions, daylighting, electric lighting, and furnishings. Four of the IEQ criteria were not supported by any findings of employees' satisfaction in the AWSp. They included IAQ conditions, thermal conditions, vibration and movement, and view conditions. In summary, there is an overwhelming focus on employees' satisfaction with the F (SBI) and the PWSp and a lack of substantial research on AWSp in the literature. The next section will discuss employees' satisfaction as an observation in the design environment through a model developed illustrating the affordance theory.

Affordance Theory

Affordance theory was developed by Gibson (1986) and serves as the theoretical framework for this research. The theory originated out of the scientific perspectives of ecological psychology (information arising out of the relationship between observers and the environment) and Gestalt psychology (information obtained through the sense of vision of the environment). Gibson's early work focused on the phenomena of perception. With this in mind, he developed a detailed description of the visual process as it occurred through the apparatus (data collectors) in the eyes, the distribution of optical rays, and the stimulus experienced from a moving point of observation.

Gibson proposed that organisms (humans and animals) observe affordances in the environment (nature and social settings), moving from a pre-awareness (unreflective) stage to awareness (meaning, information, knowledge), where the potential for actions exist (Gibson, 1986; Heft, 2003).The Affordance Theory, reduced to its basic element, suggests that “the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill” (Gibson, 1986, p. 127). Affordances are not fixed to a feature of the environment – they exist in a person’s perception and are independent of observation itself. Affordances are associated with a single observer, and other observers in the environment have their own, unique perceptual experience of the environment.

Affordances in the environment can be as simple as an unrestricted path of travel that affords locomotion or movement. Constraints in the environment can be associated with obstacles, barriers, margins, and edges that may restrict locomotion and become a constraint, which is the opposite of affordance. Applied to the built environment, occupants can travel safely along paths or corridors uncluttered by objects or through doorways that allow movement in and out of spaces. A clear path of travel and a functional door or opening affords the action of movement, locomotion, and use of other spaces.

Gibson (1986) described the basic components of the environment beginning with mediums, substances, and substrates. Mediums include matter in the form of gas (air), liquid (water), and solids (earth). Surfaces possess attributes of luminance, shading, volume, opacity, texture, homogeneity, and rigidity and describe the appearance, layout, or geometry of a surface, object, or shelter. Substances differ in chemical and physical properties and afford opportunities for modification or manipulation in ways that can affect behaviors in observers (humans or animals).

Gibson (1986) used the concept of nesting to describe different layers of the environment. Nesting refers to units (objects and tools) that exist in a hierarchical relationship where one unit is held or contained by another unit without regard to size. Objects have surfaces with texture, color, and shape; whereas tools are portable detached objects used as an extension of the hand. Layout refers to surfaces (planes) that possess attributes of geometry or enclosure. The term display involves the application of artificial objects or images to a surface to modify or alter its impressions. Gibson proposed these terms to facilitate discussion among scholars, but also recognized that they were subject to revision – thus indicating the dynamic nature of the theory.

Gibson's theory is complex, philosophical, and at times, vague. It serves as a source of debate in the field of ecology, environmental psychology, social psychology, and more recently, the design of products and environments. For example, Chemero, Klein, and Cordeiro (2003) note that affordances "between the animal and its environment have consequence for behavior" (p. 20). Chemero et al. (2003) also suggests that an affordance "is a resource that the environment offers any animal that has the capabilities to perceive and use it. As such, affordances are meaningful to animals; they provide opportunity for particular kinds of behavior" (p. 182). Turvey (1992) argues that affordances are properties of the environment, whereas Stoffregen (2003) considers affordances to be properties of the animal-environment system and are more consistent with the act of perception. Pepper (2008) emphasizes affordances that "allude to the notion that physical objects … have capabilities that are not incumbent upon discourse about those objects" (p. 320). K. Jones (2003) suggests "objects and events have inherent meaning, which is detected and exploited by the animal without mental calculation" (p. 107). Finally, Clapham (2011) asserts that "affordance will depend on the objectives of the individuals," which frames intention and incorporates elements of meaning (p. 373).

Recently, affordance theory has been adapted and used to solve practical concerns (Valenti & Gold, 1991). For example, the theory has been used to examine affordances and constraints associated with product design (Norman, 1988), the study and application of human-computer interaction (Song, 2011), and workplace environments that provide opportunity for social interactions (Billet, 2008). Norman (1988) suggested that affordance occurs in the design of products when "appropriate actions [are] perceptible and inappropriate ones are invisible," suggesting that appropriate clues can imply how to use an object (p. 9). Workplace researchers also make note of the social aspect of work and the need or desire to interact with others for the exchange of information (Heerwagen et al., 2004**)**. In a study of workplace social interactions, Billett (2008) suggests that workplace affordance invites workers to engage and participate in workplace activities for both support and reward. Billet (2008) elaborates on workplace interactions and affordances in the following:

> …workplaces afford participation and how individuals elect to engage with the work practice, termed co–participation. Workplace experiences are not informal. They are a product of the historical–cultural practices and situational factors that constitute the particular work practice, which in turn distributes opportunities for participation to individuals or cohorts of individuals. That is, they shape the conduct of work and learning through these practices and the designed environment that affords spaces and furnishings for actions to take place. (p. 211)

Pepper (2008) writes that “affordances are not just physical properties; rather, they are properties with utilities. A physical property may afford look-out-ability, sit-ability, lean-ability, and so forth” (p. 321).The observer can take cues from the environment and engage in an action or desired behavior. Furniture designers studying office settings took cues from observations of workplace behaviors and developed a furniture component to accommodate a variety of workplace activities. Allsteel (2011) developed the Hedge (see *Figure* 27) as a low partition to serve as a space separator and also to provide employees with a place to lean on when they stopped and engaged in impromptu social interaction. Thus, the Hedge affords lean-ability, look-out-ability, and write-ability for workers in AWSp (team space).

Figure 27. The ‘Hedge’ and affordances related to lean-ability, look-out-ability, and write-ability (Allsteel, 2011, p. 12)

Finally, architects and interior designers have integrated this theoretical approach into their own research and design practice. Maier, Fadel, and Battisto (2009) developed the Affordance Based Design (ABD) framework to study human–building interactions (form, function, and meaning) and an evaluation tool to assess design objectives against outcomes. Koutamanis (2006) suggested that by examining and codifying spatial and interactive building features early in the design process, desired affordances could be directed at a specific goals and unintended uses of spaces.

Kim, Kim, Jeong, and Park (2009) used affordance theory to observe and analyze subjects performing simple task activities (e.g., writing and sitting) in a building lobby. Researchers employed the Function Task Interaction (FTI) method to identify, analyze, and map the relationship of ‘affordance features’ associated with the observer and the designed environment (e.g., physical setting and objects). The FTI method is summarized in *Figure* 28-31. *Figure* 28 illustrates a ball that provides a surface for ‘sit-ability’ and ‘place-ability’ whereas the observer’s posture facilitates ‘write-ability’ (a place to sit, write, and place personal objects). *Figure* 29 is a graphic illustration of a table listing observed activities (e.g., walking, sitting, writing, etc.) and the related affordance with the observer (human element), their belongings (objects), and the physical environment (the space, furnishings and objects). *Figure* 30 is an affordance-matrix illustrating the physical environment and an analysis of specific features associated with the space, zone, area, set, objects, and detail attributes. *Figure* 31 depicts the results of the study in an affordance-feature map. Observer activities and interactions with the environment are summarized in a path analysis, drilling down further into features of the space, noting the physical enclosure (walls, floors and ceiling), lighting, furnishings, and more.

Figure 28. Affordances associated with the observe and the environment (Kim, Kim, et al., 2009, p. 2-455)

Task	Activity No.	Activities of Participants	Related Affordance		
			with Physical Feature	with Human Feature	with Belongings Feature
T-1 (15)	T1-A1	Looking for sitting place.	Look-ability (10), Walk-ability (10)		
	T1-A2	Walking.	Walk-ability (9)		
	T1-A3	Stepping up and down.	Step-ability (8)		
	T1-A4	Sitting.	Sit-ability (15)		
	T1-A5	Supporting a leg.		Support-ability (2)	
	T1-A6	Placing the bag on somewhere.	Place-ability (10)	Place-ability (5)	
	T1-A7	Supporting the bag on somewhere.	Support-ability (1)	Support-ability (4)	
	T1-A8	Hanging the bag.		Hang-ability (5)	
	T1-A9	Looking something.	Look-ability (8)		
	T1-A10	Touching something.	Touch-ability (1)		
T-2 (15)	T2-A1	Placing eggs/bread and a cup of beverage.	Place-ability (14)	Place-ability (1)	Place-ability (2)
	T2-A2	Supporting a cup of beverage.		Support-ability (1)	
	T2-A3	Tapping eggs.	Tap-ability (7)		
	T2-A4	Eating eggs/bread.	Eat-ability (12)		
	T2-A5	Drinking a cup of baverage.	Drink-ability (15)		
	T2-A6	Holding a cup of baverage.		Hold-ability (14)	
T-3 (15)	T3-A1	Placing the magazine.	Place-ability (5)	Place-ability (5)	Place-ability (3)
	T3-A2	Supporting the magazine.		Support-ability (13)	
	T3-A3	Holding the magazine.		Hold-ability (5)	
	T3-A4	Leaning.	Lean-ability (1)		
	T3-A5	Reading the magazine.	Read-ability (15)		
T-4 (15)	T4-A1	Looking for a trash can.	Look-ability (11), Walk-ability (11)		
	T4-A2	Dumping the trash.	Dump-ability (11), Push-ability (11)		
T-5 (15)	T5-A1	Stepping up the winding stairs.	Step-ability (15)		
	T5-A2	Looking something.	Look-ability (1)		
	T5-A3	Exitng outside.	Enter/Exit-ability (15), Walk-ability (15)		
	T5-A4	Looking for the entrance of Tower 2.	Look-ability (15), Walk-ability (15)		
	T5-A5	Looking at the sign.	Information access-ability (15)		
	T5-A6	Entering the entrance.	Enter/Exit-ability (15), Walk-ability (15)		
	T5-A7	Looking for the escalator.	Look-ability (14), Walk-ability (14)		
	T5-A8	Stepping up the escalator.	Step-ability (15)		
	T5-A9	Holding the escalator's handrail	Hold-ability (6)		

Figure 29. Observer activities and related affordances in the designed environment (Adapted from Kim et al., 2009, p. 2-456)

Features	Walk-ability	Step-ability	Enter/Exit-ability	Sit-ability	Lean-ability	Plaace-ability	Support-ability	Look-ability	Information access-	Tap-ability	Touch-ability	Hold-ability	Push-ability	Pull-ability	Rotate-ability	Dump-ability	Eat-ability	Drink-ability	Read-ability	Draw-ability	Lace-ability	Hand-ability	SUM	
Red Stool area B	1			1													1	1	1		1		6	46
floors	1																						1	
flat surface	1																						1	
1-step		1				1																	2	
stone material		1				1																	2	
height 300mm		1				1																	2	
¬ 'surface		1																					1	
ceilings																								
walls (+ virtual walls)					1																		1	
stone tile material					1																		1	
wall partition								1															1	
Gogh, V. V.'s painting								1															1	
lighting								1															1	
columns & beams																								
general lightings																								
red stools				1																			1	
red stool B				1		1															1		3	
red color																								
FRP material (hard surface)				1		1																	2	
height 350mm sphere mass				1		1																	2	
hipline surface				1																			1	
stone stool B				1		1				1							1		1		1		6	
stone material				1		1				1													3	
height 350mm parallelepiped				1		1				1													3	
depth 400mm flat surface				1		1				1													3	
¬ 'surface				1						1													2	

Figure 30. Affordance Matrix illustrating the space, zone, area, set, object, and detail attribute (Adapted from Kim et al., 2009, p. 2-459)

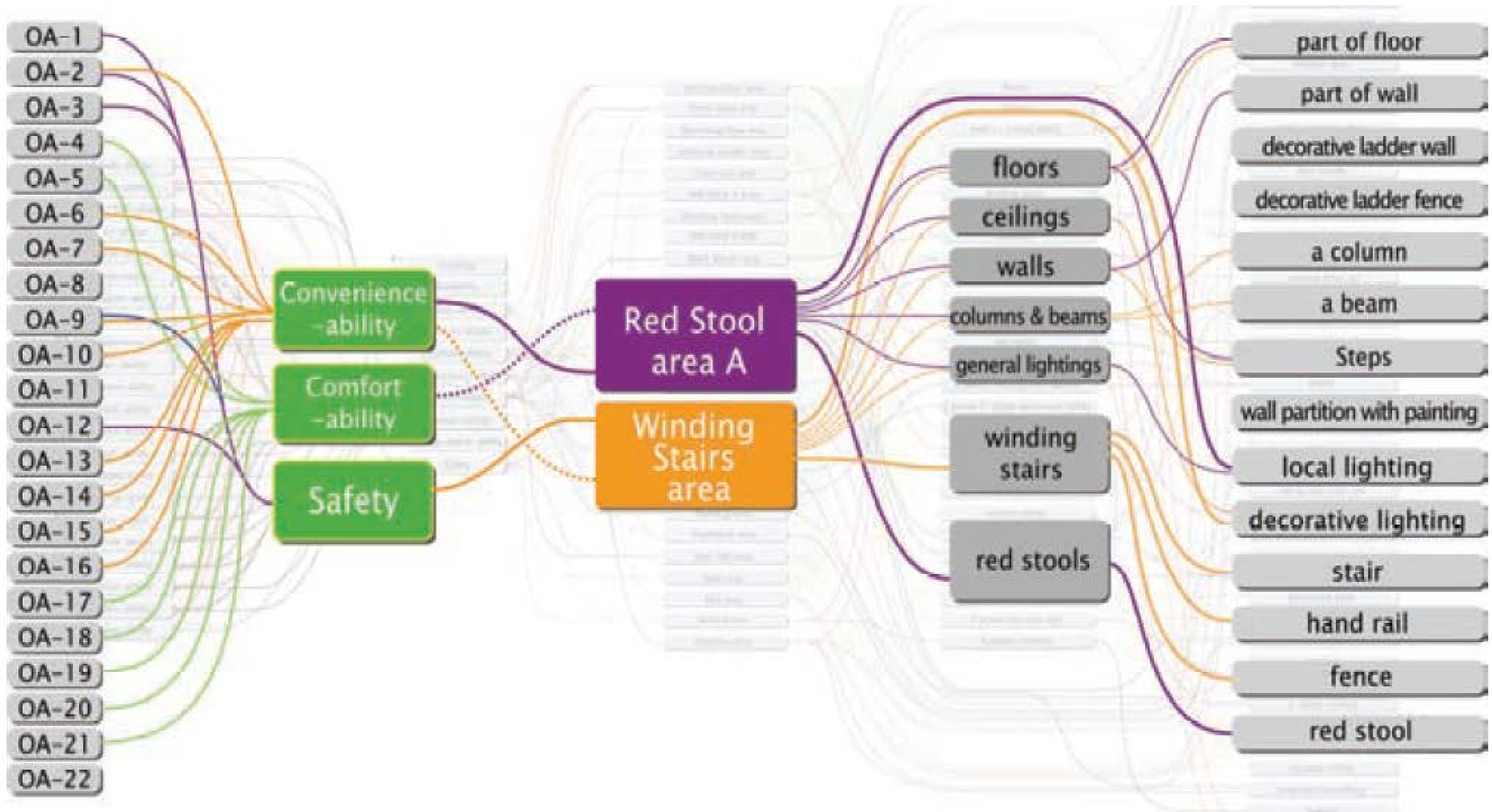
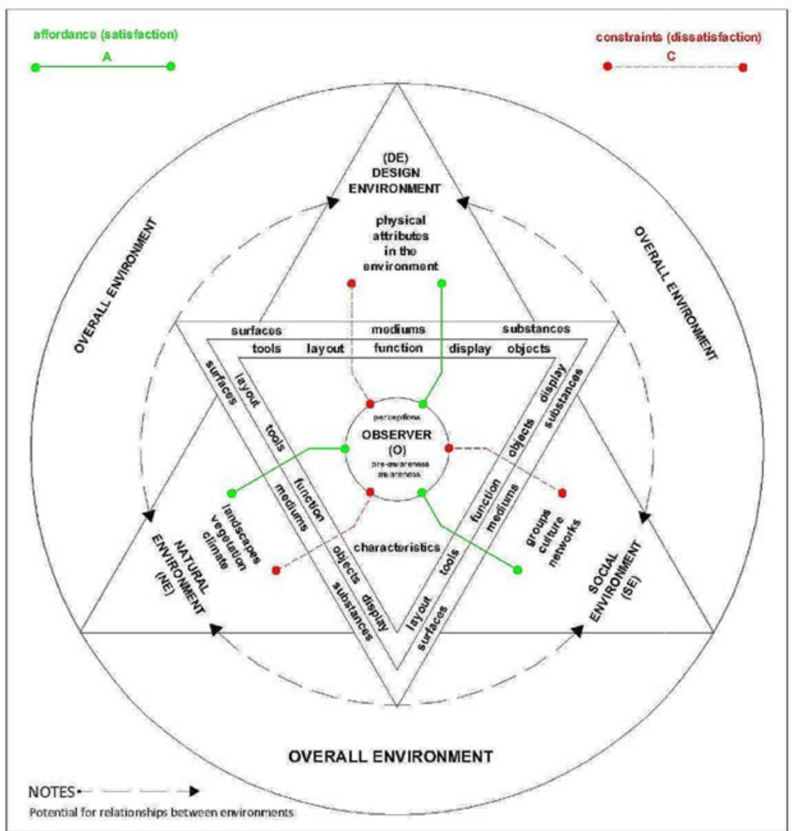


Figure 31. Affordance Feature Map; the observed affordances with physical space (Adapted from Kim et al., 2009, p. 2-462)

As with Gibson's original theory, the affordance features identified in the study conducted by Kim et al., (2009) were identified in a hierarchy of attributes beginning with the area (designated space type), set (interior walls, floors, ceiling and organization), objects (furnishings, tools, artifacts), and details (materials, finishes, colors). Building features were then categorized as having 'high-affordance' and 'low-affordance' for different tasks.

In a similar approach, Kim, Kim, Lee, Lee, Lee, and Lim (2007) conducted a case study on conference room spaces and the activity of meeting with others. Functional affordances were defined and decomposed using the same nested components of area, set, objects, and details. IEQ criteria, (e.g., thermal conditions, lighting, acoustics, function, and furnishings) were included in this study with an emphasis on 'control-ability.' The researchers identified specific building affordances to serve as benchmarks and recommended guidelines for future interior design projects. In a separate study on affordances, the researchers reviewed differences observed in the setting and concluded that "humans do not think and act equally although they look at [the] same features…humans perceive different emotional affordance based on their personal characteristics, resulting in different activities for the same tasks done in the same environments" (Kim, Lee, Park, Kim, & Kim, 2009, p. 6-334).

To date, the Affordance Theory has lacked a conceptual model to illustrate a basic relationship between the observer and their perceptions of the environment. For this study, the researcher developed a model to illustrate affordance theory from the viewpoint of a single observer and affordances in the overall environment. *Figure* 32 shows the observer surrounded by three distinct environments; the designed environment (DE), the natural environment (NE), and the social environment (SE) in the overall environment.



Affordance Theory Research Model: The observer and the environment (DE, NE, SE)

Figure 32. Bauer’s Affordance Theory Research Model; adapted from Gibson’s Affordance Theory

The model places the observer (O) (or employee) at the center of the overall environment in the most inner circle and nested within the social, design, and natural environments. The outermost circle is the overall environment. The observer perceives affordances (resulting in satisfaction) or constraints (resulting in dissatisfaction) within the various environments. The observer has characteristics such as age, gender, years worked in the facility, type of work role, etc. The three surrounding environments also have characteristics associated with them. The DE includes physical attributes such as furnishings, appearance, electric lighting and other IEQ criteria. Characteristics associated with the SE include the work culture, corporate guidelines and policies, and density workspaces, etc. Characteristics associated with the NE include landscape, vegetation, natural light, etc.

As discussed, Gibson describes the basic components of the environment through substances, mediums, and surfaces and suggested features of the environment such as display, tools, objects, and layout. These components are indicated as two triangles that intersect the DE, SE, and NE and can be associated with or found in each of the three environments. It is important to note that the potential for relationships between each environment is indicated by dashed lines. The long dashed line suggests that environments can interact with each other and can= how observers perceive affordance. The three environments are identified as separate and exclusive environments when in fact; one environment can impact another environment and affect affordance or satisfaction. For example, the physical environment of a building provides conditions for lighting that can be delivered through both electric light (DE) (luminaires wired to a power source) and natural daylight (NE) (delivered through openings, windows, skylights). Both of these affordances are clearly associated with the DE, and natural daylight is associated only with the NE.

Observer perceptions can be associated with affordances (shown in green or a short dashed line) or as a constraint (shown in red or a short dashed line). Affordances that exist in the environment, but are not yet perceived by the observer, are associated with the color gray. Observer perceptions are depicted with dashed lines to indicate initial stages of pre-awareness (unreflective) to deeper levels of awareness (meaning, information, knowledge).

Gibson (1986) considered affordances as properties of the perceptual process, although Pepper (2008) and Turvey (1992) argued that affordances are associated with properties or features in the environment. It is beyond the scope of this study to argue philosophical concepts related to the theory. They are included in this illustration to acknowledge that they exist as a potential for action and to recognize the deeper levels of discussion of the theory. Simply put, this model recognizes that affordances (or constraints) that exist in states of the observer's pre-awareness are associated with the observer, and those that exist in the physical environment as a potential affordance (or constraint) may not yet be perceived by the observer.

In the state of pre-awareness, observers can see the environment without seeing an affordance (or constraint). For example, software programs may display an icon or image associated with a feature to streamline a desired task or action. Observers may see the icon image and not be familiar with the potential affordance associated with image (pre-awareness) and therefore, they do reflect on or utilize the affordance associated with using the feature. In addition, observers might not see an affordance (or constraint) in the environment and yet it still exits. Consider that the software program provides this feature, but it is embedded in a menu item that has not been switched on. The affordance exits, however the observer does not perceive it.

The Affordance Theory Model illustrated here represents an over simplification of a complex set of exchanges occurring in observer perceptions of the overall environment. At the same time, the model provides an opportunity to visually organize studies of the relationships between variables of interest in the overall environment and to drill deeper into specific attributes associated with each environment. It also provides the ability to examine deeper levels of perception in the observer moving from pre-awareness (unreflected) to awareness (meaning, knowledge). Relationships between environments provide an opportunity to examine levels of affordance or constraints. For example, privacy can be associated with the ability to arrange physical attributes to achieve a desired level of separation, and it can be associated with social environments and the ability to regulate interaction (visual or acoustic) with others.

This affordance theory model was developed for this study and serves as a framework to assess observer (employee) perceptions (satisfaction levels) with the physical environment (DE). Consistent with Gibson's theory, the DE encompasses nested units, e.g., the PWSp, the AWSp, and 11 IEQ criteria. The role of the Observer in this model is served by employees and their perceptions of the environment that are reflected in their satisfaction level. Perceptions of satisfaction result in an affordance observed in the environment and perceptions of dissatisfaction result in a constraint in the environment.

Research Questions

As previously presented, POE studies investigating employees' satisfaction with IEQ conditions in workplace environments have been focused on the F (SBI) or the PWSp; very little is known about employees' satisfaction with IEQ conditions in AWSp. This study utilizes the Affordance Theory Research Model to explore individual IEQ criteria [acoustics, aesthetics (appearance), daylighting, electric lighting, indoor air quality, privacy, thermal conditions, vibration and movement and view] associated with the physical environment (DE and NE) of the AWSp and how they afford employees' satisfaction. Further, this study explores the relationship between employees' satisfaction with overall AWSp, PWSp, and the F (SBI). Lastly, this study explores the overall IEQ score associated with employees' satisfaction with the AWSp and PWSp, which could be seen as an observed measure of affordance. Overall IEQ scores represent a composite of employees' satisfaction using a weighted mean. IEQ scores identify which IEQ criteria have the most and the least impact on employees' satisfaction, therefore are affordances or constraints.

This study involves self-reported perceptions of the environment and equates employees with observers; observations resulting in satisfaction as an affordance and dissatisfaction as a constraint, and the physical environment as the designed built environment. The following research questions are proposed in this study:

1. What is the relationship of employees' satisfaction with the physical environments of the F (SBI), PWSp, and the AWSp?
2. What is the relationship of employees' overall IEQ satisfaction score between the PWSp and the AWSp?
3. What is the relationship of employees' satisfaction with the individual 11 IEQ [acoustics, appearance (aesthetics), daylighting, electric lighting, function, furnishings, indoor air quality, privacy, thermal, vibration and movement, view conditions] in their PWSp and the AWSp?

Hypotheses and Theoretical Framework

Null Hypotheses

A research hypothesis is “a tentative assumption made in order to draw out and test its logical or empirical consequences” (Hypothesis, def.2, n.d.). A null hypothesis (H_0) is a statement proposing that there is no significant difference between the variables of interest whereas an alternative hypothesis (H_1) is a statement proposing that there is a significant relationship. The variables of interest in this study are a measurable phenomenon. For this study, employees’ satisfaction is the phenomena of interest and serves as the dependent variable with IEQ conditions serving as independent variables in this research. The proposed hypotheses are stated as a null hypothesis and indicate that there is no significant difference between the dependent and independent variables. The significant difference is determined through a series of statistical tests that are presented in Chapter Three and discussed in Chapter Four.

$H1_0$ There is no significant difference among employees’ satisfaction with the physical environment associated with the overall F (SBI), PWSp, and AWSp.

$H2_0$ There is no significant difference between the employees’ overall IEQ satisfaction score with their PWSp and AWSp.

$H3_0$ There is no significant difference between employees’ satisfaction with the 11 individual IEQ criteria (acoustics, appearance (aesthetics), daylighting, electric lighting, function, furnishings, indoor air quality, privacy, thermal, vibration and movement, view) associated with their PWSp and the AWSp. The individual IEQ conditions are states as follows:

a. There is no significant difference between employees' satisfaction with the acoustic conditions (ACC) of their PWSp and the AWSp.
b. There is no significant difference between employees' satisfaction with the appearance (aesthetics) conditions (APP) of their PWSp and the AWSp.
c. There is no significant difference between employees' satisfaction with daylighting (DAY) conditions of their PWSp and the AWSp.
d. There is no significant difference between employees' satisfaction with electric lighting (ELE) conditions of their PWSp and the AWSp.
e. There is no significant difference between employees' satisfaction with the function (FUN) of their PWSp and the AWSp.
f. There is no significant difference between employees' satisfaction with the furnishing (FUR) conditions of their PWSp and the AWSp.
g. There is no significant difference between employees' satisfaction with the indoor air quality (IAQ) conditions of their PWSp and the AWSp.
h. There is no significant difference between employees' satisfaction with the privacy (PRI) conditions of their PWSp and the AWSp.
i. There is no significant difference between employees' satisfaction with the thermal (THE) conditions of their PWSp and the AWSp.
j. There is no significant difference between employees' satisfaction with the vibration and movement (VIB) conditions of their PWSp and the AWSp.
k. There is no significant difference between employees' satisfaction with the view (VIE) conditions of their PWSp and the AWSp.

A framework identifying the relationship between the Observer (Employee) and the DE is included in

Figure 33. The framework includes the three hypotheses and identifies the theory constructs for the O (observer or employee) and the DE (design environment) encompassing the F (SBI) and nested components of the PWSp and AWSp.

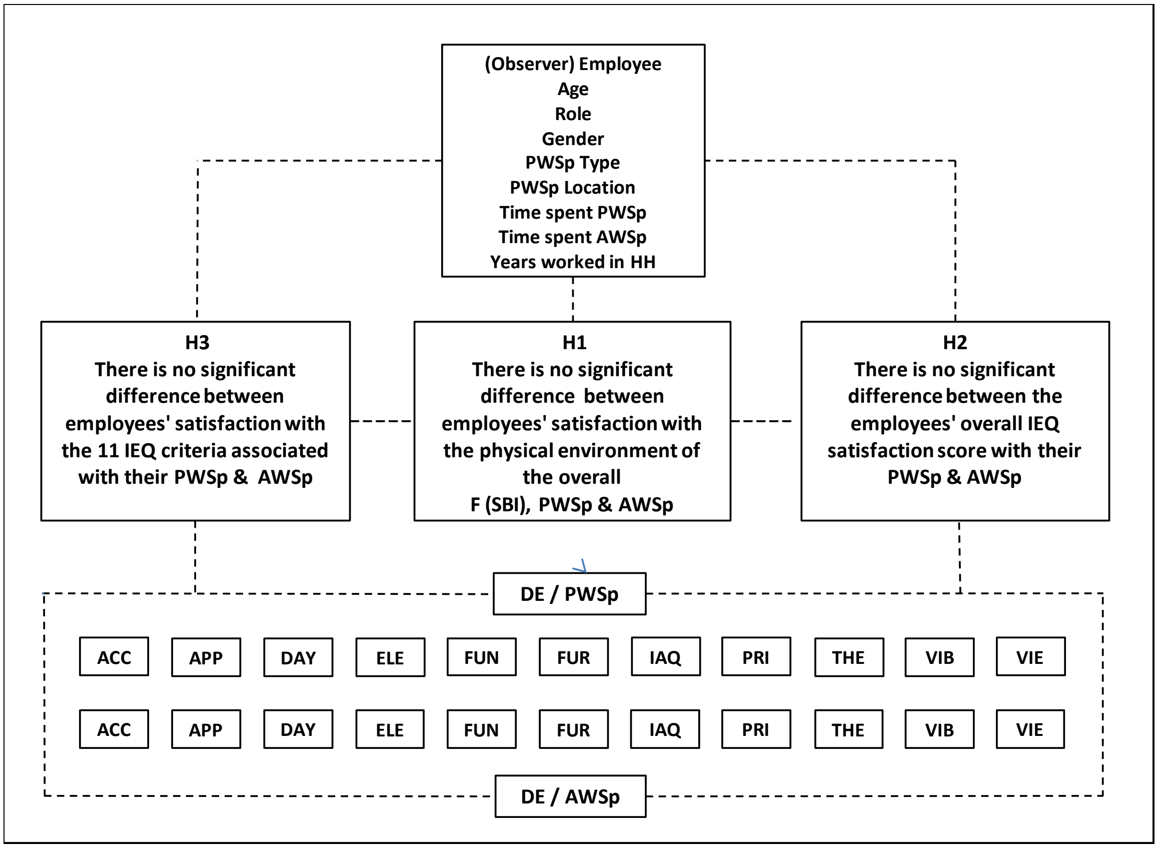


Figure 33. Research framework: H1, H2, and H3

Summary

This research examined changes in workplace environments over the last century leading up to new ways of working and new places to work from, referred to in this study as AWSp. Concern for the employee experience, i.e., employees' satisfaction, overall environment satisfaction, and job satisfaction, in workplace environments fostered the development of sustainable building guidelines that address IEQ. To evaluate the success of sustainable design criteria, researchers conduct POE studies to collect feedback on employees' satisfaction with the IEQ criteria in the design environment. Thus far, POE assessment has focused on the F (SBI) and the PWSp. Studies examining IEQ conditions associated with AWSp are limited and generally ancillary to the research focus on task performance or work modes.

This study recognizes the growing presence of AWSp in workspace environments and the need to examine employees' satisfaction with AWSp in workplace environments and satisfaction with IEQ criteria in the PWSp and AWSp. A discussion of the 11 category level IEQ criteria (appearance, acoustics, daylighting, electric lighting, function, furnishings, IAQ, privacy, thermal conditions, vibration and movement, and view) was presented. The literature identified definitions and standards for each IEQ criteria along with a review of employees' satisfaction with their F (SBI) and PWSp in workplace environments. Similar research representing employees' satisfaction with IEQ conditions in AWSp was less supported in the literature.

The affordance theory was presented as a theoretical framework for this study. A model of the affordance theory was developed to illustrate the employee in the role of the 'observer' of the environment (design, natural, and social) and perceptions of environmental conditions (IEQ criteria) resulting in satisfaction as 'affordances.'

Dissatisfaction with IEQ criteria is considered a ‘constraint’ where satisfaction is not present or not yet observed. Chapter 3 describes the SPOES research tool, the fit of theoretical model to this study, the building selected for the study, the sample population, the data collection methods used, the analysis used, and the limitations of the study.

CHAPTER THREE

This chapter describes the process and methods used to examine employees' satisfaction with indoor environment quality (IEQ) in their workplace environments. As previously presented, the specific areas of focus include employees' overall satisfaction with the facility (site, building, and interior) [F (SBI)], primary workspace (PWSp), and alternative workspace (AWSp); the overall composite IEQ satisfaction score for the AWSp and PWSP; and satisfaction with each of the 11 individual IEQ criteria.

The Sustainable Post-Occupancy Evaluation Survey (SPOES) was adapted to this study and modified to include the same IEQ questions used for both AWSp and PWSp locations. The survey instrument and the individual sections applicable to this research and the process for distribution will be presented in greater detail. The Herbert M. Hanson, Jr. Hall, (hereafter Hanson Hall), is a mixed-use office and classroom building located on the west bank campus at the University of Minnesota (UMN) was selected for this study due to the significant allocation of AWSp in the overall building function.

Affordance theory was used as the theoretical framework and developed into a model to explore employees' satisfaction with IEQ criteria (acoustics, appearance, daylighting, electric lighting, function, furnishings, indoor air quality, privacy, thermal conditions, vibration, and movement and view conditions) associated with the physical environment. This chapter includes discussion of the research method used to collect the data, theoretical framework aligned with variables, building and sample description, data analysis method, and limitations.

Research Methods

Instrument Development: SPOES Scan V2 and AWSp Module

The instrument used for this study was the SPOES Scan V2 + AWSp Module. The Center of Sustainable Building Research (CSBR) developed and uses the SPOES Scan V2 instrument as a standard evaluation tool to assess employees' perceptions of IEQ criteria in B3 (Building, Benchmark, and Beyond) project sites. As this instrument includes questions only for the F (SBI) and PWSp, a series of questions was developed to collect data on employees' satisfaction with their AWSp, hereafter referred to as the AWSp module and discussed in detail later.

The instrument includes four distinct sections as follows: Section 1 addresses employees' satisfaction and perception of work performance and health of the overall F (SBI). Section 2 addresses employees' satisfaction, perception of work performance and health in the PWSp, and satisfaction with IEQ conditions (both category and attribute level criteria). Section 3 addresses aspects of employees' physical activity and commuting behaviors. Section 4 addresses employees' demographics such as age, gender, role, years of service, and years associated with the building. Employees rate their satisfaction and their perception of performance and health on a 7-point Likert-type scale with “7” indicating they were “very satisfied” with the IEQ criterion and “1” indicating they were “very dissatisfied.” Responses for mean scores at “4” or above are associated with satisfaction and scores below “4” are considered dissatisfied. The scale is a continuous scale, and the results are discussed in terms of satisfaction ranging from high levels of satisfaction to low levels. An open-ended question is included at the conclusion of each section of the F (SBI) and the PWSp to capture additional employee comments or concerns.

The questionnaire was administered online with the help of building staff who served as site survey coordinators and have access to a listserv of employees associated with the building. A message (see Appendix B.1) was sent to all employees in the building inviting them to participate, on company time, in a survey about their satisfaction with the physical environment of their workplace F (SBI), their PWSp, and specific AWSp they used. A link to the survey was included in the invitation. Surveys remained live for a 10-day period; a reminder notice was sent to employees near the end of the survey time period to encourage participation.

SPOES Scan V2+AWSp Module

The SPOES Scan V2 does not include questions about employees’ AWSp. Therefore, a module was developed to evaluate employees’ satisfaction with selected

AWSp in Hanson Hall. Questions in the module replicated the PWSp IEQ questions. Almost half of the physical workspace in Hanson Hall included AWSp that serves both employee and student users. Therefore, it became an important component of this research to develop the method by which the SPOES instrument can be inclusive of the entire building, not only PWSp. By completing the same set of questions for both PWSp and AWSp, employees provided in-depth evaluation of all workspaces in the building.

The AWSp Module was developed in three stages. First, interviews were conducted with site survey coordinators from each department on the use of AWSp in Hanson Hall; e.g., employee access to spaces, use associated with the AWSp, times they used, etc. Following the interview, a walk-through of all AWSp provided additional information on employees' use, e.g., writing on boards, additional privacy mechanisms installed in some areas, bikes stored in some locations, etc. Lastly, space allocation plans were used to identify departments and units having AWSp spaces in Hanson Hall. Following a careful analysis and review of the plans and information gathered from the onsite interview and walk-through, a master list of 33 individual AWSp in Hanson Hall were identified as candidates for analysis.

The initial nine-month post occupancy evaluation (POE) survey was administered in May, 2013 to employees in Hanson Hall to both pre-test the modified survey process and to identify which AWSp were used most frequently. A survey including the same set of questions was developed for the three departments participating in the survey. The three departments include the Carlson School of Management (CSOM), the Office Institute Technology (OIT), and the Economics (Econ) Department]. The surveys differed only in department specific AWSp that were distributed in different areas of the building. Common or shared access AWSp, for example, Starbucks and the computer lab where included in all three surveys.

As previously stated, all SPOES instruments are designed to address overall satisfaction with the F (SBI), overall satisfaction with the PWSp, satisfaction with individual IEQ criteria associated with the PWSp, physical activities afforded by the building, community practices and brief questions on demographics. To transition through the survey as quickly as possible, employees were first asked if they had a PWSp in Hanson Hall. Employees who responded ‘yes’ advanced to a set of questions that focused specifically on the PWSp. At this point, they were asked to identify their type of PWSp from a standard list of workspace types (e.g., private office, shared office, workstation, desk, etc.), and then to identify the location of their workspace in the overall building (e.g., first floor, second floor, third floor, etc.). Employees were then asked to respond to a standardized set of IEQ questions directed at overall satisfaction with their PWSp, followed by satisfaction with individual IEQ criteria associated with the PWSp.

Employees that responded ‘no’ advanced directly to the next section which focused specifically on AWSp. As with the procedure developed for the PWSp section, employees were asked if they used AWSp for work-related activities. If they answered ‘yes’, the survey was designed to allow employees to select up to three different AWSp in Hanson Hall for further evaluation. As earlier discussed, the AWSp included on the survey were developed from the plan review, on-site interviews and walk-through of the entire building environment and therefore, each space and location were associated with each of the three departments responding to the survey (CSOM, OIT, and Econ). Once the employees identified the AWSp they wanted to evaluated, they were directed to the same set of identical set of questions associated with the PWSp (overall satisfaction and satisfaction with individual IEQ criteria) except that these new questions were directed at their self-identified AWSp. If employees only selected one space, they could opt to advance to the final set of questions (demographic information, physical activity and commuting practices). If employees did not use any AWSp, they automatically advanced to the final sections of the survey.

The results of the initial nine-month survey suggested the 33 different AWPs be reduced to 16 spaces overall and incorporated into one survey and administered to all three departments. Selection of these 16 spaces was guided by the response rate, use, and access to these spaces by those employees who participated in the initial nine-month pilot study. To conserve participation time and minimize survey fatigue, the employees selected only one AWSP from the 16 different spaces. The SPOES Scan V2 + AWSp

Module was administered between March 6th -15th, 2014.

Employees responded to the same set of questions regarding their overall satisfaction with the F (SBI), PWSp, and AWSp, followed by 22 questions related to IEQ category and attribute level questions associated with the PWSp and AWSp. Eleven IEQ criteria representative of category level IEQ were selected for this study. They include: appearance (aesthetics), daylighting, electric lighting, function, furnishings, indoor air quality, privacy, thermal conditions, vibration and movement, and view conditions. Mean scores were developed for satisfaction with each IEQ criterion, satisfaction with the overall F (SBI), PWSp, and AWSp along with an overall IEQ weighted mean score for the PWSp and AWSp. The results also reveal which IEQ category level criteria contribute the most or the least to employees' satisfaction.

Affordance Theory, Observer Perceptions of IEQ conditions

A model of the Affordance Theory served as the research framework to test hypotheses was previously presented. The Affordance Theory Research Model was adapted to this study and reflects specific variables of interest. *Figure* 34 illustrates Bauer's research model of the Affordance Theory with the specific variables of interest related to the observer, environment, and IEQ criteria.

The observer (O) or employee is characterized by age, gender, role in the workplace; years working at this facility; hours worked in a typical week; type of workspaces used (PWSp and AWSp); and location within the F (SBI). The employees' PWSp and AWSp are 'nested components' in the design environment (DE) or F (SBI). Although this study focuses primarily on physical aspects associated with the DE, it also recognizes the relationship of the design environment (DE) to the natural environment NE (e.g., views and daylight). and the social environment (SE) (e.g., acoustic and visual privacy). The literature review discussed linkages between environments (SE, NE, and DE). Employees' self-reported satisfaction indicates an affordance with the environment (illustrated by the color green or a short dashed line), and dissatisfaction indicates a constraint with the environment (illustrated by the color red or a short dashed line).

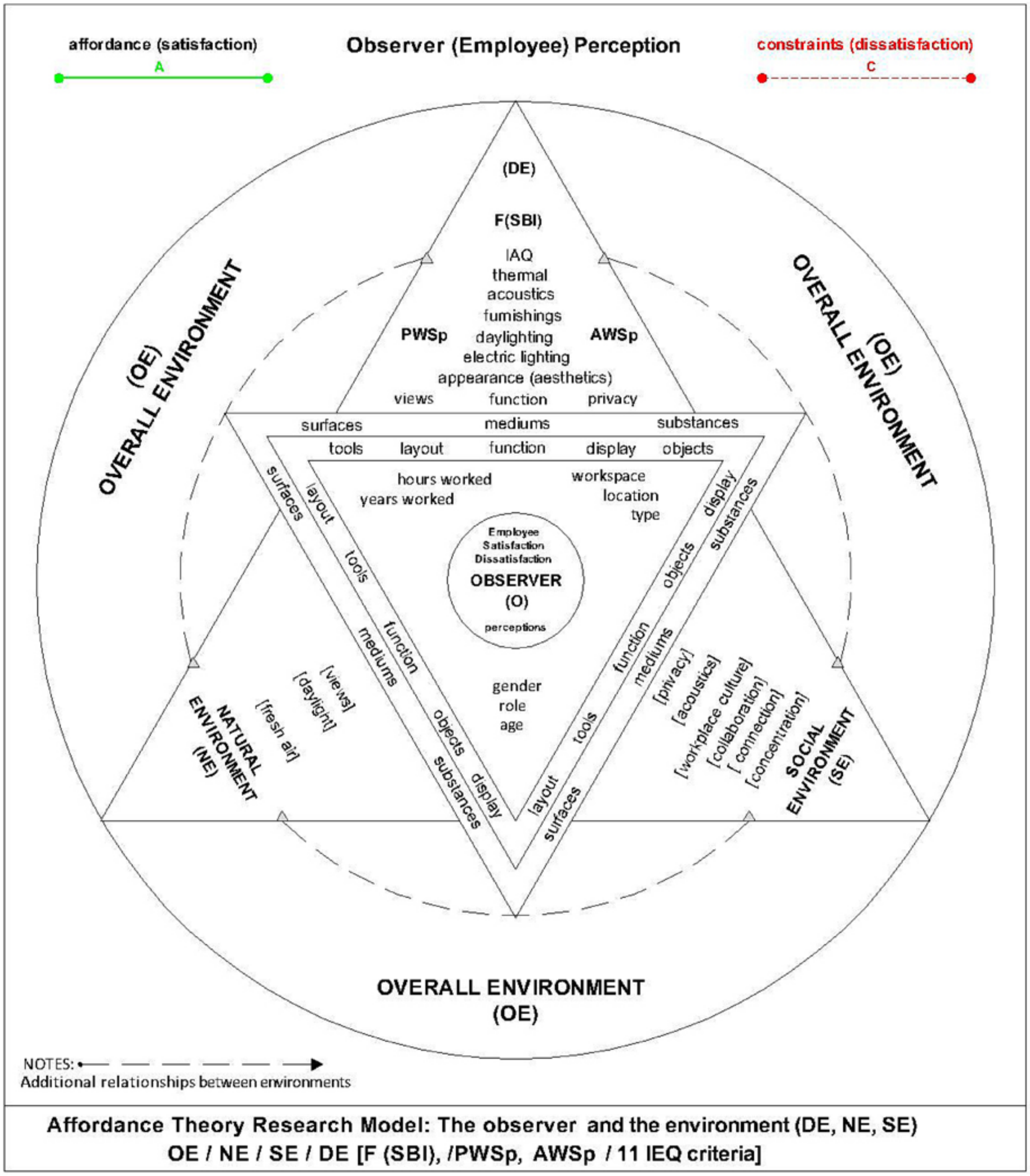


Figure 34. The Affordance Theory Research Model: O, DE, NE, and SE

The theoretical constructs (observer and affordances) are reflected in Tables 1-4 that identify specific survey questions, type of measurement (nominal or scale), and type of response as a fit to the theoretical model.

Table 1. Observer (O) employee: demographics and time spent in the workplace includes the observer (employee) construct and questions in the questionnaire associated with individual characteristics (e.g., work role, age, and gender) and time spent in the workplace. Table 2 includes the observer (employee) construct and questions associated with their PWSp and AWSp (types and locations). Table 3 summarizes the DE construct and questions associated with observer (employee) satisfaction related to $H1_0$ [employee satisfaction with the overall F (SBI), PWSp, and AWSp]. Table 4 summarizes the DE construct and questions associated with observer (employee) satisfaction related to H 2 and H3 (employees' satisfaction with the individual IEQ criteria associated with the PWSp and AWSp).

Table 1. Observer (O) employee: demographics and time spent in the workplace

Theory Construct	**Employee Demographics**	**Type of Measure: Nominal Select from:**
Observer (O) Employee	115. What is your age?	18 --- 90
	116. What is your gender?	Male or Female
	117. Which of the following best describes your role in Hanson Hall?	Undergraduate Student. Graduate Student, Staff, Faculty
	118. How many years have you worked at Hanson Hall?	Less than 1 year 1-2 years, 2-3 years, More than 3 years
	119. In a typical week, how many hours do you spend at Hanson Hall?	Less than 20 hours. 20-30 hours, 31-40 hours, more than 40 hours
	120. During a typical work week, approximately what percentage of time do you spend each type of workspace? PWSp AWSp	1% - 10%, 11% - 20%, 21% - 30%, 31% - 40%, 41% - 50%, 51% - 60%, 61% - 70%, 71% - 80%, 81% - 90%, 91% - 100%

Table 2. Observer (O) employee: PWSp and AWSp characteristics

Theory Construct	**Employee Demographics**	**Type of Measure: Nominal** **Select from:**
Observer (O) Employee	6. Which of the following best describes your primary workspace, i.e., the one where you spend the most time?	Enclosed office, private Enclosed office, shared with others Cubicle with low partitions (< 5’) Cubicle with high partitions (>5’) Cubicle with low and high partitions Desks in open office (no partitions) Other, please specify
	7. What floor is your PWSp located on?	Lower Level, First Floor, Second Floor, Third Floor, Fourth Floor
	13. Do you use AWSp for work related activities?	Yes or No
	14. From the list below, please select an AWSp that you use for work related activities. You will be directed to questions regarding that specific workspace.	2nd F (2-202)Coffee Shop (Starbucks) 2nd F (2-205) Conference Rm 2nd F (2-233) Conference Rm (So) 2nd F (2-245) UG Seminar Lounge 2nd F (2-250) Conference Boardroom 2nd F (2-255) UG Recruiters Lounge 3rd F (3-100) OIT Conference NE area 3rd F (3-100) Lounge Meeting 3rd F (3-170) Econ Computer Lab 3rd F (3-145) Econ Library 4th F (4-117) Econ Small Conference 4th F (4-186) Econ Large Seminar Rm 4th F (4-170) Econ Large Classroom 4th F (4-170) Econ Med Conference Rm 4th F (4-155) Econ Lounge / Kitchen

Table 3. DE: HI Observer satisfaction with the overall F (SBI), PWSp, and AWSp

Theory Construct	Workplace Environment Overal Satisfaction F (SBI) PWSp and AWSp	Type of measure: Likert-type scale 1-7
H1 There is no significant difference in employees' satisfaction with the designed environment among AWSP, PWSp, and F (SBI)		
DE	Overall F (SBI) 2. Overall, how satisfied are you with the physical environment of Hanson Hall (site, building, and interior)? Overall PWSp 10. Overall, how satisfied are you with the physical environment of your primary workspace? Overall AWSp 17. Overall, how satisfied are you with the physical environment of your primary workspace?	"1" – very dissatisfied to "7" – very satisfied Satisfaction = Affordance Dissatisfaction = Constraint Dissatisfaction < 4.0 Satisfaction > 4.0

Table 4. DE: H2 & H 3 Observer satisfaction with PWSp & AWSp IEQ conditions

Theory Construct	Workplace Environment Satisfaction with IEQ Criterio PWSp and AWSp	Type of measure: Likert-type scale 1-7
H2. There is no significant difference in employees' satisfaction between the IEQ score for the AWSp and		
H3. There is no significant difference in employees' satisfaction with IEQ conditions (acoustics, appearance (aesthetics), daylighting, electric lighting, function, furnishings, indoor air quality, privacy, thermal, vibration and movement, view) between their PWSp and their AWSp.		
DE	11 PWSp and 16+ AWSp Please indicate how satisfied you are with each of the following aspects of: The overall acoustic quality The overall appearance (aesthetics) The overall daylighting conditions The overall electric conditions The overall furnishings The overall indoor air quality The overall function The overall privacy conditions The overall thermal conditions The overall vibration & movement The overall view conditions	"7" – very satisfied "1" – very dissatisfied Satisfaction = Affordance Disatisfaction = Constraint Satisfaction > 4.2 Dissatisfaction < 4.0

Building Characteristics for Hanson Hall

Hanson Hall is a mixed-use classroom and administrative office facility that includes both PWSp and AWSp for employees' use. The building was designed and developed referencing the B3-MSBG guidelines and occupied in 2008. Hanson Hall is located on the West Bank of the Twin Cities (Minneapolis and St. Paul) campus at the University of Minnesota (UMN) (see *Figure* 35). UMN is a world-renowned land grant public research university founded in 1851 and is committed to:

> the belief that all people are enriched by understanding, is dedicated to the advancement of learning and the search for truth; to the sharing of this knowledge through education for a diverse community; and to the application of this knowledge to benefit the people of the state, the nation, and the world. (UMN, n.d.a)

Figure 35. Hanson Hall, West Bank, Twin Cities Campus (UMN, n.d.b)

The university carries out their mission of Research and Discovery, Teaching and Learning, and Outreach and Public Service across four outstate campuses (Duluth, Morris, Crookston, and Rochester) and at the metropolitan Twin Cities campus. The Twin Cities campus is recognized as the flagship university in the state of Minnesota and encompasses three separate locations referred to as West Bank, East Bank, and St. Paul.

The West Bank campus lies adjacent to the Minneapolis downtown hub. *Figure* 36 shows an aerial view of the East Bank and West Bank campuses, connected by a vehicular and pedestrian covered bridge spanning the Mississippi River.

Figure 36. Aerial view of West Bank and East Bank Campus, University of Minnesota (Wikipedia, n.d.b)

Hanson Hall is located on the southern tip of the West Bank campus near the Cedar-Riverside development area, along with the Humphrey School of Public Policy, the West Bank Art Quarter, Law School, and the Carlson School of Management. Travel in and around the West Bank area is made possible by way of bus, light rail, bike, and pedestrian paths via the Washington Avenue Corridor Bridge. Major freeways intersect the perimeter of the West Bank campus, and several parking ramps accommodate commuter vehicles. The intercampus shuttle bus operates free-of-charge between the East Bank, West Bank, and St. Paul campuses. *Figure* 37 illustrates the location of Hanson Hall on a campus map of the East Bank and West Bank at the University of Minnesota.

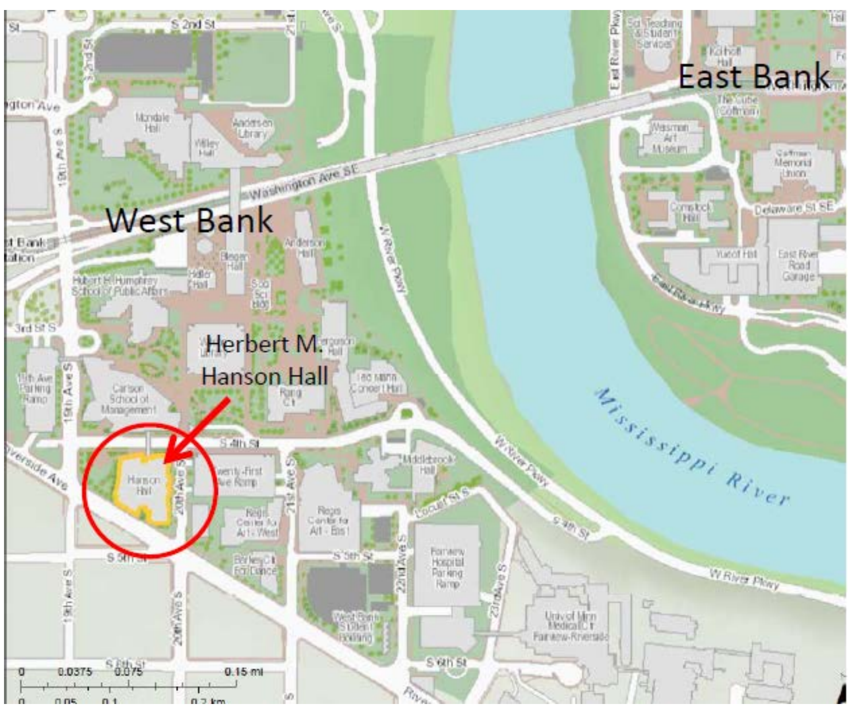


Figure 37. Campus map illustrating the location of Hanson Hall on the west bank of the Minneapolis campus (University of Minnesota, n.d.c)

Hanson Hall and Departments

Hanson Hall occupies approximately 124,000 square-feet over five floors - four levels above grade and one level below grade. The building is widely recognized by the student population as a classroom facility serving undergraduate freshmen through senior level classes in business and economics. The lower level, first floor, and second floor surround a large interior courtyard, flooding daylight into two separate building structures. A glass façade of offices is located on the east side of the base building and provides two additional floors of administration space. The second floor is connected to the Carlson School of Management through a skyway, allowing easy connections to between departmental functions and classes.

Hanson Hall has nine classrooms / lecture halls and dedicated student breakout spaces located on the first floor. The CSOM provides office space for both graduate and undergraduate student services on second floor. In conjunction with CSOM, the OIT provides office space for the Information Technology Student Services (ITSS) on the third floor and operates the student computer lab on the lower level. The Department of Economics (Econ) has administrative office space for graduate and faculty on the third and fourth floors. The University Dining Services provides operational space for Starbucks Coffee® on the second floor and vending provisions on the lower level.

PWSp varies throughout the building from private offices with guest seating to cubicles or workstations to countertop work surfaces with task seating and small kiosk-style desks. Permanent faculty and staff members are assigned to these primary workspaces. Undergraduate and graduate students are employed part-time through semester appointments and are provided PWSp (work surface, task seating, and network connections) to support work-related activities.

Hanson Hall has a number of different types of AWSp distributed throughout the building that accommodate different styles of work such as concentration spaces (library spaces), collaboration (meeting / training rooms), and connection spaces (break rooms / lounges). The building hosts several open lounge and seating areas in the lower level, first floor, and second floor that are open to all users of Hanson Hall. There are several dedicated student break-out rooms on the lower level, first floor, and second floor that are administered by the COM and CSOM. The remainder of AWSp in Hanson Hall is associated with and / or used by a specific department. Table 5 shows a breakdown of the overall PWSp, AWSp, classroom spaces (COSp), and building services and amenities (BSA) located throughout the building to provide a more comprehensive understanding of the allocation of space and functional use. A breakdown of AWSp included in the study and that which is provided here to illustrate the significance in the amount of space that is not typically addressed in POE research.

Table 5. DE: Building space allocations (BSA, COSp, PWSp and AWSp)

Level / Floor	Total SF	BSA Building Services (etc.)	COSp Not in study	PWSp in study	AWSp included in study	AWSp Not in study	Total AWSp HH
Lower Level	22,532	15,550	0	1,827	2,394	2,761	5,155
First Floor	34,390	14,786	18,810	0	0	794	794
Second Floor	31,074	11,389	0	7,026	4,720	7,939	12,659
Third Floor	14,880	4,085	0	8,418	1,846	531	2,377
Fourth	15,063	4,156	0	8,119	3	214	2,938
Total	**117,939**	49,966	18,810	**25,390**	**8,963**	**12,239**	**23,923**

The first floor, dedicated primarily to COSp, is included in this table to provide an overall reference to the use of space contributes to the overall AWSp available to both staff and students. BSA provides facility services to support the building function and includes telecom closets, mechanical rooms, restrooms, etc. BSA is not associated with any type of workspace and is generally considered as 'class D' space in most space allocation reports. As indicated, BSA occupies the most significant amount of non-workspace in Hanson Hall. COSp is operated by OCM, and space allocations listed are for reference only. The remainder of the table identifies the total amount square feet dedicated to PWSp (25,390 sf) and the total amount of square feet dedicated to AWSp (23,923 sf) in the building. The AWSp represents a significant amount of space that is not currently addressed in other Hanson Hall POE studies. The following discussion focuses on individual floors, assigned departments, and functions within the department.

Hanson Hall - Lower Level

The lower level surrounds a day lit atrium and is accessible to the first floor via an open stairway. It is the home of the collaborative student learning center and includes the undergraduate student study lounge, a computer learning lab, help desk, laptop repair center, and secure laptop storage lockers. Six collaborative breakout rooms, fitting the physical description of AWSp, are dedicated for student use and managed by the OCM. The ITSS provides office space for lab attendants and management personnel to oversee the laptop and technology service program. Primary workspaces consist of countertop work surfaces in reception areas, workstations (with various panel heights), and one enclosed private office. Over half of the space on the lower level is dedicated space for building services (HVAC, storage) and related amenities (vending and network communication services) to support building operations. *Figure* 38 illustrates the overall spatial arrangement of the lower level and is color coded for ease in reading the plans. Specific locations of AWSp (included in the study) are beige; PWSp (included in the study) are yellow; AWSp (not included in the analysis of the study) are light green; and building services and amenities (BSA) (not included in the analysis of this study) are gray.

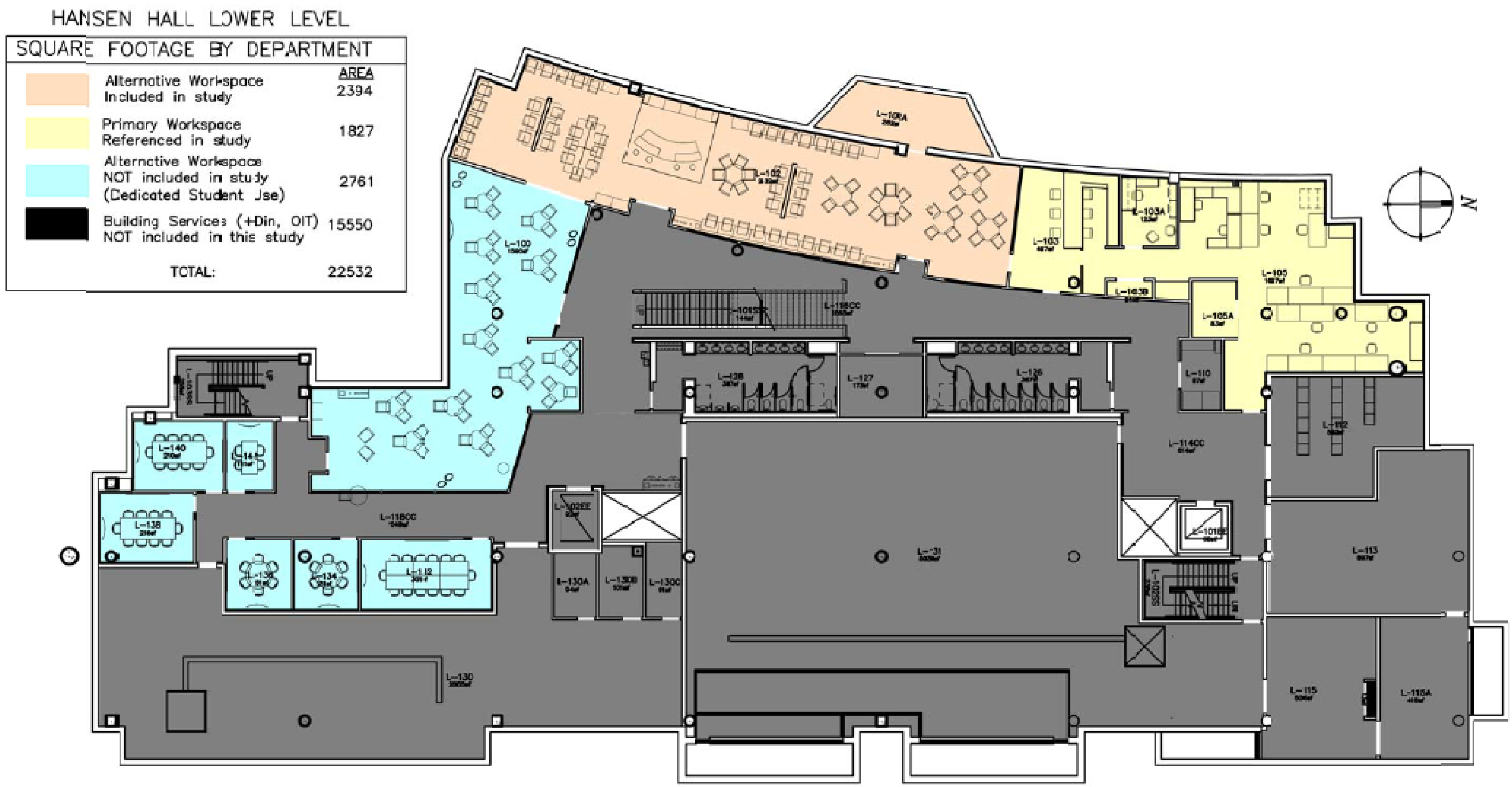


Figure 38. Hanson Hall, Lower Level Color shading indicates space allocations AWSp, PWSp, and BSA
*Note: Floor plan adapted from drawings (Capital Planning & Project Management, University of Minnesota, not to scale)

Hanson Hall - First Floor

The majority of first floor of Hanson Hall is operated by the OCM. There are five 75-seat classrooms and four 124-seat classrooms. Over 9,000 students attend classes in Hanson Hall each semester (Administrator, UMN Office of Classroom Management, personal communication, 2014). Four breakout rooms (conference rooms) lie adjacent to the large lecture halls and provide dedicated student breakout space for collaborative class activities. There are no primary workspaces on the first floor. Although there are spaces that fit the physical requirements for AWSp that serve as dedicated collaborative student breakout rooms, none of these were used in the study due to their limited use. Classroom spaces and their associated student breakout rooms were in the scope of this study but remain integral to the discussion on overall utilization building spaces. *Figure* 39 illustrates the overall space allocations for the first floor and includes classrooms (blue shaded), dedicated student AWSp for (light green shaded) and BSA (gray shaded). While the spaces included on the first floor are outside of the scope of the study, they are included here to provide a more comprehensive understanding of the building function and AWSp that are typically not included in POE research.

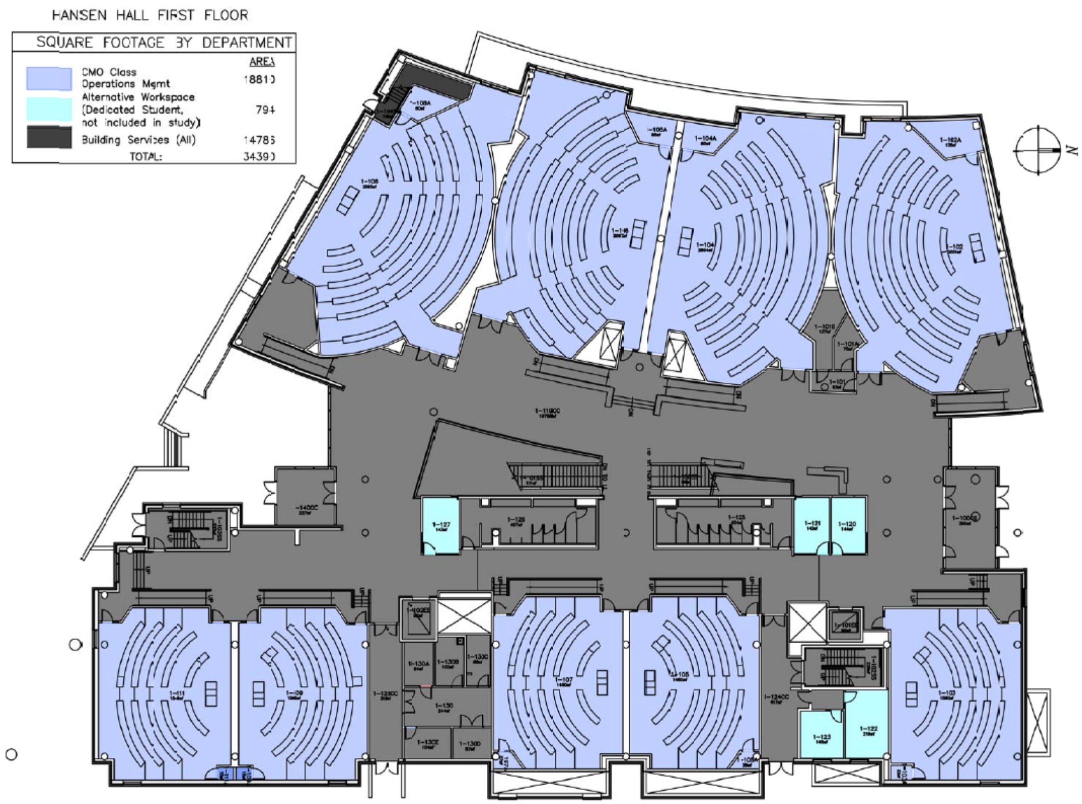


Figure 39. Hanson Hall, 1st Floor, Color shading indicates space allocations AWSp, PWSp, and BSA
*Note: Floor plan adapted from drawings (Capital Planning & Project Management, University of Minnesota, not to scale)

Hanson Hall - Second Floor

The second floor is open to the first floor and lower level via the central atrium area. The CSOM provides space for the Undergraduate Business Career Center (UBCC), the Graduate Business Career Center (GBCC), and the Undergraduate Programs Academic Advising Office. The floor plan reflects enclosed, private offices for selected staff with managerial roles, workstations (with various panel configurations), and work surface configurations in reception areas. The CSOM UBCC and the CSOM GBCC provide a seminar space for informational corporate presentations, a recruiting lounge for networking events, 22 mock interview rooms, a career research center, and office space for career guidance counseling. Student interns majoring in accounting have dedicated office space that is operable during the tax season in spring semester each year. The remainder of the year, the space remains locked and unused. Starbucks Coffee® is located on the northwest corner of the second floor and accommodates dining, lounge, and study space both inside and outside on the patio deck. *Figure* 40 illustrates the overall spatial arrangement of second floor and specific locations of AWSp (included in the study) are coded beige, PWSp (included in the study) are yellow, AWSp (not included in the analysis of the study) are light green, and BSA (not included in the analysis of this study) are gray color.

Figure 40. Hanson Hall, 2nd Floor, Color shading indicates space allocations AWSp, PWSp, and BSA
*Note: Floor plan adapted from drawings (Capital Planning & Project Management, University of Minnesota, not to scale))

Hanson Hall – Third Floor

The third floor provides office space for both the Department of Economics (Econ) and the Information Technology Student Services (ITSS). Overall, a significant portion of the floor plan reflects dedicated, enclosed, shared workspaces for graduate teaching assistants (TA) who have a desk, task chair, and file storage. The Econ Research Library is located on the south side of the building, receiving a substantial exposure to natural daylight, while the Econ Computer Lab, a small kitchen /lounge, and copy work areas are located in the central corridor of the building in windowless spaces. ITSS occupies the northern section of the floor, and includes office space, copy/kitchen /workspace, and a few small conference and lounge spaces tucked into corners around the floor. Recent changes in administrative services and retrenchment of staff due to budget cutbacks have left some spaces underutilized and other areas wholly repurposed as storage areas. *Figure* 41 illustrates the overall spatial arrangement of the third floor. AWSp (included in the study) are coded as beige; PWSp (included in the study) are yellow; AWSp (not included in the analysis of the study) are light green; and BSA (not included in the analysis of this study) is gray.

Figure 41. Hanson Hall, 3rd Floor Color shading indicates space allocations AWSp, PWSp, and BSA
*Note: Floor plan adapted from drawings (Capital Planning & Project Management, University of Minnesota, not to scale)

Hanson Hall - Fourth Floor

The fourth floor is occupied solely by the Department of Economics, a program that is highly recognized across the nation for its leadership in the advancement of new research, theory, and graduate student education. The floor plan reflects a significant amount of dedicated enclosed, private offices used as PWSp for full-time faculty and selected administrative staff; cubicle space for staff; and a few enclosed, shared workspaces for graduate teaching assistants. The fourth floor includes several collaborative meeting spaces that line the central corridor of the floor plan. A southern facing lounge includes a full kitchen and dining area for private meetings and department events. *Figure* 42 illustrates the overall spatial arrangement of fourth floor. Again, specific locations are color coded with AWSp (included in the study) as beige; PWSp (included in the study) are yellow; AWSp (not included in the analysis of the study) are light green; and BSA (not included in the analysis of this study) are gray color.

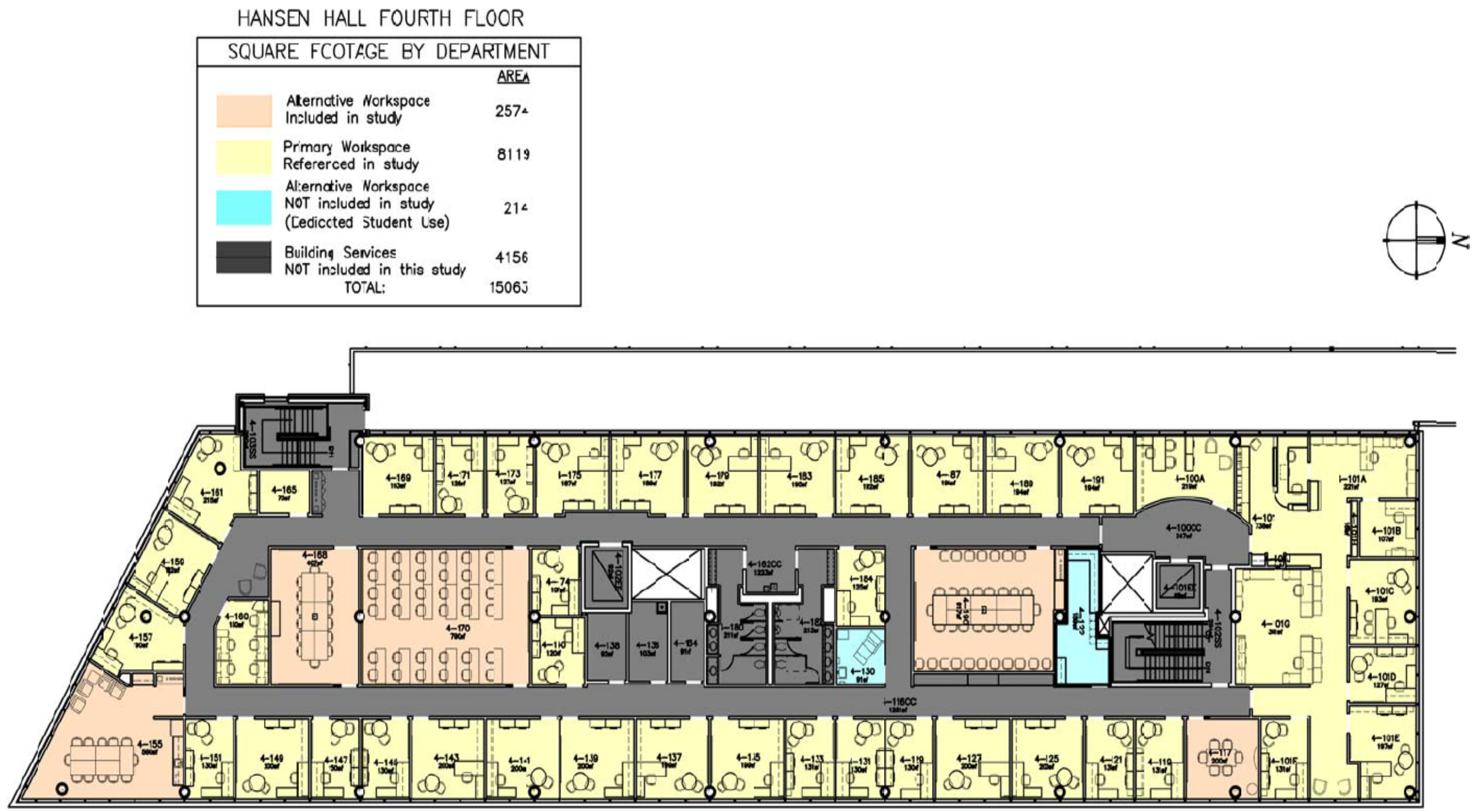


Figure 42. Hanson Hall, 4th Floor, Color shading indicates space allocations AWSp, PWSp, and BSA
*Note: Floor plan adapted from drawings (Capital Planning & Project Management, University of Minnesota, not to scale)

Building Population and the Survey Event

Hanson Hall employees affiliated with the CSOM Undergraduate Program Office, the CSOM Undergraduate Career Center, the CSOM Graduate Career Center (second floor), CSOM Information Technology Student Services (the lower level and third floor), and the Department of Economics (third and fourth floor) were invited to participate in this survey. Staff administrators serving as site survey coordinators forwarded a message with a survey link to all employees in their department who had PWSp in Hanson Hall. The survey was administered in early March 2014 and received a response rate of approximately 27% or approximately 67 individuals responding to the survey.

The survey data were cleaned and missing or incomplete survey responses were eliminated. The final sample (N) consisted of 26 respondents who completed all three sections of the survey or approximately 10% of the total building population. Over one half of the employees responding to the survey did not complete the survey. It is unclear if survey fatigue or other conditions contributed to incomplete surveys associated with AWSp.

Survey fatigue is generally accepted as an encumbrance on the respondent's time, and can contribute to lower response rates (Sharp & Frankel, 1983). Porter, Whitcomb, and Weitzer (2004) note that "the more time is demanded, as in multiple surveys, the lower the response rate will be" (p. 65). Is important to note that employees' progress from Section 1 F (SBI) (three overall questions) to Section 2 PWSp (three overall questions and 23 IEQ category and attribute level questions) and finally onto Section 3 AWSp (three questions and 23 of IEQ category and attribute level questions).By the time employees reached the AWSp questions, the number of respondents dropped. These conditions may contribute to survey fatigue and/or lower response rates related to fully completed surveys. Surveys with low response rates do not necessarily provide an accurate reflection of all individuals involved in the survey event as some of the population or their opinions may be under-represented or remain unacknowledged (Porter, Whitcomb & Weitzer, 2004).

To expedite the survey experience, the questionnaire was designed to allow employees to advance through sections 1, 2, and 3 based on their declared use of that physical environment. Response rates varied for each section, with the greatest number of responses occurring in the beginning and tapering off with each separate physical environment. Completed responses to each section were as follows: 100% with Section 1 F (SBI), 92% with Section 2 (PWSp), and 55% with Section 3 (AWSp). Approaches describing the measures of sampling adequacy (MSA) are presented under data analysis to identify steps taken to ensure that the reduced sample set was acceptable for statistical analysis.

The building population consists of approximately 240 employees and includes undergraduate students, graduate students, faculty, visiting scholars, administrative staff, and management personnel. Employees include both part-time and full-time staff with varying lengths of employment with their departments. The overall total building population fluctuates throughout the calendar year and peaks significantly during active semester periods.

Sample Data for the F (SBI), PWSp and AWSp

The sample data representing the building population are summarized in Table 6. Results indicated that employees responding to the survey ranged in age from 20 - 58 years, with a mean age of 34.50 years; 50 % were male and 50 % were female. Respondents' work-related roles showed that 46% were administrative staff, 42% were graduate assistants, and the remaining12% were faculty.

Related to the type of PWSp, results indicated that 42% of the employees worked in enclosed, shared private offices; 38% worked in enclosed private office by themselves; and 20% worked in cubicles (with various partition heights) or desks in open office spaces. Over 57% of the employees had PWSp on the 3rd floor, followed by 27% on the 2nd floor, more than 15% on the 4th floor, and 2% on the lower level. Employees responded to 11 of the 16 AWSp included in this study. The AWSp receiving the most responses were the 3rd Floor (3-170) Econ Computer Lab at over 30%, followed by the 4th Floor (4-186) Econ Large Seminar, and the 3rd Floor (3-100) IT Conference Room with both at 11.5%.

Table 6. Employee (Observer / O) sample demographics

Theory Construct	Description	Measure		Years
Observer (O) Employee	Age	Mean		34.5
		Mode		26 & 51
		Range		20-58
	Description	**Measure**	**Percent of Total**	**Frequency of Respondents**
	Gender	Male	50%	**12**
		Female	50%	12
		Totals	**100%**	**24**
	Primary Role	**Staff**	**45.80%**	**11**
		Graduate Student	41.70%	10
		Faculty	12.50%	3
		Totals	**100%**	**24**
	Types of PWSp	Enclosed office, private	38.50%	10
		Enclosed office, shared	**42.30%**	**11**
		Cubicle with low partitions (<5' h')	3.80%	1
		Cubicle with high partitions (>5'h)	11.50%	3
		Cubicle with both partitions	3.80%	1
		Total	**100%**	**26**
	Floor / Level	Lower Level	0%	0
		First Floor	0%	0
		Second Floor	26.90%	7
		Third Floor	**57.70%**	15
		Fourth Floor	15.40%	4
		Totals	**100%**	**26**
	Types of AWSp	2nd Fl (2-201) Starbucks	7.70%	2
		2nd Fl (2-206) Conference Rm	3.80%	1
		2nd Fl (2-245) Seminar Rm	7.70%	2
		2nd Fl (2-250) Conference Rm	3.80%	1
		2nd Fl (2-255) Recruiters Lounge	7.70%	2
		3rd Fl (3-100) IT Conference Rm	11.50%	3
		3rd Fl (3-170) Econ computer lab	30.80%	8
		3rd Fl (3-145) Econ Library	7.70%	2
		4th Fl (4-117) Econ S. Conference	3.80%	1
		4th Fl (4-186) Econ L. Seminar	11.50%	3
		4th Fl (4-170) Econ L. Meeting	3.80%	1
		Totals	**100%**	**26**

The amount of time employees spend in a work environment reflects directly on the amount of time they are exposed to IEQ criteria and the potential for satisfaction or dissatisfaction. Employees responded to questions (during an active semester period) regarding the amount of time they work during a typical week, the amount of time they spend in their primary workspaces, and the amount of time they spend in AWSp. It is important to note that respondents that serve in a teaching role at Hanson Hall may also spend time in classroom environments on the first floor. However, these classrooms and associated IEQ conditions are not a part of this study. Table 7 summarizes the number of years and time respondents spend in Hanson Hall. Sixty-four percent of the respondents indicated they had worked at Hanson Hall for over three years, followed by 16% who had worked less than 1 year, 12% worked from 1-2 years, and 7% worked from 2-3 years. Responses to the amount of time spent in primary workspaces were reported in increments of 10% to allow for greater flexibility in individual work habits and the ability to summarize responses. Overall, the results indicated that employees spend a significant amount of time in Hanson Hall and at their primary workspace. Specifically, 34% of employees spend more than 40 hours a week in Hanson Hall, followed by 30% spending at least 30-39 hours a week, 17% at 20-29 hours a week, and approximately 19% spending less than 20 hours a week in Hanson Hall. Fifty-one percent of the employees spend at least 80% of their time in their PWSp and approximately 12% spend 30% or less time in their PWSp.

Table 7. Hanson Hall building population and time spent in PWSp and AWSp

Description	Measure	Percent of Total	Frequency of Respondents
Years worked in Hanson Hall	< 1 year	16%	4
	1-2 years	12%	3
	2-3 years	8%	2
	> 3 years	**64%**	**16**
	Total	100%	25
Time Spent in PWSp	10%	0.00%	0
	20%	8.00%	2
	30%	0.00%	1
	40%	8.00%	1
	50%	8.00%	2
	60%	24.00%	6
	70%	12.00%	3
	80%	**24.00%**	**6**
	90%	16.00%	4
	100%	0.00%	0
	Total	100%	25
Time Spent in AWSp	**10%**	40.00%	10
	20%	32.00%	8
	30%	8.00%	2
	40%	8.00%	2
	50%	4.00%	1
	60%	0.00%	0
	70%	4.00%	1
	80%	0.00%	0
	90%	0.00%	0
	100%	4.00%	1
	Total	100%	25

Data Analysis

This was an exploratory study to examine employees' satisfaction with IEQ conditions associated with AWSp in workplace environments. As previously discussed, 67 employees responded to the survey, of which, 26 individuals completed the majority of all three sections F (SBI), PWSp, and AWSp. Cronbach's alpha (Cronbach, 1951) analysis was conducted to check the reliability of the questionnaire items for all new AWSp Module questions.

Descriptive statistics were used to describe and summarize scores using central measures of tendency (mean and standard deviation), frequencies, and percentiles (Wonnacott & Wonnacott, 1990). Inferential statistics were used to develop conclusions "about the characteristics of the larger populations that the sample is supposed to represent" (Urdan, 2010, p. 3). The descriptive and inferential statistical methods used in this analysis are described with each hypothesis along with the levels of acceptance and tests used to validate and correct the testing procedure for potential violations or sampling

To test H10, descriptive methods were used to determine employees' overall mean satisfaction scores for the F (SBI), PWSp, and AWSp. Given the exploratory nature of this study, Pearson product-moment correlation coefficient (PPMCC) was used to analyze the degree of strength and direction in the relationship between the three different workplace environments in this study. Correlations are represented in values ranging from -1.0 to +1.0, and the direction of the linear relationship is expressed in a negative or positive value. A perfect correlation, represented by $r = +1.0$, indicates that an increase of a score representing one set of variables of interest, e.g., X, results in a direct increase in a related variable, Y. Conversely, a negative correlation is represented by *r* = -1.0 indicates that an increase of a score representing one set of variables of interest, e.g., X, results in a direct decrease in a related variable, Y. Correlations between variables also provide information on the strength of the relationship and those approaching *r* = +1.0 or *r* = -1.0 represent stronger relationships between variables than those with correlations near *r* = 0.00 (Urdan, 2010).

Analysis of variance (ANOVA) was used to determine the statistical significance of the difference of the means between the F (SBI), PWSp, and AWSp at the .05 level. To proceed with the analysis, the data were first examined for sphericity or conditions of variance among paired means. The assumption being, that all pairwise combinations in the data set are considered equal and when inconsistences in this assumption arise, it is considered a violation. The violation of sphericity involves “the proportion of rejections of the null hypothesis is larger than the α level when the null hypothesis is true” (Abdi, H. 2010). Mauchly’s test for sphericity is more liberal in the assumption of sphericity whereas the Greenhouse-Geisser procedure is used to correct the degrees of freedom and provide a more accurate significance value (Greenhouse & Geisser, 1959).

To test $H2_0$, Bartlett’s tests for sphericity (Bartlett, 1937) and Kaiser-Meyer-Olkin (KM0) (Kaiser, H. 1970) were conducted as measures of sampling adequacy (MSA) to confirm the smaller sample size was acceptable for statistical analysis for $H2_0$.

Descriptive methods were used to determine employees' satisfaction with each IEQ criteria associated with the PWSp and AWSp. From these results, exploratory factor analysis (EFA) was conducted to determine an overall composite IEQ criteria mean satisfaction score for both the PWSp and the AWSp (hereafter IEQ Score). Paired t-tests were conducted to determine the significant difference between the IEQ Scores for the PWSp and the AWSp. The IEQ Score also identifies which IEQ criteria contribute the most and the least to employees' satisfaction and dissatisfaction.

Finally, to test $H3_0$, descriptive statistics were used in paired t-test to determine the significant difference between the paired IEQ means for all 11 criteria. In this test, each of the individual IEQ satisfaction scores for the PWSp and AWSp were considered accepted or reject at the level of 0.05, if $p \leq \alpha$.

Limitations

The limitations for this study include the self-administered process of the online-distributed questionnaire; there was no way to verify who filled out the survey response or to verify subjective reports of satisfaction or dissatisfaction. The response rate is appropriate for an on-line survey. This research serves as an exploratory study useful to the development of future research strategies involving the study of IEQ criteria associated with AWSp. The survey results lend themselves to describe potential responses for other University mixed-use (classroom / office buildings) populations.

AWSp questions used in this study were added to a pre-existing questionnaire used to assess employees' satisfaction with selected buildings following B3 guidelines in the State of Minnesota. The questions used for the AWSp were identical to the PWSp with respect to satisfaction and the IEQ criterion of interest. They were not modified to accommodate any unique conditions that might be related to the AWSp.

Hanson Hall has over 23,000 sf dedicated to AWSp, and this study was not able to collect data on all AWSp in the facility. As previously stated, this study followed a preliminary nine-month study conducted in May, 2013, which identified 33 AWSp on a master list of potential spaces used by employees. Following the results of the initial study, the list of AWSp was narrowed to 16 AWSp that had high use and were located throughout the building. Some of these spaces were associated with the departments in which they were located (e.g., the Econ Library in the Econ Department), and some were available to all employees (Starbucks Coffee). In an attempt to offset survey fatigue, employees were limited to selecting one AWSp they use for work-related activities, regardless of the number of AWSp they may use or the importance of one AWSp over another. This survey did not consider any further explanation of the employees' self-identified AWSp. For example, some reasons for the AWSp selection could be related to events scheduled in that location by others, availability, colleagues present, type of work, or other unknown explanations.

The total number of survey respondents was highest for F (SBI) and lowest for AWSp. Low levels of responses for AWSp does not demonstrate that AWSp are not used, just that there were less respondents completing the final section involving IEQ questions for AWSp. The lack of responses to Section 3, AWSp could be associated with survey fatigue and the ability for employees to leave the survey before advancing to this section.

Lastly, PWSp is typically considered as a “home base” for employees to put their work products and personal belongings and has higher levels of ownership. AWSp are associated with “to go places” and more likely to be associated with lower levels of ownership. This study did not query employees regarding the influence of satisfaction relative to layers of ownership as noted in *Figure* 9. Workplaces are social spaces, and there was no attempt to assess the influence of confounding variables due to ownership of AWSp between the different departments, or if ownership influences satisfaction with PWSp and or AWSp.

This research study was limited in scope and in sample size; therefore it is considered an exploratory study and the results are not generalizable beyond the sample. However, one goal was to develop the protocol for sample selection of the AWSp and validation of the AWSp Module questions. It is important to begin the process of recognizing the growing presence of AWSp in commercial office environments and to develop a research vocabulary and protocol around the study of these spaces.

Therefore, this research addressed this gap in knowledge by examining AWSp within workplace environments, first by examining overall satisfaction with the F (SBI), PWSp, and AWSp, and secondly, through specific attention directed at employees' satisfaction with IEQ conditions associated with PWSp and AWSp. By doing this, a more comprehensive view of employees' satisfaction with workplace environments can be achieved. It responds to changes occurring due to increasing use of AWSp in office environments and shifts in employees' work modes.

CHAPTER 4 RESULTS

This chapter presents the results of the study to investigate employees' satisfaction with the physical environments of the facility (site, building, and interior) [F (SBI)], primary workspace (PWSp), and alternative workspace (AWSp). Thus far, Chapter Two presented the literature review, research questions, and theoretical framework used in this study. Chapter Three reviewed the instruments, i.e., Sustainable Post Occupancy Survey, Version 2 + Alternative Workspace Module (SPOES V2 + AWSp Module), used to collect the data and the method of analysis (descriptive and inferential tests) used to examine employees' satisfaction for each hypothesis. Chapter Four begins with a discussion of the tests used to establish the validity, reliability, and adequacy of the sample population. Next, the results of the hypothesis and the tests used in this study are presented and discussed. The chapter concludes with a discussion of the overall results of the study and a fit to the theoretical model. Chapter Five will discuss the overall implications regarding future examination of employees' satisfaction with indoor environment quality (IEQ) conditions in AWSp.

Measurement Scales and Descriptive and Inferential Statistics

The SPOES V2+AWSp Module included two levels of variable measurement: nominal and ordinal. Nominal levels of measurement provide distinct categories for responses that have no distinct value or ranking (e. g., yes or no; red, blue, white). The data are presented in frequency counts (number of responses) or percentiles (e.g., 10%, 79%, 99.5%, etc.). The ordinal level of measurement is associated with a Likert-type of scale and ranges from 1 to 7. This study discusses results using descriptive terms (means and standard deviations); in some cases, means are also referred to as scores. The midpoint of the 1-7 scale was set at 4; therefore means that landed below 4 were interpreted as 'dissatisfied' and those that landed above 4 were interpreted as 'satisfied.' Means above or below the mid-point are discussed in terms of moderate to high levels or moderate to low levels of satisfaction. Means are often reported with a corresponding standard deviation (SD) which measures variability between scores (or how scores vary around the mean score). Data involving scale measurements are also subjected to inferential statistics and will be addressed within each hypothesis tested.

Inferential statistics provides researchers with an opportunity to draw conclusions or make propositions from a set of data and reflect on conditions of the sample population to a larger set of population. Understanding how scores land in a data set, the degree of relationship between variables, or the correlation between variables from one set to another are conditions of research that are examined through statistical analysis. Crocker and Algina (1986) characterize inferential statistics as an opportunity to "test hypothesis about whether or not a given sample of observations has been obtained from a population with certain distribution characteristics" (p. 19).

Data Analysis Results

Reliability and Validity: The AWSp Module, Section 3 Alternative Workspaces

The AWSp Module (Section 3, see Appendix B) included the same set of questions in the SPOES V2 Scan Primary workspace (Section 2) to assess employees' satisfaction with AWSp and IEQ criteria. To be assured that the AWSp module questions were valid and reliable, Cronbach's alpha (Cronbach, 1951) was conducted. Cronbach established that 'a reliability coefficient demonstrates whether the test designer was correct in expecting a certain collection of items to yield interpretable statements about individual differences" (Crocker & Algina, 1986, p. 297). Reliability is confirmed at the .70 level and establishes a level as a common measure for internal consistency. The result of this test was a score of .94 and demonstrated a high level of acceptability with for the overall set of 11 questions. The Cronbach scores of the individual questions ranged from .935 (AWSp Vibration) to .944 (AWSp View).

$H1_0$: Employees' satisfaction with the overall F (SBI), PWSp, and AWSp

$H1_0$ stated that 'there is no significant difference between employees' satisfaction with the physical environments associated with the overall F (SBI), PWSp, and AWSp. Employees' satisfaction with the work place was examined for the strength of the relationship among the three workspaces and the significant difference among the means.

Pearson product-moment correlation coefficient (PPMCC) was used to analyze the strength and direction of the relationship among the three different workplace environments in this study. Correlations are represented in values ranging from -1.0 to +1.0, and the direction of the linear relationship is expressed in a negative or positive value. A perfect correlation, represented by $r = +1.0$, indicates that an increase of a score representing one set of variables of interest, e.g., X, results in a direct increase in a related variable, Y. Conversely, a negative correlation is represented by $r = -1.0$ indicates that an increase of a score representing one set of variables of interest, e.g., X, results in a direct decrease in a related variable, Y. Correlations between variables also provide information on the strength of the relationship and those approaching $r = +1.0$ or $r = -1.0$ represent stronger relationships between variables than those with correlations near $r = 0.00$ (Urdan, 2010).

$H1_0$: Employees' satisfaction F (SBI), PWSp, and AWSp (PPMCC and ANOVA)

Table 8 shows employees' mean satisfaction with the three areas of interest in the DE, the overall F (SBI) (Mean = 5.65, SD = 1.38), the PWSp (Mean = 5.27, SD = 1.56), and the AWSp (Mean = 5.0, SD =1.64).

Table 9 shows the results of the PPMMC, which considered the strength of the relationship between satisfaction with one area and satisfaction with another. The correlation between employees' satisfaction (N = 26) in the three workspace environments is highest between the F (SBI) and the PWSp (r = .877, .000), and slightly less between the F (SBI) and the AWSp (r = .656, .000), and the PWSp and the AWSp (r = .612, .001).

Table 8. $H1_0$ Employees' satisfaction with the overall F (SBI), PWSp, and AWSp

Theory Construct	Overall Workplace Satisfaction	N	Mean	SD
DE	F (SBI) Satisfaction	26	5.65	1.38
	PWSp Satisfaction	26	5.27	1.56
	ASWp Satisfaction	26	5.00	1.67

Table 9. $H1_0$ Employees' overall satisfaction PPMC F (SBI), PWSp, and AWSp

Theory Construct			PWSp Satisfaction	ASWp Satisfaction
DE	SBI Satisfaction	Pearson Correlation	.877**	.656**
		Sig. (2-tailed)	.000	.000
		N	26	26
	PWSp Satisfaction	Pearson Correlation		.612**
		Sig. (2-tailed)		.001
		N		26

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10 shows the results of the Analysis of variance (ANOVA) and related tests for sphericity (italicized in the table) used to examine the significant difference among all three means. Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, X^2 (5) = 11.74, p<.05. The degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\sum$ = .721). Furthermore, the results show significant mean differences among the three variables, F (1.44, 36.06) =3.93, 0<.05.

Table 10. H1_0 Employees' satisfaction with F (SBI), PWSp, AWSp and ANOVA

Theory Construct	**ANOVA Test of Three Means**				
			Mauchly's Test of Sphercity		
	Within Subjects Effect	Mauchly's W	*Approximate Chi Square*	df	*Sig.*
	Workplace F P A	0.613	*11.736*	2	*0.003*
	Within Subjects Effect		*Greenhouse - Geisser*	Huynh-Feidt	Lower-bound
	Workplace F P A		*0.721*	0.763	0.5
			Tests Within-Subject Effects		
DE					df
	Workplace F P A			Spericity Assumed	**2**
				Greenhouse-Geisser	*1.44*
	Error Workplaces F P A			Spericity Assumed	
				Greenhouse-Geisser	*36.06*
				Mean Squares	df
	Workplace F P A		Spericity Assumed	2.808	3.93
			Greenhouse-Geisser	*3.894*	*3.93*

H1_0: Rejected

The results of the means of the employees' overall satisfaction with the F (SBI) F (SBI) (M = 5.65), PWSp (M = 5.27), and AWSp (M = 5.0) indicate a moderate level of satisfaction with three areas identified within the designed environment (DE), and a general trend of decreasing satisfaction moving from the F (SBI) to the AWSp. The results of the PPMCC indicate a positive, moderate - strong relationship between the satisfaction of one workspace type and another workspace type for employees at Hanson Hall. The strongest relationship of employees' satisfaction occurred between F (SBI) and PWSp followed by the F (SBI) and the AWSp. The ANOVA and post-hoc tests comparisons of means indicated that there is a significant difference between employees' overall satisfaction with the three areas of interest in the DE (F (1.44, 36.06) =3.93, 0<.05) therefore $H1_0$ was rejected.

$H2_0$: Employees' IEQ Satisfaction Score with the PWSp and AWSp

$H2_0$ states 'there is no significant difference between employees' overall IEQ satisfaction Score with their PWSp and AWSp. The IEQ Satisfaction Score was developed to demonstrate real outcomes associated with the B3 guideline initiates and is used here to further explore employees' satisfaction with specific areas of the DE, in particular the PWSp and AWSp. It is a composite score of IEQ categories combined from 11 individual questions as opposed to a singular question asking about overall satisfaction with a particular workspace.

$H2_0$: Adequacy of the sample size for EFA analysis

The IEQ Score requires several tests to create one composite score beginning with determining individual mean scores of IEQ criteria and validating the sample size for statistical analysis [Kaiser-Meyer-Olkin (KMO) and Bartlett's test for sphericity]. The Exploratory Factor Analysis (EFA) procedure determines factor loads to explain proportions of variance associated with observed and unobserved (latent) variables in the data; the results are included for both the PWSp and the AWSp.

Exploratory factor analysis works best with large sample studies. The survey response total was 67 employees, of which 26 cases were identified as being substantially complete in all three sections [F (SBI), PWSp, and AWSp]. To confirm that the smaller sample set was acceptable for selected statistical analysis, Kaiser-Meyer-Olkin (KMO) (Kaiser, H. 1970) measures of sampling adequacy and Bartlett's tests for sphericity (Bartlett, 1937) were conducted. KMO tests whether the partial correlations among variables are small, and Bartlett's test of "sphericity determines whether the correlation matrix is an identity matrix, which would indicate that the factor model is inappropriate" (SPSS Inc., n.d., p. 397). The threshold to conduct factor analysis using the KMO test occurs when correlation values are greater than .50; values approaching 1.0 are indicative of stronger correlations between variables. The threshold for the Bartlett's test of sphericity occurs when the significance is less than .05 (SPSS, n.d.). The result of the KMO test for the PWSp was .795 and the AWSp was .728. Both are greater than the threshold of .50 needed to proceed with EFA. The results of these tests demonstrate that the sample set was acceptable to conduct EFA.

H20: PWSp and AWSp IEQ criteria mean scores and the IEQ satisfaction score

The results of employees' satisfaction scores with each of the 11 individual criteria are included in Table 11. The satisfaction means show that employees were satisfied with all 11 IEQ categories for the PWSp and the AWSp (all means > 4.0).

Table 11. H2_0 IEQ criteria and employees' satisfaction with PWSp and AWSp

PWSp Descriptive Statistics	N	Mean	SD
PWSp The overall indoor air quality	26	5.73	1.25
PWSp The amount of daylighting	26	5.73	1.76
PWSp The overall vibration & movement	26	5.54	1.50
PWSp The overall function	26	5.46	1.42
PWSp The amount of electric light	26	5.46	1.45
PWSp The overall furnishings	26	5.38	1.55
PWSp The overall appearance (aesthetics)	26	5.31	1.38
PWSp The overall view conditions	26	5.31	1.78
PWSp The overall thermal conditions	26	4.73	2.01
PWSp The overall privacy	26	4.65	1.77
PWSp The overall acoustic quality	26	4.62	1.75

AWSp Descriptive Statistics	N	Mean	SD
AWSp The overall vibration & movement	26	5.58	1.39
AWSp The overall acoustic quality	26	5.38	1.36
AWSp The overall furnishings	25	5.28	1.14
AWSp The overall thermal conditions	26	5.27	1.69
AWSp The overall appearance (aesthetics)	25	5.24	1.30
AWSp The overall function	25	5.16	1.43
AWSp The overall indoor air quality	26	5.15	1.46
AWSp The amount of electric light	26	5.12	1.63
AWSp The overall privacy	25	5.00	1.38
AWSp The amount of daylighting	25	4.96	2.13
AWSp The overall view conditions	25	4.96	2.21

Mean satisfaction scores for the PWSp were the highest for indoor air quality (M= 5.73, SD =1.25), daylighting amount (M= 5.73, SD =1.76, and vibration and movement (M= 5.54, SD =1.5), and lowest for thermal (M= 4.73, SD =1.38), privacy (M= 4.65, SD =1.77), and acoustic conditions (M= 4.62, SD =2.01). Mean satisfaction scores for the AWSp were highest for vibration and movement (M= 5.58, SD =1.39) acoustic conditions (M= 5.38, SD =1.36), and furnishings (M= 5.28, SD =1.14), and lowest for privacy (M= 5.0, SD =1.38), daylighting amount (M= 4.96, SD =2.13), and view conditions (M= 4.96, SD =2.21).

Overall, the results show that employees' were satisfied with all 11 IEQ categories for both the PWSp and the AWSp, i.e., each mean was above 4.0. Although scores indicated employees were satisfied with the IEQ conditions associated with their PWSp and AWSp, the scores were mid-range, reflecting a moderate level of satisfaction.

Satisfaction scores were higher for the PWSp and slightly lower for the AWSp.

Table 12 includes the EFA factor loads and identifies which IEQ criteria contribute to the overall IEQ satisfaction score and is listed from high levels of satisfaction contributing to the score to low levels of satisfaction contributing to the score. The ranking reveals which IEQ criteria contribute the most and the least to the overall IEQ satisfaction Score for the PWSp and the AWSp. The factor loads for IEQ criteria associated with the PWSp range from .909 for Electric Light (ELE) and .442 for Thermal Conditions (THE). The factor loads for AWSp range from .927 for Function (FUN) and .532 for View Conditions (VIE). The factor loads for each IEQ criteria along with their respective means combine to create the overall IEQ Satisfaction Score for both PWSp and the AWSp.

Table 12. $H2_0$ Factor loading associated with IEQ criteria for the PWSp and AWSp

PWSp IEQ Criteria	Factor Load
PWSp Electric light	**0.909**
PWSp Function	**0.894**
PWSp Furnishings	**0.848**
PWSp Vibration & movement	0.833
PWSp Appearance (aesthetics)	0.831
PWSp Indoor air quality	0.830
PWSp View conditions	0.680
PWSp Acoustic quality	0.612
PWSp Privacy	**0.549**
PWSp Daylighting	**0.472**
PWSp Thermal conditions	**0.442**

AWSp IEQ Criteria	Factor Load
AWSp Function	**0.927**
AWSp Vibration & movement	**0.903**
AWSp Indoor air quality	**0.892**
AWSp Appearance (aesthetics)	0.881
AWSp Acoustic quality	0.865
AWSp Furnishings	0.837
AWSp Privacy conditions	0.823
AWSp Electric light	0.656
AWSp Thermal conditions	**0.603**
AWSp Daylighting	**0.581**
AWSp View conditions	**0.532**

The overall IEQ Satisfaction Scores for the PWSp and the AWSp are included in Table 14. The overall IEQ Satisfaction Score for the PWSp is 5.32 (SD 1.15), and the AWSp is 5.29 (SD 1.16). Both the PWSp and the AWSp results are considered 'satisfied' but at a moderate level of satisfaction with IEQ conditions for both workspace locations.

Table 13. $H2_0$ PWSp and AWSp overall IEQ satisfaction scores

Overall IEQ Score	N	Mean	SD	Variance
PWSp IEQ Satisfaction	26	5.32	1.15	1.33
AWSp IEQ Satisfaction	23	5.29	1.16	1.34

The final statistical analysis required for H20 utilizes a paired t-test (descriptive statistics, correlation values, and inferential statistics) to determine if there is a significant difference between the IEQ Scores (μ) (Elvers, G., n.d.a). The combined test results are included in Table 14. The result for the IEQ satisfaction score was interpreted with the following equation (p = sig.): if $p \leq \alpha$, then reject the hypothesis and if $p > \alpha$, then accept the hypothesis. The paired samples t-test revealed a statistical difference of p=.433 between the IEQ Scores of the PWSp μ (M = 5.31, SD = 1.44) and the AWSp μ (M = 5.29, SD = 1.6).

Table 14. $H2_0$ Paired t-tests and the IEQ satisfaction scores for the PWSp and AWSp

Paired Samples Test											Interpretation
Theory Contruct	IEQ Satisfaction Score		Paired Differences					t	df	Sig. (2-tailed)	α = .05 If p ≤ α, reject H3 If p > α, accept H3
			Mean	SD	Std. Error	95% CI Lower	95% CI Upper				
DE	Pair 1	AWSp PWSp	-0.163	0.977	0.204	-0.585	0.260	-0.798	22	.433	If .433> α, **Accept H3**

$H2_0$: Accepted

The paired samples *t*-test failed to reveal a statistical difference between the IEQ Scores of the PWSp and the AWSp within the overall DE, therefore $H2_0$ is accepted. The IEQ criteria that contribute the most to the overall IEQ satisfaction score for the PWS is Electric light, followed by Function and Furnishings. The IEQ criteria contributing the least to employees' satisfaction with the PWSp are privacy, daylighting, and thermal conditions. The IEQ criteria that contribute most to the satisfaction score for the AWSp includes function, vibration and movement, and indoor air quality. IEQ criteria contributing the least include thermal conditions, daylighting, and view conditions for the AWSp.

$H3_0$: Employees' satisfaction with 11 IEQ criteria in their PWSp and AWSp

$H3_0$ states 'there is no significant difference between employees' satisfaction with the 11 individual IEQ criteria [acoustics (ACC), appearance (APP), daylighting (DAY), electric lighting (ELE), function (FUN), furnishings (FUR), indoor air quality (IAQ), privacy (PRI), thermal (THE), vibration and movement (VIB), view (VIE)] associated with their PWSp and the AWSp. Unlike the overall IEQ Satisfaction Score, each individual IEQ criterion identified in Chapter Three serves as a single hypothesis statement capable of being statistically accepted or rejected. As with the previous hypothesis, the results for the test for sphericity and sample size were sufficient to conduct paired t-tests for both the PWSp and the AWSp for each IEQ criterion.

The results of the paired t-tests between the individual IEQ criterion means (μ) for both the AWSp and PWSp are included in Table 15. Each of the 11 IEQ criteria represents an individual hypothesis statement about the significant difference between means. Remembering that the level of significance was set at = 0.05, if $p \leq \alpha$, then $H3_0$ is rejected, and if $p > \alpha$, then $H3_0$ is accepted. The results of the paired t-tests demonstrate mixed results with two of the hypothesis (ACC and IAQ) rejected and nine of the hypothesis accepted. The details of each are presented in separate discussions.

Table 15. $H3_0$ Employees' satisfaction means with IEQ criteria and paired T-Tests

DBE IEQ criteria PWSp and AWSp		Paired Differences					t	df	Sig. (2-tailed)	Interpretation α = .05 If $p \leq \alpha$, reject H2 If $p > \alpha$, accept H2
		Mean	SD	Std. Error Mean	95% Confidence Lower	95% Confidence Upper				
Pair 1	PWSp IEQ: IAQ AWSp IEQ: IAQ	0.58	1.10	0.216	0.132	1.022	2.670	25	**.013**	**H3 Rejected**
Pair 2	PWSp IEQ: ACC AWSp IEQ: ACC	-0.77	1.84	0.361	-1.512	-0.026	-2.132	25	**.043**	**H3 Rejected**
Pair 3	PWSp IEQ: ELE AWSp IEQ: ELE	0.35	1.02	0.200	-0.065	0.757	1.735	25	**.095**	**H3 Accepted**
Pair 5	PWSp IEQ: DAY AWSp IEQ: DAY	0.72	2.30	0.460	-0.230	1.670	1.565	24	**.131**	**H3 Accepted**
Pair 5	PWSp IEQ: THE AWSp IEQ: THE	-0.54	1.90	0.373	-1.307	0.230	-1.443	25	**.161**	**H3 Accepted**
Pair 6	PWSp IEQ: FUN AWSp IEQ: FUN	0.32	1.22	0.243	-0.182	0.822	1.317	24	**.200**	**H3 Accepted**
Pair 7	PWSp IEQ: VIE AWSp IEQ: VIE	0.44	1.89	0.379	-0.342	1.222	1.161	24	**.257**	**H3 Accepted**
Pair 8	PWSp IEQ: FUR AWSp IEQ: FUR	0.24	1.27	0.254	-0.283	0.763	0.947	24	**.353**	**H3 Accepted**
Pair 9	PWSp IEQ: PRI AWSp IEQ: PRI	-0.32	2.15	0.431	-1.209	0.569	-0.743	24	**.465**	**H3 Accepted**
Pair 10	PWSp IEQ: APP AWSp IEQ: APP	0.12	1.45	0.291	-0.480	0.720	0.413	24	**.683**	**H3 Accepted**
Pair 11	PWSp IEQ: VIB AWSp IEQ: VIB	-0.04	0.92	0.180	-0.408	0.331	-0.214	25	**.832**	**H3 Accepted**

$H3_0$: IEQ Criteria Accepted

Table 15 includes the results of the paired t-tests. The mean (μ) scores for nine criteria met the level of significance set at 0.05, if $p > \alpha$. The tests show that there is no significant difference between the means when comparing PWSp to AWSp for Thermal Conditions [t (25) = 1.44, p = .161], Electric Lighting [t (25) = 1.73, p = .095], Daylighting [t (24) = 1.56, p = .131], View [t (24) = 1.61, p = .257], Vibration and Movement [t (25) = .214, p = .832], Privacy [t (24) = .743, p = .465], Furniture [t (24) =

.947, *p* = .353], Function [t (24) = 1.317, *p* = .2], and Appearance [t (24) = .413, *p* = .683]. Therefore, the null hypothesis failed to be rejected and is accepted.

$H3_0$: IEQ Criteria Rejected

Table 15 includes the results of the paired t-tests indicating the remaining two IEQ criteria mean (μ) scores. The tests show that there is a significant difference between the means when comparing PWSp to AWSp for Indoor Air Quality [t (25) = .680, *p* = .01] and Acoustics [t (25) = .318, *p* = .043]. Therefore, the $H3_0$ IAQ and $H3_0$ ACC are rejected.

Affordance Theory: Employees' Satisfaction

This study used the Affordance Theory as the theoretical framework to examine the relationship between the observer (employee) and affordances perceived in the built environment. A research model was developed by the researcher for this study. Satisfaction in the workplace is shown as an 'affordance' with IEQ conditions and dissatisfaction as a 'constraint' (see *Figure* 32). For example, the literature review revealed that employees' satisfaction with daylighting conditions is associated with positive impacts on employees' well-being and retention (Leather, 1998; Lottrup, 2013). Conversely, dissatisfaction with thermal conditions (too warm or too cold) can adversely affect overall IEQ satisfaction with the physical environment (Frontczak & Wargocki, 2011; Huang, et al., 2012).

A final study model of the test results of employees' satisfaction with the F (SBI), PWSp, AWSP (Table 8) and 11 IEQ criteria (Table 13. $H2_0$ PWSp and AWSp overall IEQ satisfaction scores

) is shown in

Figure 43. One of the important premises of Gibson's Affordance Theory is the concept of 'nesting' whereas one unit is held or nested by another unit, which in turn is held or nested by another unit and so forth. In this study, the 11 IEQ criteria were the smallest 'units' or components of interest, followed by satisfaction with the AWSp and PWSp, and overall satisfaction with the F (SBI), PWSp and AWSp.

The model also illustrates the F (SBI) as contained or nested in the DE. The natural environment (NE) and the Social Environment (SE) along with the DE is contained or nested in the overall environment, all of which are perceived by the observer. The model shows how some of the basic 'units' of interest can be shared between the NE, SE, and DE with the long dashed lines connecting the two environments. In some instances, it is important note the related areas of research interest. For example, the IEQ criterion for privacy is associated with both the DE and SE. In workplace environments, an employee's desire to withdraw or self-regulate exposure to others in the social environment is served by some degree of enclosure or location removed from these conditions that is provided by the built environment. For the most part, this research focused on workspaces and their IEQ criteria primarily associated with the DE and to a lesser extent, the SE and NE.

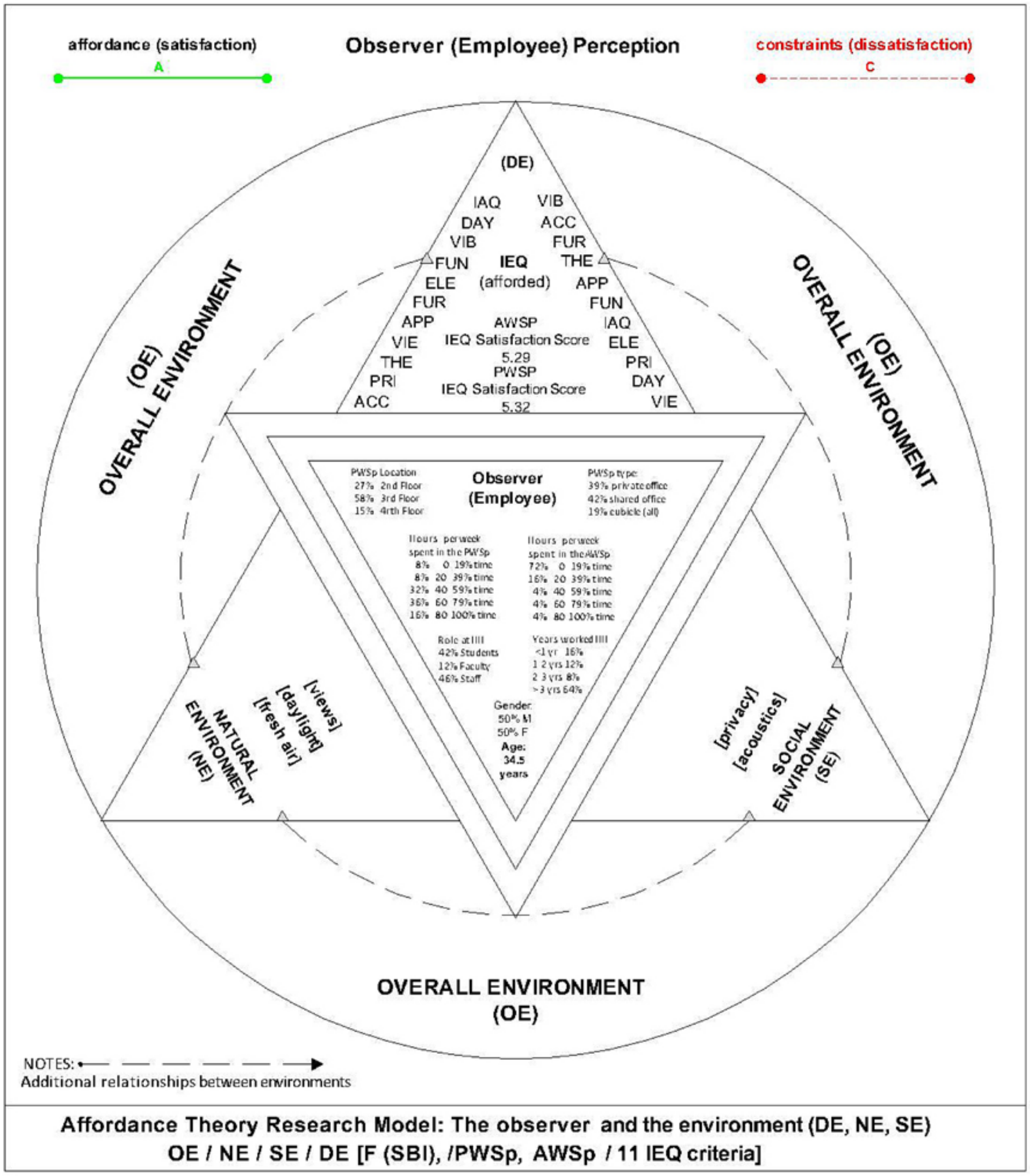


Figure 43. Bauer's Affordance Theory Research Model

As previously presented, the mean results depicting employees' satisfaction with the F (SBI), PWSp, and AWSp and all 11 IEQ criteria were all above the 4.0 level established for satisfaction. Thus, employees' satisfaction is afforded in the different workspaces by IEQ criteria in the Hanson Hall workplace.

The Research Framework: Summary of the Results

This research operationalized the research questions as three hypotheses tasked to determine the significant difference in employees' satisfaction with IEQ in various types of workspaces. *Figure* 44 depicts the framework outlining the observer characteristics for the sample population in the HH F (SBI) and results of the $H1_{0,}$ $H2_{0,}$ and $H3_0$ tests.

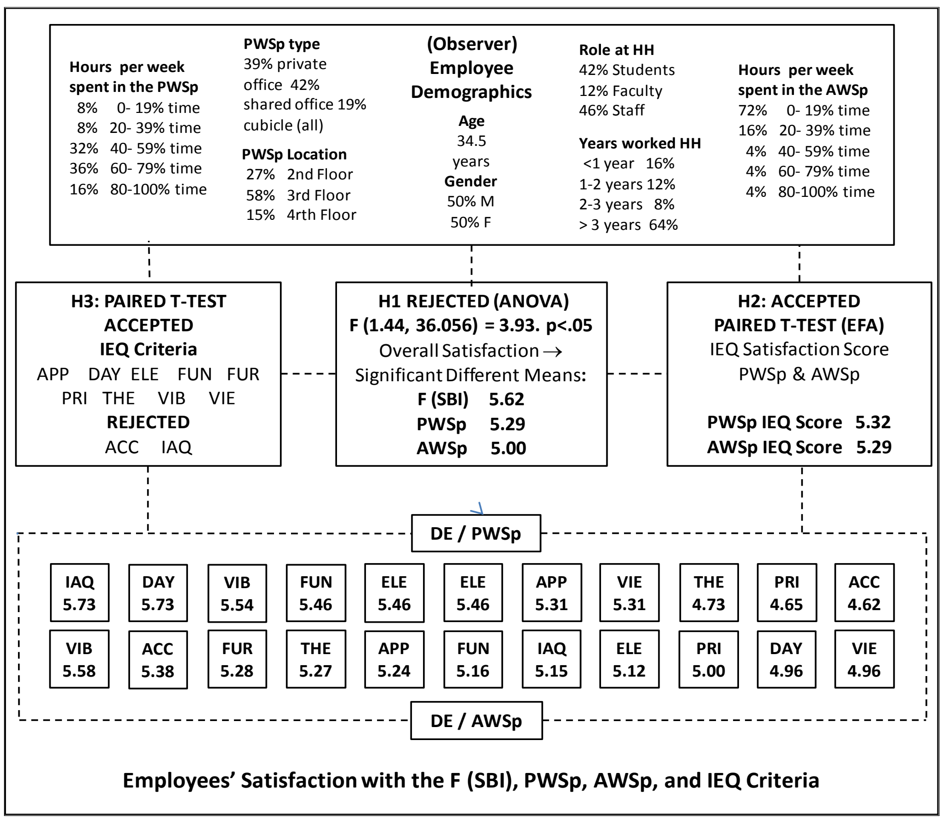


Figure 44. The Research Framework: H1, H2, H3, and Employee Characteristics

Overall, the hypothesis tests had mixed results. First, $H1_0$ and nine of the 11 criteria associated with $H3_0$ failed to show a statistically significant difference in employees' satisfaction and were therefore accepted. Second, $H2_0$ and two of the 11 IEQ criteria associated with $H3_0$ were statistically different and therefore the hypotheses were rejected. Employees' satisfaction showed decreasing levels of satisfaction moving from a moderate level of satisfaction with the F (SBI) towards low levels of satisfaction with their self-identified AWSp. Satisfaction scores with the IEQ criteria ranged from 5.73 (PWSp IEQ IAQ and DAY) to 4.62 (PWSp IEQ ACC) also indicated moderate to low levels of satisfaction.

Finally, slightly different results were noted with the IEQ criteria associated with the means (Table 11) and the IEQ criteria associated with the factor loads (Table 12). Each table includes data that show descending means or factor loads and the IEQ criteria are used to determine the overall IEQ satisfaction score for each space. For example, the PWSp highest means were associated with IAQ (M = 5.73) and DAY (M = 5.73) and lower means associated with PRI (Mean = 4.65) and ACC (M = 4.62) whereas the IEQ criteria that contributed the most to the overall IEQ satisfaction score were ELE and FUN, and those contributing the least were DAY and THE. The AWSp showed higher means associated with VIB (M = 5.58) and ACC (M = 5.38) and lower means associated with DAY (M = 4.96) and (M = 4.96). whereas the IEQ criteria that contributed the most to the overall IEQ satisfaction score were FUN and VIB, and those contributing the least were DAY and VIE.

Taken together, the results can be somewhat confusing as the difference in the results is driven by different statistical processes. The mean scores provide a better understanding of employees' satisfaction with each IEQ criteria, and the overall IEQ satisfaction score reveals how the composite score is weighted by each IEQ criteria. If the prevailing goal is to raise the overall IEQ satisfaction score with the PWSp, then designers may want to look at improving conditions related to the IEQ criteria that contributed the least to the IEQ satisfaction score (e.g., DAY and THE). If the goal is to learn more about the individual IEQ scores and improve conditions related to lower mean scores in the PWSp, designers might look more carefully at the attribute level questions for each IEQ category. The lowest mean score associated with the PWSp is PRI (M = 4.65) and ACC (M = 4.62).

Further, the literature review revealed that the IEQ related to ACC conditions had two attributes –ability to hear desired sounds and ability to limit undesired sounds. PRI conditions had two attributes – visual privacy and acoustic privacy. Dissatisfaction with acoustic conditions (as stand-alone category or as an attribute of privacy conditions) may be driving lower employee satisfaction scores.

In closer examination of the demographics included in *Figure* 44, 42% of the respondents were students, 42% shared PWSp with others, and 58% of the population had PWSp on 3rd floor. In looking at the 3rdfloor plan (*Figure* 41), several PWSp were actually high density workspaces designed to accommodate several graduate teaching assistants in an enclosed room or office. Some these offices are located along the peripheral area of the building and had windows, while others are located off central corridors and have no access to daylight. The overall IEQ satisfaction score associated with the PWSp (M = 5.32) revealed that IEQ criteria DAY and THE conditions contributed the least to the satisfaction score.

The research identifies opportunities where additional trenching into the data might occur, in particular type of workspace (open, shared, or private) may impact employees' satisfaction, or access to daylighting conditions. This example further demonstrates how the individual IEQ criteria are not mutually exclusive to the physical environment of the DE but in fact, that the three environments (DE, NE, and SE) are connected on some finer layer of significance.

The literature review also discussed both visual and acoustic attributes with the IEQ criterion 'privacy.' The results indicated low levels of satisfaction with privacy for both the PWSp (mean = 5.0) and AWSp (mean = 4.65) and did not drill down to the level of the attributes. Results also indicated a low level of satisfaction with the 'acoustic conditions' for the PWSp (mean = 4.62).

Results also revealed low levels of satisfaction with the 'daylighting' (mean =

4.96) and ‘views’ (mean = 4.96) for the AWSp. The literature discussed potential links between daylighting and views, both of which are associated with the NE and the DE. Reflecting on the sample demographics in Table 6 and the building third and fourth floor plans in

Figure 41 and *Figure* 42 respectively, 51 % of the population used AWSp (3rd floor Economics computer lab and the 4th floor seminar room) and did not have access to daylight or views. Additional research focused on related IEQ categories level criteria (e.g., daylight and views) may provide researchers and designers with opportunities to address design strategies of the natural environment.

The IEQ Criteria, PWSp, and AWSp: Implications for Design Practitioners

This study examined 11 IEQ criteria associated with the workplace environments. The literature review identified how and where the B3 Guidelines intercept required and recommended performance goals and where they did not. They include the following: IEQ Criterion – Acoustic Conditions (B3 IEQ 1.7); IEQ Criterion – Daylighting Conditions(B3 IEQ 1.6 and EA 1.1); IEQ Criterion – Furnishing Conditions (B3 MR 1.1, 1.2, and 1.3); IEQ Criterion - Indoor Air Quality Conditions (B3 IEQ 1.1, 1.2, and 1.4); and IEQ Criterion – Thermal Conditions (B3 IEQ 1.4 and 1.5), IEQ Criterion – Vibration and Movement Conditions (B3 IEQ 1.8). Performance recommendations are available for IEQ Criterion – View Conditions (B3 IEQ 1.10). Three IEQ criteria do not have specific

Building, Benchmarks, and Beyond (B3) performance requirements or recommendations, and they include appearance (aesthetics), function, and privacy. They are, however, important to employees' satisfaction with the overall workplace environment and therefore included in the SPOES instrument. The final section briefly discusses results of the individual IEQ criteria and considerations for design practice in workplace environments.

IEQ Criteria: Acoustic Conditions (Results and Implications)

The results of the mean scores associated with acoustics for the PWSp was 4.62 (SD 1.75) and the AWSp was 5.38 (SD 1.38). The results of the paired t-tests (t (25) = .318, p = .043), indicated that employees' satisfaction was significantly different between the two workspaces. To improve satisfaction scores, designers first need to clearly identify and understand site attributes, occupant needs, and overall acoustic goals in the project and expected differences between PWSp and AWSp. Acoustic conditions are a category level criterion with two attributes (ability to hear desired sounds and limit desired sounds). Therefore, designers need to be aware of conditions in the built environment and social environment that support employees' ability to hear desired sounds and to limit desired sounds.

Expectations around acoustic goals in AWSp may differ across different AWSp types. Enclaves designed to support concentration activities have a different acoustic consideration than collaboration activities in meeting rooms or connection activities in café spaces. Design practitioners should carefully examine the range of work activities impacting acoustic conditions, the spatial layout of each room, the adjacency of quiet spaces to noisy spaces, the finishes, the need for passive and active acoustic treatments, and audio equipment speakers used during presentation.

IEQ Criteria: Appearance Conditions (Results and Implications)

The results of the mean scores associated with appearance for the PWSp was 5.31 (SD 1.38) and the AWSp was 5.24 (SD 1.30). The results of the paired t-tests ($t\ (24) = .413$, $p = .683$), indicated that employees' satisfaction was not significantly different between the two workspaces. Appearance is a category level criterion, currently unsupported by any additional attribute level questions. The B3 guidelines do not have any required or recommended performance criteria associated with this criterion. Yet, the appearance of the work environment establishes a visual and symbolic connection to the users of that space, and is considered by many users and design professionals, very important to the overall work environment.

To improve satisfaction scores, practitioners can examine client expectations early in the design phase and share proposed design solutions with users of the space. Hanson Hall is a work environment that supports work activities over long periods of time and a considerable amount of 'hot-bunking' occurs where graduate level students work throughout the night. Therefore, material and furnishings should reflect conditions of heavy use over long periods of time.

IEQ Criteria: Daylighting Conditions (Results and Implications)

The results of the mean scores associated with the daylighting conditions for the PWSp was 5.73 (SD 1.76) and the AWSp was 4.96 (SD 2.13). The results of the paired t-tests ($t\ (24) = 1.56$, $p = .131$), indicated that employees' satisfaction was not significantly different between the two workspaces. Daylighting conditions are currently a category level criterion in the B3 guidelines. It is also associated with overall lighting conditions in the workplace environment and the ability to control daylighting conditions where glare or excess solar gain is present.

Daylighting solutions are frequently part of a larger plan to maximize natural light and to offset energy consumption. Daylight is made possible through fenestrations in the exterior façade or from roof top locations. Therefore, designers need to be aware of conditions in the built environment and natural environment that support employees' ability to access natural lighting and view conditions where appropriate.

For the most part, private office for faculty and senior level staff members are located along the exterior window wall in Hanson Hall, whereas shared office space for students is located near central corridor (without access to daylight) and near the exterior window walls (with access to daylight). The mean score for AWSp is the lowest satisfaction score, and the results may be low in part due to the number r students responding to the survey who do not have access to daylight. To increase satisfaction scores, design practitioners should consider locating PWSp near exterior window walls or central corridors adjacent to atrium areas that have daylighting provisions. Satisfaction scores can be also be improved by providing controls to mitigate glare and unwanted solar gain.

IEQ Criteria: Electric Lighting Conditions (Results and Implications)

The results of the mean scores associated with the electric lighting conditions for the PWSp was 5.46 (SD 1.50) and the AWSp was 5.12 (SD 1.63). The results of the paired t-tests ($t\ (25) = 1.73$, $p = .095$), indicated that employees' satisfaction was not significantly different between the two workspaces.

Electric lighting conditions are currently a category level criterion in the B3 guidelines. It is also associated with overall lighting conditions in the workplace environment, the ability to control electric lighting conditions to meet user needs, general ambient levels throughout the space, and plug loads.

Several researchers (Boyce et al., 2006; Veitch and Newsham, 1996; Wyon, 1996) identified the complexity of the interior environment and the challenges involved in defining all the mechanisms involved in luminous quality that contributes to employees' satisfaction. Designers need to consider the overall lighting goals, site conditions, daylight harvesting opportunities, the color and efficiency of the light source, user and activity requirements, and more. Some of these opportunities are more straight forward. For example, lighting needs for work activities in the PWSp can be supplemented by task lighting. Lighting goals for AWSp may need additional consideration to address the wide range of activities that occur in different AWSp types and work related to concentration, collaboration and connection activities.

IEQ Criteria: Function (Results and Implications)

The results of the mean scores associated with the function for the PWSp was 5.46 (SD 1.42) and the AWSp was 5.16 (SD 1.43). The results of the paired t-tests (t (24) = 1.317, p = .2), indicated that employees' satisfaction was not significantly different between the two workspaces. Function is a category level criterion, currently unsupported by any additional attribute level questions. The B3 guidelines do not have any required or recommended performance conditions associated with this criterion.

As presented in the literature review, the function of any aspect of the work environment is often tied to 'how well this or that works or performs for the intended use.' It can be a chair, the height of a work surface, the size of a room for the furniture, the type of finishes, and more. Design practitioners can improve satisfaction scores by identifying overall goals associated with the variety of functions, furnishings, and features needed to support work activities in the workspace. Where expectations may be compromised, designers should share that information with the users of that space or consider different solutions to minimize how a space functions over the intended use. For example, *Figure* 45 (the image on the left shows a PWSp floor plan with a column located near a small conference area, which can impede function use for some users of this space and (the image on the right) furnishings selected for a space and located in an area that compromises access and usability for the employee. If designers are working with furniture standards throughout the workspace environment, they may want to consider changes in the furniture standard that improve the functional layout for the users of that space.

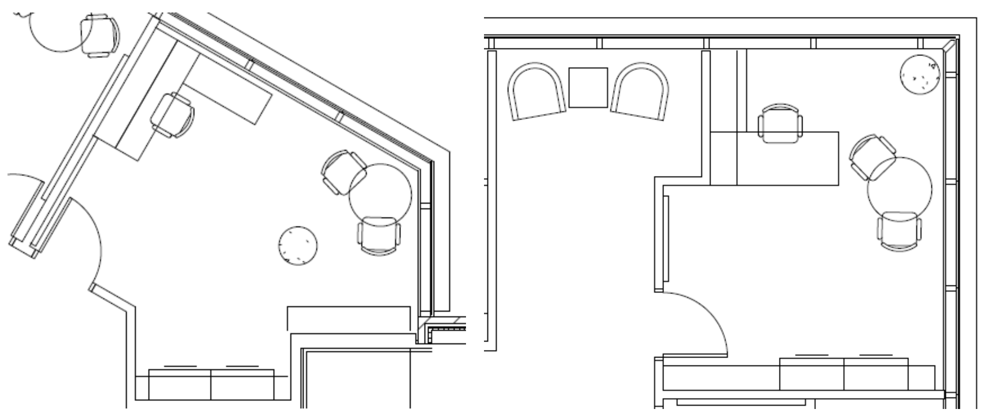


Figure 45. Selected PWSp Private Office, Hanson Hall (not to scale)

Design practitioners need to consider AWSp and the changing nature of work to ensure as work activities change. AWSp can accommodate a range of activities or include additional AWSp to cover how users are actually using the space. For instance, during the initial walk-through of the space, the support staff indicated that the well-being room –

initially designed to function as a private lactation room for mothers - was actually functioning as a quiet reading room for faculty needing to escape distraction from others. Therefore, additional consideration should be given to different AWSp to ensure that the variety of work activities over time can easily adapt to new functions or be repurposed when under-utilized.

IEQ Criteria: Furnishings (Results and Implications)

The results of the mean scores associated with the appearance conditions for the PWSp was 5.38 (SD 1.55) and the AWSp was 5.28 (SD 1.14). The results of the paired t-tests ($t\ (24) = .947$, $p = .353$), indicated that employees' satisfaction was not significantly different between the two types of workspaces. Furnishings are a category level criterion, currently unsupported by any additional attribute level questions. The B3 guidelines address conditions related to furnishings through performance requirements in the materials and resource section.

As presented in the literature review, materials and resources address the type of materials used in the construction of furnishings, where and how they area obtained, manufacturing process through delivery, installation, end-of-life strategies, and more. Many of these goals are beyond the immediate concern for the users of the space. Once installed, users are more likely to think of how well the furniture functions, looks, and maintains its value over time for the intended purpose. Therefore, design practitioners can improve employees' satisfaction by clearly identifying the goals associated with PWSp and AWSp and specifying furnishings that meet the required sustainability guidelines and communicating the sustainability features of the furnishings to users (where appropriate). As noted in *Figure* 45, furnishing plans should also be developed carefully so that they work with the spatial features of each space and address the needs of the user. Again, additional consider should be given to AWSp to ensure that the variety of work activities over time and can easily adapt to new functions.

IEQ Criteria: Indoor Air Quality Conditions (Results and Implications)

The results of the mean scores associated with the IAQ conditions for the PWSp was 5.73 (SD 1.25) and the AWSp was 5.15 (SD 1.46). The results of the paired t-tests ($t(25) = .680$, $p = .01$), indicated that employees' satisfaction was significantly different between the two workspaces. Employees' satisfaction with IAQ conditions was the highest IEQ score associated with the PWSp and significantly lower with the AWSp.

To improve satisfaction scores, designer practitioners will need to be aware of materials, furnishings, and finishes that impact off-gassing; work with facility managers to ensure appropriate cleaning materials are used in the maintenance processes; and develop a procedure to ensure that appropriate solutions for ventilation issues are addressed.

IEQ Criteria: Privacy Conditions (Results and Implications)

The results of the mean scores associated with the privacy conditions for the PWSp was 4.65 (SD 1.77) and the AWSp was 5.00 (SD 1.38). The results of the paired t-tests (t (24) = .743, p = .465), indicated that employees' satisfaction was not significantly different between the two workspaces. Employees' satisfaction with privacy conditions was the second lowest mean IEQ score for the PWSp and was lower than employees' satisfaction with the AWSp. Privacy is a category level criterion that includes 'visual and acoustic considerations.' however it is currently unsupported by any specific attribute level questions. The B3 guidelines do not have any required or recommended performance conditions associated with this criterion.

Conditions regarding these results were previously reviewed for both the PWSp and the AWSp. To increase satisfaction scores, design practitioners should consider privacy needs for individuals working together in shared workspaces and provide additional AWSp where privacy needs can be met for short and long-term requirements. In addition, privacy needs should consider both visual and acoustic solutions such as spatial separation or privacy screens between adjacent spaces.

IEQ Criteria: Thermal Conditions (Results and Implications)

The results of the mean scores associated with the thermal conditions for the PWSp was 4.73 (SD 2.01) and the AWSp was 5.27 (SD 1.59). The results of the paired t-tests (t (25) = 1.44, p = .161), indicated that employees' satisfaction was not significantly different between the two workspaces. Lower satisfaction scores with may be in part related to thermal loss or gain in PWSp located adjacent to window wall locations.

Thermal conditions are a category level criterion with four attributes related to temperature, humidity, velocity of air, and adjustability. As presented in the literature review, employees' satisfaction with thermal conditions relates to overall satisfaction with the overall environment. For the most part, thermal conditions designed to meet sustainability goals in workplace environments are the responsibility of architectural designers and mechanical engineers. Performance criteria are frequently modeled and evaluated against projected goals following occupancy. Design practitioners can review planning goals to ensure that system furniture panels do not block thermostat controls; that file cabinets and desks do not cover vents; and equipment used in the workplace is properly vented as required. Following occupancy, practitioners can work with facility managers and building owners to establish procedures to log employee concerns over adverse thermal conditions.

IEQ Criteria: Vibration and Movement Conditions (Results and Implications)

The results of the mean scores associated with the vibration and movement conditions for the PWSp was 5.54 (SD 1.5) and the AWSp was 5.58 (SD 1.39). The results of the paired t-tests (t (25) = .214, p = .832), indicated that employees' satisfaction was not significantly different between the two workspaces.

Vibration and movement conditions are a category level criterion in the B3 guidelines. As with thermal conditions, responsibilities for vibration and movement are typically under the direction of the architect and structural engineers. Design practitioners need to be aware of the spatial layout of the furniture and equipment on each floor and implications with furniture changes that may affect vibrational frequencies in floor movement for occupants below the floor plan.

IEQ Criteria: View Conditions (Results and Implications)

The results of the mean scores associated with the view conditions for the PWSp was 5.31 (SD 1.78) and the AWSp was 4.96 (SD 2.21). The results of the paired t-tests (t (24) = 1.61, p = .257), indicated that employees' satisfaction was not significantly different between workspaces. View conditions are a category level criterion in the B3 guidelines and are included as a recommendation as opposed to a requirement. View conditions are associated with views to outdoor spaces or distant views within the building, i.e., sight lines.

The literature reviewed discussed the restorative benefits associated with the view of natural settings and the associated benefit of access to daylight. However, it is also important to recognize desired views and undesired views in workplace environments. For example, some external views in office environments may capture views of mechanical equipment on an adjacent roof or a deteriorating nearby building structure. In these instances, design practitioners need to provide opportunities to screen undesired views.

Design practitioners also need to consider desired and undesired views of interior spaces. For example, employees may need to have a clear, unimpeded view of an entrance area for the purposes of security or welcoming visitors and block views into storage and restroom areas. Employees in enclosed windowless PWSp can benefit from having a window into a corridor to provide opportunities for a distant view. Designers also need to consider privacy issues in the workplace, noting views to adjacent colleagues and others if distractions are problematic.

Results and Implications for Design Practice and Workspace Environments

Chapter four presented the results of the data analysis, fit to the theoretical model, and implications for design practice related to improvements in employees' satisfaction with IEQ conditions. Chapter five will review the AWSp research protocol and implications for future research and practice.

CHAPTER FIVE

Overview

Chapter One proposed the rationale and purpose of this research, noting how the presence of alternative workspace in workplace environments grew out of the trends associated with the ‘third places’ and ‘fourth places’ and variations in placed-based work activities (Florida, 2010; Oldenburg,1989; 2002). Chapter Two reviewed literature pertaining to sustainable design guidelines, interior design responsibilities for developing sustainable environments, and definitions for 11 indoor environment quality (IEQ) criteria included in this study. The Affordance Theory (Gibson, 1986) was presented as the research model and associated employee satisfaction with affordance and dissatisfaction as a constraint. Three hypotheses were proposed comparing employees' overall satisfaction across three workspace types [facility (site, building and interiors) F (SBI), primary workspaces (PWSp) and alternative workspaces (AWSp)] and indoor environment quality criteria between the PWSp and AWSp. Chapter Three described the building, employee population, and the data analysis methods used to explore employees' satisfaction. Chapter Four presented the results of the hypothesis tests and implications for design practice for each IEQ criteria in both PWSp and AWSp.

Chapter Five presents the final discussion on the goal to provide a more comprehensive understanding of the overall workplace environment. Considerations for future research in PWSp and AWSp are presented. Specific attention is directed at the unique differences associated with PWSp and AWSp workspace types; differences in employees' work activities (concentration, collaboration, and connection); differences associated with layers of ownership of AWSp; differences associated with various locations of AWSp and PWSp across the workplace environment; and finally, differences in building types, employee occupations and individual preferences that impact employee satisfaction. This chapter concludes with a summary discussion of implications for future research for AWSp related to post occupancy evaluation (POE) studies and more.

Developing a Comprehensive Perspective of Workplace Environments

One of the supporting arguments for this research was to provide a more comprehensive understanding of employees' satisfaction with workplace environments and to include under-represented workspaces in the POE process. The plan analysis (Table 5) revealed an important characteristic of the workspace in Hanson Hall that made it an ideal site for this study - almost one-half of the workspace was dedicated to PWSp (51%) and one-half was dedicated to AWSP (49%). Of the 33 AWSp in Hanson Hall, employee feedback was obtained for 16 AWSp (or 48% of the total AWSp) in this study. Again, these were workspaces that were previously unrepresented in POE studies.

Finally, this study began with the goal to evaluate employee's satisfaction for the F (SBI), PWSp, and AWSp) (macro-level of the physical environment) and followed with an evaluation of employee's satisfaction with 11individual IEQ criteria in PWSp and AWSp (micro-level of the physical environment). By reaching further into the inventory of space types and examining employee's satisfaction across different levels of the environment - the goal of providing a more comprehensive evaluation of workspace using the POE assessment method was achieved.

Workplace Trends: Implications for Future Research

Variations in workspace types

The research process and findings revealed several implications for future research. First, employees' satisfaction scores for the PWSp and the AWSp reflect a statistical mean (average) for all of the different workspace types identified in the survey instrument. Employees were asked to select their PWSp from a list of workspaces that included private offices, shared offices, workstations in open areas (with varying partition height), lab bench space, etc. Employees were then asked to select an AWSp from a pre-determined list of spaces that included in the overall building environment. The AWSp locations varied in type, function, accessibility, and layout, e.g., from a Starbucks coffee shop to computer labs, meeting rooms, library space, kitchen / lounge space, etc. As with the variation in types of PWSp, this study did not evaluate satisfaction with each type of the AWSp primarily due to the small sample size (N26). However, in studies with larger sample sizes, research could benefit from drilling deeper into satisfaction with specific workspace types. From this point, researchers can look at satisfaction levels with each individual IEQ criteria in both the PWSp and AWSp. For example, one might consider what differences might arise in workspaces having access to daylight and views from those that do not or those that provide different levels of privacy related to acoustical and visual conditions. There are unique differences in PWSp and AWSp features that may warrant a closer examination of the physical attributes of each workspace type that can impact how each IEQ criterion affects employees' satisfaction.

Variations in work activities (concentration, collaboration, and connection)

This study asked employees' to rate their satisfaction with their PWSp and AWSp, but it did not ask employees to rate their satisfaction while engaged in a specific work mode, e.g., concentration, collaboration, or connection activities. A typical private office achieves privacy through walls, enclosures and or other screening devices, minimizes visual and acoustical disruptions, and thereby affords an employee's ability to concentrate. However, the location, the size of the space, and furnishings associated with private offices may constrain an employee's ability to collaborate effectively with other colleagues. Alternative workspaces used as project team rooms provide an assortment of furnishings, tools, and equipment to support meetings and collaborative activities with other colleagues. However, the lighting, acoustic and thermal conditions associated with alternative work spaces may constrain an employee's ability to concentrate on individual work activities. Work café spaces and lounge areas provide furnishings and spaces for employee's to interact and connect with others, but the same furnishings may not support an employee's ability to concentrate on individual work activities or to collaborate effectively with others.

Therefore, researchers may want to first examine where employees engage in concentration, collaboration, and connection activities in the workplace and second, develop a process to assess their satisfaction level with each space, based on each individual work mode. Research that address the rhythm of work, specific work activities, and the duration of work activities will help designers understand the shifts in work modes that need to be considered across a given work period (Steelcase, n.d.a.). Designing spaces that support flexible work activities affords employee satisfaction and enhances space utilization across the workspace.

Variations in layers of ownership

As previously presented, PWSp is considered a 'home base' and AWSp are considered 'go to spaces.' Workplaces, (e.g., Steelcase Global Headquarters) that provide a 'palate of places' in their workplace environments allow workers (individuals and teams) to align their work mode with a workspace that supports the needed activities. In Chapter One, *Figure* 7, *Figure* 8, and *Figure* 10 illustrated several different types of PWSp and AWSp distributed throughout the office environment. Further, *Figure* 3, *Figure* 4, *Figure* 5, and *Figure* 6 illustrated different types of AWSp in terms of size, furnishings and technology. Some of these spaces illustrate areas for project teams, and some spaces appear open to all employees (e.g., the work café). Steelcase associated some these different spaces with 'layers of ownership' for use by individuals, groups of individuals, and all employees.

Hanson Hall clearly had similar types of AWSp with 'layers of ownership' that may have contributed to the AWSp the employee selected for their evaluation. For example, employees associated with the Carlson School of Management (CSOM) on 2nd floor may have been less likely to evaluate AWSp on the 3rd and 4th floor located in the Economics Department, and employees affiliated with the Economics Department (Econ) might have been less likely to evaluate meeting spaces in some of the CSOM locations. AWSp associated with departments are more likely to be used by their employees due to location, scheduling, and maintenance of the AWSp by the department. In addition, there are some employees that may frequent a specific AWSp, and thereby, form a temporary ownership of space. Reoccurring usage of a space by one or more individual is recognized by others as 'their space.'

Finally, the use of AWSp may be tied to an employee's position or role, frequency of use, or simply adjacency of space to their PWSp. Employee's may not see the AWSp as truly available for their use due to dedicated or implied 'ownership' associations and reflect negatively on the space. If an AWSp is open to all employees but habituated by one or more individuals that make the space appear unavailable, there may be issues with the PWSp or special work accommodations that are not being met elsewhere in the office environment.

Therefore, researchers should first understand who has access to the AWSp and attempt to identify if there are patterns of usage that may interfere with other employees' who might want to access these spaces and / or satisfaction with these spaces if trace evidence of others are left behind. If the space is assigned to a particular project team, it may be beneficial for researchers to conduct a focus group with individual members of the project team and learn more about satisfaction individual level and satisfaction at the as a group.

Differences in physical features and adjacencies of PWSp and AWSp

The floorplans included in, *Figure* 38 through *Figure* 42, (see Chapter Three) illustrated the location, size, shape and layout of the PWSp and AWSp across the each floor and entire building environment. In close examination, PWSp and AWSp with window spaces aligned with the interior atrium and exterior wall had access to daylight and views and other workspaces along the interior core did not. Some AWSp were large, semi-flexible meeting spaces and others were quiet spaces with dedicated functions. Future research should give greater attention to the physical features of a space and how they afford or constrain employees' satisfaction with each workspace. In this area, researchers can examine IEQ criteria as an individual category level and at the attribute level in order to dive deeper into how employee's satisfaction is afforded or constrained with each criterion.

In addition, the adjacency of PWSp to AWSp may also affect employee's satisfaction level. For example, placing an AWSp as a work café and lunchroom may not be appropriate when placed adjacent to a large open office environment. Noisy project team rooms may not be a good fit next to quiet, private enclaves where concentration tasks are a frequent work mode.

Employees may want to move from their PWSp space into an AWSp that is convenient and accessible; while others may seek out AWSp that are at greater distance to further separate themselves from work group or department. Other considerations for PWSp and AWSp may be related to aspects of compatibility in program goals. Designers need to adjacencies between workspace, work mode, distance of travel and other factors affecting PWSp to AWSp location and adjacencies. Future research should dive deeper into employees' satisfaction with AWSp spaces and consider space utilization based availability, distance of travel, and physical features (associated with IEQ criteria).

Variations in building types, occupations, and individual work styles

This study began with a discussion on space utilization that presented research studies reporting a wide variation in the amount of time that employees' spent in their PWSp and/or other AWSp throughout the office environment. The variation in the actual time spent in the PWSp suggests that differences among building types and employees' occupations may be associated with differences in the amount of time employees spend in their PWSp or in AWSp.

This is an important consideration for design teams and researchers alike. For example, Hanson Hall is a mixed-use building with both classroom and workspace environments. Several of the AWSp in Hanson Hall served both educational purpose (as an extension of the classroom) and a work purpose (meeting space among peers). Table 7 (see Chapter Three) indicated that over a half of the employees spent over 70% of their time in their PWSp and over 60% spent only 10-20% of their time in AWSp. This is a significant amount of time in spent in PWSp when compared with AWSp, but it may be in an expected range given the type of work that is associated with this building workplace environment. Research and other forms of scholarly work by academicians require high amount of focus work and therefore, it is easy to understand why employees in Hanson Hall spend a significant amount of time in their PWSp. If this building environment was designed to support product development and the employees spent significant amounts of time in collaboration, or supported workspace for a large population of mobile workers, the results of the time reported time spent in PWSp may have been much different.

In studies with larger sample sizes or data bases, researchers should look more closely at space utilization across population / occupation and building types in order to develop benchmarks for an ideal mix for PWSp and AWSp in the workplace environments. Once benchmarks are developed, researchers could direct their attention to POE studies and examine employee's satisfaction levels with specific types of AWSp designed and how they are actually designed to support work functions.

Finally, it is important to note that variations not only occur across building type and employees' occupations, but within individuals as well. As suggested by Steelcase researchers (Steelcase, n.d.a.), provisions for 'a palette of places' allows individuals or work groups to align their work activities with spaces that best fit their needs. Satisfying the need to accomplish a work task may be just one aspect of why AWSp are utilized. As previously discussed, employee's may fluctuate in the type of space they use based on their own rhythm of working. For example, some employees may go to AWSp so they or their work can be seen by others, other employees may go to spaces where they or their work is not visible to others. Employees have different motivations, reasons, and individual preferences for selecting a given AWSp and these factors may change over a given time period. These factors may be related to the time of the day, events occurring in the workplace, changes in individual work responsibilities. All of these conditions and more require agility on the part of the organization to respond to changing needs of the workplace environment. Workplace studies by Gensler (2013) levels of environmental stress (views of nature) or high levels of presence in the office environment (social café's or break bars).

Concluding Comments and Implications for Future Research

Chapter One identified how this research responded to strategic shifts in workplace design, changes in workplace activities, and the need to develop workspace environments that reflected sustainable design goals and deliver high performance environments to ensure organizational success. Findings from Gensler's (2013) workplace studies suggested that an employee's ability to choose their workspaces and tools to fit their responsibilities strengthens ability to make meaningful and successful decisions in their job. Newsham et al. (2009) linked employees' overall satisfaction with their workstations and job satisfaction along with other organization factors. Several studies discussed employees as a largest cost to the organization and (Brill, Margulis, & Konar, 1984; Cohen, 2007; Guerin et al., 2012; Harter, Schmidt, & Keyer, 2002; McCoy, 2005; Veale, 1989) and a leading resource of creative talent necessary to meet the needs of an organization (Voss, 2010). Finally, Gensler, (2006) considered that retaining and attracting the necessary talent to meet the goals of the organization was paramount to maintaining a competitive edge. Therefore, creating a workplace environment that affords employee's satisfaction with their PWSp and various AWSp is important to organizational success.

Chapter Five presented several considerations for future research in support of POE studies focused on employee satisfaction in workplace environments. Large organizations can conduct continuous and periodic assessment through facility management systems. For example, employee's involved in staff moves, workspace relocations, and building remodels can be routinely set surveys to respond to their satisfaction with the move experience and new workplace environment. AWSp that are utilized through a reservation or scheduling system may provide an option to forward employee survey's following the use of the space or spot periodic uses of the space. On-the-spot pop-up surveys provide another opportunity to gather important feedback on employee's satisfaction with their workspace.

Throughout this research, POE studies have illustrated how they provide important feedback on building performance, but they are not the only approach that can be used to learn how the workspace meets the needs of the occupants. Researchers can also conduct focus groups, interviews, behavior observations, trace observation and adopt new and emerging diagnostic tools to identify important issues and deliver appropriate solutions.

Finally, it would be easy and convenient to look at building environments where employees' satisfaction was high and consider that the design team 'got it right,' No two buildings or design projects are alike. Getting it 'right' in one project and using a prescriptive approach to achieve satisfaction in another project may not work. There will always be new information, preferences, and occupants to consider. In addition, low levels of satisfaction levels are indicative of problems and concerns that need to be addressed in the building environment. Some of the issues may be as simple as improving adjustable thermal controls in areas exposed to frequent changes in temperature. Other concerns may point to issues that require a comprehensive analysis to evoke new and innovative thinking around employees' concerns.

There are several performance metrics identified with successful sustainable design guidelines with the goal of demonstrating real outcomes. The Building, Benchmark, and Beyond (B3) Guidelines analyzes the physical and financial performance of the sustainable initiates referenced in the building design. These measurements reflect on the energy consumed, carbon emissions, water usage, diverting construction and demolition from the waste stream, and IEQ conditions. With respect to the B3 Guidelines, there is only one evaluation that focuses on the voice of the occupants and it is achieved through the POE process. In doing so, we are reminded us that it really the people that care about the building and it is by their voice that reveals the truth of its success.

REFERENCES

Abbaszadeh, S., Zagreus, L., Lehrer, D., & Huizenga, C. (2006). Occupant satisfaction with indoor environmental quality in green buildings. UC Berkeley, Center for the Built Environment. Retrieved from http://escholarship.org/uc/item/9rf7p4bs.

Abdi, H. (2010). The Greenhouse-Geisser correction. *Encyclopedia of Research Design. Sage Publications*, 544-548.

Acoustics, def.1, (n.d.). In *Merriam-Webster.com*. Retrieved on 7.15.2014 from http://www.merriamwebster.com/dictionary/acoustics

Alberts, D. S., & Papp, D. S. (1997). *The information age: An anthology on its impact and consequences*. National Defense University Press DTIC Document.

Allsteel. (2011). *Gather design guide: Supporting and inspiring interaction and collaboration.* Retrieved from http://www.allsteeloffice.com/SynergyDocuments/ GatherDesignGuide.pdf

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2004a). *ASHRAE standard ventilation for acceptable indoor air quality*. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers. Retrieved from http://www.techstreet.com/cgi-bin/pdf/preview/ 2339577/previews /ASHRAE_62_1_2004_2006Reprint_pre.pdf

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). (2004b). Standard 55-2010. Thermal environmental conditions for human occupancy. Atlanta: American National Standards Institute (ANSI). Retrieved from http://c0131231.cdn.cloudfiles. rackspacecloud.com/ ASHRAE_Thermal Comfort Standard.pdf

Arens, E. (2007). Assessment of indoor environments, Proceedings, Room vent 2007: *10th International Conference on Air Distribution in Buildings,* Helsinki, 13-15 June.

Aries, M., Veitch, J., & Newsham, G. (2010). *Journal of Environmental Psychology, 30*(4), 533.

Association for Contract Textiles, (n.d.) *Facts.The Definitive Sustainability Certification*

Program for Commercial Textiles. Retrieved on 07.25.14 from http://contracttextiles.org/index.php?page=sustainability-guideline

Astolfi, A., & Pellerey, F. (2008). Subjective and objective assessment of acoustic and overall environmental quality in secondary school classrooms. *The Journal of the Acoustic Society of America, 123*(1), 163-173.

Augenbroe, G., Pearce, A. R., Guy, B., & Kibert, C. (1998). Sustainable construction in the USA: A perspective to the year 2010. *Sustainable Development and the Future of Construction, Vol. report, 225*.

Augustin, S., & Brand, J. L. (n.d.). *Impact of the physical environment on knowledge worker performance*. Retrieved from http://www.haworth.com/en-us/Knowledge/Workplace-Library/Documents/ Impact -of-the-physical-environment-on-knowledge-worker-performance-white-paper.pdf

Bakó-Biró, Z., Wargocki, P., Weschler, C. J., & Fanger, P. O. (2004). Effects of pollution from personal computers on perceived air quality, SBS symptoms and productivity in offices. *Indoor Air, 14*(3), 178-187. Doi: 10.1111/j.1600-0668.2004.00218

B3 Guidelines. (n.d.a). Minnesota B3 Guidelines, Version 2.2. Retrieved from http://www.b3mn.org/guidelines/index.html

B3 Guidelines. (n.d.b). Minnesota B3 Guidelines, Version 2.2 Guidelines. Retrieved from http://www.b3mn.org/guidelines/guidelines.html

B3 Guidelines. (n.d.c). Minnesota B3 Post occupancy evaluation, Welcome to the B3 post occupancy evaluation (POE) web site. Retrieved from http://www.b3mn.org/ poe/index.html

B3 Guidelines. (n.d.d). Post occupancy evaluation. About sustainable post-occupancy evaluation survey (SPOES). Retrieved from http://www.b3mn.org/poe/ about.html

B3 Guidelines. (n.d.e). B3 Guidelines, Indoor environmental quality guidelines. Retrieved from http://www.b3mn.org/guidelines/ieq.html

B3 Guidelines. (n.d.f). Minnesota B3 Guidelines, Indoor environmental quality guidelines,1.7 Effective acoustics, Retrieved from http://www.b3mn.

org/guidelines/i_7.html

B3 Guidelines. (n.d.g). Minnesota B3 Guidelines, M.1 Life cycle assessment of building assemblies,Retrieved from http://www.b3mn.org/guidelines/ m_1.html

B3 Guidelines. (n.d.h). Minnesota B3 Guidelines, Materials and Waste Guidelines, M.2 Environmentally Preferable Materials. Retrieved from: http://www.b3mn.org/ guidelines/m_2.html

B3 Guidelines. (n.d.i). Minnesota B3 Guidelines, Indoor environmental quality guidelines, 1.2 Specify low-emitting materials. Retrieved from http://www.b3mn.org/guidelines/m_1.html

B3 Guidelines. (n.d.j). Minnesota B3 Guidelines, Indoor environmental quality guidelines, Daylight 1.9. Retrieved from http://www.b3mn.org/guidelines /i_9.html

B3 Guidelines. (n.d.k). Minnesota B3 Guidelines, Indoor environmental quality guidelines I.6 Quality Lighting. Retrieved from http://www.b3mn.org/ guidelines/i_6.html

B3 Guidelines. (n.d.l). Minnesota B3 Guidelines, Materials and waste guidelines, M. 3 Waste Reduction and Management. Retrieved from http://www.b3mn.org/ guidelines/m_3.html

B3 Guidelines. (n.d.m). Minnesota B3 Guidelines, Materials and waste guidelines. Retrieved from http://www.b3mn.org/guidelines/materials.html

B3 Guidelines. (n.d.n). Minnesota B3 Guidelines, Indoor environmental quality guidelines, 1.1 Restrictive Environment Tobacco Smoke. Retrieved from http://www.b3mn.org/guidelines/i_1.html

B3 Guidelines. (n.d.o). Minnesota B3 Guidelines, Indoor environmental quality guidelines, 1.4 Ventilation Design, Retrieved from http://www.b3mn.org /guidelines/i_4.html

B3 Guidelines. (n.d.p). Minnesota B3 Guidelines, Indoor environmental quality guidelines, 1.10 View Space and Window Access. Retrieved from http://www.b3mn.org/guidelines/i_10.html

B3 Guidelines. (n.d.p). Minnesota B3 Guidelines, Indoor environmental quality guidelines, 1.10 View Space and Window Access. Retrieved from http://www.b3mn.org/guidelines/i_10.html.

B3 Guidelines. (n.d.q). Minnesota B3 Guidelines, Indoor environmental quality guidelines, 1.5 Thermal Comfort. Retrieved from Retrieved from http://www.b3mn.org/guidelines/i_5.html

B3 Guidelines. (n.d.r). Minnesota B3 Guidelines, SB2030 Energy Standard, B3 Sustainable Building 2030 Energy Standards. Retrieved from http://www.b3mn.org/2030energystandard

B3 Guidelines. (n.d.s). Minnesota B3 Guidelines, Indoor environmental quality guidelines, Vibration and Movement. Retrieved from http://www.b3mn.org/guidelines/i_8.html

B3 Guidelines. (n.d.t). Minnesota B3 Guidelines, Indoor environmental quality guidelines, Appendix I-10 View Space Diagrams and Tables for I.10**.** Retrieved from http://www.b3mn.org/guidelines/i_10.html

B3 Guidelines. (n.d.u). Minnesota B3 Guidelines, Case Studies Database. Retrieved http://casestudies.b3mn.org/

Barber, C., Laing, A., & Simeone, M. (2005). Global workplace trends: A North American and European comparison. *Journal of Corporate Real Estate, 7*(3), 210-221.

Bartlett, M. S. (1937). Properties of sufficiency and statistical tests. *Proceedings of the Royal Society of London. Series A-Mathematical and Physical Sciences, 160*(901), 268-282.

Bear, A. R., & Bell, R. I. (1992). The CSP index: A practical measure of office lighting quality as perceived by the office worker. *Lighting Research and Technology, 24*(4), 215-225. doi: 10.1177/096032719202400405

Berens, M. (2013, December). CIDA's Standards Revision Project: Summary Report. Retrieved from http://accredit-id.org/wp-content/uploads/2010/03/Enviro_Scan_Summary.pdf

Benya, J. (2003). Daylighting and Electric Lighting. *CHPS (Collaborative for High*

Performance Schools), Lighting Manual, USA, 20.

Billett, S. (2002). Workplace pedagogic practices: Co–participation and learning. *British Journal of Educational Studies, 50*(4), 457-481

Billett, S. (2008). Learning through work: Exploring instances of relational interdependencies. *International Journal of Educational Research, 47*(4), 232-240. Doi: 10.1016/j.ijer.2008.07.006

Biner, P. M., Butler, D. L., & Winsted, D. E. (1991). Inside Windows: An Alternative to Conventional Windows in Offices and Other Settings. *Environment and Behavior, 23*(3), 359-382. doi: 10.1177/0013916591233006

Blum, A. (2006). Work and the workplace in 2006. *Dialogue, 13,* Gensler. Retrieved from http://www.gensler.com/uploads/documents/ D13_07_17_2008.pdf.

Bluyssen, P. M., Aries, M., & van Dommelen, P. (2011). Comfort of workers in office buildings: The European HOPE project. *Building and Environment, 46*(1), 280-288. Doi: 10.1016/j.buildenv.2010.07.024

Bonda, P., & Sosnowchik, K. (2007). Sustainable commercial interiors. Hoboken, New Jersey: John Wiley and Sons.

Boyce, P. (1998). Lighting quality: The unanswered questions. Keynote Address presented at the CIE Symposium on Lighting Quality, Ottawa, Canada, May 9± 10.

Boyce, P., Hunter, C., & Howlett, O. (2003). The benefits of daylight through windows. *Troy, New York: Rensselaer Polytechnic Institute*.

Boyce, P. R., Veitch, J. A., Newsham, G. R., Jones, C., Heerwagen, J., Myer, M., & Hunter, C. (2006). Lighting quality and office work: two field simulation experiments. *Lighting Research and Technology, 38*(3), 191-223.

Boubekri, M., Hull, R. B., & Boyer, L. L. (1991). Impact of Window Size and Sunlight Penetration on Office Workers' Mood and Satisfaction A Novel Way of Assessing Sunlight. *Environment and Behavior, 23*(4), 474-493.

Brager, G., Heerwagen, J, Buaman, F., Huizenga, C., Powell, K., Ruland, A., & Ring, E. (2000). *Team space and collaboration: Links to the physical environment*. Final

Internal Report. UC Berkeley, Center for the Built Environment. Retrieved from http://www.cbe.berkeley.edu/ research/pdf_files/Brager2000-IR-TeamSp.pdf

Brainard, G. C. (2002, November). Photoreception for regulation of melatonin and the circadian system in humans. In *Fifth International LRO lighting research symposium, Orlando*.

Brill, M., Margulis, S., & Konar, E. (1984). *Using office design to increase productivity*. Vol. 1 and 2. Buffalo, NY: Workplace Design and Productivity, Inc.

Butler, D. L., & Biner, P. M. (1989). Effects of Setting on Window Preferences and Factors Associated with Those Preferences. *Environment and Behavior*, *21*(1), 17-31. doi: 10.1177/0013916589211002

Butler, D. L., & Steuerwald, B. L. (1991). Effects of View and Room Size on Window Size Preferences Made in Models. *Environment and Behavior*, *23*(3), 334-358. doi: 10.1177/0013916591233005

Cao, B., Ouyang, Q., Zhu, Y., Huang, L., Hu, H., & Deng, G. (2012). Development of a multivariate regression model for overall satisfaction in public buildings based on field studies in Beijing and Shanghai. *Building and Environment, 47*(0), 394-399. Doi: 10.1016/j.buildenv.2011.06.022

Carlopio, J. R. (1996). Construct validity of a physical work environment satisfaction questionnaire. *Journal of Occupational Health Psychology, 1*(3), 330-344. Doi: 10.1037/1076-8998.1.3.330

Carter, R. D., & Zhang, J. S. (2007). Definition of standard office environments for evaluating the impact of office furniture emissions on indoor VOC concentrations. Transactions-American Society of Heating, Refrigerating and Air Conditioning Engineers, *113*(2), 466-477.

Center for Sustainable Building Research. (n.d.a). Minnesota Sustainable Building 2030. History of Minnesota Sustainable Building 2030 (SB 2030). Retrieved from CSBR website http://www.b3mn.org/guidelines/archive/ version2_1/overview.html

Center for Sustainable Building Research (n.d.b). The State of Minnesota Sustainable Building Guidelines (MSBG), B3 State of Minnesota Sustainable Building Guidelines, B3-MSBG Version 2.1 (December 21, 2009) (MSBG). Retrieved from http://www.b3mn.org/guidelines/archive/version2_1/index.html

Center for Sustainable Building Research (n.d.c). MSBG, version 2.1, Indoor environmental quality guidelines, Download Version 2.1 Documents Guidelines Retrieved from http://www.msbg.umn.edu/downloads_v21/ LEEDMSBG.pdf

Center for Sustainable Building Research (2010b). Minnesota Sustainable Building, Version 2.1, Indoor environmental quality guidelines, Download Version 2.1 Documents Guidelines Retrieved from http://www.b3mn.org/ guidelines/archive/version2_1/downloads_v2_1/LEEDWorksheet_NCv2.2_MSBG.pdf

Cetegen, D., Veitch, J. A., & Newsham, G. R. (2008). View size and office luminance effects on employee satisfaction. National Research Council, Canada Institute for Research in Construction.

Chatterjee, D. (1987). Repetition strain injury—a recent review. *Occupational Medicine, 37*(1), 100-105.

Cheng, Y., Niu, J., & Gao, N. (2012). Thermal comfort models: A review and numerical investigation. *Building and Environment, 47*(0), 13-22. doi: 10.1016/j.buildenv.2011.05.011

Chemero, A., Klein, C., & Cordeiro, W. (2003). Events as changes in the layout of Affordances. *Ecological Psychology, 15*(1), 19-28. Retrieved from http://dx.Doi: 10.1207/s15326969eco1501_02.

Choi, J. H., Aziz, A., & Loftness, V. (2009). Decision support for improving occupant environmental satisfaction in office buildings: The relationship between subset of IEQ satisfaction and overall environmental satisfaction. In: *Proceedings of Healthy Buildings,* Syracuse, NY, USA, paper nr 747.

Choi, S. (2011). *The relationship among indoor environmental quality, occupant satisfaction, work performance, and sustainability ethic in sustainable buildings*. Dissertation, University of Minnesota, Retrieved from http://conservancy.umn. edu/handle/11299/119815

Christensen, P. H. (n.d.). *Open space offices as a HR tool for building social networks*. Denmark: Copenhagen Business School.

Clapham, D. (2011). The embodied use of the material home: An affordance approach. *Housing, Theory and Society, 28*(4), 360-376. Doi: 10.1080/14036096.2011.564444

Cohen, L. M. (2007). Bridging two streams of office design research: A comparison of design/behavior and management journal articles from 1980-2001. *Journal of Architectural and Planning Research*, *24*(4), 289-307.

Council for Interior Design Accreditation. (2014, January). *Professional Standards 2014*. Council for Interior Design Accreditation. Retrieved from http://accreditid.org/wp-content/uploads/2010/03/Professional-Standards-2014.pdf

Crocker, L., & Algina, J. (1986). *Introduction to Classical and Modern Test Theory*, Holt, Rinehart & Winston, Orlando, Florida,

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334. doi:10.1007/bf02310555

Cuttle, C. (1983). People and windows in workplaces. *Proceedings of the people and physical environment research conference, Wellington, New Zealand,* 203-212.

Danielsson, C. B., & Bodin, L. (2008). Office type in relation to health, well-being, and job satisfaction among employees. *Environment and Behavior*. *40*(5), 636-668.

Danielsson, C. B., & Bodin, L. (2009). Difference in Satisfaction with Office Environment Among Employees in Different Office Types. *Journal of Architectural and Planning Research, 26*(3), 241-257.

Darrach, C. G. (1906). The design, installation and maintenance of modern office building. *Modern Office Building*. Presentation April 5th, 1906.

Davenport, T. (2005). *Why office design matters*, Harvard Business School, Retrieved from http://hbswk.hbs.edu/archive/4991.html

Davis, M.C., Leach, D. J., & Clegg, C. W. (2011). *The physical environment: An evolving topic*. Paper presented at the Annual Meeting of the Academy of Management, Montreal, Canada. Retrieved from http://lubswww.leeds.ac.uk/stc/our-projects/maximising-existing-workspace

Dawis, R. V. (2002). Job Satisfaction J. C. Thomas (Ed.) *Comprehensive Handbook of*

Psychological Assessment. Industrial and Organizational Assessment. V. 4 (pp. 470-481). Hoboken, New Jersey, John Wiley and Co.

Deloitte (2009). *Why change now preparing for the workplace of tomorrow*, Deloitte Development. Retrieved from http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/us_talent_PreparingfortheWorkplaceofTomorrow_federal_081709.pdf

DeMarco, T., & Lister, T. R., (1999). *Peopleware: Productive projects and teams, (2nd Ed.),* New York, Dorset House Publishing.

Dravigne, A., Waliczek, T. M., Lineberger, R., & Zajicek, J. (2008). The effect of live plants and window views of green spaces on employee perceptions of job satisfaction. *HortScience, 43*(1), 183-187.

Driza, P., & Park, N-K. (2014, March). *How satisfied are occupants with the indoor environment quality in LEED-certified higher education buildings*? Paper presented at the Interior Design Educators Conference, New Orleans, Louisiana, Abstract retrieved at http://conf.idec.org/2014/how-satisfied-are-occupants-with-the-indoor-environmental-quality-in-leed-certified-higher-education-buildings/

Drucker, P. (1959) *Landmarks of Tomorrow*. New York: Harper.

Dogrusoy, I. T., & Tureyen, M. (2007). A field study on determination of preferences for windows in office environments. *Building and Environment, 42*(10), 3660-3668. doi: 10.1016/j.buildenv.2006.09.010

Elvers. G, (n.d.a). *Using SPSS for t Tests.* Retrieved from: http://academic.udayton.edu/gregelvers/psy216/spss/ttests.htm

Elkington, J. (1997). *Cannibals with forks. The triple bottom line of 21st century*. Oxford: Capstone Publishing.

Ellison, M. (1978). Ecodesign: Implications for energy-conscious interior designers *Journal of Interior Design, 4*(2), 36-49. Doi: 10.1111/j.1939-1668.1978.tb00276.x

Energy Resource Center. (1995). *Sourcebook: A Guide to the Energy-Efficient and Environmentally Friendly Features of Sustainable Design*. Southern California Gas Company, Downey, CA.

Escuyer, S., & Fontoynont, M. (2001). Lighting controls: a field study of office workers' reactions. *Lighting Research and Technology, 33*(2), 77-94. doi: 10.1177/136578280103300202

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological methods, 4*(3), 272.

Farley, K. M., & J. A. Veitch (2001). A room with a view: a review of the effects of windows on work and well-being. National Council Research Canada, Institute for Research in Construction.

Fayard, A.-L., & Weeks, J. (2007). Photocopiers and water-coolers: The affordances of informal interaction. *Organization studies, 28*(5), 605-634.

Florida, R. (2010, July 06). Starbucks offers free Wi-Fi and the fourth place for work. *The Daily Beast*. Retrieved from http://www.thedailybeast.com/articles/

Forest Stewardship Council, (n.d.). *Chain-of-Custody Certification*. Retrieved on 07.25.14 from https://us.fsc.org/chain-of-custody-certification.201.html

Fowler, K. M., & Rauch, E. M. (July 2006). *Sustainable Building Rating Systems Summary*. Prepared for the U.S. General Services Administration under Contract DE-AC05-76RL061830, Pacific Northwest National Laboratory, Battelle Memorial Institute. Retrieved from: http://wbdg.org/ccb/GSAMAN/sustainable_bldg_rating_systems.pdf

Fransson, N., Västfjäll, D., & Skoog, J. (2007). In search of the comfortable indoor environment: A comparison of the utility of objective and subjective indicators of indoor comfort. *Building and Environment*, *42*(5), 1886-1890.

Freihoeffer, K. (2012). T*he relationship between sustainable indoor environmental quality (IEQ) and employees' satisfaction with their office environments.* Dissertation, University of Minnesota, Retrieved from http://conervancy.umn.edu/bitstream/128718/1/Freihoeffer_umn_0130E_12653.pdf

Freihoeffer, K., Guerin, D., Martin, C., Kim, H.-Y., & Kulman Brigham, J. (2013). Occupants' satisfaction with, and physical readings of, thermal, acoustic, and lighting conditions of sustainable office workspaces. *Indoor and Built Environment*. doi: 10.1177/1420326x13514595

Frontczak, M., Schiavon, S., Goins, J., Arens, E. A., Zhang, H. P. D., & Wargocki, P. (2012). Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design. Retrieved from UC Berkeley, Center for the Built Environment, website: http://escholarship.org /uc/item/1wc7t219

Frontczak, M., & Wargocki, P. (2011). Literature survey on how different factors influence human comfort in indoor environments. *Building and Environment, 46*(4), 922-937. doi: http://dx.doi.org/10.1016/j.buildenv.2010.10.021

Function, Def 2. (n.d.). *Merriam-Webster.com*. Retrieved on 08.24.14 from http://www. merriam-webster.com/dictionary/function

Fuller, B. (1963). *Operating manual for spaceship earth.* Lars Muller Publisher. Retrieved online from http://www.bfi.org/about-bucky/resources /books /operating-manual-spaceship-earth

Gale, S. F. (2012). From green to black. *Project Management Network*, *27*(7), 28-35. Retrieved from http://www.pmnetwork-digital.com/pmnetworkopen/ 201207?sub_id=aPS7MC41hVoS#pg

Galasiu, A. D., & Veitch, J. A. (2006). Occupant preferences and satisfaction with the luminous environment and control systems in daylit offices: a literature review. *Energy and Buildings, 38*(7), 728-742. doi: http://dx.doi.org/10.1016/ j.enbuild.2006.03.001

Gensler. (2006). *The Gensler design + performance index The U.S. workplace survey.* Retrieved from Gensler website: http://www.gensler.com/uploads/documents/ Design+Performance_Index_ 10_22_2008.pdf

Gensler. (2008). *2008 Workplace survey United States*. A design + performance report. Retrieved from Gensler website: http://www.gensler.com/ uploads/documents /2008_Gensler_Workplace_Survey_ US_09_30_2009.pdf

Gensler, (2013). *2013 U.S. Workplace Survey / Key Findings.* Retrieved from Gensler website: http://www.gensler.com/uploads/documents/2013_US_Workplace

Gibson, J. J. (1986). *The ecological approach to visual perception*. Boston: Houghton Mifflin.

Gillen, N.M. (2006). The future workplace, opportunities, realities and myths: A practical approach to creating meaningful environments. In J. Worthington (Ed.), *Reinventing the Workplace* (2nd Edition), (pp. 61–78). Burlington, MA: Oxford Architectural Press.

Gillies, J., & Cailliau, R. (2000). *How the web was born: The story of the world-wide web*. New York, NY: Oxford Publishing.

Greenhouse, S.W., & Geisser, S. (1959). On methods in the analysis of profile data. *Psychometrika*, 24, 95–112.

Guerin, D.A., Kim, H.-Y. Kulman-Brigham, J., Choi, SM., & Scott, A. (2012). Post-occupancy evaluation of employees' work performance and satisfaction as related to sustainable design criteria and workstation type. *Journal of Green Building, 7*(4), 85-99. doi: 10.3992/jgb.7.4.85

Hadjri, K., & Crozier, C. (2009). Post-occupancy evaluation: Purpose, benefits and barriers. *Facilities, 27*(1/2), 21-33. DOI 10.1108/02632770910923063

Hanagan, L. (2005). Walking-Induced Floor Vibration Case Studies. *Journal of Architectural Engineering, 11*(1), 14-18. doi: doi:10.1061/(ASCE)1076-0431(2005)11:1(14).

Hanagan, L., & Murray, T. (1997). Active Control Approach for Reducing Floor Vibrations. *Journal of Structural Engineering, 123*(11), 1497-1505. doi: doi:10.1061/(ASCE)0733-9445(1997)123:11(1497)

Hanifin, J. P., & Brainard, G. C. Photoreception (2007). for circadian, neuroendocrine, and neurobehavioral regulation. *Journal of physiological anthropology*, *26*(2), 87-94.

Harter, J. K., Schmidt, F. L. & Keyer, C. L. (2002). Well-being in the workplace and its relationship to business outcomes: a review of the Gallup Studies. In C. L. Keyes and J. Haidt, (Eds.) Flourishing: The positive person and the good life (pp. 205-224). Washington D.C.: American Psychological Association. Retrieved from http://media.gallup.com/DOCUMENTS/whitePaper--Well-BeingInTheWorkplace.pdf

Harris, R. (2006). Real estate and the future. In J. Worthington (Ed.), *Reinventing the Workplace* (2nd Ed), (pp. 50–77). Oxford: Architectural Press.

Haworth. (n.d.a). *Advanced technology showcase*. Haworth. Retrieved from http://www.haworth.com/en-us/Knowledge/Workplace Library/Pages/ WorkspaceLibrary.aspx

Heerwagen, J. H., Kampschroer, K., Powell, K. M., & Loftness, V. (2004). Collaborative knowledge work environments. *Building Research & Information, 32*(6), 510-528. doi: 10.1080/09613210412331313025

Haworth. (n.d.c). *The shrinking workstation.* Haworth. Retrieved from http://www.haworth.com/en-us/Knowledge/Workplace-Library/Documents/The-Shrinking-Workstation.pdf

Hedge, A. (1988). *Job stress, job satisfaction, and work-related illness in offices.* Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.

Hedge, A., Burge, P. S., Robertson, A. S., Wilson, S., & Harris-Bass, J. (1989). Work-related illness in offices: A proposed model of the “sick building syndrome”. *Environment International 15*(1): 143-158.

Heerwagen, J. (2000). Green buildings, organizational success and occupant productivity. *Building Research and Information 28*(5-6): 353-367. doi: 10.1080/096132100418500

Heerwagen. J., Anderson, D., & Porter, W. (2012). *Network The Future Work Place,* Anderson Porter Design.

Heerwagen, J. H., & Orians, G. H. (1986). Adaptations to Windowlessness: A Study of the Use of Visual Decor in Windowed and Windowless Offices. *Environment and Behavior, 18*(5), 623-639. doi: 10.1177/0013916586185003

Heerwagen, J., & Zagreus, L. (2005). *The human factors of sustainable building design: Post-occupancy evaluation of the Philip Merrill Environment Center*, Annapolis, MD. Report prepared for Building Technology Program of U.S. Department of Energy. Retrieved from http://www.cbe.berkeley.edu/research/pdf_files /SR_CBF_2005.pdf

Heft, H. (2003). Affordances, Dynamic Experience, and the Challenge of Reification. *Ecological Psychology, 15*(2), 149-180.doi: 10.1207/s15326969eco1502_4

Herman Miller. (n.d.a). Herman Miller Space Utilization Services. Making Real Estate Work Harder: Aggregated Data, Trends, and Examples. Retrieved from http://www.hermanmiller.com/content/dam/hermanmiller/ documents/research_topics/SpaceUtl.pdf

Herman Miller. (n.d.b). *Herman Miller Action Office System*. Retrieved from Herman Miller website: http://www.hermanmiller.com/products/seating/performance-work-chairs/ergon-3-chairs.html

Herman Miller. (n.d.c). *Herman Miller Action Office System*. Retrieved from Herman Miller website: http://www.hermanmiller.com/content/dam/hermanmiller /documents/product_literature/brochures/Action_Office_System_brochure.pdf

Herzog, T. R., Colleen, Maguire, P., & Nebel, M. B. (2003). Assessing the restorative components of environments. *Journal of Environmental Psychology, 23*(2), 159-170. doi: http://dx.doi.org/10.1016/S0272-4944(02)00113-5159-170

Heinberg, R. (2010). *Peak Everything; Waking Up to the Century of Decline*. Gabriola Island, BC, Canada: New Society Publishers.

Hicks, S. (2004). Vibration characteristics of steel–concrete composite floor systems. *Progress in Structural Engineering and Materials, 6*(1), 21-38. doi: 10.1002/pse.163

Hua, Y., Loftness, V., & Hicks, S. (2004). Vibration characteristics of steel–concrete composite floor systems. *Progress in Structural Engineering and Materials, 6*(1), 21-38. doi: 10.1002/pse.163

Heerwagen, J., & Powell, K.M. (2011). Relationship between workplace spatial settings and occupant-perceived support for collaboration. *Environment and Behavior*, *43*(6), 807-826. doi: 10.1177/0013916510364465

Hua, Y., Oswald, A., & Yang, X. (2011). Effectiveness of daylighting design and occupant visual satisfaction in a LEED Gold laboratory building. *Building and Environment, 46*(1), 54-64. doi: 10.1016/j.buildenv.2010.06.016

Huang, R., & Sarigöllü, E. (2008). Assessing satisfaction with core and secondary attributes. *Journal of Business Research, 61*(9), 942-949. Doi: 10.1016/j.jbusres.2007.10.003

Huang, L., Zhu, Y., Ouyang, Q., & Cao, B. (2012). A study on the effects of thermal, luminous, and acoustic environments on indoor environmental comfort in offices. *Building and Environment, 49*(0), 304-309. doi: http://dx.doi.org/10.1016/j.buildenv.2011.07.022

Humphreys, M. A. (2005). Quantifying occupant comfort: are combined indices of the indoor environment practicable? *Building Research and Information, 33*(4), 317-325. Doi: 10.1080/09613210500161950

Hypothesis, def.2, (n.d.). In *Merriam-Webster.com*. Retrieved on 7.15.2014 from http://www.merriam-webster.com/dictionary/hypothesis

Ihle, K. A. (2010). *Thermal Comfort and Window Proximity as They Relate to Perceived Employee Performance and Satisfaction.* Master's Thesis, University of Minnesota. Retrieved from http://conservancy.umn.edu/handle/11299101716

International Organization for Standardization. (2005). *ISO 7730:2005 Ergonomics of the thermal environment* -Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria. International Organization for Standardization. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso:7730:ed-3:v1:en

Jensen, K., Arens, E., & Zagreus, L. (2005). Acoustic quality in office workstations, as assessed by occupant surveys. *Proceedings of the Indoor Air Conference*, Beijing, China.

Jones, K. S. (2003). What is an affordance? *Ecological Psychology, 15*(2), 107-114.

Jones, L. (2008). Global sustainability: The macro perspective. In Jones, L. (Ed.), *Environmentally responsible design: green and sustainable design for interior designers* (pp. 3-40). Hoboken, NJ: John Wiley and Sons, Inc.

Johnson, J., & Hargis, S. (2011). *Just because you build it doesn't mean they will come, Planning for effective workplace interaction and collaboration*. Allsteel. Retrieved from http://www.allsteeloffice.com/2011New Products/gather/downloads/files/materials/Executive_Workplace_Interaction_CollabWhitePaper_7b.pdf

Jørgensen, R. B., Hanssen, S. O., Bakke, J. V., & Jensen, E. K. (2009). Indoor air quality *General, Applied and Systems Toxicology*: John Wiley and Sons, Ltd. DOI:

10.1002/9780470744307.gat090

Kaiser, H. (1970). A second generation little jiffy. *Psychometrika, 35*(4), 401-415. doi: 10.1007/bf02291817.

Kamarulzaman, N., Saleh, A. A., Hashim, S. Z., Hashim, H., & Abdul-Ghani, A. A. (2011). An overview of the influence of physical office environments towards employee. *Procedia Engineering, 20*(0), 262-268. Doi: 10.1016/j.proeng.2011.11.164

Kang, M., & Guerin, D. A. (2009). The characteristics of interior designers who practice environmentally sustainable interior design. *Environment and Behavior, 41*(2), 170-184.Doi: 10.1177/0013916508317333

Kano, N. (1984). Attractive quality and must-be quality. *Hinshitsu—The Journal of the Japanese Society for Quality Control 1984*, 39–48.

Kaplan, S. (1992). *The restorative environment: Nature and human experience.* Paper presented at the Role of Horticulture in Human Well-being and Social Development: A National Symposium. Timber Press, Arlington, Virginia.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of environmental psychology*, *15*(3), 169-182.

Kaplan, R. (2007). Employees' reactions to nearby nature at their workplace: The wild and the tame. *Landscape and Urban Planning, 82*(1–2), 17-24. doi: http://dx.doi.org/10.1016/j.landurbplan.2007.01.012

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. N.Y., N.Y.: Cambridge University Press Archive.

Kayode, F., Ojo, B., & Sheba, E. A. (2008). Review Paper: Design, Aesthetics and the Issue of Integrity in the Built Environment: The Nigerian Example. *Indoor and Built Environment*, *17*(4), 283-298. doi: 10.1177/1420326x08094897

Kim, J., & de Dear, R. (2012). Nonlinear relationships between individual IEQ factors and overall workspace satisfaction. Building and Environment, *49*(0): 33-40.

Kim, Y. S., Kim, M. K., Jeong, J. Y., & Park, J. A., (2009). *A* Case Study of Affordance and Affordance Feature Identification through User Observation. In *DS 58-2:*

Proceedings of ICED 09, the 17th International Conference on Engineering Design, Vol. 2, Design Theory and Research Methodology, Palo Alto, CA, USA, 24.-27.08.2009. Pages: 453-464.

Kim, Y., Kim, M., Lee, S., Lee, C., Lee, C., & Lim, J. (2007, January). Affordances in interior design: a case study of affordances in interior design of conference room using enhanced function and task interaction. Paper no. DETC2007-35864. In *ASME 2007 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* (pp. 319-328). American Society of Mechanical Engineers.

Kim, Y. S., Lee, S., Park, J. J., Kim, M. K., & Kim, M. (2009). Study on Personal Characteristics and Affordance Perception: Another Case Study. Paper presented at the *DS 58-6: Proceedings of ICED 09, the 17th International Conference on Engineering Design, Vol. 6, Design Methods and Tools* (pt. 2), Palo Alto, CA, USA, 24.-27.08. 2009.

Kim, Y. S., Lim, J. S., & Park, J. A. (2009). *Affordance Feature Reasoning: A Case Study for Human-Product Interaction.* Paper presented at the DS 58-2: Proceedings of ICED 09, the 17th International Conference on Engineering Design, Vol. 2, Design Theory and Research Methodology, Palo Alto, CA, USA, 24.-27.08. 2009.

Kluver, R. (2000). Globalization, informatization, and intercultural communication. *American Journal of Communication, 3*(3), Oklahoma City University. Retrieved from: http://unpan1.un.org/intradoc/groups/public/documents/apcity/ unpan002006.html

Knight, C., & Haslam, S. A. (2010). Your place or mine? Organizational identification and comfort as mediators of relationships between the managerial control of workspace and employees' satisfaction and well-being. *British Journal of Management, 21*(3), 717-735. Doi: 10.1111/j.1467-8551.2009.00683

Knoll. (2012, October 24). Activity Spaces: A variety of spaces for a variety of work. Retrieved from: http://www.knoll.com/knollnewsdetail/activity-spaces

Knoll. (2013, June 07). Creating collaborative spaces that work: A Performance-based approach to successful planning. Retrieved from: http://www.knoll.com/ knollnewsdetail/creating-collaborative-spaces-that-work

Koutamanis, A. (2006). Buildings and affordances *Design Computing and Cognition'06* (pp. 345-364). Netherlands: Springer.

Kryter, K. D. (1985). *The effects of noise on man*. Orlando, FL: Academic Press.

Kwok, K. C. S., Hitchcock, P. A., & Burton, M. D. (2009). Perception of vibration and occupant comfort in wind-excited tall buildings. *Journal of Wind Engineering and Industrial Aerodynamics, 97*(7–8), 368-380. doi: 10.1016/j.jweia.2009.05.006

Lai, J. H., & Yik, F. W. (2007). Perceived importance of the quality of the indoor environment in commercial buildings. *Indoor and Built Environment, 16*(4), 311-321.

Lai, A.C.K., Mui, K.W., Wong L.T., & Law L.Y. (2009). An evaluation model for indoor environmental quality (IEQ) acceptance in residential buildings. *Energy and Buildings,41*(9), 930-936.

Laing, A. (2006). New patterns of work: The design of the office. In J. Worthington (Ed.), *Reinventing the Workplace* (2nd ed.), (pp. 29–49). Oxford: Architectural Press.

Langhoff, J. (2007). *Does place still matter? The role of the workplace in a distributed world*. Retrieved from Haworth website: http://www.haworth.com/en-us/Knowledge/Workplace-Library/Documents/Does-Place-Still-Matter.pdf

Leather, P., Pyrgas, M., Beale, D., & Lawrence, C. (1998). Windows in the Workplace: Sunlight, View, and Occupational Stress. *Environment and Behavior, 30*(6), 739-762. doi: 10.1177/001391659803000601

Lee, S. (2011). Introduction, In Editor: Sang Lee. *Aesthetics of sustainable architecture*. Rotterdam 2011: 010 Publishers.

Lee, Y. S. (2010). Office layout affecting privacy, interaction, and acoustic quality in LEED-certified buildings. *Building and Environment, 45*(7), 1594-1600. doi: 10.1016/j.buildenv.2010.01.007

Lee, Y. S., & Guerin, D. A. (2009). Indoor environmental quality related to occupant satisfaction and performance in LEED-certified buildings. *Indoor and Built Environment, 18*(4), 293-300.

Lee, Y. S., & Guerin, D. A. (2010). Indoor environmental quality differences between office types in LEED-certified buildings in the US. *Building and Environment, 45*(5), 1104-1112. doi: http://dx.doi.org/10.1016/j.buildenv.2009.10.019

Leeds, J. (2001). *The power of sound, how to manage your personal soundscape for a vital, productive and healthy life.* Rochester, Vermont: Healing Arts Press.

Leslie, R. P. (2003). Capturing the daylight dividend in buildings: why and how? *Building and Environment, 38*(2), 381-385.

Levin, H. (2008). *Environmental sustainability through new ways of working*. Originally published by New Ways of Working, LLC. Retrieved from http://www.haworth.com/en-us/Knowledge/Workplace-Library/Pages/WorkspaceLibrary.aspx

Lighting Research Center, (n.d.a). *Daylighting.* Retrieved on 08.08.14 from http://www.lrc.rpi.edu/researchareas/daylighting.asp

Lighting Research Center, (n.d.b). *Controls.* Retrieved on 08.08.14 from http://www.lrc.rpi.edu/researchAreas/daylighting.asp

Locke, E. (1976). The nature and causes of job satisfaction. In M. D. Dunette (Ed.), *Handbook of industrial and organizational psychology* (pp. 1297-1343). Chicago: Rand McNally.

Loe, L., Mansfield, K. P., & Rowlands, E. (1994). Appearance of lit environment and its relevance in lighting design: Experimental study. *Lighting Research and Technology, 26*(3), 119-133. doi: 10.1177/096032719402600301

Long, K. (2004). *User Effective Buildings,* Denver, Aardex Corporation. ISBN 9790975552406.

Lottrup, L., Stigsdotter, U. K., Meilby, H., & Claudi, A. G. (2013). The Workplace Window View: A Determinant of Office Workers’ Work Ability and Job Satisfaction. *Landscape Research*, 1-19. doi: 10.1080/01426397.2013.829806

Malmqvist, T. (2008). Environmental rating methods: selecting indoor environmental quality (IEQ) aspects and indicators. *Building Research and Information*, *36*(5), 466–485.

Marans, R. W., & Spreckelmeyer, K. F. (1982). Measuring Overall Architectural

Quality. *Environment and Behavior, 14*(6), 652-670. doi: 10.1177/0013916582146002

Marans, R.W., & Yan, X. (1989). Lighting quality and environmental satisfaction in open and enclosed offices. *Journal of Architectural and Planning Research*, 6, 118–131.

Maier, J. R. A., Fadel, G. M., & Battisto, D. G. (2009). An affordance-based approach to architectural theory, design, and practice. *Design Studies, 30*(4), 393-414. doi: http://dx.doi.org/10.1016/j.destud.2009.01.002

Masuda, Y. (1982). *Information society as post-industrial society.* Bethesda, MD: World Future Society.

Matzler, K., & Renzl, B. (2007). Assessing asymmetric effects in the formation of employee satisfaction. *Tourism Management*, *28*(4), 1093-1103. Doi: 10.1016/j.tourman.2006.07.009

Mawson, A. (n.d.a). The workplace and its impact on productivity. Advanced Workplace Associates. Retrieved from http://www.advanced-workplace.com/uploads/pdfs/3-Workplace_Imapct_On_Productivity.pdf

McCoy, J. M. (2005). Linking the physical work environment to creative context. *The Journal of Creative Behavior, 39*(3), 167-189. Doi: 10.1002/j.2162-6057.2005.tb01257

Mendell, M. J. (2003). Commentary Indices for IEQ and building-related symptoms. [Article]. *Indoor Air, 13*(4), 364-368. doi: 10.1046/j.0905-6947.2003.00229

Mendell, M. J., Fisk, W. J., Kreiss, K., Levin, H., Alexander, D., Cain, W. S., . . . Wallingford, K. M. (2002). Improving the health of workers in indoor environments: Priority research needs for a national occupational research agenda. *American journal of public health, 92*(9), 1430-1440. doi: 10.2105/ajph.92.9.1430

Miles, A. K., & PerrewÉ, P. L. (2011). The relationship between person–environment fit, control, and strain: The role of ergonomic work design and training. *Journal of Applied Social Psychology, 41*(4), 729-772. doi: 10.1111/j.1559-1816.2011. 00734

Miller, N. G., Erickson, A., & Yust, B. L. (2001). Sense of Place in the Workplace: The

Relationship Between Personal Objects and Job Satisfaction and Motivation. *Journal of Interior Design, 27*(1), 35-44. doi: 10.1111/j.1939-1668.2001.tb00364

Minnesota Pollution Control Agency. (n.d.). *Design guidelines, specifications, and rating systems*. Retrieved from http:// http://www.pca.state.mn.us/index.php/ topics/ preventing-waste-and-pollution/green-building/design-guidelines-specs-and-rating-systems.html

Mollison, B. (2012, June). *Presentation consumption over last 100+ years*. St. Croix Institute for Community Presentation at St. Croix Institute for Sustainable Community Development, University of Wisconsin, River Falls, Wisconsin.

Moore, T., Carter, D., & Slater, A. (2002). A field study of occupant controlled lighting in offices. *Lighting Research and Technology, 34*(3), 191-202. doi: 10.1191/1365782802lt047oa

Nahikian, A. (2012).Creating sustainable value for the 21st century. *Steelcase 360*, *64*:88-93.

Nasrollahi, N., Knight, I., & Jones, P. (2008). Workplace satisfaction and thermal comfort in air conditioned office buildings: Findings from a summer survey and field experiments in Iran. *Indoor and Built Environment, 17*(1), 69-79.

National Council for Interior Design Qualification (NCIDQ). (n.d.). Definition of Interior Design Retrieved from http://www.ncidq.org/AboutUs/AboutInteriorDesign/ DefinitionofInteriorDesign.aspx

Navai, M., & Veitch, J. A. (2003). *Acoustic satisfaction in open-plan offices: review and recommendations* (IRC-RR-151). Ottawa, ON: National Research Council of Canada, Institute for Research in Construction. Retrieved from http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/ctrl?action=rtdoc&an=20386513&article=0&fd=pdf

New South Wales Government Workplace Guidelines. (2005). *Space types*. Retrieved from http://www.gamc.nsw.gov.au/workplace-guidelines/3_wpdirections/ 3_04.htm

Newell, P. B. (1994). A systems model of privacy. *Journal of Environmental Psychology, 14*(1), 65-78.

Newsham, G. R., Veitch, J. A., & Charles, K. E. (2008). Risk factors for dissatisfaction with the indoor environment in open-plan offices: An analysis of COPE field study data. *Indoor Air, 18*(4), 271-282. doi: 10.1111/j.1600-0668.2008.00525

Newsham, G., Brand, J., Donnelly, C., Veitch, J., Aries, M., & Charles, K. (2009). Linking indoor environment conditions to job satisfaction: a field study. *Building Research and Information, 37*(2), 129-147. Doi: 10.1080/09613210802710298

Norman, D. A. (1988). *The design of everyday things*. New York: Doubleday.

Nugent, R. (2012). *Ergonomic Analysis of Work Related Musculoskeletal Disorder Risk to Plasterers Working in Ireland.* College of Engineering and Informatics, National University of Ireland, Galway.

Nunnaly, J. (1978). *Psychometric theory*. New York: McGraw-Hill.

Nussbaumer, L. (2008). Indoor air quality._In Jones, L. (Ed.), *Environmentally responsible design: green and sustainable design for interior designers (pp. 135-154).* Hoboken, NJ: John Wiley and Sons, Inc.

Office museum (n.d.a). Three men in office, Talking Tubes, c. 1903, Early Office Museum. Antique Office Photographs, 1900-1903. Retrieved from http://www.officemuseum.com/IMagesWWW/Three_Men_in_Office_| Talking_Tubes_Thur_15_Jan.jpg

Office museum (n.d.b). Order Entry Department, Sears, Roebuck & Co., Chicago, IL, c. 1913, Early Office Museum. Antique Office Photographs, 1912-1914. Retrieved from http://www.earlyofficemuseum.com/photo_gallery_1910s%20p.%20B.html

Oi, N. (2002). Lighting quality and luminance distribution: Where is the important part of field of view? *Environmental Ergonomics, No.10,* pp.377-380. doi: http://homepage3.nifty.com/naoyuki_oi/Research/ICEE2002_oi2.pdf

Oldenburg, R. (1989). The great good place: cafes, coffee shops, community centers, general stores, bars, hangouts, and how they get you through the day. New York: Paragon Books.

Oldenburg, R. (2002). *Celebrating the third place: Inspiring stories about the "Great good places" at the heart of our communities*, Marlowe Publishing, NY., NY.

Oliver, R. L. (1997). Customer satisfaction: A behavioral perspective on the consumer.

New York: McGraw-Hill.

O'Neil, M. (2009). *Future work and work trends.* Retrieved from Knoll website: http://www.knoll.com/research/downloads/WP_future_work_work_trends.pdf

O'Neil, M. (2010). *Generational preferences: A glimpse into the future office*. Retrieved from Knoll website: http://www.knoll.com/research/downloads/WP_ Generational Differences.pdf

O'Neil, M. (2011). *Shaping the dynamic workplace: An overview of recent Knoll research*. Knoll, Inc., New York, NY. Retrieved from http://www.knoll.com/ research/downloads/OverviewShapingDynamicWorkplace.pdf

O'Neil, M. (2013). *Design features and effective work.* Retrieved from Knoll website: http://www.knoll.com/knollnewsdetail/design-features-and-effective-work

O'Neil, M., & Wymer, T. (2011). *The metrics of distributed work: Financial and performance benefits of an emerging work model.* Retrieved from Knoll website: http://www.knoll.com/research/downloads/WP_DistributedWork.pdf

Oseland, N., Marmot, A., Swaffer, F., & Ceneda S. (2011). Environments for successful interaction, *Facilities, 29*(1):50 - 62.

Ouye, J. (2011). *Five trends that are dramatically changing work and the workplace*. Retrieved from Knoll website: http://www.knoll.com/research/downloads/ WP_FiveTrends.pdf.

Paron-Wildes, A. J. (2012, April). *Planning for interaction and collaboration*. Presentation at Henricksen, Inc., Minneapolis, MN, Adapted from CoreNet MCR course "Enabling Mobility" taught by Keith Perske, Group 5 and Jan Johnson, Allsteel

Pepper, G. L. (2008). The physical organization as equivocal message. *Journal of Applied Communication Research*, *36*(3), 318-338. Doi: 10.1080/00909880802104882

Pernica, G. (1990). Dynamic load factors for pedestrian movements and rhythmic exercises. *Canadian Acoustics*, *18*(2), 3.

Perkins, J. (1997). Frank B. Gilbert's research: The quest of the one best way. *Newsletter* *of the Gilbreth Network. 1*(2). Retrieved from: http://gilbrethnetwork.tripod. com/qv1n2.html

Peretti, C., Schiavon, S., Goins, J., Arens, E. A., & De Carli, M. (2010). *Evaluation of indoor environment quality with a web-based occupant satisfaction survey: A case study in northern Italy*. Retrieved from UC Berkeley, Center for the Built Environment website: http://www.escholarship.org/uc/item/8559k1qpn.a

Peretti, C., & Schiavon, S. (2011). Indoor environment quality survey: A brief literature review. *Proceedings of Indoor Air 2011*. Austin, TX, June 5-10. Retrieved from http://www.escholarship.org/uc/item/0wb1v0ss

Peterson, T. O., & Beard, J. W. (2004). Workspace technology's impact on individual privacy and team interaction. *Team Performance Management, 10*(7/8), 163-172.

Porter, S. R., Whitcomb, M. E., & Weitzer, W. H. (2004). Multiple surveys of students and survey fatigue. New Directions for Institutional Research, 2004: 63–73, doi: 10.1002/ir.101

Preiser, W. F. (1995). Post-occupancy evaluation: how to make buildings work better. *Facilities, 13*(11), 19-28.

Pile, John. (2005). *A History of Interior Design*, 2nd ed. Hoboken, New Jersey: John Wiley and Sons.

Preiser, W. F., Rabinowitz, H. Z., & White, E. T. (1988). *Post-occupancy evaluation*: Van Nostrand Reinhold New York.

Price, B. (1990). Frank and Lillian Gilbreth and the motion study controversy, 1907-1930. *A Mental Revolution: Scientific Management since Taylor,* D. Nelson, ed. Chicago, IL: The Ohio State University Press. Retrieved from http://cmapspublic.ihmc.us/ rid%3D1226616144986_190407339_22545/ Gilbreth%2520article.pdf

Rashid, M., Wineman, J., & Zimring, C. (2009). Space, behavior, and environmental perception in open-plan offices: a prospective study. *Environment and Planning B: Planning and Design, 36*(3), 432-449.

Rashid, M., & Zimring, C. (2008). A review of the empirical literature on the relationships between indoor environment and stress in health care and office settings problems and prospects of sharing evidence. *Environment and Behavior, 40*(2), 151-190.

Rea, M., Figueiro, M., & Bullough, J. (2002). Circadian photobiology: an emerging framework for lighting practice and research. *Lighting Research and Technology, 34*(3), 177-187. doi: 10.1191/1365782802lt057oa

Reid, N. (2008). A strategic view of sustainability. *Dialogue, Real Estate That Works*. Gensler Publication. 11:30-31.

Roper, K. O., & Juneja, P. (2008). Distractions in the workplace revisited. *Journal of Facilities Management, 6*(2), 91-109. Doi.org/10.1108/14725960810872622

Saari, L. M., & Judge, T. A. (2004). Employee attitudes and job satisfaction. *Human Resource Management, 43*(4), 395-407. Doi: 10.1002/hrm.20032

Salter, C., Powell, K., Begault, D., & Alvarado, R. (2003). Case studies of a method for predicting speech privacy in the contemporary workplace. Retrieved from UC Berkeley, Center for the Built Environment website: http://escholarship.org/uc/item/8qf0z5v4

Schakib-Ekbatan, K., Wagner, A., & Lussac, C. (2010). Occupant satisfaction as an indicator for the socio-cultural dimension of sustainable office buildings – development of an overall building index. In: Proceedings of Conference: Adapting to Change: New Thinking on Comfort, Windsor, UK.

Schwede, D. A., Davies, H., & Purdey, B. (2008). Occupant satisfaction with workplace design in new and old environments. *Facilities*. *26*(7/8):273-288. DOI:0263-2772 DOI 10.1108/02632770810877930

Siler, E. A. (2009*). How does beauty matter? An exploration of employee perceptions of office aesthetics.* Dissertations. Paper 26.http://scholarworks.umass.edu/open_access_dissertations/26

Shepley, M. M., Zimmerman, K. N. A., Boggess, M. M., & Lee, Y. J. (2009). Architectural Office Post-Occupancy Evaluation. *Journal of Interior Design, 34*(3), 17-29.

Smithsonian Museum (n.d.). *Carbons to Computers, Scientific Method,* Smithsonian Musuem.org (online museum): Retrieved from http://www.smithsonianeducation.

org/educators/lesson_plans/carbons/scimgmt.html

Song, Y. (2011). What are the affordances and constraints of handheld devices for learning in higher education. *British Journal of Educational Technology, 42*(6), E163-E166. doi: 10.1111/j.1467-8535.2011.01233

Soni, Raj. (n.d.). My Simple Definition of Ergonomics - What is the Role of an Ergonomist? *Hub Pages*. Retrieved from http:// http://soni2006.hubpages.com/ hub/my-simple-definition-of-ergonomics-what-is-therole-of-an-ergonomist

Sop Shin, W. (2007). The influence of forest view through a window on job satisfaction and job stress. *Scandinavian Journal of Forest Research, 22*(3), 248-253.

Spreckelmeyer, K. F. (1993). Office relocation and environmental change. *Environment and Behavior, 25*(2), 181-204. Doi: 10.1177/0013916593252002

Sprigg, C. A., & P. R. Jackson (2006). Call centers as lean service environments: Job-related strain and the mediating role of work design. *Journal of Occupational Health Psychology **11***(2): 197.

Sharp, L. M., & Frankel, J. (1983). Respondent burden: A test of some common assumptions. *Public Opinion Quarterly, 47*(1), 36-53.

.SPSS, Inc. (n.d.). SPSS Statistics Base 17.0 User's Guide, ISBN-13: 978-1-56827-400-3. Retrieved from: http://scholar.google.com/scholar?q=SPSS+Statistics+Base+ 17.0+harvard&btnG=&hl=en&as_sdt=0%2C24

Steelcase. (n.d.a). The new third place. *Steelcase 360*, *Issue 63*, 60-79. Retrieved from Steelcase website: http://360.steelcase.com/articles/the-new-third-place/

Steelcase. (n.d.b). Harder working spaces: The workplace just got smarter. *Steelcase 360, Issue 59*, p. 2-11. Retrieved from Steelcase website http://360.steelcase.com/ issues/harder-working-spaces/

Steelcase. (n.d.c). Space Odyssey. *Steelcase 360*, *Issue 69*, 60-83. Retrieved from Steelcase website: http://360.steelcase.com/articles/space-odyssey/

Steelcase. (n.d.d). Real Work. *Steelcase 360, Issue 69*, 32-83. Retrieved from Steelcase website: http://360.steelcase.com/articles/space-odyssey/

Steelcase. (n.d.e). Offices on the Cutting Edge. *Steelcase, 360, Issue 54*, pp 1-8. Retrieved from Steelcase http://360.steelcase.com/issues/offices-on-the-cutting-edge/

Steelcase. (n.d.f). Sustainability comes of age, *Steelcase 360, Deep Dive*, p. 1-5 Retrieved from Steelcase website http://360.steelcase.com/white-papers/sustainability-comes-of-age/

Stoffregen. T. A. (2003). Affordances as properties of the animal-environment system. *Ecological Psychology, 15*(2), 115-134. Doi: 10.1207/s15326969eco1502_2

Sullivan, L. H. (1896). The tall office building artistically considered. *Lippincott's Magazine, 57*(3), 406.

Sundell, J. (2004). On the history of indoor air quality and health. *Indoor Air, 14*, 51-58. Doi: 10.1111/j.1600-0668.2004.00273

Sundstrom, E., Burt, R.E., & Kamp, D. (1980). Privacy at work: Architectural correlates of job satisfaction and job performance. *The Academy of Management Journal*, Vol.23, No.1, 101-117. Stable URL: http://www.jstor.org/stable/25549

Sundstrom, E., H., Herbert, R. K., & Brown, D. W. (1982). Privacy and communication in an open-plan office. *Environment and Behavior, 14*(3), 379-392. Doi: 10.1177/0013916582143007

Sundstrom, E., & Sundstrom, M. G. (1986). *Work places: The psychology of the physical environment in offices and factories*, Cambridge, MA: Cambridge University Press.

Sundstrom, E., Town, J. P., Rice, R. W., Osborn, D. P., & Brill, M. (1994). Office Noise, Satisfaction, and Performance. *Environment and Behavior 26*(2): 195-222.

Sutton, R. I., & Rafaeli, A. (1987). Characteristics of work stations as potential occupational stressors. *Academy of Management Journal, 30*(2), 260-276.

Taylor, F. W. (1911). *The Principles of Scientific Management*. New York, NY, US and London, UK: Harper and Brothers. LCCN 11010339. OCLC 233134. Retrieved from Project Gutenberg: http://www.gutenberg.org/ebooks/6435

Tennessen, C. M., & Cimprich, B. (1995). Views to nature: Effects on attention. *Journal* *of Environmental Psychology, 15*(1), 77-85.

Thalheimer, E. (1996). Practical approach to measurement and evaluation of exposure to whole-body vibration in the workplace. *Seminars in Perinatology*, 20(1), 77-89.

Turvey, M. T. (1992). Affordances and prospective control: An outline of the ontology. *Ecological Psychology, 4,* 173–187.

Ulrich, R. S. (1979). Visual landscapes and psychological well-being. *Landscape Research, 4*(1), 17-23. doi: 10.1080/01426397908705892

Ulrich, R. (1984). View through a window may influence recovery. *Science, 224*(4647), 224-225.

United States Environmental Protection Agency (EPA). (n.d.a). *Indoor air quality*. Glossary of terms. Retrieved from http://www.epa.gov/iaq/glossary.html

United States Environmental Protection Agency (EPA). (n.d.b). *Radon Protection*. Retrieved from http://www.epa.gov/radiation/radionuclides/radon.html?_ ga=1.70154706.337265881.1425131879

United States Environmental Protection Agency (EPA) (1991, Feb.). *Indoor Air Facts No. 4 (revised) Sick Building Syndrome*. United States Air and Radiation (6609J) Research and Development Environmental Protection (MD-56) Agency. Retrieved from http://www.epa.gov/iaq/pdfs/sick _building_factsheet.pdf

United States Environmental Protection Agency (EPA). (1994, June). *Radon Prevention in the Design and Construction of Schools and Other Large Buildings*. (EPA l625/R-921016). Washington DC 20460.United States Environmental Protection Agency Retrieved from http://nepis.epa.gov/Exe/ZyPDF.cgi/30004KZ6.PDF? Dockey=30004KZ6.PDF

United States Green Building Council (USGBC). (n.d.). LEED Rating-systems, commercial-interiors. Retrieved from http://www.usgbc.org/leed/rating-systems/commercial-interiors

United States Green Building Council (USGBC). (2006). *LEED for Commercial Interiors Version 2.0 Reference Guide*. U.S. Green Building Council: Washington D.C.

University of Minnesota (n.d.a). University of Minnesota, History and Mission, Retrieved from http://www1.umn.edu/twincities/history-mission/index.html

University of Minnesota (n.d.b). University of Minnesota, Twin Cities Campus Maps, Herbert M. Hanson, Jr. Hall (HMH). Retrieved from http://www1.umn.edu/twincities/maps/HMH/

University of Minnesota (n.d.c). University of Minnesota, History and Mission, Retrieved from http:// campusmaps.umn.edu/tc/map.php?building=250

Urdan, T. C. (2010). Statistics in Plain English, New York, NY: Routledge Academic. ISBN-13: 978-0415872911.

Valenti, S. S., & Gold, J. M. M. (1991). Social affordances and interaction I: Introduction. *Ecological Psychology, 3*(2), 77.

Van Exel, J., & de Graaf, G. (2005). *Q methodology: A sneak preview*. http://www.qmethodology.net/PDF/Q-methodology

Veale, P. R. (1989). Managing corporate real estate assets: current executive attitudes and prospects for an emergent management discipline. *The Journal of Real Estate Research 4*(3): 1-22.

Veitch, J. A., Charles, K. E., Farley, K. M. J., & Newsham, G. R. (2007). A model of satisfaction with open-plan office conditions: COPE field findings. *Journal of Environmental Psychology, 27*(3), 177-189. doi: 10.1016/j.jenvp.2007.04.002

Veitch, J. A., & Newsham, G. R. (1996). *Determinants of Lighting Quality II: Research and Recommendations.* Paper Presented at the 104th Annual Convention of the American Psychological Association Toronto, Ontario, Canada. August 12, 1996, ED408543.

Veitch, J. A., & Newsham, G. R. (2000). Preferred luminous conditions in open-plan offices: research and practice recommendations. *Lighting Research and Technology, 32*(4), 199-212. doi: 10.1177/096032710003200404

Veitch, J. A., Stokkermans, M. G. M., & Newsham, G. R. (2013). Linking Lighting Appraisals to Work Behaviors. *Environment and Behavior, 45*(2), 198-214. doi: 10.1177/0013916511420560

Venezia, C. D. (2007). *The voice of mobile workers translating practices, relationships* *and components into effective workplaces*. Retrieved from Knoll website: http://www.knoll.com/research/downloads/ VoiceofMobileWorkers.pdf

Vincent, A. J. P., Spierings, E. L. H., & Messinger, H. B. (1989). A controlled study of visual symptoms and eye strain factors in chronic headache. *Headache: The Journal of Head and Face Pain 29*(8): 523-527.

Vithayathawornwong, S., Danko, S., & Tolbert, P. (2003). The Role of the Physical Environment in Supporting Organizational Creativity. *Journal of Interior Design, 29*(1-2), 1-16. doi: 10.1111/j.1939-1668.2003.tb00381

Vivian, P. (2012, April 11). Typological [r]evolution of the workplace. *Architecture Now*. Retrieved from: http://architecturenow.co.nz/articles/typological-reevolution-of-the-workplace.

Voss, J. (2010). *Knowledge in the workplace*. Retrieved from http://www.haworth.com /en-us/Knowledge/Workplace-Library/Documents/knowledge-in-the-workplace_p2-pdf

Wang, N., & Boubekri, M. (2010). Investigation of declared seating preference and measured cognitive performance in a sunlit room. *Journal of Environmental Psychology, 30*(2), 226-238.

Wang, N., & Boubekri, M. (2011). Design recommendations based on cognitive, mood and preference assessments in a sunlit workspace. *Lighting Research and Technology, 43*(1), 55-72. doi: 10.1177/1477153510370807

Wargocki, P., Frontczak, M., Schiavon, S., Goins, J., Arens, E., & Zhang, H. (2012). *Satisfaction and self-estimated performance in relation to indoor environmental parameters and building features*. UC Berkeley: Center for the Built Environment. Retrieved from http://escholarship.org/uc/item/451326fk

Wargocki, P., Lagercrantz, L., Witterseh, T., Sundell, J., Wyon, D. P., & Fanger, P. O. (2002). Subjective perceptions, symptom intensity and performance: a comparison of two independent studies, both changing similarly the pollution load in an office. *Indoor Air, 12*(2), 74-80. doi: 10.1034/j.1600-0668.2002.01101

Wikipedia (n.d.a). *Portion of an office landscape floor plan showing traditional desks, curved screens, potted plants, and organic geometry*. Retrieved from Wikipedia http:// http://en.wikipedia.org/wiki/File:Office-landscape-plan.jpg

Wikipedia (n.d.b). *Aerial photo of the Minneapolis campus*, *facing east*, by Bobak Ha'Eri. CC-BY-SA-2.5. Retrieved from Wikipedia http://en.wikipedia.org/wiki/University_of_Minnesota#mediaviewer/File:AerialUMN-MPLS012506.jpg

Wells, M. M. (2000). Office clutter or meaningful personal displays: The role of office personalization in employee and organizational well-being. *Journal of Environmental Psychology*, *20*(3), 239-255. Doi: 10.1006/jevp.1999.0166

Winchip, S. M. (2005). *Designing a quality lighting environment*. New York: Fairchild.

Wonnacott, T. H., & R. J. Wonnacott. (1990). Introductory statistics. New York, N.Y., Wiley.

Wong, L., Mui, K., & Hui, P. (2008). A multivariate-logistic model for acceptance of indoor environmental quality (IEQ) in offices. *Building and Environment*, *43*(1), 1-6.

Wershler-Henry, D. (2005). *The iron whim: A fragmented history of typewriting*, New York, NY: McClelland and Stewart Ltd.

Wyon, D. P. (1996). Indoor environmental effects on productivity. In Teichman K,Y, editor. *IAQ'96*: *Paths to Better Building Environments*. Atlanta, GA: American Society of Heating, Refrigerating, and Air Conditioning Engineers, 196:5_15.

Wyon, D. P. (2004). The effects of indoor air quality on performance and productivity. *Indoor Air, 14*, 92-101. doi: 10.1111/j.1600-0668.2004.00278

Vilnai-Yavetz, I., Rafaeli, A., & Schneider-Yaacov, C. (2005). Instrumentality, Aesthetics, and Symbolism of Office Design. *Environment and Behavior* ***37***(4): 533-551.

Yildirim, K., Akalin-Baskaya, A., & Celebi, M. (2007). The effects of window proximity, partition height, and gender on perceptions of open-plan offices. *Journal of Environmental Psychology*, *27*(2), 154-165. doi: http://dx.doi.org/10.1016/j.jenvp.2007.01.004

Zagreus, L., Huizenga, C., Arens, E., & Lehrer, D. (2004). Listening to the occupants: A web-based indoor environmental quality survey. *Indoor Air*, *14*, 65-74. doi: 10.1111/j.1600-0668.2004.00301

Zagreus, L., Lehrer, D., & Huizenga, C. (2006). Occupant satisfaction with indoor environmental quality in green buildings. Proceedings from *Healthy Buildings 2006.* Lisbon. Vol. III 365-370. Retrieved from http://escholarship.org/uc/item/9rf7p4bs

Zakim, M. (2006). The business clerk as social revolutionary; Or, a labor history of the nonproducing classes. *Journal of the Early Republic, 26*(4), 563-603. Retrieved from http://muse.jhu.edu/journals/jer/summary/v026/26.4zakim.html

Zalesny, M. D., & Farace, R. V. (1987). Traditional versus open offices: A comparison of sociotechnical, social relations, and symbolic meaning perspectives. *The Academy of Management Journal, 30*(2):240-259.

APPENDIX A

Abbreviations and Acronyms

ACC	Acoustical Conditions – (IEQ criterion)
ACT	Association for Contract Textiles
ABD	Affordance Based Design (research framework proposed by Maier, Fadel, and Battisto, 2009))
APP	Appearance Conditions - (IEQ criterion)
ASID	American Society of Interior Designers
ANSI	American National Standards Institute
ANOVA	Analysis of variance
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
AWSp	Alternative workspace (can be assigned to teams and groups or open to the all employees generally regarded as a go to space)
BIFMA	Business and Institutional Furniture Manufacturing Association
BEES	Building for Environment or the Economic Software
B3	Building, Benchmarks, and Beyond (B3 Guidelines provide sustainable guidelines to support selected building projects in the State of Minnesota. See also B3-MSBG)
B3-MSBG	Building, Benchmarks and Beyond – Minnesota Sustainable Building Guidelines
BRI	Building Related Illness
CBE	Center for the Built Environment (located in Berkley, California)

CCT	Correlated color temperature
CEU	Continuous Education Units
CIDA	Council for Interior Design Accreditation
CRI	Color Rendering Index
CSBR	Center for Sustainable Building Research (University of Minnesota)
CSP	Comfort, Satisfaction and Performance (used to assess employees perceptions in lighting studies)
CCT	Correlated color temperature
DAY	Daylight Conditions - (IEQ criterion)
dBA	Decibel Levels (unit of measurement)
DE	Designed Environment (one of the three environments in the overall environment included in the research model)
EAF	Affordances
EFA	Exploratory Factory Analysis
ELE	Electric Conditions - (IEQ criterion)
EPA	Environmental Policy Agency (or United States Environmental Policy Agency) Environmental Policy Agency (hereafter, referred to as the EPA
ERID	Environmentally Responsible Interior Design
FAF	Affordances …
FTI	Function Task Interaction (affordance theory)
FUN	Functional Conditions - (IEQ criterion)
FUR	Furnishing Conditions - (IEQ criterion)

F (SBI)	Facility (Site, Building, and Interior)
GSA	General Services Administration
HVAC	Heating, Ventilation Air Conditioning
IAQ	Interior Air Quality - (IEQ criterion)
IDC	Interior Designers of Canada
IDEC	Interior Design Educators Council
IEQ	Indoor Environment Quality
IESNA	Illuminating Engineering Society of North America
IIDA	International Interior Design Association
ISO	International Organization for Standardization
KMO	Kaiser-Meyer-Olkin (Statistical Test)
LCA	Life cycle assessment
LEED	Leadership Energy Environment Design
LED	Light-emitting diode (LED)
MCS	Multiple chemical sensitivity
MHT	Mean radiant temperature
MSA	Measure of Sampling Adequacy
MSBG	Minnesota Sustainable Building Guidelines (developed and administered through the CSBR in response to state legislation to demonstrate real outcomes with sustainable design guidelines) in 2000 at the direction of the Minnesota State Legislature
NC	Noise Curve

NE	Natural Environment (one of the three environments in the overall environment included in the research model)
O	Observer (The observer in the research model is the employee and represents their perceptions of the environment)
PPMCC	Persons Product Moment Correlation Coefficient
POE	Post Occupancy Evaluation
PRI	Privacy Conditions - (IEQ criterion)
PWSp	Primary workspace (generally assigned or regarded as a 'home base')
RH	Relative Humidity
SBS	Sick Building Syndrome
SD	Standard Deviation
SE	Social Environment (one of the three environments in the overall environment included in the research model)
SPOES	Sustainable Post Occupancy Evaluation Survey
TBL	Triple Bottom Line (examining ….)
THE	Thermal Conditions - (IEQ criterion)
USGBC	United States Green Building Council
VIB	Vibration and Movement Conditions - (IEQ criterion)
VIE	View Conditions - (IEQ criterion)
VOC	Volatile Organic Compounds

APPENDIX B

SPOES V2 + AWSp Module

SPOES Scan V.2 AWSp Hanson Hall Offices 2

Consent Form for Occupancy Evaluation of Workspace
You are invited to be in a research study because you have a workspace in a building designed to meet the Buildings, Benchmarks, and Beyond - Minnesota Sustainable Building Guidelines (B3-MSBG). This survey is part of the followup required by the B3-MSBG. Please read this form and ask any questions you may have before agreeing to be in the study. This study is being conducted by researchers associated with the Center for Sustainable Building Research (CSBR), University of Minnesota.

Background Information
The purpose of this study is to assess employees' perceptions of their facility and workspaces. The survey will take around 10 -15 minutes to complete. The survey results can be used to inform adjustments or improvements to the facility and will inform the content and application of sustainable building guidelines in the future.

Procedures
If you agree to be in this study, please complete the online questionnaire, which will be submitted to the CSBR at the University of Minnesota for analysis. Your employer will receive a report of the overall analysis, but no data on individual responses will be included.

Risks and Benefits of Being in the Study
There are no risks or benefits to you for being in this study.

Confidentiality
The records of this study will be kept private and stored securely; only researchers will have access to the records. In any report we might publish, we will not include any information that will make it possible to identify any individual respondent in the results. Your employer will not have access to these records.

Voluntary Nature of the Study
Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. You are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions
The CSBR is conducting this study, and you may ask any questions you have before you begin the survey or later. To do so, please contact Theresa Bauer, at baue0003@umn.edu or Denise Guerin, Ph.D. at dguerin@umn.edu or (612)626-1257. If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 6251650.

*** 1. Answer YES to provide your consent and complete the questionnaire.**

○ Yes

○ No

Directions:
There are several pages in this questionnaire, and completion of the entire questionnaire is important to understand how the physical environment of Hanson Hall site meets your needs.

Section 1. Overall perception of site, building, and interior
First, please answer the following questions related to your perceptions of how you are affected by the physical environment of Hanson Hall (site, building, and interior).

2. Overall, how satisfied are you with the physical environment of Hanson Hall (site, building, and interior)?

Very Dissatisfied 1	2	3	4	5	6	Very Satisfied 7
○	○	○	○	○	○	○

Page 1

SPOES Scan V.2 AWSp Hanson Hall Offices 2

3. Overall, how does the physical environment Hanson Hall (site, building, and interior) affect your work performance?

Hinders Work Performance 1	2	3	4	5	6	Enhances Work Performance 7
◯	◯	◯	◯	◯	◯	◯

4. Overall, how does the physical environment Hanson Hall (site, building, and interior) affect your health?

Hinders Health 1	2	3	4	5	6	Enhances Health 7
◯	◯	◯	◯	◯	◯	◯

Workspaces in Hanson Hall

Next, we would like to learn more about your perceptions of the workspaces in Hanson Hall (primary workspaces and alternative workspaces).

Section 2. Primary Workspace

Your primary workspace (private office, workstation, desk or assigned workspace) is the work area that you consider to be your home base and / or store your belongings.

***5. Do you have a primary workspace in Hanson Hall?**

◯ Yes

◯ No

Other (please specify)

6. Which of the following best describes your primary workspace, i.e., the one where you spend the most time?

◯ Enclosed office, private

◯ Enclosed office, shared with other people

◯ Cubicle with low partitions (less than five feet high)

◯ Cubicle with high partitions (five or more feet high)

◯ Cubicle with both low and high partitions

◯ Desk in open office with no partitions

◯ Other, please specify

7. What floor is your primary workspace located on?

- ◯ Lower Level
- ◯ First Floor
- ◯ Second Floor
- ◯ Third Floor
- ◯ Fourth Floor

8. Overall, how does the physical environment of your primary workspace affect your work performance?

Hinders Work Performance 1	2	3	4	5	6	Enhances Work Performance 7
◯	◯	◯	◯	◯	◯	◯

9. Overall, how does the physical environment of your primary workspace affect your health?

Hinders Health 1	2	3	4	5	6	Enhances Health 7
◯	◯	◯	◯	◯	◯	◯

10. Overall, how satisfied are you with the physical environment of your primary workspace?

Very Dissatisfied 1	2	3	4	5	6	Very Satisfied 7
◯	◯	◯	◯	◯	◯	◯

11. Please indicate how satisfied you are with each of the following aspects of your primary workspace:

	Very Dissatisfied 1	2	3	4	5	6	Very Satisfied 7
The overall thermal conditions [temperature (hot or cold), air velocity (drafty or stagnant), and humidity (dry or moist)] of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The temperature (hot or cold) of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The air velocity (drafty or stagnant) in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The humidity (dry or moist) in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The adjustability of the thermal conditions of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall indoor air quality (free of odors, staleness, chemicals or irritants) your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall acoustic quality (ability to hear desired sounds and limit undesired sounds) in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The ability to hear desired sounds in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The ability to limit undesired sounds in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall lighting conditions (electric and daylighting) of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The amount of electric light in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The adjustability of the electric lighting in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The amount of daylighting in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The adjustability of the daylighting in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The adjustability of your task lighting in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall view conditions (outdoor or distant interior views) of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall vibration and movement of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall privacy (sound and visual privacy) conditions of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall furnishings of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall function of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall appearance (aesthetics) of your primary workspace	◯	◯	◯	◯	◯	◯	◯
The technology (computer, telephone, etc.) in your primary workspace	◯	◯	◯	◯	◯	◯	◯
The overall cleaning and maintenance of your primary workspace	◯	◯	◯	◯	◯	◯	◯

12. Please let us know any additional comments regarding how your primary workspace affects your satisfaction.

SPOES Scan V.2 AWSp Hanson Hall Offices 2

Section 3. Alternative Workspaces

Alternative workspaces (meeting rooms, libraries, break rooms, coffee shops, training rooms, lounges, etc.) are other areas in the workplace environment used for work activities (concentrating, collaborating or connecting with others).

*13. Do you use alternative workspace for work related activities?

- ◯ Yes
- ◯ No
- ◯ NA

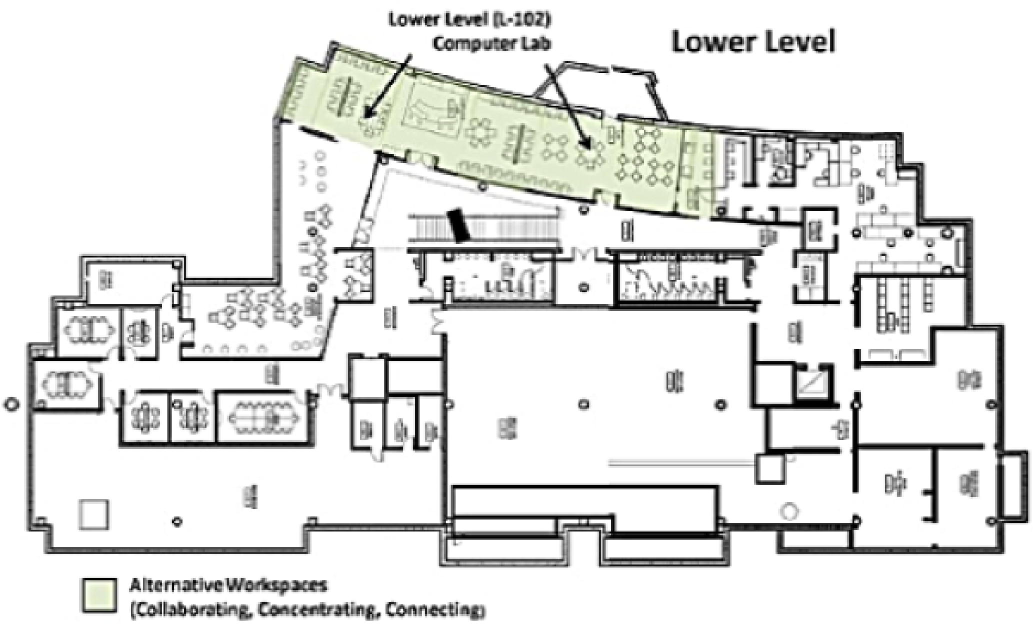
Other (please specify)

*14. From the list below, please select an alternative workspace that you use for work related activities. You will be directed to questions regarding that specific workspace.

- ◯ Lower Level (L-102) Computer Lab
- ◯ 2nd Floor (2-201) Starbucks Coffee
- ◯ 2nd Floor (2-206) Conference Room (Near Starbucks Coffee)
- ◯ 2nd Floor (2-233) Conference Room (South Side / Exterior Windows)
- ◯ 2nd Floor (2-245) Information Seminar Room (Next to Recruiter Lounge)
- ◯ 2nd Floor (2-250) Conference Room (Boardroom)
- ◯ 2nd Floor (2-255) Recruiters Lounge
- ◯ 3rd Floor (3-100) IT Conference Area NE Corner (Open Office)
- ◯ 3rd Floor (3-100) IT Lounge Meeting
- ◯ 3rd Floor (3-170) Econ Computer Lab
- ◯ 3rd Floor (3-145) Econ Library
- ◯ 4th Floor (4-117) Econ Small Conference (Exterior Window)
- ◯ 4th Floor (4-186) Econ Large Seminar Room (Conference Table)
- ◯ 4th Floor (4-170) Econ Large Group Meeting (Seminar - Classroom)
- ◯ 4th Floor (4-168) Econ Medium Conference (Near Lounge)
- ◯ 4th Floor (4-155) Econ Lounge (Kitchen)

SPOES Scan V.2 AWSp Hanson Hall Offices 2

Lower Level (L-102) Computer Lab



15. Overall, how does the physical environment of the Lower Level (L-102) Computer Lab affect your work performance?

Hinders Work Performance 1	2	3	4	5	6	Enhances Work Performance 7
○	○	○	○	○	○	○

16. Overall, how does the physical environment of the Lower Level (L-102) Computer Lab affect your health?

Hinders Health 1	2	3	4	5	6	Enhances Health 7
○	○	○	○	○	○	○

SPOES Scan V.2 AWSp Hanson Hall Offices 2

17. Overall, how satisfied are you with the physical environment of the Lower Level (L-102) Computer Lab?

Very Dissatisfied 1	2	3	4	5	6	Very Satisfied 7

18. Please indicate how satisfied you are with each of the following aspects of the Lower Level (L-102) Computer Lab.

	Very Dissatisfied 1	2	3	4	5	6	Very Satisfied 7
The overall thermal conditions (temperature (hot or cold), air velocity (drafty or stagnant), and humidity (dry or moist) of the Lower Level (L-102) Computer Lab							
The temperature (hot or cold) of the Lower Level (L-102) Computer Lab							
The air velocity (drafty or stagnant) in the Lower Level (L-102) Computer Lab							
The humidity (dry or moist)] in the Lower Level (L-102) Computer Lab							
The adjustability of the thermal conditions of the Lower Level (L-102) Computer Lab							
The overall indoor air quality (free of odors, staleness, chemicals or irritants) the Lower Level (L-102) Computer Lab							
The overall acoustic quality (ability to hear desired sounds and limit undesired sounds) in the Lower Level (L-102) Computer Lab							
The ability to hear desired sounds in the Lower Level (L-102) Computer Lab							
The ability to limit undesired sounds in the Lower Level (L-102) Computer Lab							
The amount of electric light in the Lower Level (L-102) Computer Lab							
The adjustability of the electric lighting in the Lower Level (L-102) Computer Lab							
The amount of daylighting in the Lower Level (L-102) Computer Lab							
The adjustability of the daylighting in the Lower Level (L-102) Computer Lab							
The overall view conditions (outdoor or distant interior views) of the Lower Level (L-102) Computer Lab							
The overall vibration and movement of the Lower Level (L-102) Computer Lab							
The overall privacy (sound and visual privacy) conditions of the Lower Level (L-102) Computer Lab							
The overall furnishings of the Lower Level (L-102) Computer Lab							
The overall function of the Lower Level (L-102) Computer Lab							
The overall appearance (aesthetics) of the Lower Level (L-102) Computer Lab							
The technology (computer, telephone, etc.) in the Lower Level (L-102) Computer Lab							

The overall cleaning and maintenance of the Lower Level (L-102) Computer Lab	◯	◯	◯	◯	◯	◯	◯

19. Please let us know if you have any additional comments about the physical environment of the Lower Level (L-102) Computer Lab.

***20. Thank you for your feedback on the workspaces you use in Hanson Hall. Please select the option below to proceed to the final set of questions at the end of the survey.**

◯ Proceed to Section 4.

SPOES Scan V.2 AWSp Hanson Hall Offices 2

113. What is your primary mode of transportation used for your daily commute?

- ◯ Drive alone (or with children under 16)
- ◯ Carpool or vanpool
- ◯ Motorcycle/moped
- ◯ Public transit
- ◯ Bicycle
- ◯ Walk
- ◯ Telecommute (work from home)
- ◯ Other, please specify

114. How does the Hanson Hall (site, building, and interior) affect your ability to commute to work in an alternative way (e.g., walk, bicycle, public transit, van, or carpool, etc.)?

Hinders Alternative Commuting 1	2	3	4	5	6	Enhances Alternative Commuting 7
◯	◯	◯	◯	◯	◯	◯

Section 5. Demographics

Finally, here are a few questions about you! Thank you very much for your time.

115. What is your age?

116. What is your gender?

- ◯ Male
- ◯ Female

117. Which of the following best describes your role in Hanson Hall?

- ◯ Undergraduate Student
- ◯ Graduate Student
- ◯ Staff
- ◯ Faculty

Other (please specify)

APPENDIX C

Message 1: Survey Invitation

Greetings!

In compliance with the goals established by the Buildings, Benchmarks, and Beyond - Minnesota State Building Guidelines (B3-MSBG), the Center for Sustainable Building Research (CSBR) is asking for your help in completing the final post-occupancy evaluation (POE) survey for the Hanson Hall. The Sustainable Post-Occupancy Evaluation Survey (SPOES) has been developed specifically to address the impact of indoor environmental quality (IEQ) on occupant perceptions and to gather important feedback where building concerns exist.

Last spring we conducted the first of two required post-occupancy surveys of the building occupants in Hanson Hall. This survey is being conducted in compliance with the goals of Buildings, Benchmarks, and Beyond - Minnesota State Building Guidelines (B3-MSBG). The Sustainable Post-Occupancy Evaluation Survey (SPOES) has been developed specifically to address the impact of indoor environmental quality (IEQ) on occupant and student perceptions. *This is the final **SPOES** survey required for the Hanson Hall facility (workplace and classroom spaces).*

The survey begins **today** and closes **03.14.14** at **midnight**; it will take approximately 10-15 minutes for you to complete the survey. You can access the survey anytime during this period by clicking on the following link:
https://www.surveymonkey.com/s/RKWXRSB

Please be assured that all conditions for the University of Minnesota's Institutional Review Board (IRB) have been met. All responses are stored anonymously in a secure database and available only to the researchers responsible for this study.

Once the surveys are completed, CSBR will generate a report of the findings. The report will be available on request and is subject to future publication on the CSBR B3MN website located at (http://casestudies.b3mn.org/Projects.aspx).

If you have any questions, you may contact Theresa Rae Bauer at baue0003@umn.edu or Denise Guerin, Ph.D., at dguerin@umn.edu for further information.

We look forward to your participation with this research. Thank You!

Message 2: Survey Reminder

Greetings!

Last week you were sent an invitation to participate in the post-occupancy evaluation survey that is being conducted of workspaces in Hanson Hall. This is a friendly reminder to complete the survey before the end of day, on 03.14.14 if you have not already done so.

The survey is accessible online through the following link https://www.surveymonkey.com/s/XXXXXXX and can be completed during your work time. The Sustainable Post-Occupancy Evaluation Survey (SPOES) has been developed specifically to address the impact of indoor environmental quality (IEQ) on occupant perceptions and to gather important feedback where building concerns exist.

Please give this your full attention so we have a comprehensive view of the workplace environmental quality.

If you have any questions, you may contact Theresa Rae Bauer at baue0003@umn.edu or Denise Guerin, Ph.D., at dguerin@umn.edu for further information.

We thank you for your participation with this research!