



# Comfort

## Description of the Problem

Comfort, or being comfortable, is defined as a sense of physical or psychological ease. Comfort is highly subjective.<sup>1</sup> In other words, comfort is highly personal and specific to the individual. An expanded definition of comfort includes thermal comfort, physical safety, acoustic comfort, and freedom from physical pain.

Thermal comfort is a condition of mind that expresses satisfaction with the thermal environment – temperature, humidity levels, and air flow. Thermal comfort relies on the concept of thermal neutrality for the human body. For instance, a person might feel thermally neutral overall, but if barefoot, comfort may depend on the floor temperature and flooring material.<sup>2</sup> Materials that are warm to the touch, such as wood and carpeting, are those that are low in thermal capacity and high in thermal resistance. By means of conduction, the body quickly warms the surface layer of the material to a temperature approaching the temperature of the skin, which makes the material feel warm to the touch. Materials that feel cold to the touch, like metal or ceramic tile, draw heat from the body for an extended period of time resulting in a cold feel to the touch.<sup>3</sup> Since the foot temperature is a function of the thermal state of the whole body, the temperature of the floor will influence the potential for discomfort.

Physical safety refers to the absence of serious risk of injury so an environment where one feels safe contributes to comfort. Use of the correct flooring, installed properly, may reduce the risk of injury from slip, trip or fall and carpet has been shown to reduce the impact force by 15%<sup>4</sup> and even reduce the risk of fracture resulting from a fall.<sup>5</sup>

Persons sometimes experience pain as a result of a health condition or physical discomfort may develop from the pain and fatigue associated with standing for long periods of time on hard surfaces. Finding physical and psychological

comfort allows for pain and stress to dissipate, increasing the ability to rest and recover.

Noise is uncomfortable. Noise interferes with people's daily activities at work, at school, at home and during leisure time. Noise interferes with communication, causes distractions, affects occupants' cognitive performance and concentration, contributes to fatigue, and sleep deprivation.<sup>6-9</sup> Elevated environmental noise can cause hearing impairment, hypertension, heart disease, annoyance which may evoke changes in social behavior, and sleep disturbance. Changes in the immune system have also been attributed to noise exposure.<sup>10</sup>

## Hazards & Risk Assessment

Increasing and maintaining building occupant satisfaction is tied to many factors related to the quality of the indoor space, including acoustics, aesthetics, privacy, cleanliness, and level of control over the interior environment.<sup>11</sup> In the workplace, building occupant satisfaction is important because it has been correlated with job performance,<sup>12</sup> absenteeism, and potential to quit work.<sup>13</sup> Environmental stressors, such as noise and fatigue can have a negative impact on both employees (fatigue, injury, and decreased efficiency and productivity) and on the organization (costs associated with absenteeism, retention, and recruitment). For patients, noise and fatigue have been associated with medication errors, reduction in quality rest, and increased stress.

The US Environmental Protection Agency (EPA) has stated that noise leads to increased anxiety, decreased productivity, and increased stress in individuals, especially in the work environment. Decreasing noise levels has a noticeable effect on building occupants. In a before and after study that compared an office environment with poor acoustics to a renovated office with improved acoustics, workers reported decreased noise levels, better speech intelligibility, and



feeling less pressured, more relaxed, and less irritable.<sup>14</sup> Reducing noise can also have a substantial impact on occupants' physical health by decreasing blood pressure, heart rate, and stress.<sup>6</sup>

In a hospital study funded by Mohawk Group, three flooring materials (terrazzo, rubber, and carpet tile) in patient unit corridors were compared for ambient noise levels and comfort. A significant difference was found for sound levels between the different flooring types. Carpet performed better for ambient sound reduction. In addition, patients reported lower noise levels, confirming that the sound levels in the corridors impacted patients. When the sound levels were lower, satisfaction scores increased. When responding to a survey, staff reported that terrazzo and rubber were easy for rollability while carpet was more comfortable underfoot and produced less glare.

Fatigue is a contributing factor to human error.<sup>15</sup> Fatigue has been found to have a negative impact on employee mood, alertness, psychomotor and cognitive performance, factors that contribute to reduced efficiency, productivity, and accuracy. A study that asked participants to stand for four hours at a time on seven different floors (carpet, resilient, and hard surfaces) found that in the third and fourth hours, significant differences presented for the type of floor based on participant subjective ratings. The participants complained about lower leg and lower back pain, discomfort and fatigue. The study also measured swelling and found that swelling was greater on hard floors. Increased elasticity, decreased energy absorption, and increased stiffness resulted in less discomfort and fatigue.<sup>16</sup>

Foot and leg discomfort contribute to fatigue and stress. Fatigue increases the risk of additional injuries, affecting the muscles and joints. In addition, someone suffering pain and fatigue are less alert and more likely to be distracted, raising the risk of an accident with additional injury.<sup>17</sup> Long periods of standing increase the risk of foot problems (aching feet, fallen arches, and sprains, just to name a few). The human foot is designed for mobility, not standing in one position. Maintaining an upright position for a long period of time is extremely tiring and may cause permanent damage. Continuous standing can cause the joints of bones of the feet to become misaligned and can cause inflammation that can later lead to rheumatism and arthritis.<sup>18</sup>

## Industry Impacts

Biophilic design transforms mundane spaces into stimulating ones that promote physical and mental health, fitness, and well-being. While the goal of biophilic design is clear, understanding it and its application is less so. Stephen Kellert (2008), in *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*, describes the dimensions, elements, and attributes of biophilic design. This explication provides guidance for how to effectively apply this design paradigm in the modern built environment, which has largely been stripped of natural systems and creates distance between humans and nature.

## Dimensions of Biophilic Design

### Healthcare

In healthcare facilities, reduced noise levels in patient units increased patient satisfaction, according to HCAHPS scores.<sup>19</sup> Thermal comfort and control of the ambient environment contribute to patient satisfaction. For staff, selection of resilient or soft flooring impacts physical comfort, or rather the lack of discomfort related to standing on their feet for sustained periods of time. According to a report by Press Ganey Associates,<sup>20</sup> hospitals that succeed in improving patient and employee satisfaction are reaping rewards on multiple fronts. Hospitals with highly satisfied caregivers and satisfied patients have an easier time recruiting and retaining qualified doctors, nurses, and technicians. Organizations with high satisfaction ratings are the most financially successful. Satisfied patients are more inclined to recommend the facility to family and friends, which leads to enhanced community reputation, a larger market share, and improved patient volume; and patients who are more satisfied are less likely to file malpractice suits. Comfort is a component of patient satisfaction. Designing to decreasing noise and increasing physical and psychological comfort supports increased patient satisfaction.

### Education

In education, noise can interfere with students' learning, behavior and academic achievement. Adverse health effects on children linked to noise include noise induced hearing loss, impaired cognition, physiological and psychological



effects.<sup>21</sup> Adverse health effects on teachers include noise induced hearing loss, strain on the vocal chords, stress and fatigue.<sup>21</sup> In a study that evaluated the effects of school design on student outcomes, students in carpeted classrooms scored higher on standardized tests than students in rooms with smooth flooring. The overall noise levels were lower in the carpeted rooms.<sup>22</sup>

Flooring for classrooms, especially for younger children, should allow children to participate in a variety of floor activities. While the ambient thermal comfort is very important, flooring temperature and cushioning are factors that can contribute to comfortable floor activities.

In many classrooms of K-12 students, comfort is an important component of a successful school day. High-quality classroom environments help children feel safe, secure, and valued. As a result, self-esteem increases and students are motivated to engage in the learning process.<sup>23</sup>

### Workplace

Comfort in the workplace influences job satisfaction, retention, and well-being. Control of one's ambient environment – temperature, light and sound levels – make workers feel more comfortable, satisfied with their job, committed, motivated, and with low levels of physical symptoms, emotional distress, and absenteeism.<sup>24</sup> Fatigue, however, impacts safety and productivity in the workplace. Solutions to increase control of the ambient environment and decreasing fatigue will increase worker comfort.

Noise is the most frequent complaint of office workers. Open-office designs intended to increase teamwork, communication and productivity have been shown to increase the level of noise, adding difficulty to verbal communication and the completion of complex mental tasks.<sup>25</sup> A study using a survey to evaluate occupant perceptions about acoustical quality in office workstations found that occupants were dissatisfied with acoustics citing problems with officemates talking on the phone or with each other, and speech privacy. More than 50% of respondents thought that noise in their workspace interfered with their ability to get their job done.<sup>26</sup>

### Recommendations

- Determine floor selection priorities – aesthetics, noise, fatigue, stress, anxiety, cleanability, etc.
- Use sound absorbing and low sound transmitting materials to minimize sound levels.
- Make flooring selection part of an overall acoustic design to reduce noise.
- Provide cushioned flooring in areas that require standing or walking for extended periods of time to reduce discomfort, foot and joint pain, and inflammation.
- To reduce fatigue and discomfort, specify floors with increased elasticity, decreased energy absorption, and increased stiffness.
- In patient rooms or places where occupants may be barefoot or classrooms where children may be working or playing directly on the floor, use materials that are high in thermal resistance and low in thermal capacity (feel warm to the touch).
- Evaluate proper floor cleaning processes to determine the best flooring solution for ease of cleaning.
- Use color and pattern to create an aesthetically pleasing floor landscape.

Regardless of the building type and the occupant activities, noise and discomfort have lasting effects on the occupants and the organization. Appropriate flooring selection will contribute to increased satisfaction and decreased stress, fatigue, and physical pain. Understanding the requirements for each space and the occupant outcomes desired will provide the structure to determine attributes needed during flooring selection.



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