Designing Better Buildings: What Can Be Learned from Offices, Factories & Schools

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Paper prepared for The Robert Wood Johnson Foundation, June 2004.

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Introduction

Winston Churchill once said, "We shape our buildings; thereafter they shape us." Although this statement may have reflected Churchill's own personal belief, research conducted over the past 25 years has actually proved its validity. Studies have found that the buildings in which people live, work, study, and convalesce affect productivity, satisfaction, learning, healing, and recovery.

However, most of this evidence has been applied toward the improvement of the modern office environment. For years, corporations have built offices that are designed to attract and retain employees, as well as heighten productivity. The social and economic impacts of these efforts have not been fully measured, but many corporate executives believe it to be crucial to their companies' success.

The same is true of manufacturing facilities, although not as well documented. Albert Kahn for Henry Ford designed the first "worker friendly" automobile factory in 1916.[1] Automation and the transition from the industrial age to the information age has diminished the focus on the factory environment, as more and more people now work in offices instead of on the assembly line.

Even less well documented is the impact of building design in institutional environments, although this is changing given the increasing need to renovate or replace old schools and hospitals. The Robert Wood Johnson Foundation (RWJF) has engaged The Center for Health Design to prepare a report that summarizes the evidence-based design studies for healthcare environments (available online at www.rwjf.org in October 2004). To date, researchers have found an astounding 650 credible studies, up from only about 80 five years ago[2], that show how the design of health care facilities can increase patient safety and healing and improve employee performance and job satisfaction. This paper provides an overview of the major areas of research in office, factory, and school structural design to see whether design approaches applied in these more studied environments may have analogies in health care. The health care examples cited throughout the following discussion are described and referenced in the Ulrich and Zimring paper.

The Office

Researchers studying office design have concentrated on open-plan workplaces. Many companies began migrating away from fixed wall private offices in the 1970s because of the reduced construction and maintenance costs and the flexibility that the open plan concept offered. It was also believed that by removing physical barriers, open plan would facilitate communication between individuals and groups, thus improving morale and productivity.[3]

Importance of Privacy

However, a significant body of research conducted over the past 30 years reveals that open-plan cubicle designs only minimally facilitate communication and do so at the expense of privacy. [4] The absence of a door and four walls compromises the privacy of employees when compared to a traditional office setting. In a longitudinal field study of traditional versus open office design, Brennan et al. found that open offices do not facilitate communication among coworkers and that, in fact, employees often feel that open office designs decrease communication because they prohibit confidential conversations.[5]

In the early 1980s, the Buffalo Organization for Social and Technological Innovation (BOSTI) Associates, Buffalo, NY, surveyed thousands of employees across the nation to determine how office design affects productivity and the quality of work life. Results confirmed that nearly two-thirds of workers in open offices are frequently distracted by conversations around them, resulting in reduced productivity and a host of other problems. BOSTI concluded that the most significant factor affecting individual performance, group performance and job satisfaction is an individual's ability to work in a setting that is free of distractions. [6]

The lack of privacy is in today's work environment is even more problematic as workers experience the physiological changes of aging.[7] The US Bureau of Labor Statistics estimates that over the next 10 years, the number of people in the workforce who are age 55 and older will grow by an annual rate of four percent—four times faster than the growth expected for the entire workforce.[8] Failing eyesight, hearing, flexibility, dexterity and slower response times are among the limitations that face older workers.

These issues are clearly analogous to health care situations. Research shows that patients withhold information when they believe privacy is compromised in, for example, multi-bed rooms or emergency bays separated by curtains. With new federal privacy rules, safeguarding the confidentiality of patient-related conversations and, thus, the need for private space, becomes even more important. Another issue connected to health care is the aging workforces; hospital nurses are now, on average, in their mid-40s. Noisy nursing stations and inadequate lighting in pharmacy and supply closets clearly contribute to errors and missed information.

Physical Environment and Job Performance

Brill et al. identified two factors as having the greatest bottom line impact on job performance: enclosure and layout, or the arrangement of the elements in an individual's workspace. They also identified lighting as a possible determinant of job performance. The researchers suggest that the financial reward for effectively designed office spaces are substantial, as are the costs of poorly designed ones. Calculations include an annual benefit of optimal enclosure to be eight percent of an employee's salary. An optimal layout of the employee's workspace could reap a six percent annual benefit; optimal lighting and employee control of temperature fluctuations produce a one-half percent benefit respectively.[9]

Visiting health care environments built 10 or 20 (or more) years ago readily demonstrates that the introduction of computers, printers, and other technology has not been done in the most ergonomically efficient way. Further, hospitals are 24-hour enterprises, and appropriate lighting for night shift workers requires careful attention.

The Noise Factor

Noise represents a serious and widespread problem in office environments and is detrimental to employee physical and psychological well-being, motivation, and, at times, productivity.[10] According to the American Society of Interior Designers (ASID), numerous studies identify noise as the number-one threat to office productivity. Occupant surveys administered by the Center for the Built Environment found that the most common acoustic complaint is a lack of speech privacy—overhearing other people's conversations and feeling that your own are being overheard as well.[11] Studies of hospital noise levels indicate they frequently exceed recommended ranges.

Physical Environment and Job Satisfaction

An independent study conducted by ASID found that the physical workplace design ranked as one of the top three factors in contributing to job satisfaction; only daily activities and compensation ranked higher. ASID's survey of 2,000 employees and job seekers found that the physical environment is one of the top three factors that influence their decisions to accept or leave jobs. Survey respondents who were pleased with their physical workplaces were 31 percent more likely to say they were satisfied with their jobs. Nearly half of the job seekers surveyed said the physical workplace would impact their decision to accept a position.[12]

Another study on plants in the workplace also documented the importance of an attractive office environment. The presence of plants in office space not only helped clean the air, but also contributed to greater office appeal, task performance and comfort. Researchers have also determined that access to nature can alleviate stress and anxiety, improve psychological function and increase employee's sense of identification with the environment.[13] Similarly, nature views, and access to outdoor areas have beneficial effects in healthcare environments.

In their analysis of BOSTI and other related research, Brill et al. identified additional factors that determine job satisfaction. Listed in order of importance, they include: furniture, noise, flexibility, participation, comfort, communication, lighting, temperature/air quality, and the amount of floor area in their workplace.[14]

Physical Environment and Performance

A study of a major insurance company determined that the best ergonomic furniture improved performance by 10 to 15 percent over normal conditions.[15] In a before-and-after study of major upgrades

in furniture and renovations to office space at Aetna Insurance, productivity increased by 53 percent, absenteeism dropped 14 percent, and job satisfaction increased substantially due to physical and organizational changes.[16] Conversely, Brill found that job satisfaction decreased when floor area was reduced by more than 25 percent. When floor space was decreased by 19 percent for professional and technical workers and 32 percent for clerical workers, researchers found parallel drops in job satisfaction.

Air quality also influences performance and productivity. A study of nearly 4,000 employees of the Polaroid Corporation documented a reduction in short-term sick leave through the use of high ventilation using outdoor air. Increasing ventilation rates, while lowering humidity, was shown to reduce sick leave rates almost as much as workforce flu vaccination.[17] Another study of indoor air quality determined that increasing ventilation rates to twice the minimum allowable-ventilation rate could increase employee morale and productivity, in addition to reducing pollutants and nasal irritation.[18] In health care settings, inadequate ventilation and air-cleaning can be deadly. The striking number of cases of SARS among health care workers underscored the problem of airborne infectious agents.

Finally, workspace design can have a profound impact. Workers in acoustically private workspaces—however small—are more productive than their peers in open offices, are better team players, participate more productively in meetings and useful informal interactions, complete more focused work, learn more from others and communicate better with coworkers. They are also more satisfied with their jobs.[19]

The Design Response

Office furniture and equipment manufacturers are responding to the need for greater privacy and fewer distractions in the office environment. To provide visual privacy and protection, manufacturers have introduced products such as “toppers” that provide workstations with a partial roof as well as frosted glass and plastic films for windows and partitions. Innovative sound absorbing and masking systems can pipe in “white noise” to provide speech privacy.[20]

Designing from the “inside-out,” starting with the work, worker and workgroup, is the best way to reap the benefits of appropriately designed office settings.[21] Designers have been increasingly more considerate of actual occupants by ensuring the physical environment is appropriate for the task at hand. In their study of software programmers, DeMarco and Lister[22] found that the factor that the most influential factor affecting job performance was the degree to which the physical environment suited the task at hand.

To accommodate older employees, workplace designers must also create environments that accommodate those with poor eyesight, tools that require less strength to operate and workspaces positioned at heights appropriate for an aging body.[23] Adds Kupritz, middle-aged and older workers need current information technology, large enough workspace and work surface, window access and close proximity to resources such as conference rooms, reference materials, supplies and coworkers.[24] Furthermore, all employees benefit from work environments that provide a sense of belonging. Appropriate levels of sound control and privacy, as well as workspace through the display of personal objects can improve satisfaction and motivation levels.[25] In their study of employees from a range of industries, Wells and Thelen also found that firms with generous personalization policies may benefit from higher employee satisfaction and better retention.[26]

In summary, says Brill, “… carefully designing settings for office-type work to support what people actually do is an investment that pays off in both business terms and in positive changes in organizational culture.”[27]

The Factory Setting

Noise is a major problem facing employees in the industrial workplace as well. Raffaello and Maass document numerous health risks associated with industrial noise.[28] Exposure to high levels of industrial noise may interfere with workers’ well being and satisfaction, reduce their productivity and increase accident and absenteeism rates.[29]

Researchers have also found that natural views increase satisfaction, especially in high-stress work environments. A study of workers in a wine production facility determined that providing sufficient sun

exposure could increase worker satisfaction and retention while reducing fatigue.[30] Recent research stresses the need to account for the physicality of individual employees in the industrial setting as well. To maximize worker efficiency and safety, all controls, tools and materials and special equipment in the industrial workplace should accommodate the user's body thickness, torso height shoulder width and body movement.[31] In hospital rooms, bathroom doors too narrow for patient and nurse to fit through at the same time or beds that make it difficult to move patients contribute to work-related injuries. The most radical solution, but one that may have the greatest payoff in safety and quality, for workers and patients alike, is the acuity-adaptable patient room, which minimizes costly, error-prone transfers to different hospital units.

Schools

Just as the physical environment affects job performance and satisfaction in the workplace, the physical settings of a school may also influence children's performance and satisfaction.[32] Children as young as five can reliably express preferences for environmental stimuli in school settings,[33] and nine-year-old students can articulate features of existing or ideal classroom settings.[34] Since the physical environment can be so critical in all aspects of children's development, Maxwell says it is important to discover what messages children perceive from the physical environment. Those perceptions may differ from parents' perceptions.[35]

Excessive noise in school settings can contribute to decreased motivation, learned helplessness, poor language acquisition skills, and poor reading scores.[36] Maxwell and Evans have documented that consistent exposure to high noise levels affects pre-school children's language and pre-reading skills.[37] These would be important findings to apply in pediatric care settings.

The challenges confronting the nation's urban schools are well documented. The American Architectural Foundation (AAF), in its announcement of a National School Design Initiative, stated that the general status of American urban schools is largely unsatisfactory. As a result of the poor conditions in which students live, increasing disinvestment in the schools they attend, and the deteriorating conditions of the facilities, students in these schools are struggling and, in many cases, failing.[38]

The AAF reported that over the next 20 years, the US will grow by some 60 million people, with most of the growth concentrated in urban areas. In the next decade alone, 6,000 new schools will need to be constructed to meet the demands of American communities, costing billions of dollars.

The AAF also cites new research that quantifies the many ways in which substandard school conditions seriously undermine the ability of teachers to teach and students to learn. Classrooms with limited natural light and poor ventilation dull the senses needed for mental exercise and make it difficult for students to concentrate. On the other hand, well-designed, well-maintained and welcoming schools have an enormously powerful effect.

U.S. Department of Education findings confirm that students who attend well-designed schools come to class with significantly more positive attitudes, are better behaved and are more focused on learning. In a 2002 document from the National Clearing House for Education Facilities, "Do School Facilities Affect Academic Outcomes?" research professor Mark Schnieder demonstrates that design excellence in ventilation, lighting and acoustics as well as aesthetics and spatial configuration, markedly increase student achievement and well-being.[39]

Important Factors for Classroom Design

The design of schools should, first and foremost accommodate the educational needs of students. In a study conducted by BEST (Building Educational Success Together), a program of the 21st Century School Fund, "Public School Facilities and Teaching: Washington DC and Chicago," more than 40 percent of teachers reported that their classroom was the wrong size for the type of education they were trying to deliver.[40] Research indicates that a poor fit between a student and the school environment may lead to poor performance and may carry some psychological or physiological cost, even if the student does perform well.[41]

An effective study environment must provide various stimuli, privacy and be suited to the activity being performed.[42] Researchers suggest using colors that are less stimulating where individuals must focus on tasks such as reading.[43] Findings of a study of children with attention-deficit disorder (ADD) and attention-deficit hyperactivity disorder (ADHD) found that green elements in the physical environment can help restore attention. The researchers suggest incorporating green areas into the design of school grounds to promote attention restoration in all children, including natural play areas and a view of green spaces from classroom windows.[44] Another study noted that the use of lower or differentiated ceiling heights or contrasting wall colors encourages cooperative behavior among children.[45]

Information technology (IT) has developed so rapidly that the design of workstations and classroom layouts has not kept pace and may be detrimental to learning, causing distraction, discomfort and dissatisfaction.[46] Researchers suggest providing workstations and computer monitors that can be adjusted to accommodate each student's unique needs, adequate space for books and non-computer materials, and adequate air quality and lighting. Teachers, in addition to needing adequate work space, need a room layout that allows them to move freely and view student computer screens.[47]

Research also notes that smaller schools are better for children and better for learning, especially in urban settings.[48] Researchers examining school size concluded that students in smaller schools find more opportunities to participate in activities, develop a greater sense of responsibility and excel academically.[49] High density/large class size have been linked with increased aggression, decreased social interaction and non-involvement with tasks and classroom activities, all of which were found to mediate lower achievement scores in large class sizes.[50]

Finally, involving students in the design or renovation of a school helps increase students' sense ownership of the space and the learning process.[51]

Conclusions

Many lessons from other settings can be applied to health care facilities, particularly those that benefit employees. Problems of noise and privacy for workers in offices and factories are similar to those working on a nursing unit. After all, both open plan offices and open nurse stations are settings where office work is done (computer work, paper work, talking on the telephone, etc.). Why wouldn't furniture, flexibility, participation, comfort, communication, lighting, temperature/air quality, and the amount of floor area in their workplace affect the job satisfaction of nurses just as it does office workers? Don't nurses need the same amount of support from a task chair as an office worker?

Loud machinery in the factory setting can be compared to loud medical devices or paging systems on a nursing unit. Access to natural light, effective ventilation, and pleasing color palettes that benefit teachers and children in schools can also positively affect patients and staff in hospitals.

These are only a few examples of available research on office, factory, and school environments. The growing body of evidence-based design research in health care is encouraging. Many health care executives are beginning to understand the benefits of using the evidence to design better buildings. Continuing to provide researched and documented examples seems to be the key in facilitating change.

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