

INTERIORS

Balancing the IEQ Equation

Air, lighting, sound, ergonomics and comfort — all the variables have to add up

By Naomi Millán

The 1970s: disco, leisure suits and an energy crisis. With the crisis came energy conservation strategies such as tighter building envelopes and lower ventilation rates. As the health ramifications of these practices became understood decades later, the news raced across TVs and magazines. Terms such as “indoor air quality” and “sick building syndrome” became commonplace in the general population.

Now, when an employee is plagued by unexplained headaches or other ailments in the workplace, IAQ is the usual suspect. But IAQ isn't the only potential trouble spot. The entire indoor environment affects the human mind and body. For facility executives, that means looking at IEQ — indoor environmental quality — not just IAQ. Whether a facility executive is addressing occupant complaints in an existing space or planning a new space it's important to address lighting, acoustics, thermal comfort and ergonomics, in addition to air quality.

Let the Sun Shine In

The buzz in the lighting world is daylighting. It's a fusion of the wisdom of the past with modern technology to take full advantage of the sun. For example, hotels at the turn of the century had finger plans, where building elements extend from a core. This created more perimeter on which to place windows that take advantage of breezes and sunlight.

“We got arrogant with air conditioning and electric lighting,” says Abby Vogen Horn, senior project manager with the Daylighting Collaborative. “We started creating really tight spaces and forgot all about the people.”

When lighting design considerations ignore how people may be affected, health concerns like headaches and fatigue can ensue. When lighting is appropriate to the task and does not create glare or bothersome shadows worker productivity and satisfaction can increase, says Jim Benya of Benya Lighting Design.

“People will always seek the light. It has been shown to be a powerful stimulant,” Benya says. He adds that good indoor lighting quality will help maintain healthy circadian rhythms, which lead to improved general health.

Indoor lighting quality also depends on the electrical lighting system. Sometimes, with the focus on energy conservation, foot candles and kilowatt hours dominate discussions about lighting system design instead of concepts of quality. The considerations a lighting designer has put into creating a balanced and healthy lightscape can be lost in the implementation of the design.

“They can be value engineered out,” says Stefan Graf, principal lighting designer with

Illuminart. “The thinking is it will save money, but in fact it will end up costing a lot more in the long run.”

An example is high color rendering lamps. There are three grades of fluorescent lamps. The highest grade can cost \$1 to \$2 more per lamp. Quite often installations will get changed to a lower quality, less expensive lamp. You save the \$2, but the color quality is compromised, which in turn affects visual perception, visual acuity and the psychological aspects of the space, Graf says.

Good Vibrations...And Bad

In a typical office environment, noise and vibration problems are rarely severe enough to cause health problems. The OSHA threshold for hearing protection is 85 dBA. Even a very loud office would only approach 60 dBA. Perhaps the most common health effect comes from perceptible vibration from an elevator or HVAC system. In addition to being annoying, vibrations at very low frequencies and high magnitudes can cause nausea.

That’s not to say that sound and vibration doesn’t play a big role in IEQ. Rather than health, acoustics concerns revolve around the integrity of personal work space. Especially in an open plan office, good acoustics help occupants hear what they need to hear and block out what they don’t.

Achieving this goal often means walking a fine line. For example, background noise from the HVAC system can have a good and bad aspect, says Tom Schindler, vice president of Charles M. Salter Associates. If it is too loud, it can be oppressive. Undersized diffusers, an out-of-balance system, or large supply and return ducts can introduce too much noise, Schindler says. But a moderate amount of background sound can be very useful, providing a masking noise that tends to bury what Schindler calls “annoyance factors.”

These annoyance factors — conversations are the biggest culprit — bounce in from all directions: the walls, surfaces and mechanical system elements. In an open plan work environment, or in offices where the walls don’t go all the way to the deck, these distracting sounds can make employees less productive.

Soundmasking, either in-plenum or direct field, is commonly used to supplement and balance out white noise produced by background sounds. It covers existing noises that might be distracting and provides privacy from nearby listeners. Traditionally delivered through speakers in the ceiling which bounce the masking sound up and then down through the ceiling panels, systems are now available for floor plenums or mountable on furniture systems.

As with any system, tweaking one area of IEQ might throw another one off balance. For example, LEED-level ventilation can include operable windows.

“This allows a tremendous amount of noise to come in,” Schindler says. “You can’t have an immediate open hole to the exterior.” In bucolic suburbia, the noise might be chirping birds. In the heart of the city, it might mean squalling car horns.

There has also been a trend to create buildings with raised floor environments for IT requirements and air distribution. To maintain a standard room height without getting fewer levels out of a building, the tendency is to use open ceilings. “You then have acoustically reflective head surfaces. The sound bounces up and reflects straight back down,” Schindler says.

But defining a space as too noisy depends as much on those using it as on its physical characteristics. An open-plan with no ceiling and lots of reflective surfaces might be too noisy for a call center but just fine for a quiet group of programmers.

The Hot and Cold War

When Gary Gardner, project manager with Gensler, is working to achieve good IEQ in a space, he follows the LEED system as a guide.

The comprehensive point system helps facility executives understand the incremental improvements possible, Gardner says. While much of LEED IEQ is related to IAQ, it also includes concepts of controllability and thermal comfort.

“A window to open, a vent to adjust, a task light to turn off or on — with a higher degree of controllability there is a higher degree of comfort. It gives a sense of empowerment,” Gardner says.

The desire for controllability is perhaps most evident in regards to thermal comfort. While employees in one spot are cold, others are too warm. It can seem impossible to find the set-point that is just right.

Part of the problem is that a traditional HVAC system dumps a lot of cold air into a large space. For a person sitting below a diffuser, the blast of cold air can make life miserable.

One way to achieve a high level of control and to comply with ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy, as required by LEED, is to use a raised-floor HVAC system, Gardner says. In a raised-floor environment, adjusting the amount of airflow at the individual diffusers changes the temperature. “You deliver small quantities of air right into your breathing zones,” Gardner says.

However, this solution is not really feasible outside of new construction or complete gut rehabs. For existing spaces, Gardner suggests installing more duct runs to establish more points of control. Comfort is such a subjective concept, that even with the floor-plenum system, some hot and cold complaints will likely persist.

“It is a fact that in a large space, some people are going to be hot and some will be cold,” he says.

Every Breath You Take

Breathing is a non-negotiable aspect of life, though the quality of what we breathe is not

guaranteed. In facilities where the air quality is poor, the population can suffer from symptoms such as upper respiratory tract irritation, headaches, fatigue, and aggravated asthma. In the worst cases, occupants may develop conditions such as Legionnaire's Disease or humidifier fever.

It's no wonder that a 2004 Building Owners and Managers Association/Urban Land Institute survey found that 95 percent of office tenants desire good IAQ, says Jim Newman, managing partner with Newman Consulting.

How do IAQ problems develop? A look behind the walls of a building may reveal the answers. All too often, there are clogged drain pans, dirty interior duct work, and poorly maintained dampers, which all lead to poor air. Filters, which may not be appropriate to the demands of the system in the first place, don't get changed when they should be. Air intakes suck in exhaust fumes or other undesirable elements.

There is no single way to prevent IAQ problems. LEED identifies a range of measures to ensure good IAQ. At minimum, IAQ performance must meet ASHRAE 62-2004 and exposure to volatile organic compounds must be minimized in all interior sources. Other important steps are providing the best mechanical system, maintaining it properly and minimizing the amount of pollutants that come into the space.

Unfortunately, good IAQ principles are often forgotten when a building is under construction. One of the first things to be cut when a project is going over budget is the mechanical system. That's an invitation to IAQ disaster. "Cutting mechanical systems, which are the heart of the building, can affect the quality of the air," says Newman. He says money is rather spent on items like Italian marble. "The building owner wants it to be good looking so it has good curb appeal."

Spaces may be built without regard to basic principles of good ventilation. "If there isn't proper mixing in the spaces, it makes people lethargic," Newman said. This can happen inside cubes because high partition walls prevent the air from getting in. People might also block diffusers because they're too cold – or too hot.

Ill-advised cost cutting doesn't stop when the building is complete. Poor maintenance also contributes to IAQ problems.

Sometimes, measures to improve IAQ will increase energy use, and therefore raise costs. But in some cases, adjustments can be made to reduce or eliminate the cost impact. For example, maintaining proper humidity levels is important to good IAQ. "While you use up energy to humidify, you can drop the temperature a little bit. It makes people feel a lot better," Newman said.

The Science of Work

One field that considers all the aspects of IEQ is ergonomics. Ergonomics actually means "the science of work," and includes lighting, eyestrain, where to place computer screens, noise and acoustics, thermal conditions, and air pollutants.

One variable that affects all aspects of IEQ is the age of your workforce. The average age of the US worker is 50, says Alan Hedge, director of the Human Factors and Ergonomics Laboratory at Cornell University. Even though the environment might not change, an aging worker's response to it will. For example, by the early 40s, less light gets through to the retina. The skin thins out, so the same chair that is comfortable to a younger worker will start to seem too hard. As people age, they also tend to gain weight, necessitating wider seat pans or more clearance to reach the keyboard.

When IEQ issues arise, it is key to respond quickly. It is easy to label the employees with habitual complaints as career grumblers, writing them off by saying that you can't please all of the people all of the time.

"Facility executives don't trust that employee concerns are important because they're not life-threatening and they usually have more pressing things to attend to," Hedge says. "Facility executives tend to think these symptoms are imagined. Whether they're imagined or not, they actually do have an effect."

People know what they're experiencing, but they're not likely to know what is causing it. For example a headache could be caused by poor posture, a draft blowing across the neck, stress from the job, arthritis or glare. Ask employees to keep a diary of symptoms. Is there anything in the building systems that corresponds with the pattern? If not, then look at how the individual works.

"It's like any other detective process. You eliminate things and try solutions until you find one that works," Hedge says. "You have to have a process that maintains a dialog. When you do figure out the problem, people see you as a hero and the company as the best company to ever work for. It's well worth the investment."