INDOOR AIR QUALITY: THE ARCHITECT'S ROLE

You need to know not only what products to specify, but how to handle the human dimension.

Though architects typically rely on mechanical engineering consultants to assure clean, breathable air, problem buildings often need more than just a ventilation fix. The National Institute of Occupational Safety and Health (NIOSH) has found that indoor air-quality-related symptoms may be "exacerbated by a variety of ergonomic, organizational, and psychosocial stresses." Among these are poor housekeeping and lighting, furnishings that are inadequate (boxes stacked in front of air outlets), or inappropriate (not intended for extended use of computer screens). Since air-quality problems—in new buildings especially—have been widely publicized, codes are changing, and users increasingly expect owners (and their architects) to specifically address the indoor environment.

Unfortunately, with the exception of asbestos (RECORD, October 1990, pages 110-111) and radon (below), sources of indoor air pollution may be diverse and hard to identify; corrective measures may not definitively do the job. Sometimes perceived air-quality problems are multiplied by a kind of mass psychology. A remedial approach, therefore, must address the human dimension *and* the mechanicals ("Hysteria?" opposite).

Types of air-quality problems

The Environmental Protection Agency (EPA) calls symptoms related to a single, identifiable toxic substance stemming from a specific building material or activity "building-related illness." When the cause (or causes) of symptoms are hard to identify, which is much more common, the malady is called "sick building syndrome." In the latter case, airborne toxic chemicals may become so concentrated that building users begin to suffer physiological symptoms such as fever, chills, muscle aches, and irritation of eyes, nose, and throat. Behavioral effects may include mental confusion, dizziness, and fatigue.

In some buildings, accumulations of carbon dioxide are excessive; in others, a host of chemicals may be at fault. The EPA has focused on volatile organic compounds (VOCs) since many are known carcinogens. These chemicals figure prominently in cigarette smoke, and may be emitted by architectural elements and finishes such as paints, carpets and carpet and floor-tile mastics, plastic and synthetic fabric wall coverings, fiberboard wood products, sealants, and furnishings that contain foam cushions and gas-emitting synthetic fabrics. Office machines, including copiers, computer printers, and blueprint machines, are also of concern, as are improperly used pesticides and cleaning agents.

Conservation versus air quality

Though proliferating synthetic materials have been blamed for growing air quality complaints, the real culprit appears to be improper management of fresh air, brought on by the push to make buildings more energy efficient. ASHRAE 90, the hvac Standard for saving energy, cut recommended fresh-air replenishment in offices from 15 cu ft per minute (CFM) to 5. At the same time, the building envelope was sealed much tighter, reducing infiltration of fresh air.

In the 1980s we learned that lower energy bills came at the cost of poorer air quality. This is not to say that the energy-conservation standard was insufficient, but it did call for a level of attention to design,

DON'T DENY RADON

Solutions are straightforward, but there's a reluctance to test.

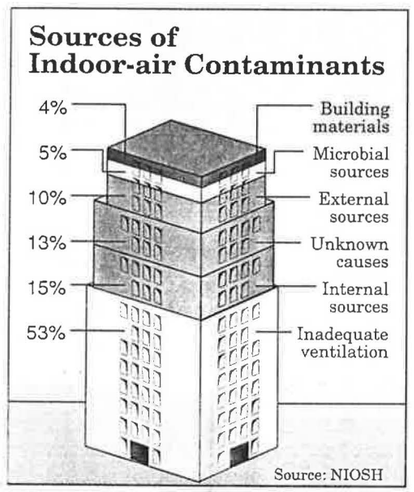
There seems to be little sense of urgency about radon, a naturally occurring gas estimated to cause from 10,000 to 40,000 cases of lung cancer per year. Radon differs from other indoor-air contaminants in that it is readily identified, and solutions are known and often quite inexpensive. The EPA loudly urges testing, but few people seem to be listening.

Radon enters habitable spaces from the soil. The combination of a well-sealed building and negative pressure within the space can draw in gas. Houses have been the focus of radon research and remediation because these structures are most likely to have high concentrations. If a large proportion of any structure is set within or bears upon soil, however, radon should be a concern, particularly in poorly ventilated areas or where changes of use (from storage to office, for example) may expose users. There are several testing devices and services to establish whether dangerous levels of radon are present within a given building. Unfortunately, the technology for testing building sites prior to construction is not yet proven, and may not be reliable because of the influence of soil structure on gas movement. Radon-control mechanisms should be built into new structures in any area that has had radon problems. For local information, most states have a radon hotline.

Results of a study at the University of California's Lawrence Berkeley Laboratory "add to the growing evidence that subsurface ventilation is often the most effective technique to reduce indoor radon levels." Usually such techniques incorporate a vapor barrier and a fan-driven series of pipes, which exhaust the gas away from the structure. Sealing cracks in slabs and walls can be effective, and altering forced-air furnaces and combustion appliances so that they don't create negative air pressure will also reduce gas concentrations. **J. S. R.**

Further information:
The EPA (address opposite) has published (with the National Association of Home Builders) "Radon Reduction in New Construction."

installation, and maintenance that now seems unrealistic. Of 529 problem buildings studied by NIOSH from 1971 to 1989, inadequate ventilation was the cause of complaints in 53 percent (chart below). The other causes identified by NIOSH would have been responsible for symptoms less frequently were our buildings not sealed so tight: *internal sources* and *building materials* primarily comprised VOCs. Buildings contaminated by motor vehicle exhaust, boiler gases, and the recirculation of exhausted air were among problems classed as *external sources*. (Exhaust gases drawn into a building's ventilation system from an adjacent parking garage were surprisingly common.) *Microbial sources* are usually associated with poorly maintained equipment. Bacteria and other biological agents breed in stagnant water accumulated in humidifiers and cooling-coil condensate pans. Architectural materials may become a source of biological contaminants if leaks or humidity problems are neglected.



Solutions

As a first step, the EPA recommends removal of all identifiable pollution sources. As yet, however, no one really knows what safe exposures are for most harmful compounds emitted by building elements. "You're looking at something like 7,000 chemicals," comments Neil R. Patterson, an engineer and director of marketing development and product planning for The Trane Company. "The EPA has got to determine threshold limit values for all of them. That process is very expensive."

Excessive levels of carbon dioxide, however, are a sure sign that ventilation is inadequate, permitting concentration of any other pollutants present. *Dilution* of contaminant sources is, in fact, the preferred means under the recently adopted ASHRAE Standard 62-1989. It returns minimum office ventilation to 15 CFM.

Just-opened buildings are a special case because gases emitted from new building materials are at their highest levels, and final balancing of the hvac system often does not take place until several months after occupancy. The EPA says testing "supports the Scandinavian decision to require 100 percent outdoor air as makeup air for the first six months of a new building's life." Experts recommend increasing the percentage of outside air in older buildings for the duration of VOC-emitting operations such as painting or carpet installation.

Other hvac-related solutions include improving maintenance operations to avoid bacterial contamination, and relocating air intakes which are either too close to the building exhaust or to point sources of exterior pollutants. Even designated smoking areas within a building may contribute to indoor-air contamination if located near a major return-air inlet.

Both owners and architects have been targeted by manufacturers of various products intended to address air quality problems. Each must be evaluated as part of an overall solution. Advanced filtration devices, for example, should only be installed after considering the impact on air speed and distribution. Most filters can reduce particle sources (such as pollen), but cannot, for the most part, absorb gaseous agents. Gas-absorbing (sorption) devices may be considered but are often expensive or require high maintenance.

Before boosting outside air, potential problems with air distribution must be evaluated and solved. (Revisions to office layouts, for example, may moot the original design scheme.) Increasing air movement alone will not solve air-quality problems if the system was poorly designed, built, or maintained. Even in nominally well-seviced structures, "we often find that a system is not being operated according to the intent of the original design," explains Greg Bourassa of the Chicago office of Flack & Kurtz. Older systems are all too often being operated beyond their useful life, and maintenance procedures may have utterly collapsed. "If needed," says Bourassa, "we can reconstruct the design intent of buildings with which we haven't been previously involved."

When ventilation is increased, energy use may go up if alternatives aren't explored, such as one of several forms of heat recovery. Operable windows "are a great source of comfort," says George Bourassa. "There are practical problems, though. An open window destroys the control of humidity and temperature that most people desire."

It is increasingly easy to identify and specify building materials and furnishings that emit lower levels of volatile gases. Many manufacturers will back up claims with independent test data.

JAMES S. RUSSELL

Research assistance by Rachel Hoffman

Further information:

Indoor Air Quality: Selected References, includes NIOSH study data and a step-by-step "Self-Evaluation of Indoor Air Quality Problems." NIOSH 4676 Columbia Parkway, Cincinnati, Ohio, 45226 (513/533-8236).

"Indoor Air Quality Facts," is a series of short articles on specific subjects available from the U. S. Environmental Protection Agency, Mail Code PM-211B, 401 M Street, S. W., Washington, D. C., 20460.

ASHRAE 62-1989 is available from the American Society of Heating Refrigeration and Air Conditioning Engineers, Publications Department, 1791 Tullie Circle N. E., Atlanta, Georgia, 30329. $28 members, $42 nonmembers.

HYSTERIA?

How do you cope with a building that has complaints but no evident air-quality problems? RECORD asked George Bourassa, managing principal of Flack & Kurtz consulting engineers, in Chicago.

George Bourassa: We have documented buildings that have had rampant complaints and yet found no chemical agent as the source. A lot of this is perception. If one person identifies some specific symptoms that appear to relate to the building, then you have a problem whether or not the building is at fault. You need to identify and correct any problems, of course. Sometimes it's just operating personnel not pursuing the design intent. Then the owner must communicate with users and tenants so they know you are aware of the issues and have taken steps.

RECORD: How should you address indoor-air problems in new buildings?

GB: Again, knowledge of the situation is probably the best way to avoid problems. The architect and consultant should meet with the owner, describe where there have been problems and what they've been attributed to. Many occupants come into a building with notions about air quality based on hype rather than facts. If the owner is prepared to speak to what has been done, chances are there will be fewer tenant complaints.... In newer buildings we think that the original design team should be called in periodically—they know whether a damper is in the wrong position, starving a building of fresh air. □