




Building The Healthy Home

Concept, Design, Materials

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synopsis

-  **The air inside our houses is often many times worse than the air outdoors—at times, two to five times worse, according to the U.S. Environmental Protection Agency (EPA).**
-  **By the 1970s, “sick building syndrome” entered the lexicon, followed by a radical increase in allergies and asthma, and an upsurge in cases of chemical hypersensitivity.**
-  **The Healthy House Institute embraces the overall concept of physical and psychological well-being, regardless of sensitivity and treats the home like an ecosystem with many interrelated parts, covering topics in depth such as air and water quality, building, remodeling and furnishing, cleaning and housekeeping, health and safety, ventilation, lighting, energy efficiency, and more.**



When it comes to housing, America took a wrong turn somewhere after World War II. Little by little, we have since filled our dwellings with synthetic chemicals. They enter our houses disguised as cleaners, paints, building materials, and furnishings, even cosmetics, grooming aids, and cookware. At the same time we have tightened up for energy efficiency, thus reducing the amount of fresh air coming in. As a result, for the first time in history, the air inside our houses is often many times worse than the air outdoors—at times, two to five times worse, according to the U.S. Environmental Protection Agency (EPA).

This polluted air is making people sick. By the 1970s, “sick building syndrome” entered the lexicon, followed by a radical increase in allergies and asthma, and an upsurge in cases of chemical hypersensitivity. Today, more than 15 percent of the U.S. population suffers from Multiple Chemical Sensitivity (MCS)—and those are diagnosed cases. Many more complain of adverse physical symptoms (from lethargy and fatigue; to headaches, dizziness, and nausea; to a range of respiratory troubles and general malaise) apparently due to indoor air pollution—a result of poor design, bad ventilation, and a plethora of unhealthy chemicals. One theory about hypersensitivity is that irritating chemicals are harmful to everyone—but most people never know it.

Fortunately, the Healthy House Institute (HHI) provides in-depth information on how to help remedy the problem. It's part of a revolution occurring in building design and construction. “In order to live healthfully, in order to live happily, we need to make educated choices,” insists Allen Rathey, Idaho businessman and HHI's president. “We need to evaluate our actions. Develop options. The Healthy House Institute helps people do that.”

What Does Healthy Building Cost?

How much does it cost to build or renovate with healthy materials? If you choose wisely, it should cost no more than one percent of standard construction costs, according to Adam Prince, Business Development Manager with Independence Energy Homes in Charlestown, Massachusetts. Some non-toxic materials cost the same as conventional brands, such as substituting exterior-grade plywood for interior grade. Others cost more initially but are more economical in the long run, such as installing radiant in-floor heat instead of a forced air system, or using high-quality insulated windows. Many states offer tax credits and rebates, which help lower costs, so be sure to check.

The Healthy House Institute

It's often a short road from good health to chemical sensitivity. It seems many people become hypersensitive to some degree after moving into a recently built house or shortly after completing a remodeling project. That's what happened to Lynn Bower. After she and her husband John renovated their Indiana farmhouse using traditional methods, materials, and finishes, she became seriously ill. Fortunately, her story has a happy ending. The event propelled the couple to research the subject, leading John to write *The Healthy House: How To Buy One, How To Build One, How To Cure A Sick One*, which has become a classic in the field of home ecology. In 1992, the Bowers founded the Healthy House Institute, published four more books and six videos, and became regular speakers at conventions and respected sources for consumers, the media, and building tradespeople.

Recently, the Bowers sold their domain name, books, research, articles, and videos to Rathey, who is transforming the Institute into an online library with a mission to become the leading book and online publisher of healthy home topics. Online in early 2007, the site treats the home like an ecosystem with many interrelated parts, covering topics in depth such as air and water quality, building, remodeling and furnishing, cleaning and housekeeping, health and safety, ventilation, lighting, energy efficiency, and more.

While the Bower's approach to healthy housing comes from a point of chemical sensitivity, the new Healthy House Institute embraces the overall concept of physical and psychological well-being, regardless of sensitivity.

Basic Concepts

Whether remodeling or building from scratch, the three most important principles of healthy construction are

eliminate, separate, and ventilate. These principles are represented by the three vertical bars in the Healthy House Institute logo.

ELIMINATE

When selecting construction and furnishing materials, elimination is by far the most important principle. Eliminating toxins in the first place leaves fewer harmful pollutants to contend with. Some of the worst offenders are manufactured wood products, paints, adhesives, vinyl, and foam cushions/mattresses. Unfortunately, these potentially polluting components are standard in most houses.

SEPARATE

If a source cannot be eliminated, then it's important to separate it from the living space. For example, insulation can often be effectively sealed from the living space by using foil-backed drywall. In older houses with asbestos-wrapped pipes, if the asbestos is in good shape, simply wrapping the pipe with low out-gassing polyethylene plastic will help contain the material. If out-gassing from the plastic jacketing of electrical wiring is offensive to sensitive persons, it can be placed inside a metal conduit.

VENTILATE, VENTILATE, VENTILATE

Because human beings need fresh air, houses should receive .35 air-changes-per-hour, according to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). Of course, that rate of ventilation may need to be adjusted based on indoor conditions. Houses built before 1965 may be able to rely on infiltration and natural ventilation (such as opening windows) for these air changes, but

The Difference Between “Green” And “Healthy”

Though these words are now often used interchangeably, traditionally there has been a difference between “green” and “healthy.” “Green” building focused on resource conservation, energy efficiency, and reducing consumption. Healthy design promoted pollution-free air and water, and products that are safe, less toxic, or harmful to human health.

The distinction can be important because there are times when green is not necessarily healthy, and vice versa. An example of a “green” product that is not healthy would be a carpet pad made of recycled tires. While this is an excellent idea from the perspective of reducing tires in the landfill, it is not a healthy product to use inside a home because tires continue to off-gas during their lifetime. Examples of healthy design that is also green include proper placement of windows and doors for natural heating and cooling, and use of natural lighting.

"In order to live healthfully, in order to live happily, we need to make educated choices."

newer houses built with insulated windows and sheet goods (like drywall and plywood) leave fewer cracks for fresh air to enter.

That's where mechanical ventilation enters the picture. The tighter the house, the more important this is. Mechanical ventilation can be controlled and fitted with filters (e.g., high-efficiency, HEPA, or carbon absorber) to provide a steady supply of clean fresh air. In many areas of the country, mechanical ventilation is a code requirement in new construction, and costs anywhere from \$500 to \$2,000 without ductwork, according to Independence Energy Homes' Adam Prince.

Most houses need localized ventilation, as well, used intermittently to reduce humidity in kitchens and baths, and to reduce pollutants from occupant-related activities, such as smoking, applying pesticides, and working in laboratories and shops. Exhaust fans are the method of choice in these cases; taking care the house doesn't become depressurized.

Overall, a three-pronged approach is best—build a tight structure, use low-toxic materials, and a modest amount of ventilation to meet occupant needs. By trying to rely exclusively on ventilation to deal with indoor pollution problems, you'll probably need a more powerful mechanical system—one more costly to install, more expensive to operate, and probably noisier, not to mention a bigger heating and cooling budget, than if you used the principles of eliminate and separate first.

Do's And Don'ts Of Healthy Design

What is healthy house design? In a nutshell, healthy houses promote good health for those who live in them, use construction materials and techniques with low environmental impact, and work in harmony with nature by making use of sun, wind, vegetation, and water to reduce energy consumption and pollution.

Once you understand the basic concepts, constructing a house that will not make occupants sick is no more difficult than "unhealthy" house construction. It involves selecting low-toxic materials, but also requires a basic understanding of how a house functions. Follow these dos and don'ts.

1. Build in a clean locale.

If outdoor air is poor, indoor air quality will also be poor. Likewise, if there are many ground pollutants—pesticides, dust, etc.—these get tracked into the house. For that reason, a mudroom or foyer is always a good idea in a healthy house.

2. Build an airtight structure.

An airtight envelope minimizes the amount of uncontrolled infiltration, improves energy efficiency, and (when coupled with a mechanical ventilation system) offers maximum control over indoor air quality.

3. Install a radon removal system.

Test for radon after the house is built. It's also much easier (and less costly) to take basic precautions before construction that may or may not be employed later (such as pre-installing pipes for sub-slab ventilation of radon), than to mitigate radon afterwards if precautions weren't taken.

4. Respect the laws of building science.

Moisture migration, wind and stack effect-induced pressure, mechanically induced depressurization, and out-gassing all follow well-defined physical laws. If these laws are properly understood and acted upon, healthy durable houses are the result.

5. Pay attention to depressurization.

If conventional combustion appliances are used, make sure back drafting and spillage of combustion gases will not occur. Better yet, specify sealed combustion appliances, solar and/or geothermal heat, electric or heat pump furnaces, and water heaters.

6. Install a mechanical ventilation system.

Mechanical ventilation can supply fresh air at the correct rate whenever it is required. There are several approaches, including supply ventilation through a fresh air duct to the return air-side of a furnace, central exhaust, and heat-recovery ventilation.

7. Avoid products containing formaldehyde.

This includes composite wood products, such as medium-density fiberboard (MDF) and interior-grade plywood, often found in cabinetry and sheet goods. Composite wood contains urea-formaldehyde binders known to out-gas into the air for months. Formaldehyde is a known carcinogen.

8. Use water-based adhesives, caulks, paints, etc.

In general, water-based products are more benign than solvent-based products. If solvent-based products must be used, minimize exposure with plenty of ventilation.

9. Test samples of materials before generally exposing sensitive occupants.

If anyone living in the house has allergies, asthma, or chemical sensitivities, consult a physician with experience in these areas, and test interior building materials for tolerance. This includes paints, wall coverings, flooring, and cabinetry. For example, with paint, allow a painted sample to air out until it seems odor free; then place it next to the person's bed. A good night's sleep often indicates tolerance.

Using Healthy Building Materials

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When specifying healthy building materials, use the following as a guide. For more information, check out HHI's Web site: www.healthyhouseinstitute.com.

Remember to read product labels, ask questions of the manufacturer, and study material safety data sheets (MSDS) to find out exactly what is in a product before you buy it. Don't assume the government is protecting you from harmful products. At times, government can barely keep up with labeling. It's up to you to be an informed consumer.

Caulks And Adhesives

Caulks and adhesives may seem like a small part of a building project, but they can make a big impact on air quality. Solvent-based adhesives have high levels of volatile organic compounds (VOCs), making them harmful to work and live with. Epoxy adhesives are noxious during application but relatively non-toxic when fully cured. White glue (polyvinyl acetate) and carpenter's glue (yellow aliphatic resin) are safe when dry.

Healthy adhesives are solvent-free or water-based. Caulks with a VOC content of 30-grams-per-liter or less is acceptable.

Cabinets, Doors, Molding, Shelving, Trim

These days conventional cabinets, doors, molding, shelving, and trim are often composite wood covered with veneer to make them look like wood. These products contain large amounts of formaldehyde. In a healthy home, cabinetry, doors, and built-ins are made of solid wood, formaldehyde-free wheat board (a rapidly renewable resource), and finished with a low-VOC paint or stain. Formaldehyde-free exterior-grade plywood is an acceptable material choice, or you can use alternative materials, such as stainless steel or metal with a baked-on finish, for cabinets.

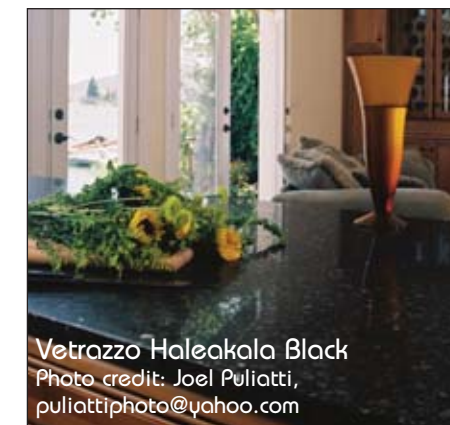
Subfloors, Sheathing, Underlayment

Subfloors, wall sheathing, countertop underlayments, and some types of wall coverings, use plywood or other composite wood products containing urea-formaldehyde binders that can off-gas for years. When using sheet goods, choose low-emission boards such as wheatboard, strawboard, isoboard, Fiber Tech™, Homasote™ (made from wheat, straw, sugarcane, or recycled paper bonded with non-toxic agents), or exterior-grade plywood. Seal it with a low-VOC vapor barrier sealant and finish with low-VOC paint.

Though plywood is not a healthy choice, exterior grade is preferable over interior grade. The phenol formaldehyde binders of exterior grade are waterproof and more stable than the urea formaldehyde binders of interior grade, which are only water resistant. It is best to seal exposed surfaces with a vapor-retardant sealer.

Countertops

In a healthy house, countertop finish material is installed over formaldehyde-free underlayment and fastened mechanically, when possible, to avoid the issue of adhesives. Avoid high-pressure plastic laminates. They contain PVCs and are often attached using high-VOC adhesives.



Vetrazzo Haleakala Black
Photo credit: Joel Puliatti,
puliattiphoto@yahoo.com

Though more expensive, materials like marble, granite, concrete, ceramic tile, and stone are healthy choices. Solid-surface synthetics don't off-gas, but they are manufactured from petroleum, so they are not optimally "green."

Butcher block makes an attractive kitchen countertop, does not require underlayment, and can be mechanically fastened to cabinets. The porous surface, however, can encourage mold and bacteria growth. Be sure seams aren't glued with formaldehyde-based adhesives. Finish with odorless non-toxic oil, such as walnut oil.

Stainless steel and copper are excellent choices but present issues with creating electromagnetic fields if these are a concern to you.

New eco-products are available. Vetrazzo® (made of recycled glass from curbside-recycling programs) is touted as a sustainable alternative to granite,



IceStone
Sage Pearl

quartz, and other quarried stone. IceStone® (composed of recycled glass and concrete) is another option. Both come in an array of colors, are strong like granite, yet not as porous as marble.

Drywall

Though economical and convenient, gypsum-based drywall (also known as Sheetrock®) is often not a healthy material for two reasons: (1) adhesives and

joint compounds off-gas irritating fumes (including formaldehyde), and (2) drywall is subject to moisture damage and mold. Chemically sensitive people often react to the off-gassing of inks used in the recycled newsprint comprising the paper facing. A less toxic solution is drywall primed with specialty paint or primer to seal off toxic fumes, and joined with non-toxic joint and texture compound, such as Murco M-100 Ni-Po, made with inert fillers and without formaldehyde and preservatives. A new type of paperless drywall by Georgia-Pacific (DensArmor Plus®) is a highly mold-resistant gypsum panel, ideal for basements and bathrooms. The glass-matte surface front and back make it a healthy replacement for paper-faced wallboard.

The most natural wall finish (short of adobe) is additive-free plaster. Plaster has the added advantage of blocking VOC off-gassing present in the gypsum and taped joints of modern construction.



As an added bonus, colored plaster never needs painting. Traditional plaster and lath construction is many times more expensive than drywall—if you can find someone to do it. Fortunately, veneer plaster systems (often called skim plaster) are available that provide many of the same benefits of traditional plaster for a price similar to standard drywall. Veneer plaster is simply a layer or two of plaster installed over special

drywall for a smooth, seamless, and impermeable finish.

Flooring

Because it covers such a large surface, non-toxic floor coverings are essential in a healthy home. There are more choices than ever before, so it's essential to do your homework.

No matter what type of flooring you choose, if it would ordinarily be finished on-site, consider a factory-finished product instead of one you finish yourself. The factory finish allows it to cure outside the home, thus lowering in-home emissions. If you choose to finish it on-site, select a low- or no-VOC water-based



adhesive.

Healthy flooring choices include ceramic tile, slate, terrazzo, brick, hardwood, pine, natural rubber, "true" linoleum, and colored concrete. Instead of wall-to-wall carpet, cover these floors with easy-to-clean natural fiber area rugs.

Avoid vinyl flooring, with the possible exception of some of the newer lower-VOC vinyl floors. Vinyl chloride fumes are a known carcinogen. Vinyl also traps moisture, which can promote delamination of subfloors and mold growth or rot, especially in hot, humid climates. In older houses, be careful removing vinyl flooring; it may be a source of asbestos.

Instead of vinyl, consider "true" linoleum (made from wood and cork "flour," limestone dust, pine resin, and

colorants mixed with linseed oil from flax seeds and baked onto a jute backing). It's durable, resilient, thermally insulating, quiet, and low maintenance with natural antibacterial properties. Available in sheets or tiles, it doesn't easily show scratches or cuts and comes with a 30- to 40-year lifespan. One type,



Marmoleum®, looks and feels like old-fashioned linoleum, is cushy underfoot, available in a variety of colors, and can be cut and inlaid to create one-of-kind patterns.

Similar to linoleum is natural rubber. It's durable, resilient, and easy to clean. Newer types of rubber flooring come in either rolls or tiles and cost \$3 to \$5 per square foot installed. Be leery of manufactured rubber flooring, though. Some are made of recycled tires, which can out-gas for a long time.

If you choose a hardwood floor, pay attention to the type of wood. The environmental choice is Forest Stewardship Council-certified wood (FSC). Be sure the underlayment doesn't contain formaldehyde. An installation that requires no glue (as in most traditional hardwood floors) is best, but if the floor must be glued use water-based glues. Finish the floor with a low- or no-VOC finish. Or, you may find a great deal on recycled wood in salvage yards and neighborhood teardowns, thus reducing the \$3 to \$8 per-square-foot cost of installing a conventional hardwood floor.



As a substitute for hardwood, check out renewable products such as cork and bamboo. Bamboo resists warping better than other types of wood floors and is surprisingly firm. Be careful, though. Most bamboo flooring is manufactured in China and may have adhesives and finishes that contain formaldehyde. Do your homework, and select formaldehyde-free bamboo. Cork has natural give, thus cushioning the foot, is durable, sustainable, provides acoustic and thermal insulation, and has antimicrobial benefits. When using cork, make sure it is not encased in vinyl. The price of installed cork is at the upper end of the range for wood flooring, and bamboo will cost \$1 to \$2 more than cork per square foot.

Beware of laminated flooring. The backing may be composite wood. Some are bonded with PVCs, which are harmful throughout their life cycle. Look for laminated floors using natural materials and biodegradable resins.

Insulation

When it comes to insulation, there's a mind-boggling array of choices, so you need to be informed.

If anyone in the house is chemically sensitive, stay clear of batt insulation backed with asphaltic coatings. Batts are not the most effective insulation, anyway. Blown-in loose-fill insulation is the better

option because it doesn't settle as much as spray-in insulation does.

If you want batt-type insulation, try a new product made of recycled blue jeans. UltraTouch Natural Fiber Insulation® by Bonded Logic is safe to handle and install, contains no formaldehyde binders, and provides better acoustics than fiberglass.

Though fiberglass is the most popular insulation, many home ecologists discourage blown-in fiberglass insulation unless it is formaldehyde-free (such as Climate Pro® or Attic Protector® by Johns Manville Corporation, and InsulSafe 4® from CertainTeed Corporation).

Cellulose insulation has high energy and acoustic performance and isn't harmful to the installer, but chemicals in the ink of shredded newsprint make cellulose bothersome to some chemically sensitive people. If using dry or damp sprayed cellulose:

- Choose a product made of recycled cardboard; second best is newspaper.
- Fire retardant should be boron, not ammonia-based.
- Damp-applied cellulose must be allowed to fully dry to under 25 percent moisture content.

In general, avoid polyurethane-based expanding foams for indoor air quality issues. Cementious expanding and plant-based expanding foams (such as Air Krete® and BioBase 501®) are healthy options, but must be installed by an experienced local installer per manufacturer's instructions.

Similarly, avoid spray polyurethane foam (SPF), which can out-gas if not sealed by drywall or plaster, and some chemically sensitive people may react to it. Rigid foam insulation, popular in the 1980s, outgases badly and should not be used on interior applications.

Other non-toxic, high R-value solutions include cork and wool. (Check out wool batts by Good Shepherd Wool Insulation and Latitude Wool Insulation.)

Paints, Sealants, Stains

More than 10,000 synthetic chemicals are used in conventional paints, sealers, and stains; many are toxic solvents, mildewcides, and fungicides. Such chemical-overburdening is unnecessary. You can now find low- and no-VOC paints, stains, thinners, and waxes made from healthier raw materials. Choose water-based materials with a low VOC content of 150 grams per liter or less. Ventilate well during and immediately after painting or sealing. **UHD**

The Author

Linda Mason Hunter, Senior Editor of the Healthy Home Institute, is a nationally recognized expert in the fields of green living and home ecology. Her first book, *The Healthy Home: An Attic-To-Basement Guide To Toxin-Free Living* (published in 1989) remains a classic in its field. She's since written two more books about home ecology—*Green Clean* (with Mikki Halpin, 2005) and *Creating A Safe & Healthy Home* (2005). She can be reached at www.hunterink.com.