# Real and Relevant Green Building

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From Gray Areas to Green Areas: Developing Sustainable Practices in Preservation Environments, 2007, Symposium Proceedings. 

Published online: September 2008 http://www.ischool.utexas.edu/kilgarlin/gaga/proceedings.html

## GREEN BUILDING: INTEGRATING HELPFUL DESIGN PRACTICES

### Introduction

Every region should employ different "Green Building" strategies that reflect the particular region's climate, availability of materials, and traditional building practices. An igloo would make perfect sense on the north slope of Alaska, but would not be an effective green building in North Carolina. When considering difficulties of human comfort and energy efficiency for residential structures in parts of the country which rely on air-conditioning, the primary culprits are the infiltration of outside air, improper orientation, excess solar heat gain, and internal loads that produce humidity and heat.

A house is a *system*. Often, one component (such as a power attic fan) can affect another, seemingly unrelated, feature (such as mold growth under a bathroom vanity). Furthermore, buildings are built differently than they were just a quarter of a century ago. Three important aspects that have radically changed the operation of a typical, modern building are the extensive use of thermal insulation, the development of tighter building envelopes, and the popular use of over-sized, forced-air heating and cooling systems.

These items have significantly added to the comfort of our homes and buildings – yet have also made them much more susceptible to problems if not done correctly! A high performance house is like a high performance car – will need more attention and operator skill!

## INFILTRATION

One of the most effective strategies for mitigating infiltration of outside air is to install a moisture and vapor retarder on the warm (or more humid) side of the wall. The goal of the retarder is to keep humidity from infiltrating the wall cavity. In northern climates, the retarder should usually be on an inside surface, unless air-conditioning is used for a significant percentage of the year. In the southern United States, the warm or humid side of the wall is usually an outside surface of an exterior wall. Typically, when a house is air-conditioned, the walls dry out toward the interior, because the A/C system draws moisture out of the air. Spray foam insulation is particularly effective in areas where significant air-conditioning and heating loads exist, because it is a safe vapor retarder that works appropriately in the summer and in the winter. Spray polyurethane foam insulation is especially effective in reducing infiltration.

Vapor barriers (including vinyl wall coverings) should never be used on the inside surface of exterior walls in buildings where air-conditioning is used for a significant part of the year. Improperly placed vapor barriers can trap moisture in the walls, leading to serious mold problems.

Excess humidity exacerbates many of the pollutants that affect indoor air quality. Indoor relative humidity should therefore be kept below 50% RH, but above 35% RH. 30# ASTM building felt, used in conjunction with a commercial-grade building wrap that is well taped, provides an effective weather barrier system. It essentially creates a "raincoat" underneath the wall cladding to compensate for the fact that houses aren't perfect, and cracks will occur that let in elements that should be kept out of the house.

All flashing should be installed "shingle style," with upper pieces overlapping lower pieces. Improper flashing installation is a commonly seen mistake on many jobsites.

Recessed can lighting (even the so called "airtight" cans, or fluorescents) that punctures the thermal envelope of the building should be used judiciously. They are counter-productive to the ultimate goal of reducing infiltration of outside air. Likewise, unnecessary light switches and electrical boxes on exterior walls will also puncture the thermal envelope.

Only well-sealed ducts should be used to move conditioned air. Unlined return-air wall chases can be especially damaging, as are open-return air plenums above dropped ceilings, and floor joist cavities. These are all common mistakes in modern building construction.

Wet blown, borate-based wall cavity insulation is also very effective against infiltration, when used in conjunction with good air sealing practices. Cellulose from recycled cardboard and paper is a "green" material which makes good use of post-consumer recycled products. Borates are also a natural insect repellent.

Unless there is a know source of ground water under the building that cannot be controlled otherwise, a vented crawl space is likely to create more moisture and humidity problems than it solves, so these are not recommended. Ventilating an attic can cause moisture and humidity problems in areas of high humidity and lead to higher energy bills. Sealing the attic and ventilating a continuous air space immediately below the roof decking, rather than the attic, is a better solution.

**ORIENTATION**

A building's orientation is a basic element of its construction, but the critical importance of this element is often overlooked. Certain fundamental guidelines can help make orientation work to a green building's advantage. Streets in newly built subdivisions should run east-west as much as possible, so that the majority of the building lots can have either a north or south facing front and rear. Buildings can be orientated to minimize summer afternoon solar heat gain, yet allow for some winter solar heat gain, with long building sides facing north and south. (With respect to solar heat gain, heat-collecting "sunrooms" or "green houses" are not appropriate for southern climates.) Buildings can also be orientated to take advantage of prevailing breezes during the

spring, summer, and fall months. Prevailing breeze direction can be determined by looking up climatological data for a particular area on the NOAA website, or by calling the local airport.

## UNWANTED SOLAR GAIN

### Passive Cooling Strategies

As mentioned above, proper orientation should minimize exposure to the afternoon sun. Dark roofs absorb heat, and therefore require the use of a radiant barrier in the summer. Ample roof overhangs make for less building maintenance, longer lasting buildings, and happier clients, enhancing the designer and builder's reputation for responsible building. Roof overhangs should shade all the east, south, and west facing windows from the spring, summer, and fall sun. "Low E" windows are not a substitute for proper shading and solar control. A properly-sized overhang functions much more effectively.

A radiant barrier on the underside of the roof will substantially reduce heat gain through the roof, reducing A/C bills, enhancing occupant comfort, and extending the amount of time during a year that the home can be comfortable without using mechanical air-conditioning. Contrary to myths of the early 1990s, radiant barriers do not lead to the deterioration of roof shingles. Radiant barriers do, however, need to be installed in conjunction with an air space, and will not provide benefit where they are in direct contact with another building material.

Sealed attics and radiant barriers also reduce the problems associated with running A/C ducts in the attic. However, it is always best to run ducts in a conditioned or semi-conditioned space, such as ceiling fur downs, or an unvented attic.

## INTERNAL LOADS

### Lighting

New types of fluorescent lamps – especially the thin "T2", "T5", and "T8" type and the new "wide spiral" compact fluorescents – provide superior light quality in a wide range of color correctness. Fluorescents put out very little heat and last longer than incandescent and halogen lamps: approximately 70% of their energy comes out in the form of light, rather than heat. 2700K to 3000K lamps approximate the light color of traditional incandescent bulbs.

Halogen and Xenon lamps do put out more lumens per watt compared to a standard incandescent, but produce a lot of glare and heat that fight the effectiveness of air conditioning. 90% of the energy used comes out as heat, while only 10% is light. Therefore, it makes sense to use them only occasionally, as accent lighting.

Proper use of natural day lighting, especially indirect daylight from high windows, can make for substantial energy savings and an enhanced indoor environment. Clerestory windows do this well and, if operable, can be used to siphon heat out of the space below naturally in the spring and fall.

**HVAC (Heating, Ventilating, & Air Conditioning)**
Proper sizing of the air-conditioning system is critical. Over-capacity can cause mold growth within the ducts and other places within the building or house, leading to poor indoor air quality and occupant health problems. With proper windows and shading, most houses should require no more than 1 ton of cooling capacity for every 650 square feet of living area; 800 sq. ft./ton is now very attainable and should be the goal of a well designed and built residence.

Leaky ducts rob energy efficiency and are unhealthy. They are an even bigger problem than low efficiency air conditioners. Supply duct leakage can cause depressurization of a home, inviting outside air and humidity into the home from unknown and unwanted sources, leading to serious indoor air quality problems and possible mold.

Ducts with a slick interior surface, such as metal, are best for delivering clean air. Ducts lined with interior insulation, such as fiberglass duct board or lined metal ducts, attract dirt and can't be effectively cleaned, setting up conditions conducive to mold.

**Plumbing**
Water heater placement is important. Gas units should be isolated from the indoor air of the home and provided with their own source of combustion air directly from the outside. So-called "sealed combustion" units are ideal. Thoughtful placement (e.g. close to bathrooms and kitchen) can also negate the need for energy-wasting circulating pumps, and still ensure quick hot water to the points of first need in a home.

Oversized water heaters (75 gallon and larger) generally do not produce heat as efficiently as smaller ones, because they are exempt from Federal Energy Conservation guidelines. A good, high-output, 50 gallon gas unit will produce the same amount of hot water more efficiently. A simple backflow prevention valve on the water line feeding the water heater can save significant energy, and keep the cold tap water from becoming undesirably warm.

*All* water lines (even cold water lines) and those running in below the foundation should be well insulated. Uninsulated cold water lines, including A/C system condensate lines, are susceptible to condensation, setting up conditions for mold growth and inviting insects into wall and ceiling cavities. Running supply water lines overhead and utilizing the manifold and sub-manifold system of distribution will ensure quicker delivery of hot water, wasting less water and less energy. This is particularly appropriate in "sealed" attics, where the insulation is placed directly below the roof decking because of the low risk of freezing temperatures.

**Indoor Air Quality**
Chemical treatments for insects (especially termites) don't last, can lead to occupant health problems, and can pollute the underlying ground water. Sand barriers or stainless steel screen barriers in and around the foundation are an effective green solution for termite control. Although the barriers cost about 1 1/2 times the cost of standard chemical treatments, the barriers are a permanent solution, while chemicals last only about five years.) Spraying the frame of a new structure with a natural brine solution will make the entire frame insect-resistant.

Most major paint manufacturers now make low VOC (Volatile Organic Compounds) latex paints for interiors. High sheen or glossy wall paint on the interior surface of exterior walls could potentially create a vapor barrier on the wrong side of the wall, and so should be avoided.

Carpeting should be aired-out for two days before installation, by unrolling it outdoors and letting it "off-gas." In this way, the VOCs from the manufacturing process are less likely to be absorbed by other elements within the home or building interior.

High quality outside-venting exhaust fans are an effective tool in bathrooms, kitchens, and other rooms where there may be a lot of internal moisture generation. However, drawing out *too* much air can create a negative pressure in the home or building that will exacerbate the infiltration of unwanted outside air. To mitigate this danger, automatic shutoff timer switches should be installed on all exhaust fans. The electronic ones are quiet, reasonably priced, and last longer than the wind-up ones.

Keeping humidity levels low is an important part of controlling indoor air quality. Front-loading clothes washers impart less humidity into a home because they are sealed during operation.

## LANDSCAPING & WATER CONSERVATION

Excess water consumption and droughts are a serious problem, even in parts of the country where drinking water has traditionally been in abundance. A few summers ago, the Northeast had a more serious drinking water supply problem than the Southwest. Water is heavy (approximately 62 pounds per cubic foot) and is expensive to move throughout a municipal water system. The energy used to treat and distribute water is usually the single greatest consumer of electricity in a typical American city. Basic water conservation measures inside the building and on the exterior landscaping can reduce municipal water treatment energy use by thirty percent or more in most southern U.S. cities.

A thicker layer of topsoil means a lawn will require less watering during the hot summer months, conserving water during drought periods. Protecting and preserving the native trees on a building site provides shade and wind buffers, and enhances the marketability of the property.

## FINAL THOUGHTS

These suggestions are not all meant to be taken verbatim for every building situation. Many of these suggestion are particularly appropriate to the southern United States. Perhaps the most important way to mainstream green building practices is to use creativity to expand on these thoughts and come up with solutions that use *locally appropriate* strategies, materials, and methods.

## USEFUL RESOURCES AND TOOLS

### Climate Data

NOAA
(828) 271-4800
http://www.noaa.gov
http://lwf.ncdc.noaa.gov/oa/documentlibrary/clim81supp3/clim81.html

### Green Building

*Environmental Building News*
http://www.BuildingGreen.com

http://www.architecture2030.org

http://www.soloso.aia.org

### Home Rating

NAHB Model Green Home Building Guidelines
http://www.nahbrc.org

### Roof Overhang And Window Sizing

The Sun Angle Calculator is available online through Ball State University's Center for Energy Research, Education and Service
http://www.sbse.org/resources/sac/index.htm

**CLIMATIC DATA FOR SELECTED CITIES**

| City, State | Latitude [Deg.] | Heating DD | Cooling DD | Avg. Rainfall |
|---|---|---|---|---|
| Orlando, FL | 28.5 (Elev. 118) | 733 | 3226 | 55.5" |
| Austin, TX | 30 | 1760 | 2920 | 33.6" |
| Asheville, NC | 35.3 | 4250 | 850 | 47" |
| Charlotte, NC | 35 | 3200 | 1650 | 43.5 |
| Wilmington, NC | 34 | 2430 | 2015 | 57" |
| Raleigh/Durham, NC | 35.9 | 3515 | 1385 | 52" |
| Albuquerque, NM | 35.1 (Elev. 4094) | 4281 | 1290 | 9.5" |

**WOOD CONSUMPTION EVALUATOR** - Board feet consumed per square foot

SIZE SPACING Note: Board feet calculation based on actual dimensions

| | 12" o.c. | 16" o.c. | 19.2" o.c. | 24" o.c. |
|---|---|---|---|---|
| **2x4** | 0.4375 | 0.3281 | 0.2734 | 0.2188 |
| **2x6** | 0.6875 | 0.5156 | 0.4297 | 0.3438 |
| **2x8** | 0.9063 | 0.6797 | 0.5864 | 0.4531 |
| **2x10** | 1.1583 | 0.8672 | 0.7227 | 0.5781 |
| **2x12** | 1.4063 | 1.0547 | 0.8789 | 0.7031 |