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GREEN BUILDING: Designing for energy efficiency

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SPECIAL TO THE CITIZEN-TIMES
September 24, 2006 12:15 am

Energy considerations in home design have come full circle. We started building, centuries ago, with a strong awareness of the climate. The Anasazi Indians of the American Southwest carefully placed their dwellings under large cliff overhangs to get the benefits of full summer shade and winter sun. Heavy adobe walls soaked up the heat like a thermal sponge, providing natural heating and cooling. Southerners built their homes long and thin with all the rooms opening to shady covered porches, maximizing cross ventilation.

We lost our awareness of and respect for the environment with the development of central heat and air conditioning combined with cheap energy. That approach continued until 1973, when a previously unheard of organization called OPEC invented the oil embargo. The long gas lines and uncontrolled oil prices of the first energy crisis forced us to re-evaluate how we lived and worked.

Research and testing during the last 30 years has proved what our ancestors knew intuitively. We have looked to the past, updating climate-sensitive design principles that have been around for centuries. These principles are based on the movement or flow of heat. Energy-efficient construction is nothing more than understanding and controlling this heat flow.

Heat is a form of energy, which moves naturally, in one of three ways:

• Radiation — the movement of heat between two objects separated by a space. The best example is the sun as it radiates energy to the Earth, which we see as light and feel as heat. A hot fireplace or wood stove warms your cold feet by radiation. Radiant heat always moves from hot to cold.

• Conduction — The movement of heat between two objects in contact with each other. If you touch that hot wood stove, conduction burns you. Heat is conducted from your hot stove burner to a cool frying pan. Heat is conducted through the walls of your home, always moving from warmer to colder.

• Convection — The movement of heat through air by gravity. When air is warmed, it expands, becomes lighter and rises. It is replaced by cooler air. As the rising air cools, it begins to fall. This rising and falling is called natural convection.

When building a new home, we can use a variety of design and construction techniques to manipulate these natural heat movements, restricting some and promoting others depending on the season.

The first step toward an energy-efficient home is conservation, or reducing the amount of heating or cooling you need. During winter, heat wants to flow out by conduction through the walls, ceiling and roof of your house.

The rate or speed of this movement depends on two things. First, the conductivity of the material or how much it resists this flow. Insulation materials have a low conductivity or high resistance (R-value). Look carefully at

the quality of the product. Equal R-value does not mean equal performance. Some products decrease in value with time and moisture content. The blown-in cellulose products perform better than fiberglass with equal R-value because they fill the cavity and do not settle, reducing air infiltration. It is also one of the best uses of recycled newspapers.

The second factor effecting flow rate is the temperature difference between inside and out. The higher the difference, the faster the flow. Lowering this difference, without sacrificing comfort, is an obvious start.

Thermal storage is the property of a material to absorb and store heat. This thermal capacity is a benefit in summer as well, working like those heavy adobe walls of the Anasazi. Cooler night air allowed into the house will draw heat out of the heavy materials. During the day the process reverses because heat flows from the warmer air to the cooler mass.

In many climates, this thermal flywheel will keep the house cooler than the outside air if you keep the windows shut during the day. Using paddle fans to enhance natural convection will increase the rate of heat transfer from air to mass.

In winter, when you say, “My house feels drafty,” you are actually experiencing a combination of heat movements. First, many homes are built with high vaulted ceilings and tall windows in the gable end. “Drafts” are caused by natural convection as the warmer air on the high ceiling contacts the cold glass, loses heat and begins to fall, increasing in velocity as it passes over the tall windows.

You can reduce this effect by keeping the glass as warm as possible by using high efficiency windows, and insulated window coverings like pleated shades. The other contributor to drafts is air infiltration, which can account for up to 40 percent of your heating bill. In most cases air doesn’t actually blow into your house. Instead, it is sucked out. When wind blows over and around your house, it creates a low-pressure area on the opposite side. This negative pressure pulls or sucks the air out through cracks in the construction. Outside air is pulled in through other cracks to replace it. This negative pressure is why sailboats are actually pulled rather than pushed by the wind.

Midwest farmers long ago proved the benefits of tree and fence windbreaks. Careful use of modern sealants at window and door openings, and pipe and wire penetrations, is time and money very well spent. In summer, these convection currents and negative pressure can be beneficial, inducing strong airflow through a house when high and low windows are opened.

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