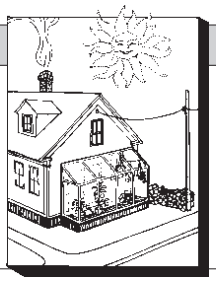


Taming Natural Convection

by Alex Wilson

How to move heat from one place to another is a major issue in building design. Usually the heat is transferred in a fluid such as water through pipes or air through ducts from a central heating system to the rooms where needed. In passive-solar houses, however, heat distribution occurs naturally via conduction, radiation, and natural convection.

Recently, this last mechanism of heat transfer—convection—has been studied intensively by researchers. By better understanding natural airflow, researchers such as Dr. J. Douglas Balcomb of Los Alamos National Laboratories have been able to offer valuable design tips that can improve heat distribution and comfort in passive-solar buildings. Some of these ideas can even be applied to non-solar houses.

Convective Airflow

Convection is the transfer of heat from one location to another through the movement of air. It is a natural process, driven by temperature differences and the buoyancy of warm air. Warm air rises and displaces cooler air, which falls, forming a "convective loop." Natural convection helps distribute warm air throughout a room in forced-hot-air heating systems, but is rarely used to transfer heat from one room to another in conventional houses.

Natural convection is useful when there is a low-cost heat source in one part of the house and we want to distribute the heat to other parts. Sunspaces and rooms heated by direct solar gain come to mind first, but woodstoves also can make good use of natural convection for heat distribution. Natural convection allows woodstove heat to warm adjoining rooms.

Open Doors

Based on several years of study, researchers have concluded that standard doors are ideal for distributing heat and controlling convective airflow. Until recently, many solar designers spent much time and effort trying to correctly size and place vents for passive airflow, but it just wasn't working well.

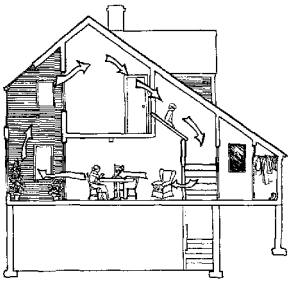
Vents usually are not needed. Doorways, it turns out, are just about right for the slow movement of large air masses required in natural heat distribution. Plus, doors can easily be opened and closed, providing a simple and effective means of control.

Designing for Natural Airflow

To successfully distribute heat by natural convection, you must roughly follow several simple guidelines. Most of these relate to passive-solar spaces, but the concepts apply to heating with woodstoves as well.

1. **Plan the room layout carefully** so that the rooms requiring the most daytime heat are closest to the solar-heated space. These might include living rooms, dining rooms, kitchens, dens, home offices, and breakfast nooks. Bedrooms, baths, and storage and utility areas do not need as much daytime heat, so linking them with solar spaces is less important.

2. **Situate solar-heated spaces lower than other living areas,** if possible. It helps natural airflow if solar-heated spaces, including direct-gain rooms and sunspaces, are a few steps lower than adjacent rooms.



Natural convection moves heat well if a house design leaves a wide-open loop for heat flow. In this modified Cape by Acorn Structures (Concord, Mass.), the north stairwell connects the sunspace loop.

Warm air rises, so providing an elevation change will help it along.

3. **Provide doorways or full-height openings to solar-heated spaces.** Doorways provide an excellent way for warm air to move from one room to another, driven by a difference in temperature. In a doorway between a warm and a cool room, the airflow is fastest at the top (warm air) and the bottom (cooler return air), with the air speed dropping to zero halfway up the doorway.

This same principle can be used to heat a small room, such as a bathroom, with warm air from the adjoining room. In very tight and well-insulated houses, you may not need to install heating elements in all small rooms and alcoves. You can rely on natural convection instead.

4. **Avoid high cathedral ceilings,** which can trap warm air in solar-heated spaces. You want the warm air in the solar-heated space to spill into the adjacent rooms. If you are relying on doorways for air movement, try to keep the distance between the top of the door and the ceiling to a minimum.

5. If possible, **use a two-story sunspace with an upper balcony and sliding glass doors.** This will allow warm air to flow into the upper rooms of the house and form a loop with air returning to the sunspace through doors on the first floor. This basic design has proved effective in several house models (see illustration) offered by Acorn Structures of Concord, Mass. Acorn's Mark Kelley recommends extending the convective loop as far back into the house as possible, but having the loop controllable through the opening and closing of doors.

6. **Keep doorways, halls, and stairways used for airflow uncluttered.** Furniture and other objects can severely disrupt airflow and reduce the heat distribution. ■

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