

1983

## EC83-405 Interior Design; The Energy Angle

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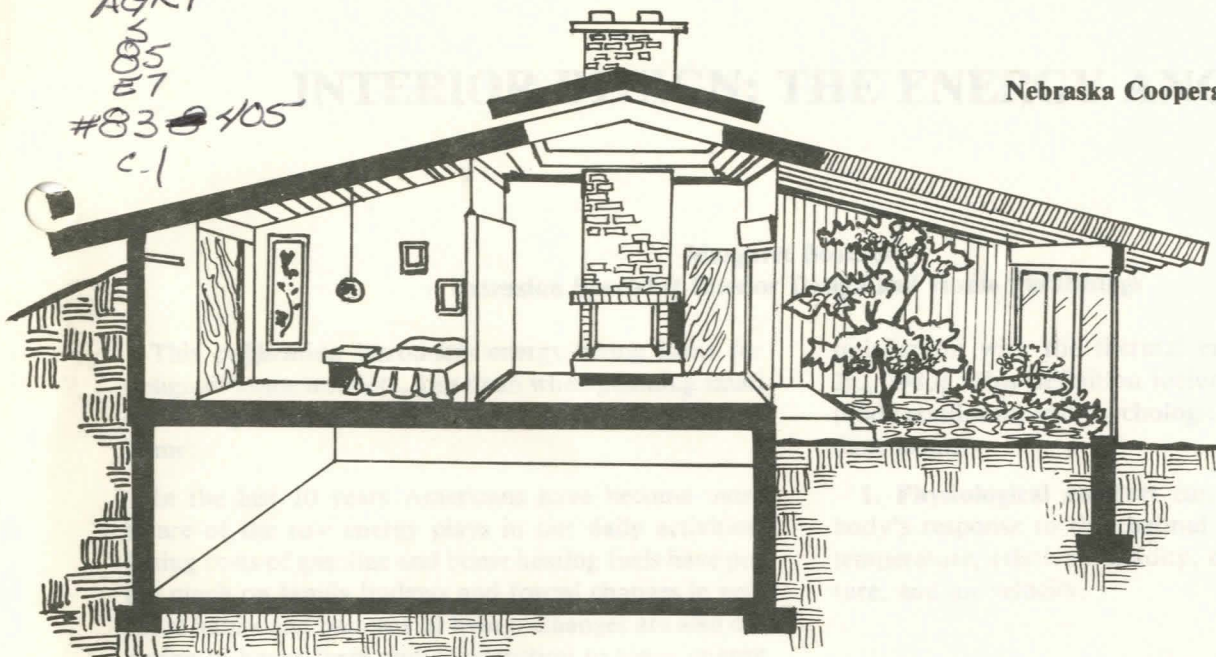
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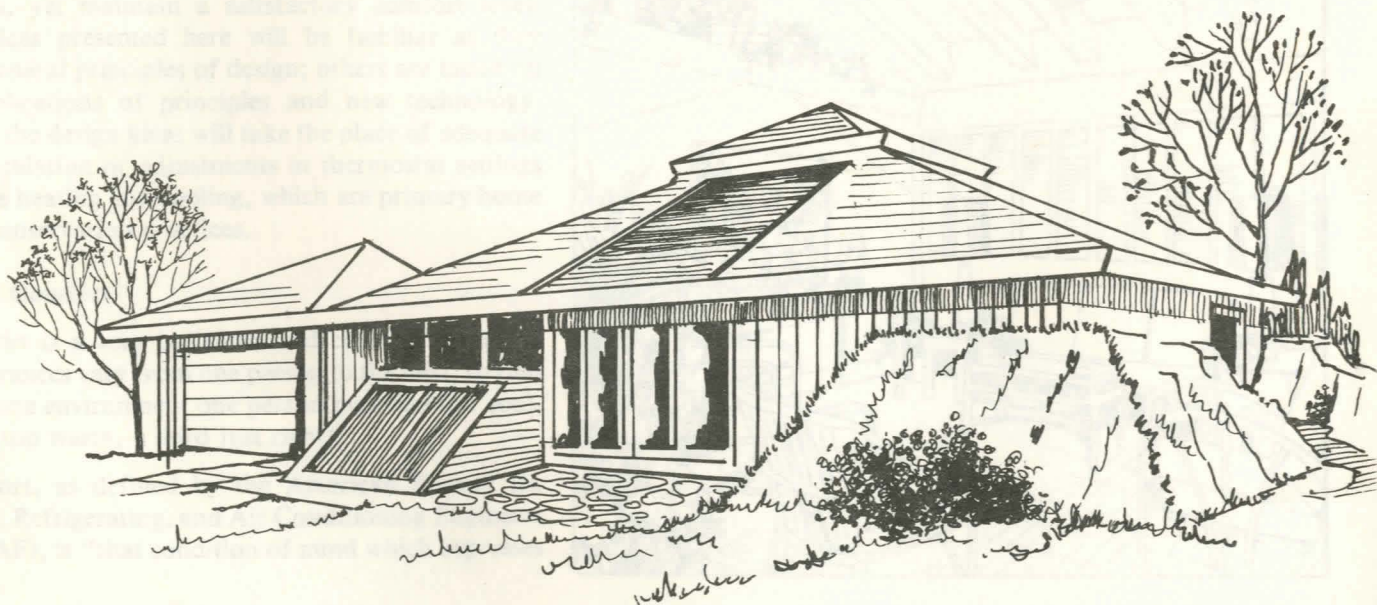
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EC 83-405



# INTERIOR DESIGN; THE ENERGY ANGLE



Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Leo E. Lucas, Director of Cooperative Extension Service, University of Nebraska, Institute of Agriculture and Natural Resources.



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# INTERIOR DESIGN; THE ENERGY ANGLE

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This publication introduces energy-saving ideas for design of home interiors. Use them when planning small home improvements, remodeling, or building a new home.

In the last 10 years Americans have become more aware of the role energy plays in our daily activities. Rising costs of gasoline and home heating fuels have put the pinch on family budgets and forced changes in personal habits and patterns of living. Changes are also occurring in house form and construction to lower energy use and adapt to alternative fuels, especially wood and solar.

House *structure* defines the interior space—size, volume, shape, and orientation. *Materials* used in building the house become an integral part of the interior design. Therefore, anything that influences the way houses are built, and the kinds of materials used in finishing the structure, has a bearing on the interior design. Wise energy management is causing subtle changes in design of home interiors, especially in the choice of materials, colors, textures, wall and floor coverings, window treatments, and lighting, as well as style and arrangement of furnishings.

Energy is the new element in interior design! The goal of an energy-effective interior is to increase energy conservation, yet maintain a satisfactory comfort level. Many ideas presented here will be familiar as they follow general principles of design; others are based on new applications of principles and new technology. None of the design ideas will take the place of adequate house insulation or adjustments in thermostat settings for home heating and cooling, which are primary home energy conservation practices.

## Thermal Comfort

Comfort is a very individualized concept: temperature tolerances vary from one person to the next, so that in the same environment one person may feel too cool, another too warm, a third just right!

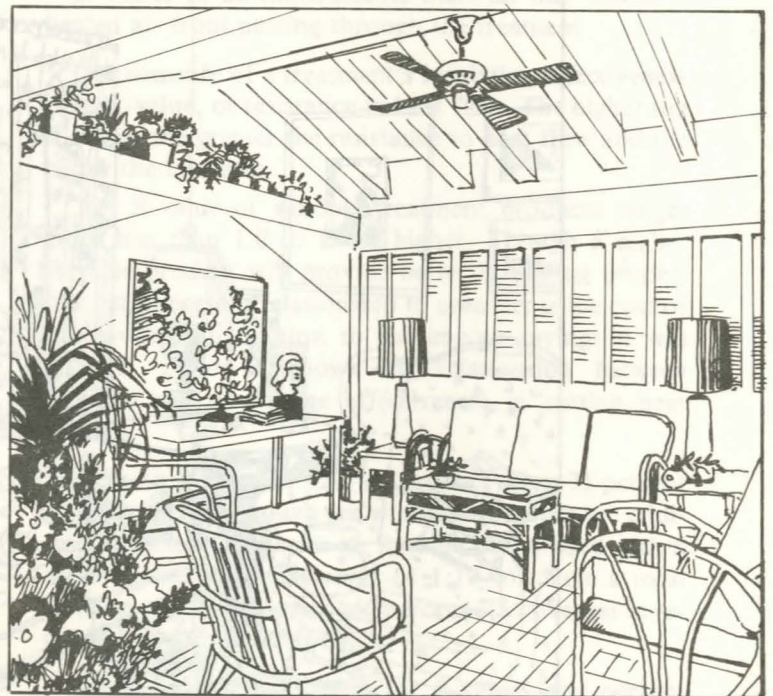
Comfort, as defined by the American Society for Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), is "that condition of mind which expresses

satisfaction with the thermal environment" (Rohles, Jr., 1980). This definition includes both physiological (body condition) and psychological (condition of mind) dimensions.

**1. Physiological comfort** can be measured by the body's response to the thermal environment, i.e., air temperature, relative humidity, mean radiant temperature, and air velocity.

**2. Psychological comfort** refers to how a person feels based upon a response to non-thermal elements of the environment, such as color, texture and room furnishings.

Both physiological and psychological comfort conditions can be influenced by furnishings and room design. For example, furnishings may be selected for their insulating or cooling capacity in helping to retain or lose body heat and maintain room temperature; while colors, textures and patterns are chosen to create a warm or cool atmosphere.





Manipulating the non-thermal elements, such as colors, furnishings, and lighting to influence comfort is called *psychological decorating*. Research shows that by varying the decor in a room, without changing thermal elements, a warm or cool feeling can be determined (Rohles and Wells, 1976). Design elements that can increase a feeling of warmth include: wood paneling, warm colors, carpeted floor, fabric window treatments, plush fabrics, pattern, and incandescent lighting.

Spare decorating creates a cooling effect: white walls, neutral or cool colors, minimum of pattern or accessories, bare floor, uncovered windows and nonupholstered furniture such as wood, metal, or glass.

Color affects emotions more than any other single design element. Color affects our feelings of temperature by association. For example, colors that contain red or yellow remind us of warm things, like candlelight, fire, sunshine, or burning coals. These colors can be used to "cheer up" or "warm up" rooms exposed to cool northern light. Colors that contain blue remind us of cool things, like water, sky, or ice. These colors can "cool down" rooms exposed to sunny warmth of southern and western exposures.

Knowledge of the thermal effect of furnishings and design elements can be used to enhance human comfort, both psychological and physiological, in energy conscious households. A return to seasonal changes in

room design is currently indicated by fashion trends reflecting these thermal comfort principles.

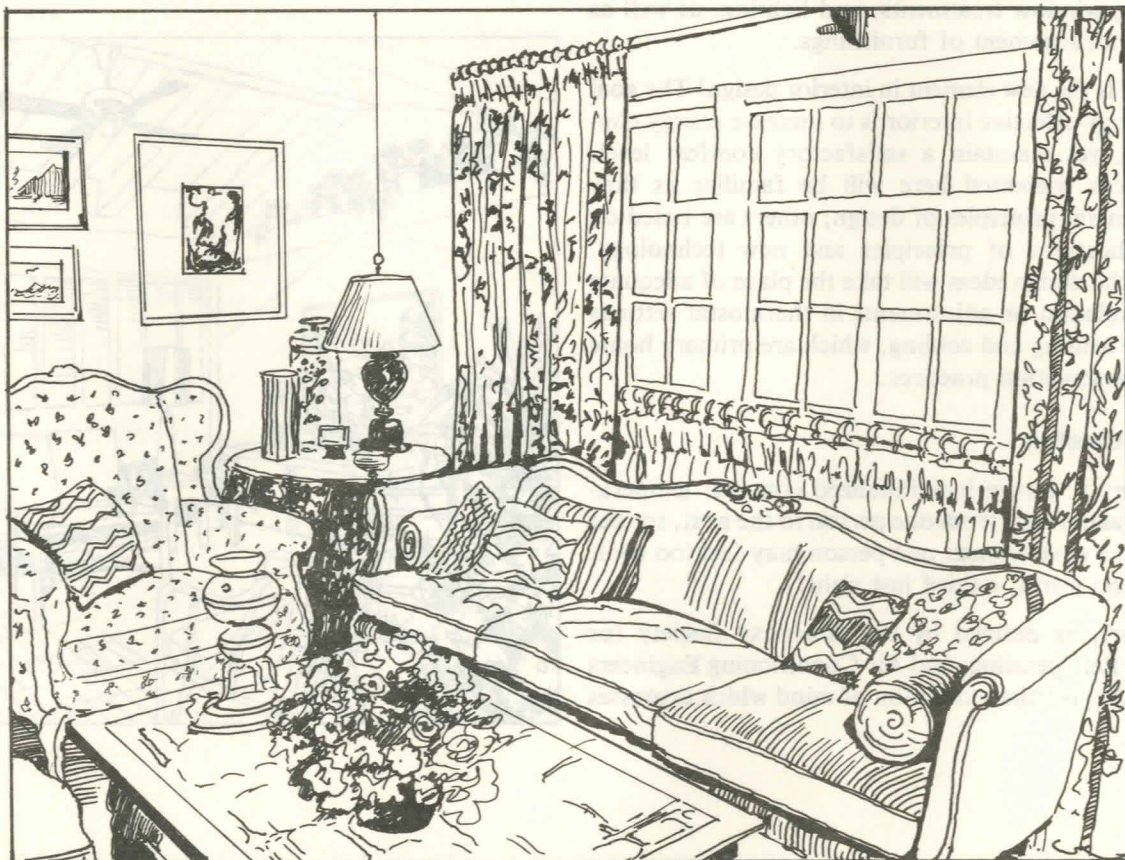
### Design Techniques for Existing Housing

Extensive changes in the house need not be made to take advantage of energy conscious interior design techniques. The following ideas include design practices that will improve your comfort and, in some cases, help lower home energy consumption.

### Furnishings

Some furnishings improve individual comfort in winter by helping to retain body heat. The wing-back chair was designed to reduce drafts, and some models with generous styling still provide this function. Sofas and chairs with enclosed styling, such as high back and arms, are cozier than models with open arms and backs. Plush and/or napped upholstery fabrics are warmer than leather or vinyl for sitting, because their structure enables them to trap air which acts as an insulator. Similarly, pillows, afghans, comforters and wooly throws increase body warmth when sitting immobile while reading, watching television, or visiting. These accessories also "warm-up" furniture made of leather, plastic, or metal.

Fabrics which enhance body warmth are ideal for upholstered furniture in winter, but when summer comes





they can be the cause of discomfort. Slip covers are making a reappearance as a way to bring seasonal comfort to upholstered furniture. Smooth, non-textured, lighter weight fabrics in cotton and cotton-blends provide maximum cooling comfort in warm temperatures. Metal and wood furniture also have a thermal advantage in summer months by remaining cool to the touch. Vinyl fabrics are uncomfortably warm in summer unless they have tiny pores for "breathing".

Furnishings may also be used to insulate the room. Book cases and/or storage wall units on an outside wall add significant insulating properties. Fabric-draped walls will add insulation and create a feeling of psychological warmth, as well. New developments in wall coverings include a foil-backed wallpaper that is claimed to reduce heat loss by 11% to 19%. Wall paneling can also add to a room's interior warmth.<sup>1/</sup> Paneling and paper are not indicated as a substitute for regular wall insulation, however.

Folding screens can help eliminate or reduce drafts around windows or seating arrangements. Foot stools keep feet off drafty floors and, therefore, warmer. Draped doorways keep room heat from spilling into hallways and little used rooms if no door is available to close them off entirely.

Increasing use of fabrics in a room decor may add to both psychological and physiological warmth. Draped, or built-in beds are making a reappearance as they eliminate cold drafts, allowing night time thermostat-settings to be lowered. Upholstered bed headboards and dust ruffles for the bed, skirted tables, and slipcovered side chairs (dining, or folding models) add to a cozy atmosphere. Consider the cost for installing and maintaining fabrics, as well as the kind of use they will receive when selecting fabric treatments.

Furniture arrangements around a central source of heat, such as a fireplace, wood stove, or chimney wall, take advantage of radiant warmth. Avoid placing large pieces of furniture in front of or on top of heating vents because this can retard heat flow and circulation in the room.

Locate furnishings for passive activities such as reading, studying, TV, or conversation near sources of heat and away from windows and cold outside walls during winter months. Furnishings for active functions like eating, working, or recreation may be located away from direct heat sources.

### Floor Coverings

In addition to the psychological advantages of carpet in affecting perceived room temperature, carpeting can be an effective insulator against heat loss in winter, or heat gain in summer. Wall-to-wall installations are

recommended for greatest advantage. According to tests results<sup>2/</sup>, density of face fibers and combined thickness of carpet plus padding have a direct relation to insulative value. The more dense the fibers, and the thicker the carpet padding, the greater the insulating effect. Fiber content and yarn type do not appear to be significant variables. If the floor is otherwise uninsulated, carpeting can contribute to significant savings on home heating and cooling costs. Cost savings would vary according to geographic location, size and shape of house, local fuel rates, seasonal degree days and type of carpet and underlayment.

### Window Treatments

Estimates vary as to the amount of household heat that can be lost through uncovered windows but there is general consensus that it could be as much as 20% to 50%. Because glass is a poor insulator, uncovered windows are a source of heat loss in winter and heat gain in summer. Interior window treatments can help.

Many new products designed to lower household heat loss are on the market. These products vary in style, installation, maintenance, cost and effectiveness. To significantly reduce heat loss through windows, an interior treatment should be:

1. An air-tight installation which will stop air infiltration and cut convective heat loss that occurs when heated air flows around and behind the treatment when closed.
2. Made of an impermeable material that will stop heated air from passing through the treatment.

One measure of a treatment's insulating effectiveness is its R-value, or resistance to heat flow. The higher the R-value, the greater the resistance to heat flow and the better the insulator.

The R-value of window treatment products ranges from less than 1.0 to 15 or higher. Though a higher R-value product will provide better insulating properties, an important relationship to consider is the cost of the product in relation to the energy savings it will achieve. Figure 1 shows the relationship between R-value and percentage effectiveness in cutting heat loss.

With an R-value of 4.0, the product stops 75 percent of the heat lost through the window. R-values are additive. A roller shade with an R-value of 1.5 used with a drapery that has an R-value of 1.19 will have a total R-value of 2.7, with about 60 percent effectiveness in reducing conductive heat loss.

Watch advertising claims for R-values and percent savings. Unlike household insulation, which must be tested under standard conditions, mandatory test stan-

<sup>1/</sup> For more information, see HEG 77-72 Paneling and Exterior Materials for Inside Walls.

<sup>2/</sup> Carpet and Rug Institute, 1977; Haynes, 1969



dards for window treatments do not exist. A window treatment's R-value may be based on manufacturer's estimates, or on actual laboratory testing. Ask how the R-value was determined. You cannot compare window treatment products on R-value unless equivalent test procedures were used.

Claims for percent savings can also be tricky, because they will vary according to the number of hours per day the treatment is closed, and the kind of glass (single, double, triple) the treatment covers, as well as the product's R-value. Percent savings refer to heat loss through treated windows, *not* total home heating.

With more window treatment products being developed with energy-savings in mind, the consumer will have increased options without having to sacrifice aesthetics. Among the new products, inside storm windows are expected to increase in popularity because they can be permanent installations. They do not reduce visibility, and they do not have to be opened and closed throughout the day. For additional information on energy efficient window treatments, see EC 80-2052 "Managing Window Treatments for Energy Efficiency."

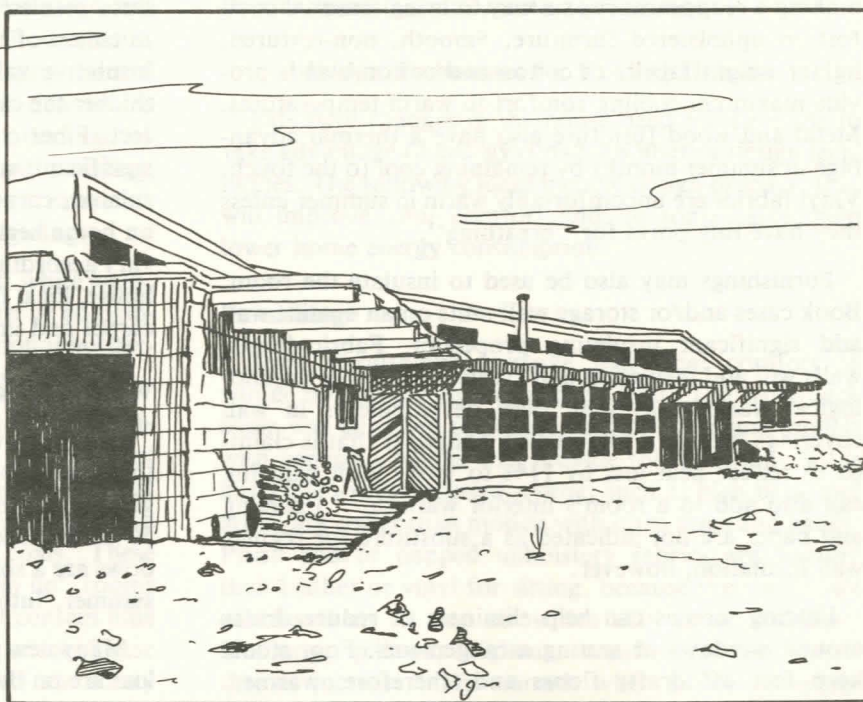
### Lighting

The key to conserving energy for home lighting is to use what you need—but not more than you need. One way to accomplish this is by using daylight as much as possible. Place furniture such as desks, work surfaces, or chairs near a window (not facing the window) so that light falls across the work or reading surface. On bright or sunny days use natural instead of artificial light for general lighting purposes. A white wall facing a window will maximize reflection of daylight; so will mirrors.

Skylights and clerestory windows will distribute daylight to interior walls and surfaces, but do require night time coverings.

The reflectance factor of interior surfaces affects both the amount and quality of light in a room. Smooth, shiny surfaces reflect the most light but can cause glare which is uncomfortable and can reduce seeing effectiveness. Matte (flat) finishes will reflect almost as much light as a glossy finish, but the light rays will be diffused and glare eliminated. Walls adjacent to windows and opposite window-walls should have a matte finish to alleviate the potential for glare. Table 1 shows desirable reflectance values for various room surfaces.

The color of interior surfaces and furnishings can dramatically affect the efficiency of a room lighting



system. Table 2 gives typical reflection values for different colors.

White or light-colored walls, ceilings, floors, draperies and furniture give optimum reflectance and can increase lighting efficiency 15 to 20 percent. Lamp shades with white liners also increase light reflectance. White or very light colored, translucent shades give maximum light to a room.

Light quality is another factor to consider in planning lighting for home interiors. Incandescent bulbs are less energy-efficient than fluorescent tubes. Most of the energy consumed by an incandescent bulb is given off as heat rather than light. However, the quality of incandescent light is often preferred. Incandescent lamps create highlights and shadows which add depth and warmth to the room atmosphere.

Fluorescent tubes waste less energy in the form of heat, so they give more light per watt than incandescent bulbs. Fluorescent ring tubes that adapt to incandescent fixtures are now available in lighting stores. A 22-watt fluorescent ring will provide as much light as a 75-watt incandescent bulb, offering a considerable energy savings. Though the cost is rather high, the adapter has a life of about 50,000 hours. Fluorescent tubes give a high-level, diffuse light that, used alone, could give a flat, dull appearance. When using fluorescent lighting in areas where color is especially important, *deluxe* tubes are recommended, even though they are less efficient than standard fluorescent tubes, and are more difficult to find.

Some combination of fluorescent and incandescent lighting would provide a pleasant yet efficient lighting



environment. For example, select fluorescent lamps for long-term, shadow-free use in work areas, and softer, warmer incandescent light sources for general lighting in family-, living- and bedrooms.

For additional information on energy and home lighting see HEG 83-174 "On The Light Side - Incandescent and Fluorescent".

### **Passive Solar Interiors**

Passive solar housing emphasizes the relationship between climate, comfort, and the thermal characteristics of the building and materials in its design. This functional approach to design has a major effect on the design of the home's interior: color, lighting, fabrics and surface textures are selected for thermal as well as aesthetic functions. In addition to the design and furnishing guides already covered for increasing comfort while reducing energy consumption in existing housing, passive solar housing presents some particular challenges to the interior designer. The ratio of window area to floor space in rooms with southern exposure is much higher than for conventional housing, so factors such as glare, insulative window coverings, sun resistance of textiles, and thermal mass properties of materials take on added importance.

There is a State tax benefit in Nebraska for passive solar systems built between January 1, 1982 and December 31, 1986. The tax benefit is 30% of the total investment not to exceed \$3,000. The credits decline 5% annually, so earlier installations are eligible for higher credits. Some window coverings and flooring materials meet the requirements for the tax benefit. For specific information contact the Nebraska Energy Office, or the Nebraska Department of Revenue.

### **Window Coverings**

Insulative window coverings can cut heat losses during long, cold winter nights. Inside storm windows, insulated shutters or panels, and/or tightly fitted shades and draperies are recommended treatments. It is important that these coverings be installed so they do not interfere with solar gain during the day. Roof overhang, exterior shutters, awnings, trellises, and deciduous shade trees along the southern facade of the house are possible alternatives for controlling sun gain during hot summer months.

### **Textiles**

In passive solar interiors, sun resistant textiles are necessary. Excessive exposure to the sun's rays can cause fading and strength loss in interior fabrics. All fibers, except glass and saran, have some degree of sensitivity to sunlight. Linen, acrylic, modacrylic and polyester fibers have very good sun resistance. But silk, nylon and most delustered acetates and rayons are weakened by lengthy exposure to sunlight.

Most reputable fiber and fabric producers select durable dye and fiber combinations, but problems can occur when fabrics manufactured for other uses are chosen for interior furnishings. Aesthetics and cost also play a part in production of interior fabrics, so not all products are equally suitable for use in high-sun areas. New fiber/fabric products with higher tolerances for sunlight are beginning to appear on the market. Another way to counter the potential for fading is to select light and greyed colors or neutrals for furnishings that will receive maximum solar exposure. These choices will not show fading as quickly as dark, or bright colored fabrics.

The thermal properties of textiles have importance when selecting energy conserving fabrics for use in home interiors. Textile products which trap air are good insulators, good for increasing warmth; while those which encourage air flow are effective ventilators, good for promoting cooling. Fibers and fabrics that are warm to the touch, especially wools and napped or plush textures, will enhance body warmth when used as furniture upholstery. These fabrics, along with firm, tightly woven, or quilted products, also make good window insulators.

Reflective fabrics, and metalized fabrics also contribute to heat conservation. When used in window treatments facing the window they help keep out unwanted summer heat; or when faced toward the room they reflect household heat back inside the room. Effectiveness is reduced when used as an inner lining because an air space is needed on the reflective side.

### **Thermal Mass**

The ability of a material to absorb sunlight is affected by its color. Medium or dark colors enhance the thermal storage properties of materials, and help reduce glare as well. Walls that do not receive direct sunlight may be lighter in color to maximize their light reflectance as well as balance out the darker surfaces. Tables 3 & 4 provide a comparison of the effectiveness of various colors and materials to absorb heat from the sun.

Interior spaces designed for direct gain of the sun's head may be more sparsely furnished, treated somewhat like a porch, with chairs for lounging and tables for breakfast or snacking. During mid-day these rooms can become very warm and must be opened to other parts of the home to distribute the heat.

### **Summary**

Take a good look at your surroundings. Can you increase your sense of comfort by making some minor changes in furniture placement? Would painting the walls a different color bring a more warm and intimate feeling to the room? Should you add additional or different light sources, or simply relocate a lamp for more



energy-efficient illumination? If you acquire slip-covers or added pillows and an afghan to the sofa would the room seem lighter, or brighter, feel warmer or cooler?

Whether you are planning a major redecoration or just looking for simple ways to cut energy costs, take the time to think how design elements can affect your sense of comfort and the amount of energy consumed. When you do, you will be incorporating the "new angle" in interior design—the energy angle!

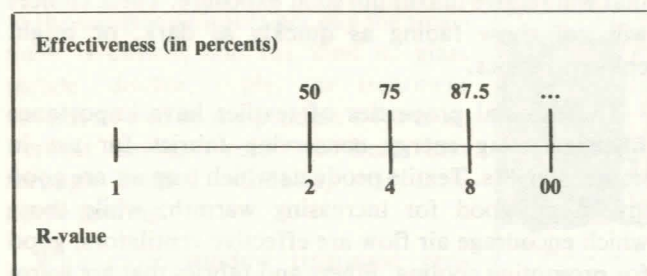


Figure 1. Relationship between R-value and percent effectiveness in reducing heat transfer. Source: Cuckierski, Gwen, "Insulating Windows: The Inside Story". Information Bulletin 172, Cornell University, February, 1981, p. 7.

Table 1. Suggested reflectance values for home interior surfaces.<sup>a/</sup>

Surface	Reflectance value
Ceiling	60 to 90 percent
Walls	35 to 60 percent
Walls with windows	70 to 80 percent
Floor	15 to 35 percent
Desk	25 to 50 percent

<sup>a/</sup> Recommendations are guides only. Personal taste, individual preference, room location, characteristics, and use also must be considered. Source: Illuminating Engineering Society.

Table 2. Reflectance values of colors.<sup>a/</sup>

Color	Reflection value
White	80 to 90 percent
Pastel yellow	80 percent
Pastel beige, lilac, rose	70 percent
Pastel blue, green	60 to 70 percent
Dark yellow	55 to 60 percent
Medium brown	25 to 30 percent
Medium blue, green	40 percent
Black	10 percent

<sup>a/</sup> Reflectance values are averages of reflectance to incandescent and to cool-white fluorescent lamps. Source: General Electric Company.

Table 3. Color and solar heat absorption.

Color	Percent absorption
white, smooth surfaces	25 to 40 percent
grey to dark grey	40 to 50 percent
green, red, brown	50 to 70 percent
dark brown, blue	70 to 80 percent
dark blue, black	80 to 90 percent

Source: American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

Table 4. Solar heat storing capacity of selected materials.

Material	Percent storage capacity
Brick, glazed white	26%
Brick, common red	68%
Marble, white	44%
Marble, dark	66%
Granite	55%
Slate, blue grey	87%
Concrete	65%
Water	62%

Source: American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

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