put in enough mass to prevent solar overheating, piling a few tons of brick in the living room won't reduce heating bills any further. It can even be a liability if night setbacks are planned. So it becomes the designer's job to decide on the right amount of mass.

Balcomb's simplest rule of thumb is that a direct-gain space should have a heavy mass surface six or seven times the area of the south glass, or 15 times for drywall construction. This is for mass in the direct-gain space. This so-called *radiatively coupled* mass is any mass in the line of sight of the mass where the sun first strikes.

The thicker the better. Insightful passive solar designers recognized early on that only the first 3 or 4 inches of thermal mass did any good. Nonetheless, many designs still feature huge fireplaces or accent walls as the home's mass.

The current thinking is that, pound for pound, thin mass works better than thick mass. The reason, says Balcomb, is simply that heat moves into and out of thin mass more readily. There's more surface area.

Thickening the mass, though, is still an effective strategy up to a point. A dense material like concrete performs better up to about 4 inches. A not-so-dense material like drywall probably levels off at a couple of inches. So doubling the drywall or plaster thickness is a good way to gain mass. It tends to double the thermal benefit of the drywall. This thin-mass approach is winning converts, such as California architect David Wright, who has been using an extra-thick finish of high-density plaster.

It's got to be in direct sun. Early texts said that thermal mass had to be in direct sun. Studies have shown, says Balcomb, that mass is about 30-percent more effective in direct sun than in reflected sunlight. But it's still more important, he adds, to spread the mass around the space.

How about convectively coupled mass—materials in rooms not exposed to solar gains, but heated by airflow? Heavy mass that is convectively coupled, says Balcomb, is about one quarter as effective as mass in south-facing rooms. But thin mass, such as drywall or plaster up to about an inch thick, is equally effective whether it's convectively or radiatively coupled.

Within a south-facing room, the floor and the back wall are good mass locations. But the ceiling, too, is an excellent spot that is often overlooked. The ceiling gets reflected light and reradiated heat off the floor and walls.

The darker the better. This is another area where the solar gospel has been updated. Early solar designers called for dark massive materials.

Current thinking, says Balcomb, is that only floors should be dark. The object here is to keep heat close to the floor to counteract stratification. Walls and ceilings, he says, should be light-colored to bounce the light around and get maximum use of a broad surface area of mass.

Another reason for light-colored walls and ceilings is their daylighting value, particularly with clerestories. Dark colors placed against bright spaces cause uncomfortable contrast glare and bring less light into the house's interior.

Mass for cooling

Mass can store coolness. This is helpful when coolness can be obtained for little or nothing during part of the day, and