Passive Solar Design

We are no experts and our approach to passive solar design has always been rather simplistic - no complicated calculations, equations or diagrams involved! We've just looked at a few basic principles and ideas and applied what made most sense (or what was easiest to do) to our own situation. This approach has been hugely beneficial to us, improving our comfort levels in both winter and summer. There have always been a few principles of passive solar design that we've been unable to incorporate, we don't worry about those, just use what we can and reap the benefits!

If you are wanting to use calculations or be more exact and scientific than we are, then you may find this a useful tool for calculating sun angles, overhangs, etc.

We live in an area (Latitude. 46.984841704°, Longitude. -64.062622415°) where heating is most definitely needed during the winter. It can be very expensive and difficult to heat a home here. Even if lucky enough to have access to firewood (as we do) it's still hard work to fell, chop and move it, so it's prudent to reduce the need as much as possible. Taking advantage of free light and heat from the sun is something we've done for many years, and so a passive solar design would always be something we would strive to achieve. The more direct sunlight we can use to heat our home, the less we will have to rely on other forms of heat. Once the design is implemented, no further work is ever required in harvesting the free heat and light!

At the same time it can be somewhat uncomfortably hot during the summer. Living close to the ocean we are able to take advantage of cooling sea breezes, but a few modifications to the overall design and insulation can make the all the difference and avoid a few sleepless nights due to the heat.

In creating our passive solar design, we've found the old 1979 "The Passive Solar Energy Book" by Edward Mazria particularly helpful, especially his 'Design Patterns' which fall under the following headings. The first 6 design patterns described by Mazria are related to the overall shape of the building and its position on the site.

We were not in the position of being able to build a new home, so needed to look for a home that would be easy enough to 'retrofit' for passive solar design and energy efficiency. Because of this, we were never going to be able to achieve the 'perfect' passive solar design, yet we knew from our previous experiences in a 140-year old farmhouse, that even achieving partial passive solar design would bring about great results.

So the first 3 design patterns were at the back of our minds when we were looking for a property, i.e. we wanted an existing building that more or less met the first 3 criteria. At Red Sand Cottage we found a house which seemed to tick all the boxes. That left the latter 3 criteria for us to fulfil ourselves, hence all the knocking down of walls, adding windows and re-arranging the internal spaces!

The site we eventually selected is a 25-acre site approx 300' wide and long in a North/South Direction. The bungalow is situated towards the north end in a cleared, sunny area. The remaining area is wooded.

Here is another useful primer on passive solar

Red Sand Cottage – Passive Solar Design

1. Building Location

We need to take advange of the winter sun between 9am - 3pm so we need to be positioned so as to 'collect' that sunshine. Mazria recommends finding an open, sunny area of the site which is not blocked from exposure to the low winter sun during those hours. Further, the building should be placed in the Northern portion of this sunny area.

When we came to view the property, we realised that this is where the bungalow was situated on the site, to the North of an open, sunny area, and why we felt it would be a good fit for a passive solar retrofit.

2. Building Shape and Orientation

Edward Mazria recommends that “a building elongated along the east-west axis will expose more surface area to the south during the winter for the collection of solar radiation. This is the most efficient shape in all climates for minimizing heating in the winter and cooling in the summer.”

This was the shape and orientation we found when first viewing Red Sand Cottage, well, it’s possibly facing slightly SE, but very nearly perfect orientation! The longer side is exposed to more heat gain during the winter months, but in the summer, the south side is exposed to less solar radiation that the roof and east & west sides.

This arrangement allows for good daylighting of internal spaces.

3. North Side

The north side is the coldest and darkest with no sun all winter, and although it would be preferable to have a north side sloping towards the ground, this isn’t always possible with an existing building. In our case, berming is not possible either, so another alternative is to supplement the existing trees to the North and for the future create a dense row of trees and shrubs to help block those chilling winter winds.

In the past, the previous owner had the foresight to plant a very dense three rows of trees on the West and North West of the property. This has done wonders the protect the property from the cooling effect of the prevailing North-westerly winter winds, although the property would benefit from a further row of trees to the North and these have now been planted by us, albeit they are rather small at the moment!

The pic below, taken in 2006 shows the rows of trees to the west and north west, the line of trees to the north has now been extended.

4. Location of Indoor Spaces

We have re-configured the internal spaces so that the main living spaces are now situated on the south side (previously the living spaces were located on the north side with bedrooms on the south). One of the newly created rooms is a craft store which is open in the summer months only, so this was located on the north side, together with a bedroom and bathroom. These rooms which are used less often, when placed on the North side can buffer between the cold north side of the house and the warmer living spaces.

Edward Mazria recommends that “a breakfast room be located to the southeast for good morning sunlight, living room to the south“, we already had that configuration but opened up that room more into the kitchen to take advantage of more winter sunshine deeper into the building.

Even though our bedroom is on the North side, it can still get too warm on a sunny day because of the solar heat which gets distributed throughout the building. At the time of writing (early Jan 2011) we had to open a bedroom window as it got too warm in there to sleep due to the sun being bright for a couple of days! Still.... better to be too warm than too cold, too warm is easily rectified by opening the window :-)

The Living room actually stretches from the North to the South of the building. It is perhaps longer than recommended (in relation to the window height), yet the winter sun shines through the entire room and lights up the entire room right up to the back North Wall. There is a small window to the North (which can be insulated with bubble wrap if the need arises) and a very large, 3-panel French window/door to the South).

5. Protected Entrance

A porch is needed to provide an airlock between the building and the outside. This is a project in planning and work will probably commence in the summer of 2011. It will be positioned to the south east and will incorporate a small greenhouse and boot/coat area.

6. Window Location

Major window openings are located to the south. Smaller windows have been replaced with larger French doors. We opted for ordinary vertical glazing as it is much easier to shade during the summer months to avoid over-heating.

If it proves imposible to increase the amount of glazing on the south side, then the use of reflectors can be helpful in increasing light and heat into the rooms (see below).

Keep the heat in

So far we've considered ways in which to optimise the capture of the sun's heat and light, but must also consider how to keep it.

There are a couple of ways mainly, one of which we have addressed quite well and the other we've hardly been able to address at all.

The first is to prevent warmth from escaping the home. That we've achieved fairly well with good insulation and sealing see Eco Energy Retrofit, thermal drapes, etc.

Secondly (the bit we don't perform so well on!) is the addition of thermal mass (i,e. brick, concrete masonry, concrete slab, tile, adobe, water) to retain heat. When working with an older home in these parts, one of the greatest disadvantages in terms of passive solar design has always been the lack of 'thermal mass' in the existing building structure. We've done what we can, but have resisted some of the 'classic' ways, e.g. trombe walls, water walls, etc., instead we've simply increased the thickness of drywall and added ceramic floors where possible. If we could rely on more sunshine during the winter months, it would seem more important to place a greater emphasis on thermal mass. Additionally, if this were a new build and we had the luxury of incorporating more thermal mass from the outset, it would certainly make good sense to do so. Since we do not have the reliable sunshine here, we considered that our retrofit $$$ would be better spent elsewhere, e.g. on good insulation. It's a shame, but with a tight budget not everything was possible and we had to prioritise our efforts given all the circumstances.

Summer Cooling

Last summer we were able to evaluate the benefits of the insulation we've installed and it made a huge difference during the summer months. The house was cool and comfortable. Now that we have increased the glazing on the south side, we will need to ensure that the house doesn't overheat. One method will be to use reflective drapes and a second project (to be completed in 2011) is to construct trellises over the south facing windows. We've already planted the first grape vine and this should help cool & shade the house and provide a lovely, leafy place to sit outside.

Conclusion

As we knew from the outset, we couldn't achieve a 'perfect' passive solar design, but have retrofitted our home to the best configuration, given our budget and abilities. On a sunny day, warmth & light pours in, eliminating the need for any other form of energy inputs except perhaps for cooking. The insulation helps us to retain that warmth well into the night, and when we are tempted to light a small fire in the evening, we end up being far too hot and having to open a window!

Of course, we have to accept that we do not live in an area where daily sunlight is guaranteed, and on those dull days just enjoy the extra light provided by the passive solar design, but can't in any way rely on solar heat. Passive solar design can only ever help us to reduce our energy requirements (at least in this current retrofit), however, it is fair to say that on any sunny day our heat, light and hot water requirements are sorted and for free.