THERMAL COMFORT

"That Condition of mind, which expresses satisfaction with the thermal environment" (ASHRAE Standard 55)

Image Courtesy of Concretenetwork.com

DESIGN CRITERIA

1. Thermally comfortable conditions achieved by integrating technologically and economically innovative, low-energy strategies:
   a. Temperatures between 72 °F and 76°F
   b. Humidity between 40.0% and 55.0%
2. Minimal distractions to the occupant
3. Easy control of thermal comfort system
4. Uniform thermal conditions exist throughout the house

BIO-$S^{(H)}IP$ THERMAL COMFORT FEATURES

Active Systems

1. Solar radiant floor heating system
2. Quiet, multi-zone ductless heat pump air-conditioning system with remote
3. Energy Recovery Ventilator that pre-conditions air entering the home

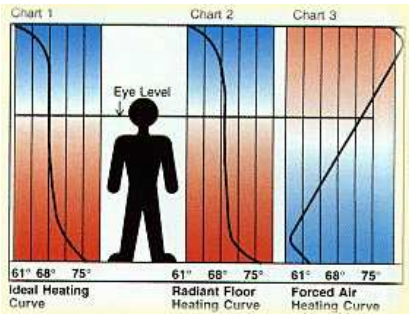
Passive Systems

1. Passive Cooling
2. Passive Heating

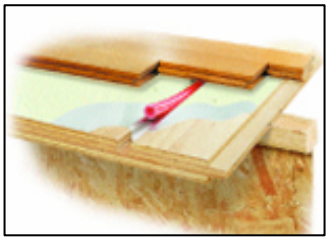
ACTIVE SYSTEMS

Radiant Floor - Warmboard

Compared to traditional forced air systems, radiant floors offer superior comfort and reduced energy consumption. The figure below compares the Ideal Heating Curve for Occupant Comfort with those created by a tradition forced air system and a radiant floor system.



Because our house and floor lack any significant thermal mass and require a fast response time for the competition, a plate-type radiant system that is built into the sub flooring was used.



A ***Warmboard*** sub-floor with tubing and wood

Image Courtesy of Warmboard

Two solar thermal panels were oriented on the South wall for collection of low winter sun. Computer simulations in EnergyPlus and TRNSYS indicated that solar heated water would meet most of the buildings heating needs. These simulations also indicated that an electric heater was the best supplemental heat source for the system.

Mini Split System AC - Mitsubishi "Mr. Slim" ductless heat pump MXZ30TN

Continuing with our ductless theme, a mini split system heat pump unit designed by Mitsubishi is used for cooling the house. The condensing unit has an inverter system, which varies the compressor speed, realizing the following benefits:

1. Reduced power consumption
2. Less room temperature variation
3. Faster response time

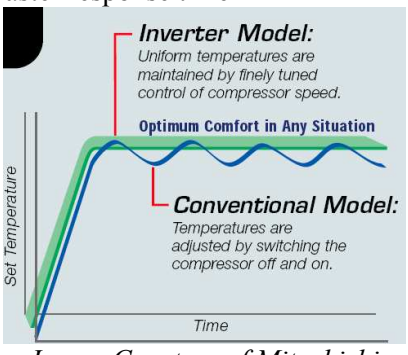


Image Courtesy of Mitsubishi

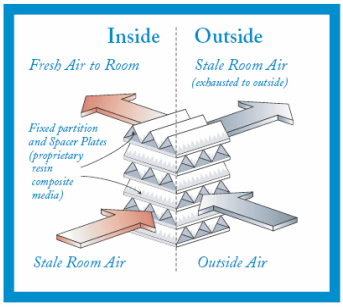
The outdoor unit is sized to 30,000 Btu/hr, while the indoor units are sized to 9,000 Btu/hr. Both units are placed near the ceiling along the South wall,

where the cooling loads are the highest. One unit is located in the bedroom, and the other is located in the Kitchen/Living Room. This design provides ample circulation throughout the space. The Mechanical Room will be indirectly cooled by the conditioned spaces.

Having a larger outdoor unit capacity allows for the new owner (Prospect) to not have to pay for a new heating and cooling system. They would only need to purchase an additional indoor unit to handle both the heating and cooling loads of any additions.

Energy Recovery Ventilator- The RenewAire BR70

When there is a large temperature and humidity difference between the inside of the home and the environment, conditioning outside air as it comes in to the home requires a lot of energy. An energy recovery ventilator can save up to 85% of this energy. Air entering for ventilation purposes will come into the home close to the humidity and temperature settings of the home, reducing the load on the air-conditioning and heating systems.



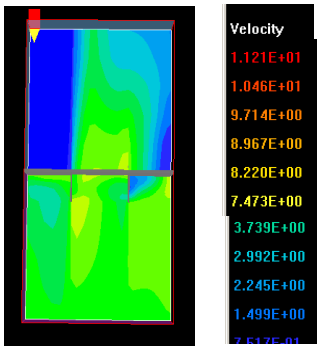
The exiting conditioned indoor air is being used to pre-treat unconditioned entering outside air. *Image Courtesy of Renewaire*.

passive systems

Heating and Cooling Systems

Passive Cooling

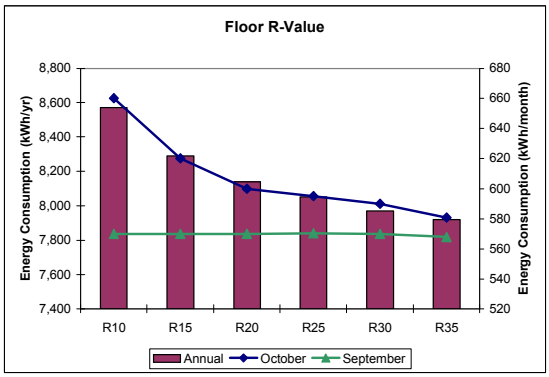
In addition to general rules of thumb, simple models were created in Phoenix to optimize the passive cooling potential of the house. A sample output of airflow through a double casement window is displayed to the right.



The occupant has control over the window operation to create airspeeds that make him feel comfortable.

Building Envelope

Multiple runs were conducted in EQuest to optimize the building construction. Insulating values were examined for diminishing returns of amount of insulation vs. energy savings. The graph below shows an example of this analysis.



Window Construction

High performance windows were designed in cooperation with Alpen Widows for used in this house. Superior comfort is achieved from the high insulating values of a triple-pane system and fiberglass window frames. The frames not only have a low embodied energy, but also are warm to the touch regardless of exterior temperatures. EnergyPlus models indicated greater energy savings would result from designing the system to maximize heat gains during the winter.

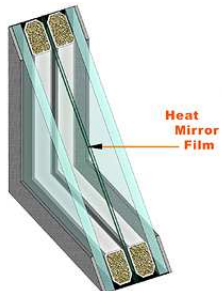


Image Courtesy of Alpen Windows

Shading Devices

Fixed PV panels serve as shading devices for the South kitchen and bedroom windows. Sliding louvers were designed for the South Entrance due to the large size of the window. The fixed overhangs were designed to provide maximum shading during the summer while still allowing heat gains in the wintertime. Below is a sample calculation graph.