A MANUAL FOR THE ENVIRONMENTAL & CLIMATIC RESPONSIVE RESTORATION & RENOVATION OF OLDER HOUSES IN LOUISIANA

Sponsored by

Louisiana Department of Natural Resources
Technology Assessment Division
Energy Section

2003

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The Industrial/Commercial Energy Reduction Program is funded 95 percent ($309,000) from the Codes and Standards Special Project and 5 percent ($16,000) by third party match as provided by the Louisiana Department of Natural Resources and approved by the U.S. Department of Energy.

This public document was published at a total cost of $22,181.77. 6,500 copies of this document were published in this first printing at a cost of $3.41. The total cost of printings of this document, including reprints, is $22,181.77. This document was published by the Department of Natural Resources, Technology Assessment Division, Energy Section, P.O. Box 44156, Baton Rouge, Louisiana 70804-4156, to promulgate the State Energy Program developed under P.L. 94-163. This material was printed in accordance with standards for printing by state agencies established pursuant to R.S. 43:31.

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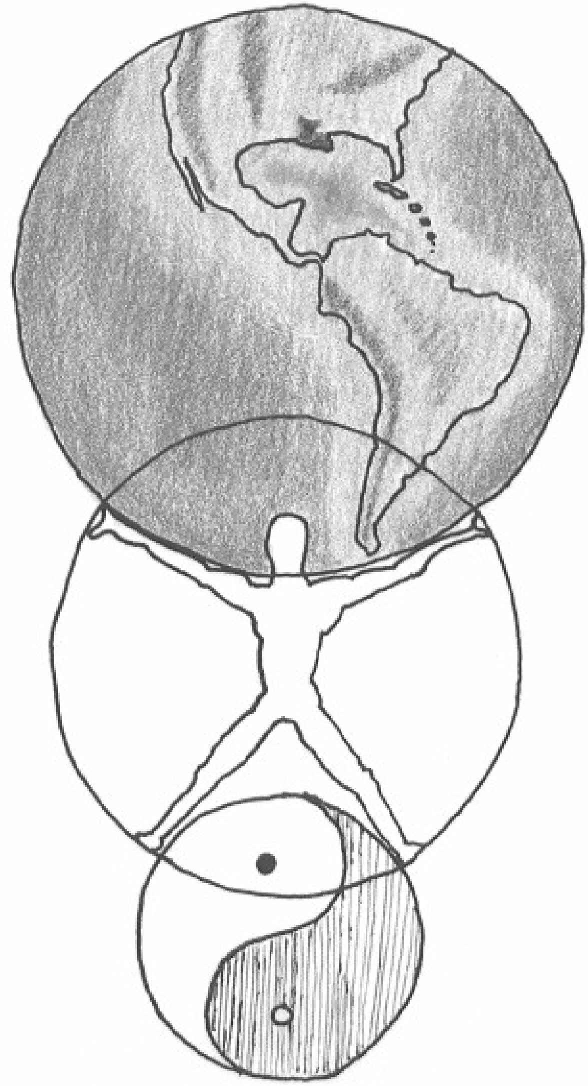

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Louisiana Department of Natural Resources
Technology Assessment Division
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FOREWORD

"What's the use of a house if you haven't got a tolerable planet to put it on?"

Henry David Thoreau

PURPOSE

The natural environment is the arena of life. A true understanding of her processes is indispensable for survival. This basic knowledge is important not only for our existence, but can be used to provide health, comfort, and delight in our daily lives. And it can help us do that while still conserving energy.

At present, the majority of our energy sources are not only finite, costly, political, undependable, vulnerable, but also environmentally degenerative.

Energy from passive solar and naturally renewable sources is infinite or regenerative, economical, dependable, decentralized, and environmentally benign. Working with the natural environment to conserve energy, and using renewable energy wisely, can lead to energy and economic self-sufficiency, to health and comfort, and to the enrichment of our lives.

Another aspect of enriching our lives is the conservation of our cultural and architectural heritage. This does not mean that we save only those structures that are listed on the National Register of Historic Places or the homes of the wealthy, but any structure that expresses the full breath of our culture. If the building has not formally been designated as a historic building, this does not mean it is not historic or worth saving. The Louisiana Office of Historic Preservation can help you with registering the building if it meets the federal requirements.

USE

This manual is designed to encourage the individual to not only save energy, but to save the architectural fabric of our culture. Therefore, it is beneficial to review the first chapter on Historical Background to understand the roots of these older structures we want to bring back to life.

The chapters on Human Comfort, Climate, and Thermodynamics address the general and technical specifics of where the house is located, what heat is all about, and how the individual relates to these thermal experiences. These chapters have more to do with design decisions than renovation techniques, but need to be understood.

The Sustainability chapter discusses the importance of how we live on this planet and how we use its resources. We must take care of the natural environment for our health and prosperity.

For construction techniques you can go straight to the chapter on Restoration & Renovation. Here each type of construction is addressed along with ways to improve and take advantage of its usefulness for human comfort. However, the previous chapters gives the reasons for these construction techniques.

ACKNOWLEDGEMENT

This manual owes its existence to the thoughtfulness of the Louisiana Department of Natural Resources, Energy Section. Wade Byrd, who directed this project, was responding to problems the general public was having with trying to heat and air-condition structures that were not designed for today's technology and comfort level. I thank him and his staff for their consideration and help.

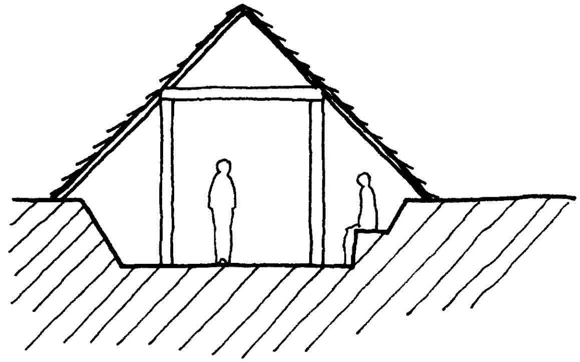
I appreciate the thoughtful and thorough reading of the drafts, along with their corrections and suggestions, by a group of people who I know understand the technical and social issues of historic architecture, energy efficiency, and human comfort. For this I most thank Nick Musso, AIA of Musso & Associates, Glenn Morgan, AIA, Architect & Historian, Harvey Landry, Wade Byrd, David McGee, Buddy Justice, Darrell Winters, and Ernie Singleton with the Louisiana Department of Natural Resources, Technology Assessment Division, Energy Section, and Barbara SoRelle Bacot, Senior Architectural Historian in the Division of Historic Preservation at the Louisiana Department of Culture, Recreation and Tourism.

For the proof reading of spelling and grammar, I thank my wife, Faye Cazayoux and my dean's assistant, Grace Bouillion, who also formatted the text – more than once.

I also owe gratitude to my student assistants, Edmond Vigé and Nicole Broussard, for their creative insight and graphic skills. It was a pleasure working with all of them.

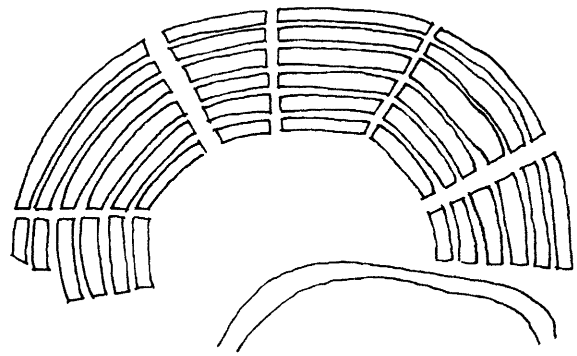
CHAPTER 1

HISTORICAL BACKGROUND



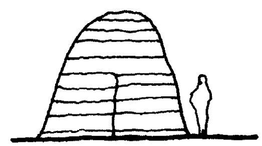
"It is important to know what the people we inherited this planet from did to live with the natural environment, before the Industrial Revolution, to see a sustainable future."

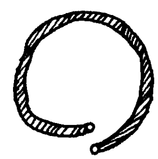
Edward Jon Cazayoux, AIA, CSI
Architect

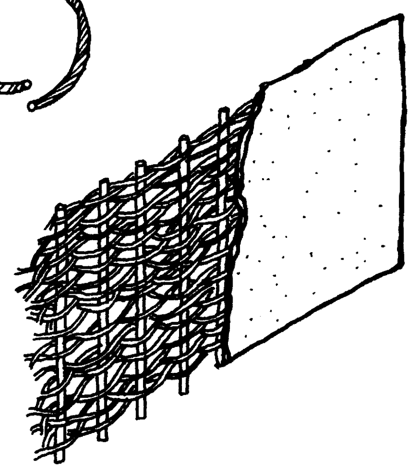


NATIVE PEOPLES

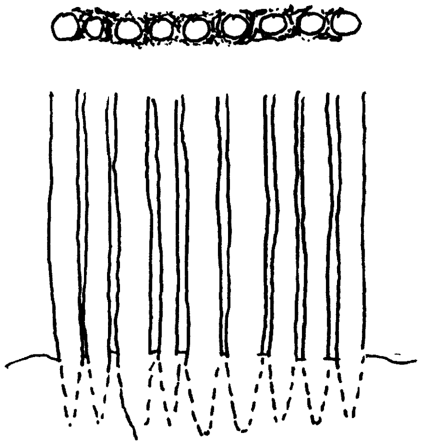
The Native Peoples of Louisiana built a variety of different types of structures to live in. Earlier, their ancestors would have built pit houses – which were spaces dug out of the earth and covered with a steep thatch roof made from river reeds or palmetto. Later, they would have started building on the ground or on man-made mounds. In lower Louisiana the structures would have the floor raised above the ground because of the high water tables and seasonal flooding.





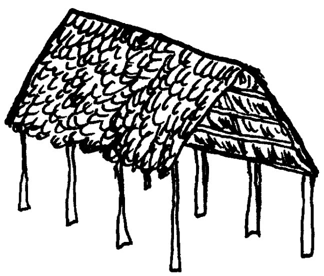


It is often debated as to whether primitive peoples discovered domestic agriculture first and this allowed them to settle in villages, or that settlements came first and this allowed them to develop agriculture. The answer for Louisiana can be found at the ancient site of Poverty Point. Sometime around 1730 BC, give or take a decade or two, a metamorphosis took place on Maçon Ridge in northeast Louisiana. Poverty Point Culture burst out of a late archaic way of life, and two political economic shifts marked its emergence – a massive building program and an extensive long-distance exchange enterprise. These hunter-gathers, before the bow and arrow or agriculture was invented, settled the land and built earthen mounds and houses to live in. The natural environment was such that a lifestyle was developed without having to roam the land or migrate with the wildlife.



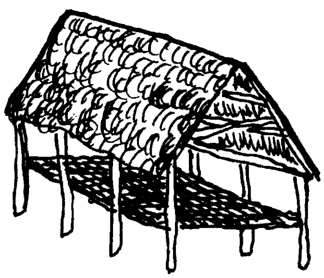
These people who started their abode in pit houses understood the thermal comfort of being in the ground. As they brought their structures above ground, they brought the earth up with them in the form of wattle and daub construction. The roofs were steep because of the amount of rain experienced in Louisiana, and thatch would need to be on a steep angle to shed rain water.

Other types of Native Peoples' structures were also built in the middle of Louisiana. The Caddo are a clan that extends to the west and they built posts in the ground, palisade style, walled structures with steep pitched thatched roofs. It was typical for the posts to be burned to char the end that was placed in the ground to protect against rot and insects. These structures had but one wall opening and that was always to the south. Sleeping and storage racks would keep everything off the floor, which then could be used for daily tasks or crafts. The Native People closer to the coast built open walled structures with a platform raised off the ground and a steep pitched thatch roof.



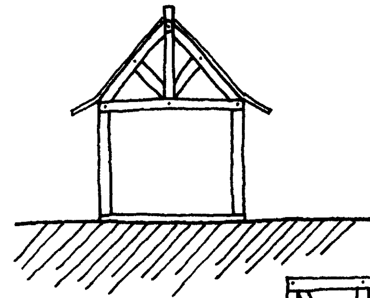
These structures were home base for these people but, except for sleeping and cold winter days they were not inhabited on an hourly basis as is done today in our homes. Most family, and all social, activity took place outside of these structures.

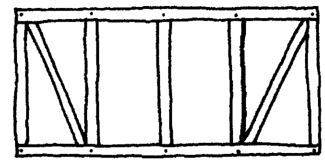
FRENCH & SPANISH COLONISTS



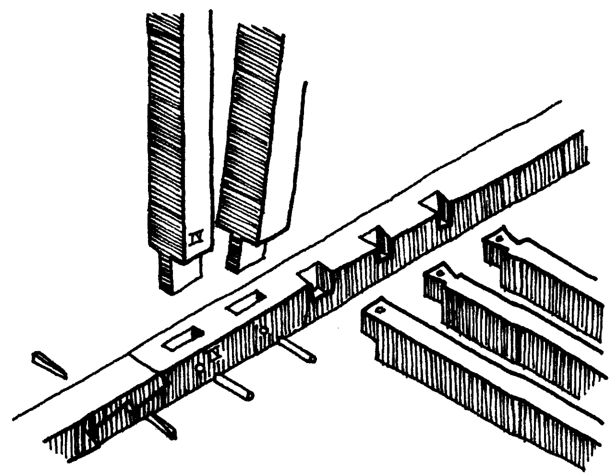
The French colonists brought with them to Louisiana an architectural design from a colder climate than is found here. This architecture was a half-timber colombage wall structure with a Norman truss roof framing system. These structures were placed directly on the ground. The roof was steep, not as a response to the amount of rain we have in Louisiana, but as a response to the snow loads in France and Canada. The French and the Spanish, plus a few other European colonists had some experience in the Caribbean before they came to the Louisiana

Coast. Why would they first build in Louisiana like they did in France or Canada's northern climate if they knew how to build in the tropics? This author contends that the two developed together at about the same time.

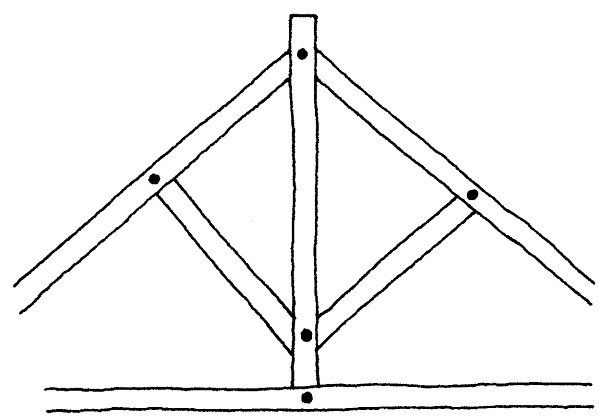




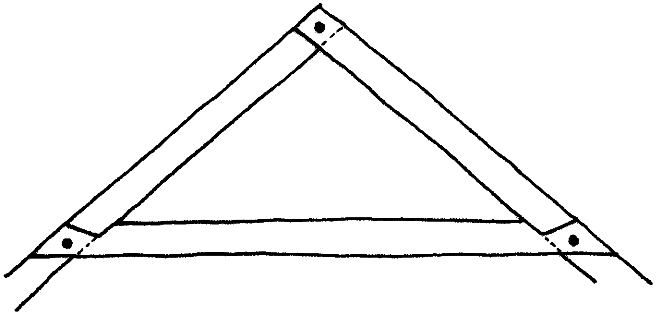
The French designed and built structures as early as 1699 in the Mississippi River Valley. The colombage frame is made of uprights squared on four sides that are mortised and pegged into a sill and a top plate. The uprights were placed at corners, doors and window openings. Some were spaced between those if the spacing was too wide. At the corners, additional posts were put at an angle for lateral stability against wind loads. The length of the sills and top plate/ beam was connected by a Z-scarf joint with wooden wedges being driven from each side to lock the two pieces of wood into one. The colombage method of construction facilitated the construction of the walls on the ground. The entire wall was raised as a single unit by several people. This type of construction is ancient. The Romans were in France at one time and that is what they built.

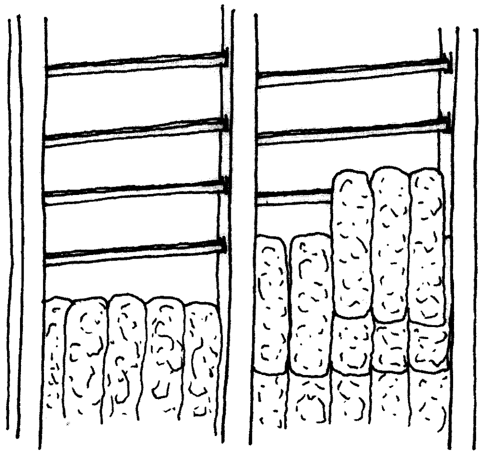


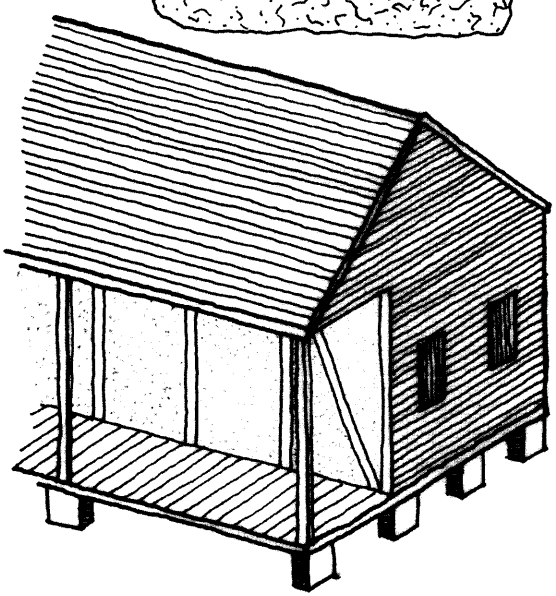
Most of the framework in lower colonial Louisiana (present day Louisiana) was of cypress, which weathers better than most woods, and was not attractive to termites. It also seems that some were pre-fabricated and taken to the site for erection as noted in a contract for the Ursuline Convent in New Orleans in 1727. "M. Mikel (master carpenter)... has his wood all ready, and is going to take it there in these days in order to soon erect the edifices." Most of the main members of the structures that exist today, are marked with Roman numerals at the joints. Trades people known as "jointers" would have shaped all of these mortised and tenoned framing members that were put together with wooden pegs.



The roof system is a heavy Norman truss all mortised, notched and pegged together, supporting rafters, and a roof finished with thatch, bark, palmetto, cypress shakes, or boards (board and board fashion). These are all natural materials. Later, slate would have been brought







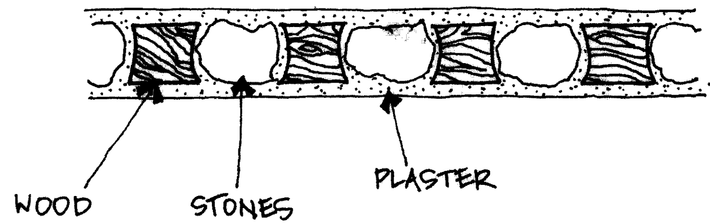
in from the outside, along with ballast from the European boats. The ballast was being used mainly for street paving.

Later roofs would have been constructed of rafters with a half lap joint with a wood peg connecting them at the top with no ridge beam/board. Collar beams would have been dovetailed to the rafters. Some rafters can be found tapered with the small end at the ridge.

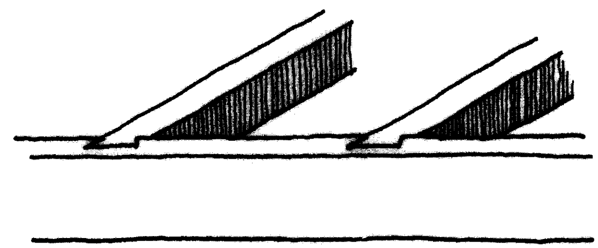
Both the colombage frame and the roof system were built of cypress and put together without any metal connections. All metal work was handmade by a blacksmith. Larger nails were used for some framing joints and batten shutters (solid at first and louvered later), and smaller forged nails were used to attach the wood shakes on the roof, the exterior siding of weather boards on the exposed walls, chair rail molding and door & window casing.

In France, the colombage construction was infilled with stone, brick, slate or earth and then plastered. The colonists did not find any of these natural materials for infill in lower Louisiana except for earth. They picked up on the technique the Native Peoples used for their wattle and daub construction, and mixed mud with retted Spanish moss as a binder to make bousillage to fill the frame. Between the upright posts of the colombage frame was a lattice of split pieux, barreauxs or batons that were wedged in place without any nails. Tauchés (shaped like dough for making bread) of the mud and Spanish moss were hung on the rungs of this lattice and compacted in from side to side working from the bottom up. Some of the earliest structures in Louisiana were left without any mass infill, but proved to be too light against hurricane winds. The mass infill also helped to stabilize temperatures and cut down on infiltration.

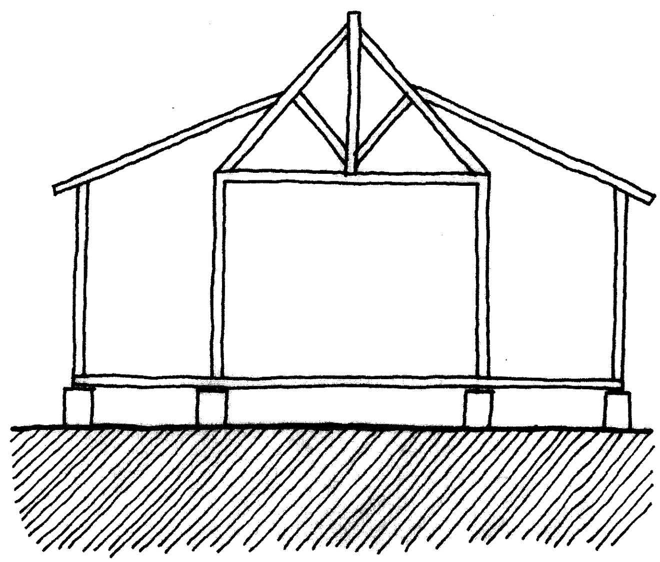
The exterior walls of the gallery would have been plastered. For gabled end structures the plaster and bousillage at the edge of the front wall would deteriorate with seasonal rainstorms, which are frequent in Louisiana. The wall ends were finished with flush boards to solve this problem and the middle stayed plastered. Later the full gallery wall might be covered with flush boards or a wainscot below the chair rail that would have run continuous at the height of the windowsill. The interior walls would have been plastered and a continuous chair rail at this same height to protect the plaster.



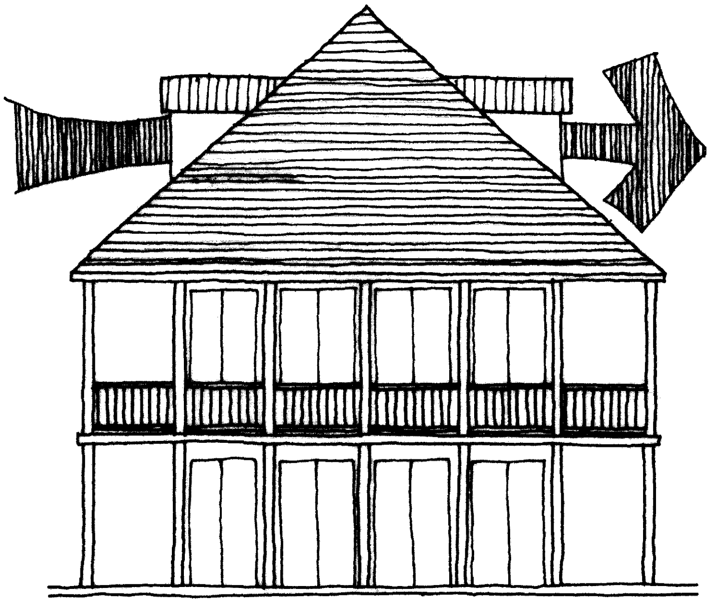
Further north in the Mississippi River Valley, in Upper Colonial Louisiana, they put the colombage frame uprights much closer together and a large kerf at the sides to hold rocks – usually Indiana limestone. It would also have been plastered.



The sill of these early structures sat directly on the ground. The earliest structures, usually part of a French colonial fortification, would just have the exposed earth as the floor. Structures that sat directly on the ground proved to be a very poor decision with our high water table and, at that time, seasonal flooding. The first response to this was raising the structure off the ground on cypress blocks or brick piers. Once raised off the ground, wood floors were the standard. The floor joists would have been dovetailed into the sills. To protect the thermal mass walls from the uncomfortable intense sun and the torrential rains of Louisiana, the early settlers put a porch around the house and covered it with a shallow pitched lean-to roof off the steep pitched hip roof. This gave a double-pitch roof that has gone by the name of "West Indies" or "Witch Hat". This double-pitch roof stayed on in the Islands, but because of Louisiana's torrential rain, the roof was transformed back to a single pitch to accommodate the natural environment here.

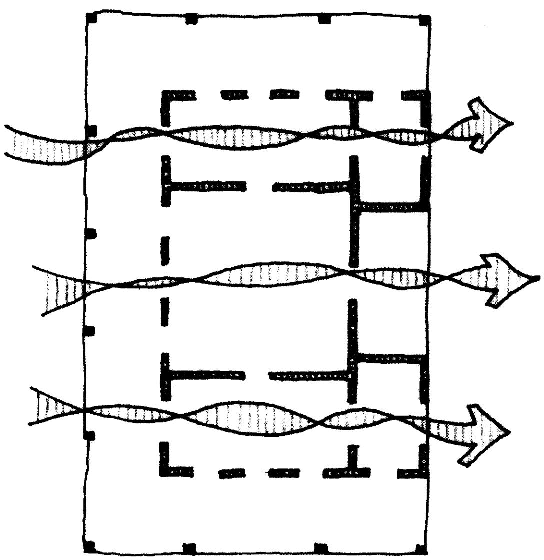


Another major change for large plantation homes was to raise the colombage frame a full story off the ground supported by a load bearing brick wall raised basement. This lower floor was not usually used as major living areas, but did accommodate dining, storage, and daily chores. These heavy brick walls would step out to provide a wider footing as they went down into the ground. It was typical that larger homes would have a separate building as a kitchen because of



the heat, possible fire hazard, and smells. The main living area was the colombage framed space now located at the second level. By this time it was typical to have higher ceilings at this level and more openings across from each other for better ventilation. Transoms above the doors helped to ventilate warm air from this floor. Once bricks were being fabricated in the new colony, they were also used as an infill in the colombage frame, especially in New Orleans, along with the bousillage (mainly in the rural areas). Some houses can be found with both brick and bousillage used as an infill.

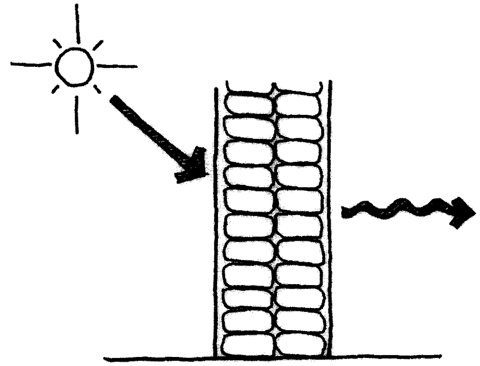
The lower pitch of the gallery roof did not shed rainwater very easily off the rough cypress shakes that covered the roof. The results would have been a leaky roof on the gallery. This was not a major problem for a gallery, but what was typical was that as the family grew and more room was needed, rooms called cabinets were enclosed at the rear of the gallery. However, it was not appropriate to have this newly enclosed room with a leaky roof. The double-pitched roof was abandoned, and the settlers returned to the steep pitched hip roof, but now extended it to the edge of the galleries. This is the classic, unique Louisiana raised cottage – a climatic adaptation of rural French provincial design to the warm and humid climate of Louisiana.

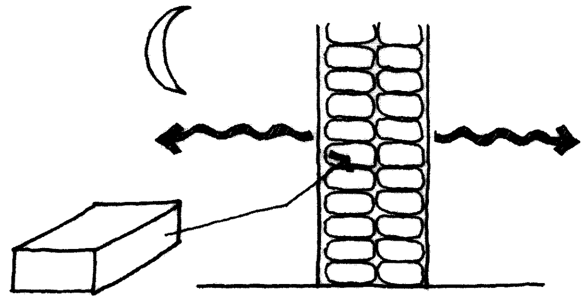


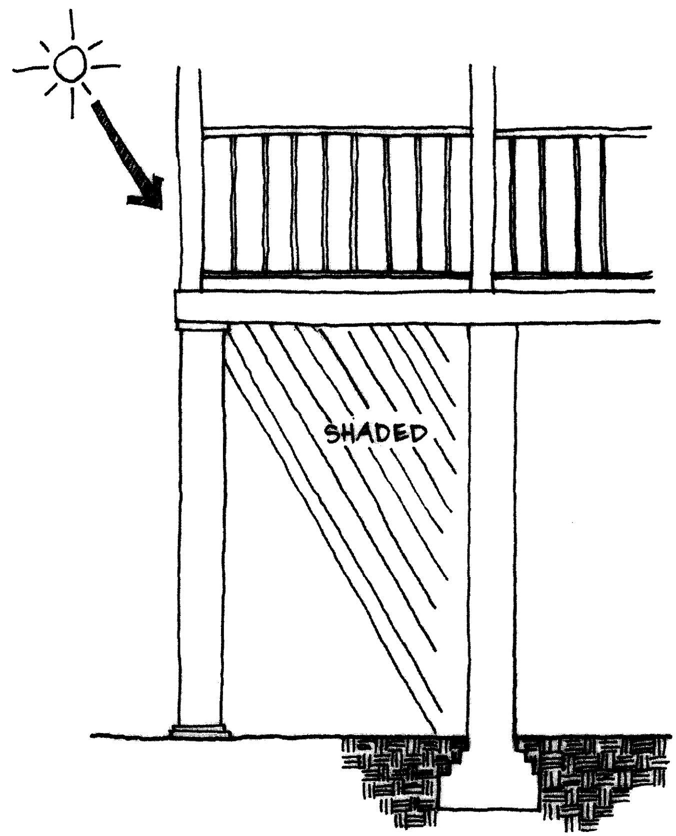
Much of the life of these early homes took place on the galleries. Here one could catch the breezes and be in communication with life in the yard and fields. People went into the house mainly to sleep, but other activities such as dining, social activities, craft making (weaving, making clothes, etc.), and cooking were also daily interior uses. The home could be opened up at night to allow the heat collected during the day to dissipate. It would have been important to try and keep the thermal mass walls as cool as possible during most of the year. Occupants would have to sleep under a mosquito net during the night. Often the night air would be very humid. As the temperature goes down, the humidity goes up. It is not unusual to reach dew point (100% relative humidity) any night. The shutters could be closed on the east side when the morning sun started to penetrate the house. The shutters could be closed on the west side during the afternoon while the ones on the east could be opened. During the winter occupants would dress warm and keep a fire going in the fireplaces.

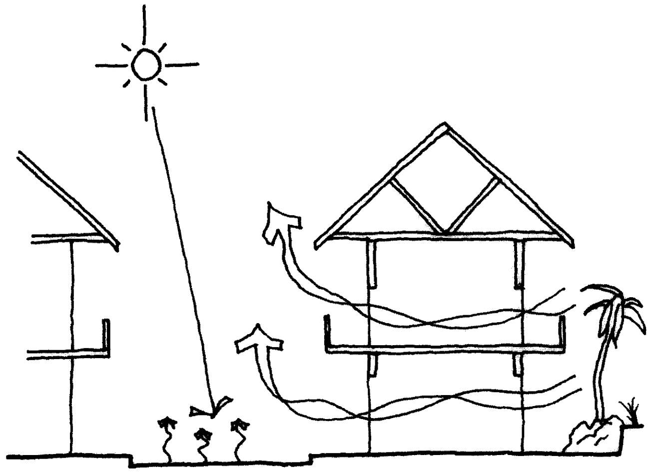
People worked with their clothing, their shelter, and the landscape to use and manipulate the natural environment for human comfort. This was a natural thing to understand the natural environment and to design WITH it. Similar architecture can be found on opposite sides of the planet that have the same climate and environment. An example of this is the adobe pueblos we find in our own southwest compared to the adobe structures found in the arid-dessert climates of Africa. The way these people reacted to their climate is very different from what was done in hot and humid Louisiana. They built massive structures with maximum sun exposure. The adobe mass would collect solar energy during the day while protecting the interior from the heat of the day. By night, when it was starting to get cold outside, the mass was starting to loose heat to the inside from the solar exposure it had during the day. Here, a type of architecture is developed to be able to switch the diurnal temperature of the day from inside to outside. The adobe structures were cool during the hot days, and warm during the cold nights. The exterior temperature varies greatly, but the interior thermal mass temperature is fairly constant.

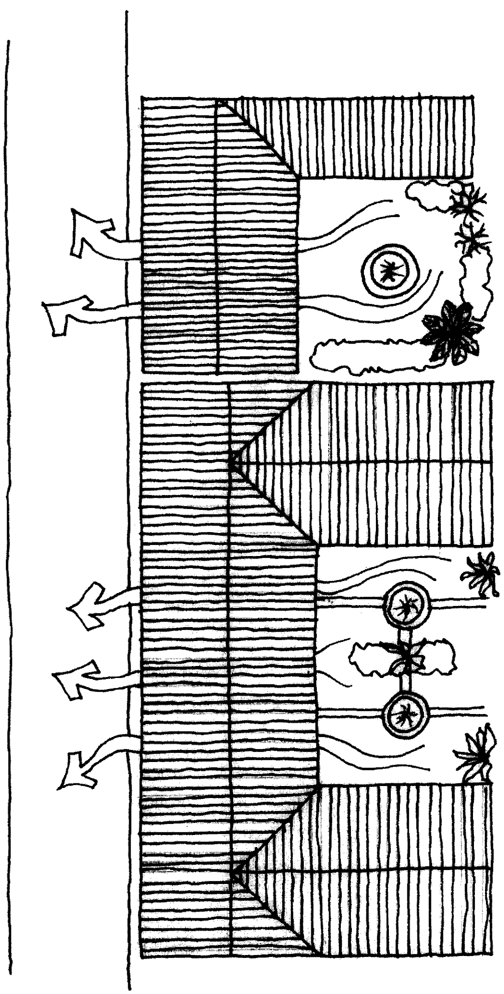
It has been said that you do not build massive structures in a hot and humid climate because there is not enough diurnal temperature swing to allow you to manipulate the temperature with the natural environment. The colonists built massive houses as they did in a colder European climates, while the Africans adopted their native architecture more closely with the Native People of this area and in the Caribbean Islands. The European model was changed to take advantage of what this natural environment positively had to offer, and protect itself from those things that were detrimental to human comfort. The mass was maintained, but extensions, in the form of











galleries, were added to protect the mass walls from the sun and rain. Just the opposite strategy that the southwest People had. They learned how to work WITH the natural environment to keep the mass cool most of the year, and warm in the winter. The constant ground temperature in Louisiana ranges from 66°F to 70°F. The first Native People of this area built pit houses in the ground and understood the comfort of those kinds of temperatures.

In trying to understand and develop new ways to stay comfortable, and to renovate houses we have today, it can be very beneficial to look back and study how those people who came before us used the natural environment to stay comfortable, especially before any mechanical systems were available.

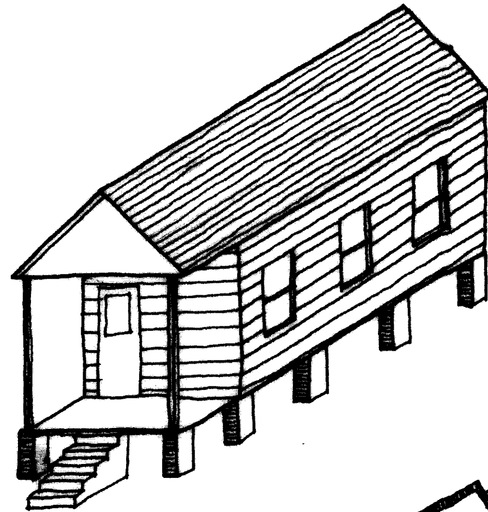
There are also many outbuildings like slave quarter cabins, garçonnieres, pigeonniers, privies, kitchens, forges, storage buildings, barns, coops, wells, cisterns, stables, fences, etc., that are not conditioned buildings, but well worthy of restoring.

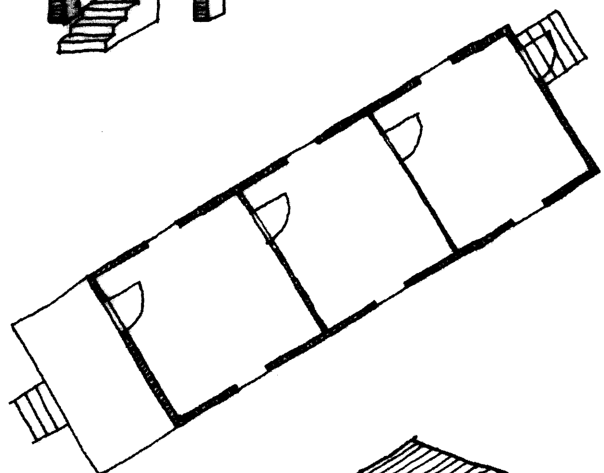
When an old house is first discovered, and being investigated for saving, check the barn and all the outbuildings for house parts. This is where you might find the shutters that were salvaged and reused for pens or other likely or unlikely accommodations.

Another housing type was the mix use of the urban ***Courtyard Houses***. The street exposure was used for commercial purposes with the upper floors being residential. All of this was typically around a courtyard with a water element and plenty of vegetation. Because of the water and vegetation, cooler air would descend into the courtyard and be pulled through the building by the rising heated air on the street side. Courtyards were very private spaces and not typically open to the public. This housing type can be found in the French Quarter in New Orleans and the old part of Natchitoches, which were the earliest settlements in present day Louisiana.

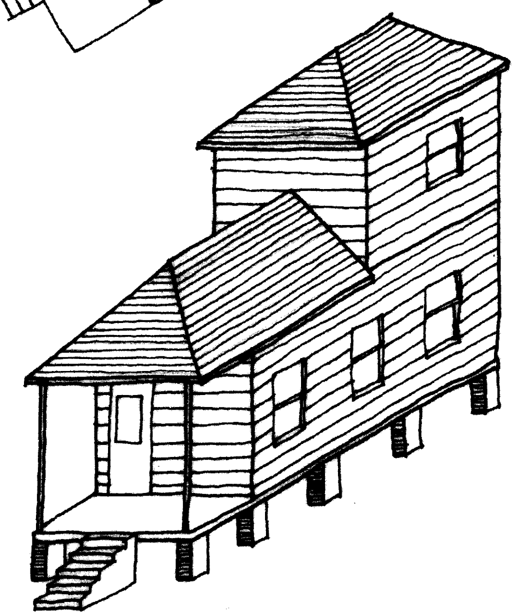
OTHER INFLUENCES

The ***Shotgun*** is a further development of the Native Peoples of the Caribbean Islands' wattle & daub construction by the Africans, some of whom had built similar structures back home, and Europeans. The Africans were slaves from mainly west Africa who were brought to the Islands to help develop agriculture by the Portuguese, French, Dutch, Spanish, British, etc. The house was elevated off the ground, with one room placed behind the other in a linear fashion without a hallway. A door to one side of the room lines up from the front door to the back, not unlike seventeenth-century living quarters in Paris. The porch and front door were on the end of the building. This, being very different from the French or Spanish incorporating the porch and entrance on the long side of the house. In New Orleans, it was typical to see duplex shotgun houses.



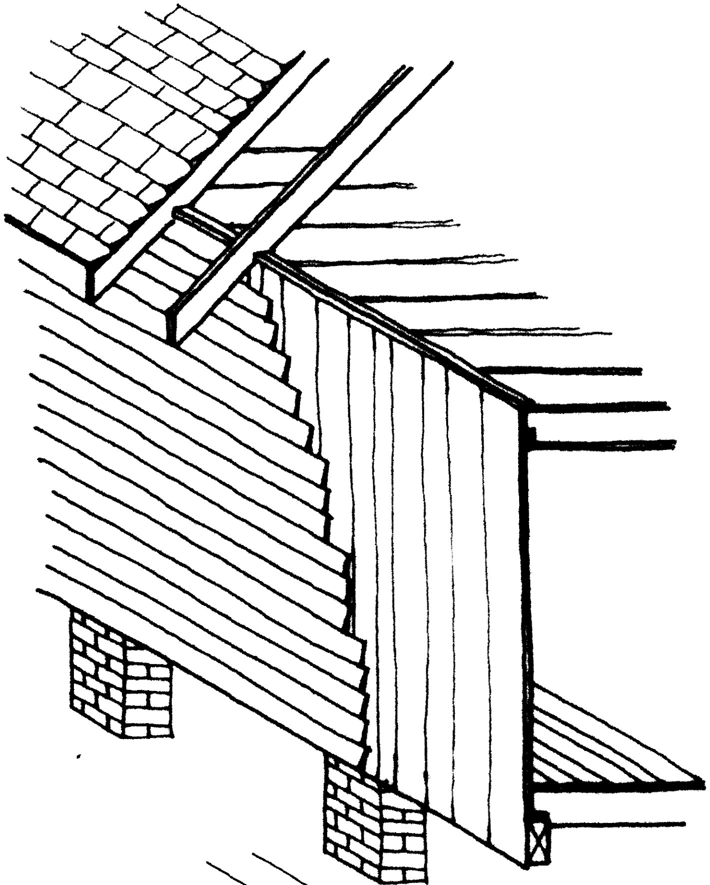


The ***Camelback*** is a take off on the shotgun with a two-story addition to the rear of the house. This was a great design for high-density single family housing in larger urban cities like New Orleans.

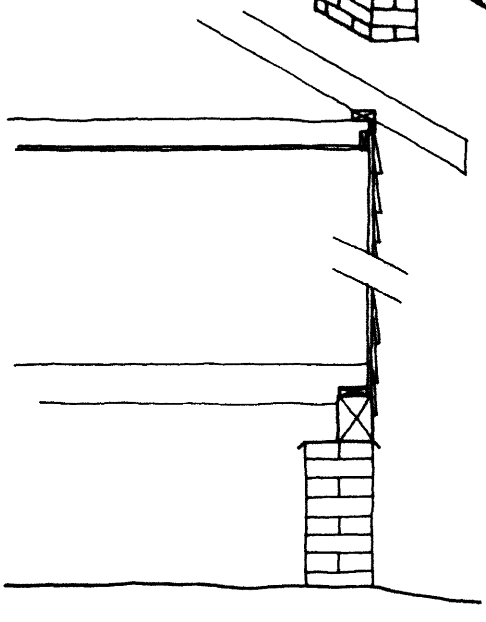


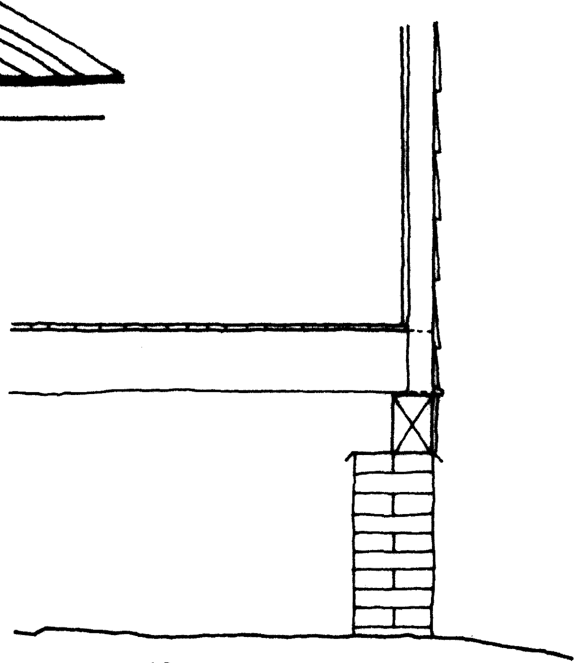
Barge Board construction developed out of a practical recycling program. Barges were built of wide boards to float commerce down river to be sold. Many of these barges were headed to New Orleans with goods destined for Europe. The materials from these barges were salvaged for house construction along with other structures, like warfs and boardwalks. This wood was usually not cypress, but pine. These boards were placed side by side and rested directly on the sill with only horizontal 2X4 top and bottom boards. These boards were the loadbearing walls without the use of any studs. The exterior would have been finished with horizontal lap siding, and the interior left as it was or papered over.

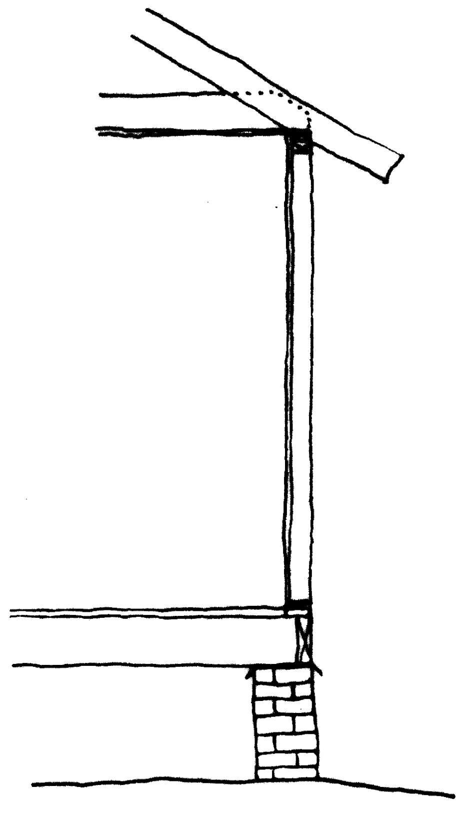
You will find that many of the older houses are constructed with the ***Balloon Framing*** system. Up until this time, the major wall framing system would have been the colombage of the French colonists. In



balloon framing, the studs rest on the sill. The subfloor and/or the finished floor go around the studs. The next step in wood frame systems is ***Platform Framing*** in which the subfloor is put over the floor joist all the way to the edge, and the stud wall framing sits on top of a pressure-treated sole plate. Both of these walls are covered in more detail in Chapter 6 under *Walls*.







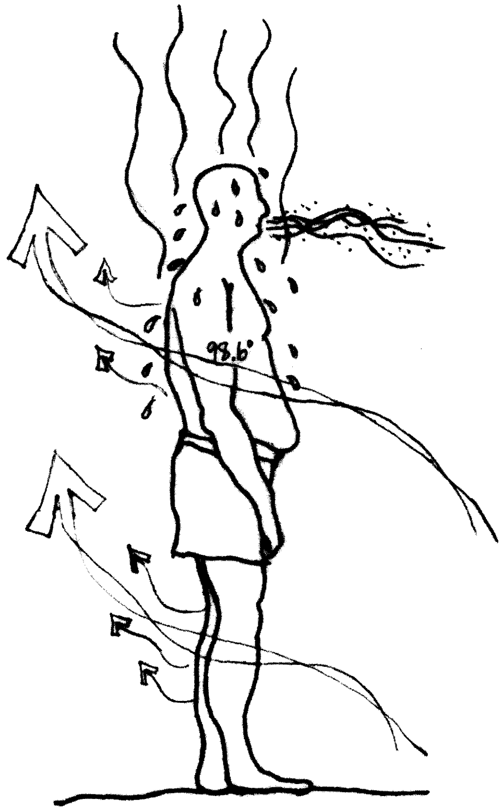
CHAPTER 2

HUMAN COMFORT

"Thermal qualities - warm, cool, humid, airy, radiant, cozy - are an important part of out experience of a space; they not only influence what we choose to do there but also how we feel about the space."

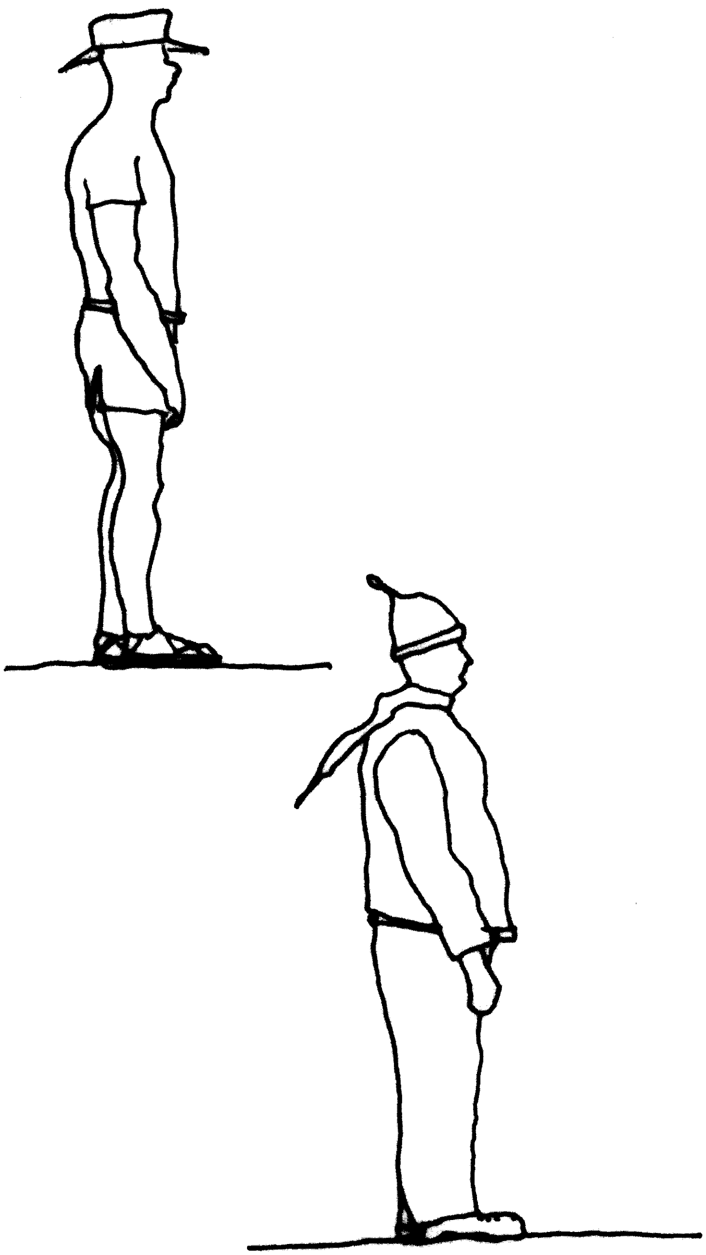
Thermal Delight in Architecture
Lisa Heschong

The main purpose of housing is to provide shelter. Shelter does not mean to merely keep the rain off one's head, but to provide for thermal comfort.



Each individual is a biological machine that burns food as a fuel source and generates heat as a byproduct. It is important to dissipate this waste heat in order to prevent overheating from this metabolic process. The human body tries to maintain a fairly constant temperature of about 98.6°F, and any minimal deviation from that creates severe stress on the body. A 10° to 15°F higher, or 20°F lower body temperature can result in death.

The human body has a number of mechanisms to help us regulate our body temperature. Some heat is given off by breathing – with the exhaling of warm moist air from the lungs. However, it is the flow of blood in the body that is the major regulator of our body temperature. In the summer the flow of blood is sent much closer to the skin to dissipate heat. As ambient temperature rises the body will send moisture to the skin to cool the body by evaporative cooling. When the relative humidity of the air is too high to evaporate the moisture, we begin to sweat. This is very typical for the Gulf Coast states. Humidity is our major problem for trying to stay within the comfort zone.



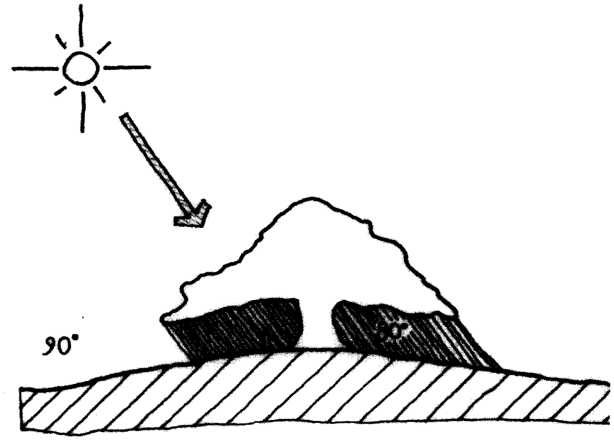
When the ambient temperature is cold, the body does not send blood to the skin's surface, but uses the skin to insulate the blood from the colder temperature. Therefore, the skin temperature is cooler in the winter than it is during the summer. Hair is another mechanism to help keep the body warm. Even though our body does not have as much hair as it once did, we still get goosebumps or goosepimples, which is a muscle reaction to make the hair stand up to insulate our body from colder air. Of course we can augment all this with the clothing we wear. It is important to dress in layers, and to insulate our extremities in the winter, like wearing gloves, a cap, and multiple socks and warm shoes. In the summer, sandals along with a straw hat and short pants are more appropriate.

Too much heat loss from the human body is called hypothermia, and too little heat loss is called hyperthermia. For the human body to be in either condition for too long a period can lead to death.

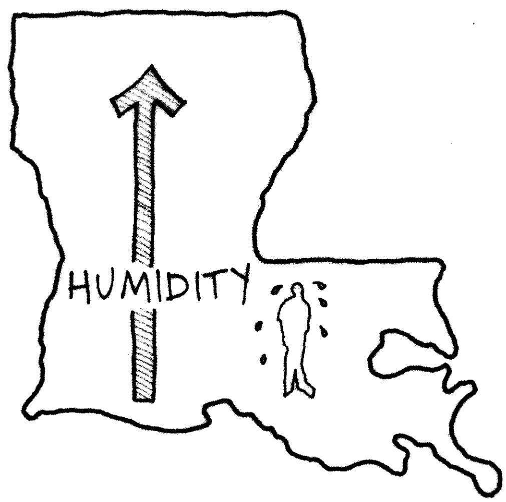
There are many other factors that affect our comfort zone. Everyone's body is different. This is true between male and female, our age, our body weight and proportion, our health, the clothes we wear, and the climatic conditions we are experiencing. The climatic conditions we experience have to do with the temperature of the air, air velocity, relative humidity, mean radiant temperature, and sun exposure.

Air Temperature. Air Temperature will determine the rate at which heat can be lost to the air, mainly by convection. If the air temperature is above 98.6°F, the heat flow is to the person and the body will gain heat from the air. The comfort zone for most people extends from about 68°F in the winter to 78°F during the summer. These figures are based on the assumption that people will dress warmer in the winter and cooler during the summer.

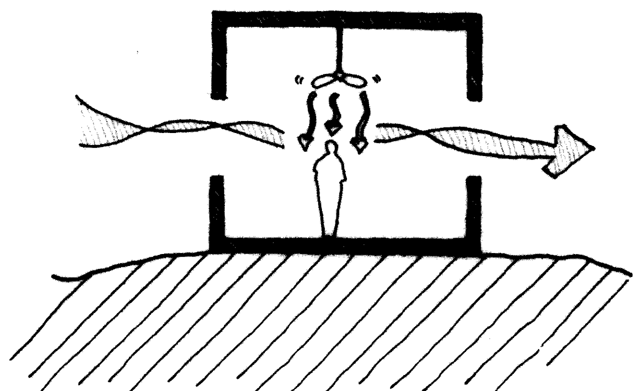
Reducing the temperature of the air is most important for the majority of the time in the Gulf Coast Region. In fact, it is much easier to prevent heat gain than it is to reduce the air temperature. However, vegetation is one way to help reduce air temperature. It also has a tendency to produce more moisture/humidity, which can be detrimental to comfort in our area. Regardless, shading is one of the best strategies for human comfort in Louisiana because it reduces heat gain.



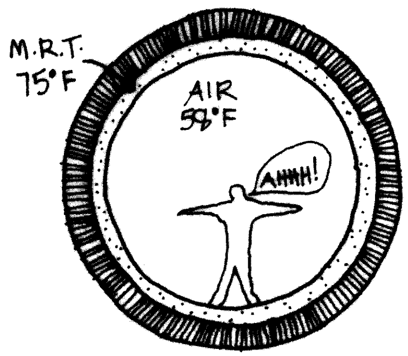
Relative Humidity. The evaporative cooling of moisture from your skin is mainly a function of air humidity. When the air is dry it will easily evaporate moisture from the skin and keep the body cooler. The more humid the air is, the less ability it has to evaporate that moisture. When the relative humidity (RH) is 100%, the air is saturated and cannot hold any more moisture. For human comfort the relative humidity should never be below 20%. During the summer it should be below 60%, and in the winter it should be below 80%. When the relative humidity is too low the human body will experience dry eyes, nose, mouth, and skin, and will increase the possibility for respiratory illnesses.



Higher humidity is good for the skin, but decreases the ability of the body to be cooled by evaporating the moisture that is pushed to the surface of the skin. At this point, the body will sweat and will be outside the comfort zone. Mold and mildew have the greatest potential for growth when the relative humidity is higher, and this can be a serious health problem. Higher humidity levels are very typical in the Gulf Coast states, and the major culprit that keeps us outside the comfort zone. Higher humidity levels in the summer make you feel warmer. The weather forecaster will give the heat index during this time, which is a combination of heat and humidity.

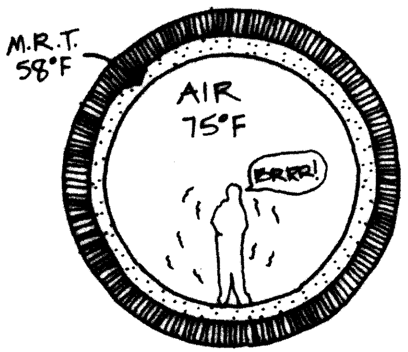


Air Velocity. The movement of air affects the ability of the human body to lose heat by both convection and evaporation. This is a great asset during the majority of the year in the Gulf Coast states, but is a detriment during the winter when we are trying to stay warm. The comfort range of air movement is between 20 and 200 feet per minute (fpm) depending on the activity of the individual. Above 200 fpm, or

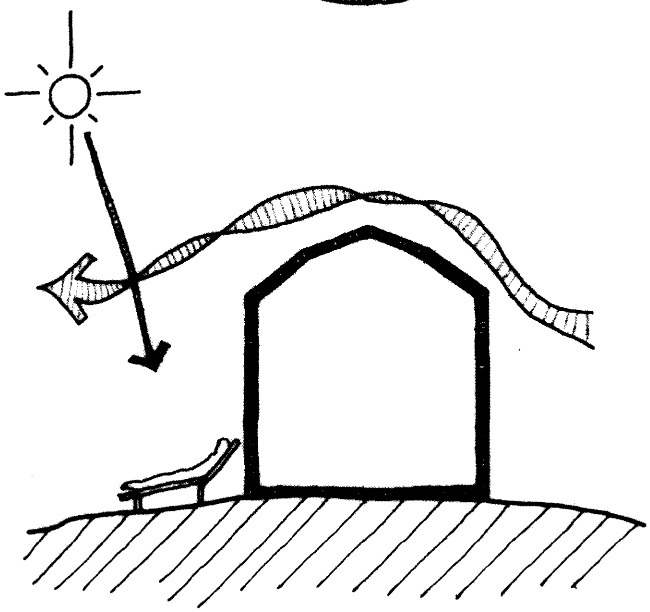


2 miles per hour (mph), the air movement can be unpleasant or disruptive depending on your activity. Natural ventilation also has the ability to remove heat from the space the individual occupies which will also increase human comfort.

During the winter, it is typical that the weather forecaster will give the wind-chill factor, which tells how the human body will react to the combination of the temperature and the velocity of the air. The higher the velocity of the air, the greater the ability it has to take heat away from the human body, and the colder the air will feel.

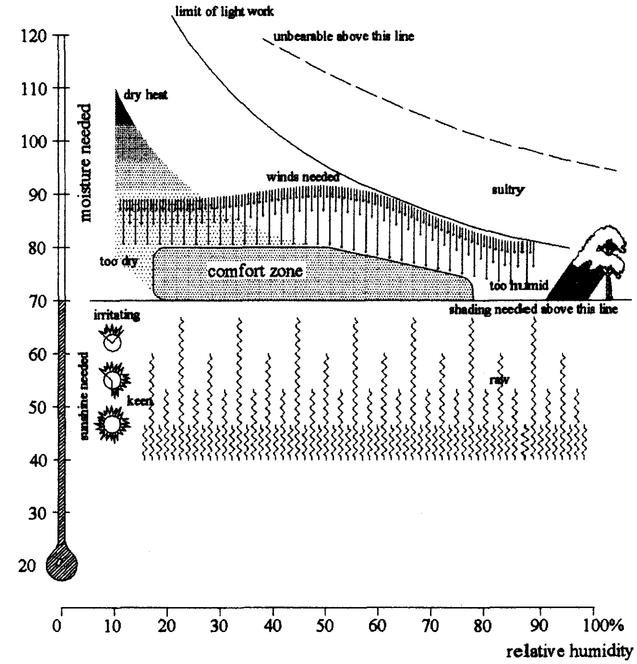


Mean Radiant Temperature. Mean radiant temperature (MRT) is the temperature of the materials that surround you. The human body relates to MRT much greater than it does to air temperature. That is because air is a good insulator, and not a great method of transferring temperatures to the body. It can make a major difference when the MRT is greatly different from the air temperature. A prime example is when an individual is in a room during the winter that receives direct sun. The body will feel the warmth of the material in the room even if the air is at a cooler temperature. However, when the sun goes away and the glass area you are next to gets very cold, you will feel the glass pulling heat away from your body even though the temperature of the air in the room is comfortable. Radiant heating and cooling are more comfortable than trying to do the same with air, resulting in a healthier situation. For maximum comfort, it is best to have the MRT a few degrees warmer in the winter than the air temperature, and likewise in the summer to have the MRT a few degrees cooler than the air temperature.



Sun Exposure. The human body will feel the radiation of the sun when in direct sunlight. This is true if you are inside or outside. When air temperature is so cold that you are uncomfortable, the human body can be brought back into the comfort zone with enough direct sun exposure. For example, if you are standing on the south side of a structure on a cold winter day – your body is protected from the cold north wind and the sun is keeping you warm even though the air temperature is very cold.

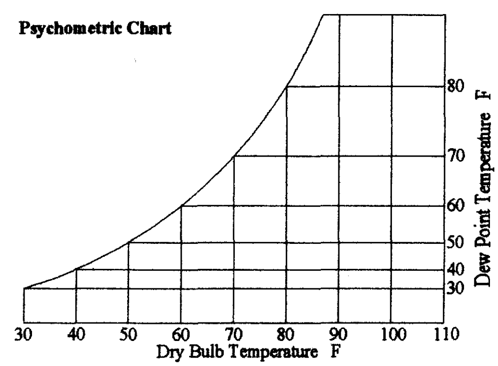
A graphic depiction of the comfort zone was demonstrated by Victor Olgyay in his classic work Design With Climate. It shows the relationship that sun exposure, air movement, wind velocity and humidity have on human comfort.



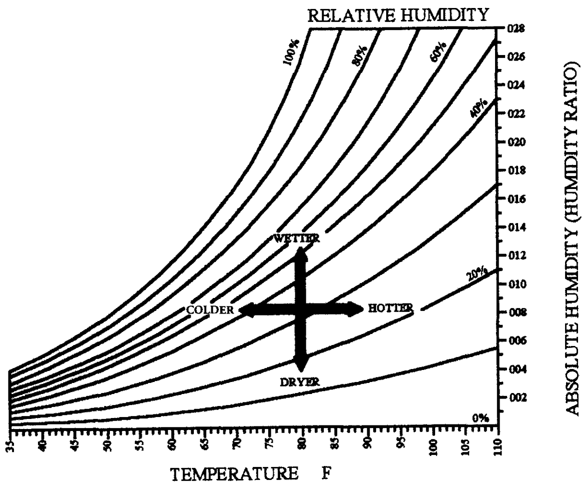
This interdependence of several air quality variables has led to psychrometrics. Psychrometrics primarily concerns itself with the characteristics and thermal energy potential of our air environment, and is a graphic definition (Psychrometric Chart) of the inter-relationship of temperature, humidity, energy constant, and volume of environmental air under all possible conditions. Psychrometrics is important to us because it is capable of directly defining a number of simultaneous factors that affect human comfort.

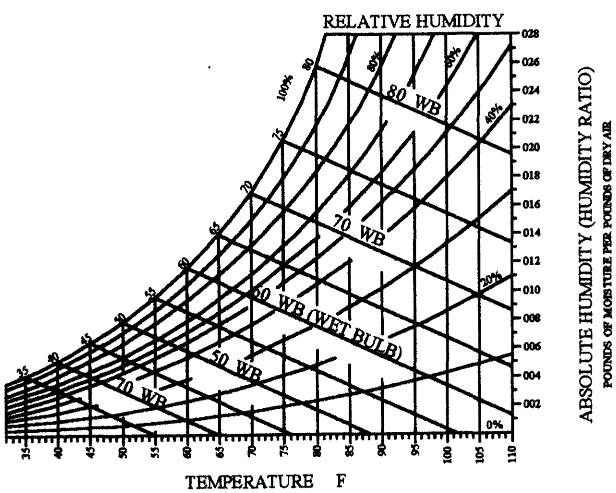
Dry Bulb & Dew Point Temperature. The basic comparison made by the psychrometric chart is the relationship between air temperature and air moisture content. The air temperature scale forms the abscissa of the psychrometric chart and is labeled as dry bulb temperature. The ordinate of the chart represents the air moisture content scale. The dew point temperature of air is a measure of moisture content. It is the lowest temperature to which a given unit of air can be driven without condensation occurring. The various dew points (the point at which dry bulb and dew point temperatures are equal) constitute the line of 100% relative humidity and form the other boundary of the psychrometric chart.

Psychometric Chart



In terms of process definition, sensible heating and cooling follow the lines of dew point temperature, and condensation follows the outer curved saturation boundary of the chart. Whenever dry bulb temperature is lower than dew point temperature, air will follow the dew point line to the outer boundary (saturation line) of the chart and moisture will condense from the air. Condensation will continue,





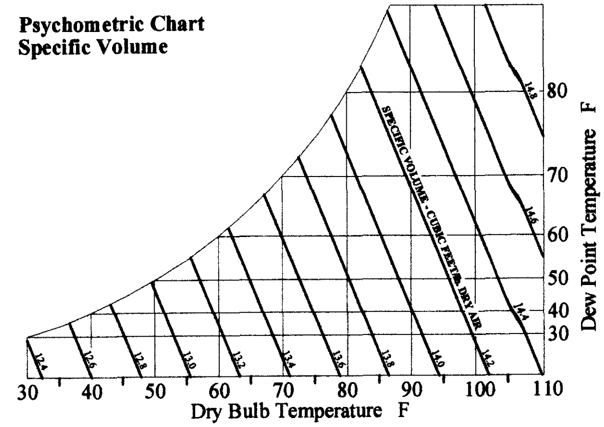
following the saturation line and lowering dew point temperature, until the dew point temperature reaches the dry bulb temperature. The common air conditioner removes moisture from the air in this manner. Moist room air (roughly 78°F dry bulb and 65°F dew point) is passed over cooling coils containing a working fluid that is approximately 55°F. The room air follows the 65°F dew point line to the saturation line and at that point condensation begins to occur on the coils and latent heat (moisture) is removed from the air until the wet bulb temperature of the air reaches the coil temperature (55°F). The air is then reintroduced to the room as cooled, dehumidified air (55°F dry bulb and 55°F wet bulb). Normal heat loads on building interiors then reheat the air sensibly (along the 55°F wet bulb line), and room air conditions ultimately come to 75°F dry bulb temperature and 55°F dew point temperature (50% RH).

Specific and Relative Humidity. The specific humidity of air is the measure of the absolute weight of water vapor that is contained in a unit of air at a given dry bulb temperature. The relative humidity is the percentage ratio of the weight of water vapor in that air (specific humidity) as compared to the weight of the water vapor which that air is capable of holding at saturation, (100% RH), at that same dry bulb temperature.

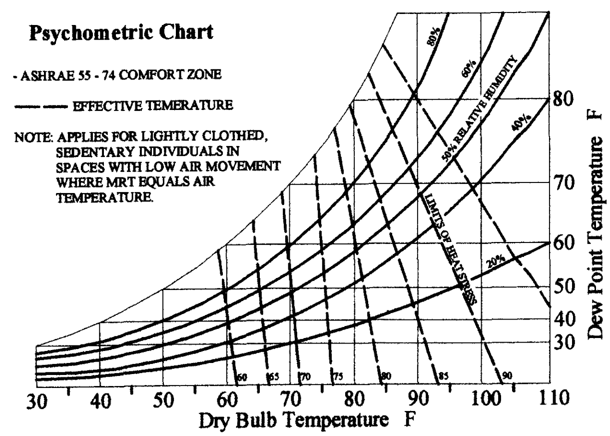
Energy Content. A given unit of air contains two types of energy, sensible energy and latent energy. The sensible energy content of air is a measure of the thermal energy of the air, and the latent energy content of the air is a measure of the heat of vaporization associated with the moisture vapor contained in the air. Enthalpy is the total heat/energy content of the air and its associated moisture (sensible heat plus latent heat). Wet bulb temperature is closely related to enthalpy and represents the lowest temperature to which a given unit of air can be driven through adiabatic (evaporative) cooling. In other words, as air is evaporatively cooled and the heat of vaporization necessary for evaporation is extracted from the air, the humidity of the air will increase along the line of wet bulb temperature until saturation (100% RH) is reached. The dry bulb temperature will fall, and the enthalpy content will remain almost unchanged. At saturation, dry bulb, wet bulb, and dew point temperatures will be equal.

The wet bulb temperature lines are important process lines in passive design. Adiabatic cooling potential is limited by wet bulb temperature, and the lines are used in the process definition of evaporative passive cooling techniques. Additionally, the action of desiccant absorption of moisture closely follows the wet bulb temperature lines with only a 5-10% entropy associated with the process. Therefore, during desiccant dehumidification, a given quantity of air will increase in dry bulb temperature while decreasing in relative humidity and the total enthalpy content of the air will rise slightly, following almost the opposite pattern of adiabatic cooling.

Specific Volume. As air is heated and as it absorbs moisture vapor, it becomes more buoyant (it weighs less per unit of volume – hot air rises). The psychrometric chart provides a method of determining the volume of air that will weigh one pound under various conditions through the lines of specific volume.

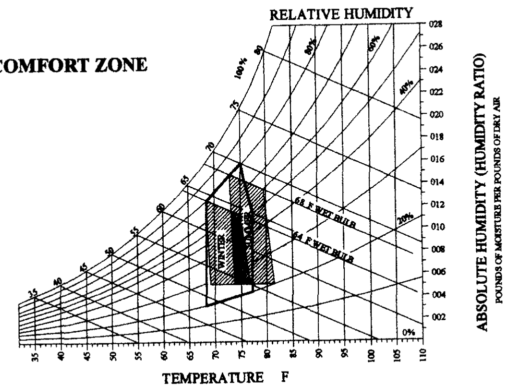


The complete psychrometric chart is useful to the designer for two major reasons. It enables a thorough understanding of all of the variables of air quality given any two of those variables, and it can be used to directly and indirectly define the conditions under which comfort will occur. Additionally, it is a useful tool in the understanding of the mechanisms of comfort conditioning. It is used extensively by mechanical and thermal engineers in the design of comfort conditioning systems. In passive cooling the psychrometric chart is very useful for process definition.

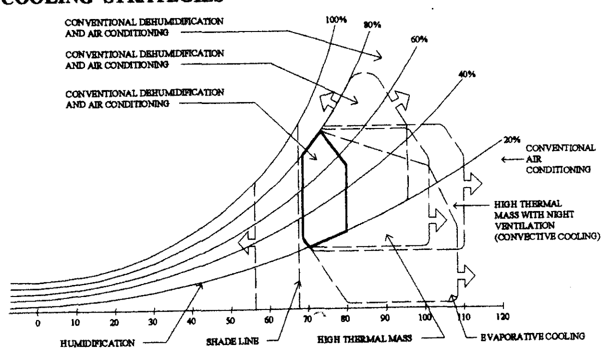


Comfort Zones & Standards. The psychrometric chart is used by ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) and many researchers as the graphic base

COMFORT ZONE



COOLING STRATEGIES



line for the definition of comfort. In ASHRAE's comfort chart an additional set of parameters are added to the psychrometric chart. The effective temperature (ET) is represented on the psychrometric chart by dashed lines. The effective temperature is an attempt to integrate temperature and humidity into one scale that represents lines of constant body stress. Toward extreme cold, the effective temperature lines approach the dry bulb temperature scale and toward extreme heat they approach the wet bulb scale. The index line for the ET scale is the 50% relative humidity curve.

The ASHRAE comfort zone is defined by the air conditions under which 80% of tested subjects would express thermal comfort. The chart is applicable only to lightly clothed, sedentary individuals in spaces with low air movement, where mean radiant temperature equals air temperature.

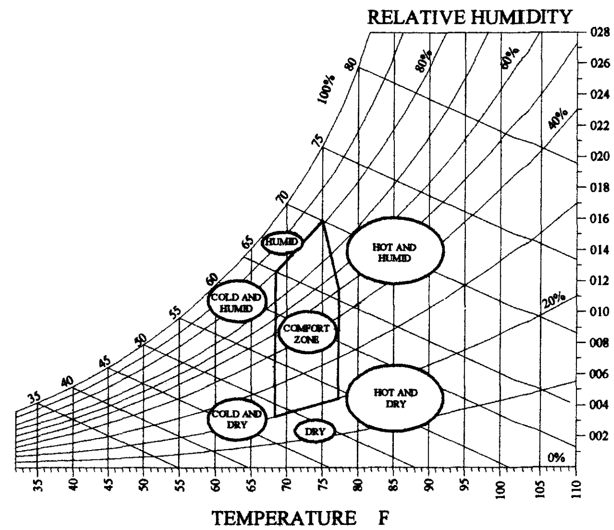
More recently, Baruch Givoni, author of Man, Climate and Architecture has provided a mechanism, using the psychrometric chart, for expressing the potential effects of passive cooling building design on human comfort. The system expresses the design strategies that can effectively bring given ambient climate conditions into the comfort zone through proper building design. In all, three major cooling design strategies are covered: 1. Evaporative cooling, 2. High thermal mass, and 3. Natural and mechanical ventilation. The following graphic does not include evaporative cooling because it is not a strategy that is very effective in the Gulf Coast states based on the fact that it mainly works in areas of low humidity.

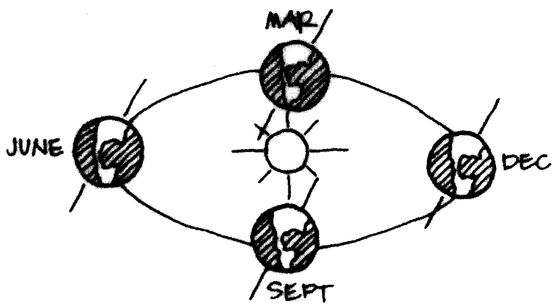
In terms of building design, each of the cooling techniques has maximum ambient climate conditions. For high thermal mass structures, a dew point temperature of 68°F is the boundary condition. For natural and mechanical ventilation, the limit seems to be a line roughly corresponding to (but with a more negative slope) and crossing the 90°F line at 50% RH.

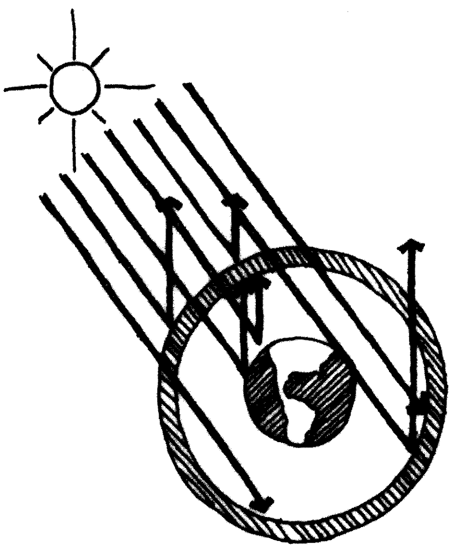
Thermal Comfort. Thermal comfort occurs when body temperatures are held within narrow ranges, skin moisture is low, and the body's effort of regulation is minimized. Certain combinations of air temperature, relative humidity, air motion, and mean radiant temperature will result in what most people consider thermal comfort. When these combinations of air temperature, relative humidity, high thermal mass, and ventilation are plotted on a psychrometric chart, they define an area known as the comfort zone.

It is important to note again that the given boundaries of the comfort zone are not absolute, because thermal comfort also varies with culture, time of year, health, the amount of fat an individual carries, the amount of clothing worn, and most importantly, physical activity. ASHRAE defines thermal comfort as "that condition of mind which expresses satisfaction with the thermal environment." While conditions required for thermal comfort vary from person to person, the comfort zone should be the goal of the thermal design of the house because it defines those conditions that most people in our society find comfortable.

Whenever possible, additional controls should be made available for the occupants of the house so that they can create the thermal conditions that are just right for them. Portable fans and heaters, ceiling fans, window fans, numerous thermostats, operable windows, and shades are some of the devices people can use to fine-tune their personal environment.







CHAPTER 3

CLIMATE

"We must begin by taking note of the countries and climates in which homes are to be built if our design for them are to be correct. One type of house seems appropriate for Egypt, another for Spain...one still different for Rome....It is obvious that design for homes ought to conform to diversities of climate."

Vitruvius
Architect, First Century BC

The earth's weather patterns are driven by the sun. Each revolution of the earth gives the heartbeat of day and night. The 23.5° tilt of the earth's axis, its rotation around that axis, and its elliptical orbit around the sun sets the annual rhythm of the seasons.

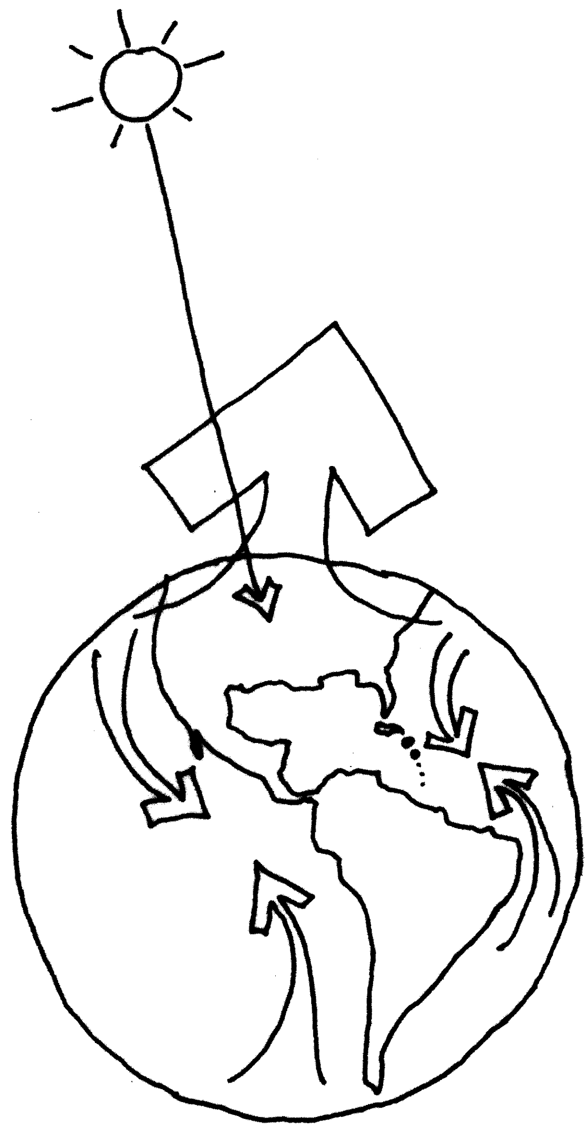
Plant material first inhabited the earth, and over millennia created the atmosphere that allows life, as we know it, to exist on this planet. The atmosphere acts as a filter to screen out the harmful rays from the sun.

The earth's envelope has performed a delicate heat loss/heat gain balancing act for centuries. Planet earth absorbs heat from the sun and stores or transforms it into some form of energy or else reradiates it back into deep space. As early mankind began populating the earth, they slowly began releasing the solar energy stored in the form of wood, by burning it for heat and light. The Industrial Revolution affected the massive burning of fossil fuels, which is a more concentrated form of stored solar energy. This, along with deforestation, is disturbing the delicate balance of nature.

As the upper atmospheric ozone layer is depleted by burning these fossil fuels, less of the sun's harmful radiation is being filtered out. It is believed that the earth will continue to have elevated temperatures.

If this is true, then the polar ice caps will start to melt, the oceans will rise, coastal cities around the globe will be flooded, and all areas will have a change in their existing climates.

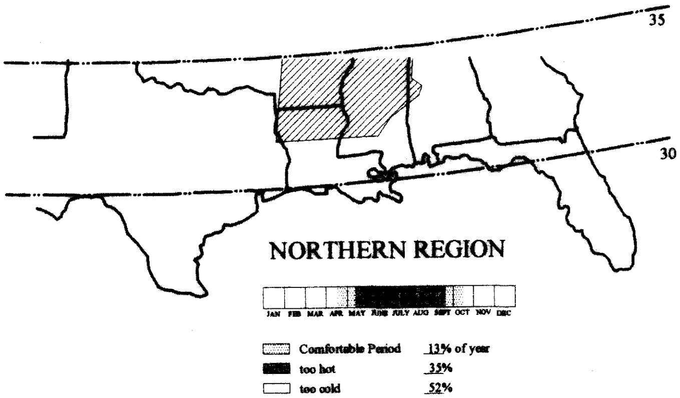
The atmosphere is a giant heat machine fueled by the sun. Since the atmosphere is largely transparent to solar energy, the main heating of the air occurs at the earth's surface. As the air is heated, it rises and creates a low-pressure area at ground level. Since the surface of the earth is not heated equally, there will be both relatively low- and high-pressure areas with wind as a consequence.

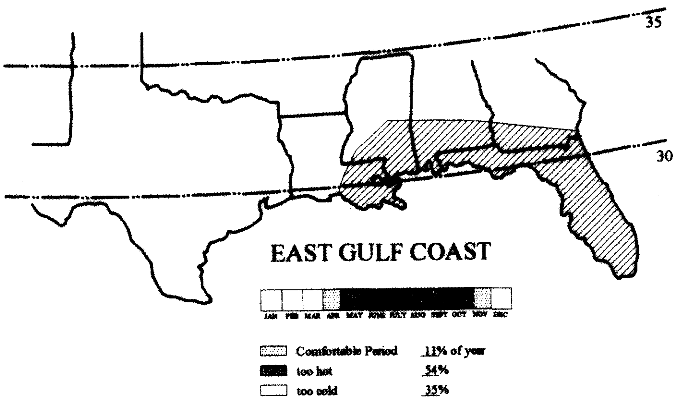


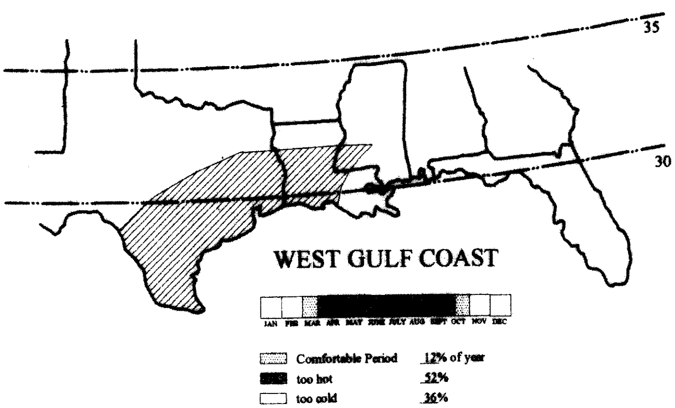
A global north-south flow of air is generated because the equator is heated more than the poles. This global flow is modified by both the changes in season and the rotation of the earth. Another major factor affecting winds and, therefore, climate, is the uneven distribution of land masses on the globe. Because of its higher heat capacity, water does not heat up or cool down as fast as the land. Thus, temperature changes over water tend to be more moderate than over land, and the farther one gets from large bodies of water the more extreme are the temperatures. For example, we would expect the temperatures in Shreveport to be colder than in Lafayette during the winter, and they are, but Shreveport is also warmer in the summer due to Lafayette's proximity to the Gulf of Mexico.

MACROCLIMATE

The general macroclimate of all of Louisiana and the Gulf Coast states is strongly influenced by their proximity to the Gulf of Mexico and the equator. This coastal area is considered a humid, subtropical climate. Breezes of the warm, moist air and cumulus clouds from the Gulf dominate most of the year. Cold fronts driven down by Canadian high pressures come from the northwest bringing cold, dry northerly winds and clear skies. Other wind patterns are influenced by high- and low-pressure centers moving over the area. The winds move







clockwise around a high-pressure center and counterclockwise around a low-pressure center. The "Bermuda High" commonly dominates the coastal states summer wind pattern with south to southeast winds from the Gulf of Mexico.

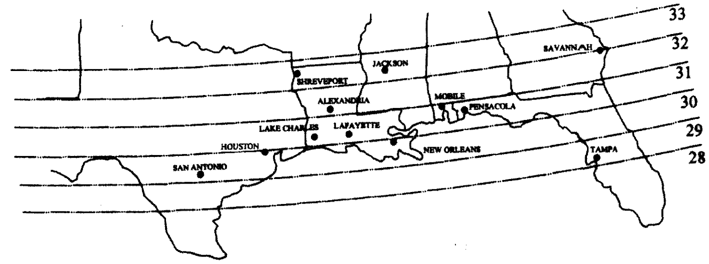
Hurricanes are low pressure storms that develop off the west coast of Africa. The winds blow in a counterclockwise direction around the calm eye of the storm. High winds, torrential rains, and the coastline tidal surge of the hurricane can be very destructive. The hurricane season is from June through November.

The coastal states are divided into three more specific areas of climate distinction:

North Louisiana & North Mississippi's climate can be considered relatively temperate with four distinct seasons. Although summers are very hot and humid and winters are quite cold with chilling winds, spring and fall are generally quite pleasant. The annual precipitation is about 48 inches and occurs fairly uniformly throughout the year.

The ***East Gulf Coast*** climate has cool but short winters. Summers, on the other hand, are hot, very humid, and long. The flat damp ground and frequent rains create a very humid climate. Besides creating thermal discomfort, the high humidity also causes mildew problems. Much of the region has reliable sea breezes, which are strongest during the day, weaker at night, and nonexistent during the morning and evening when the wind reverses direction. The annual precipitation is quite high at about 60 inches, and it occurs fairly uniformly throughout the year.

The ***West Gulf Coast*** climate is similar to the east Gulf Coast climate except that the summers are more severe. Very high temperatures and humidity levels make this a very uncomfortable summer climate. The high humidity and clouds prevent the temperature from dropping much at night. Thus, the diurnal temperature range is quite small. Fortunately, frequent coastal breezes exist in the summer. Winters are short and mild. Ample sunshine can supply most of the winter heating demands, but the main concern for the designer is summer overheating. The annual precipitation is about 45 inches and occurs fairly uniformly throughout the year.

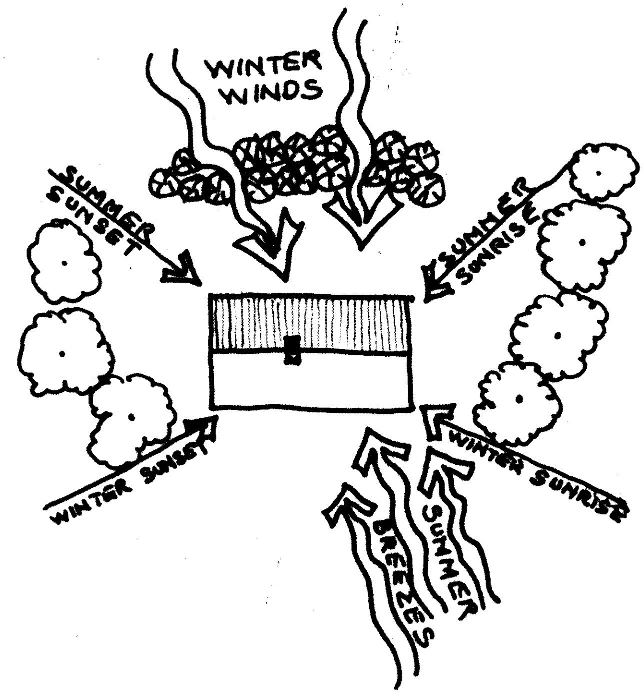


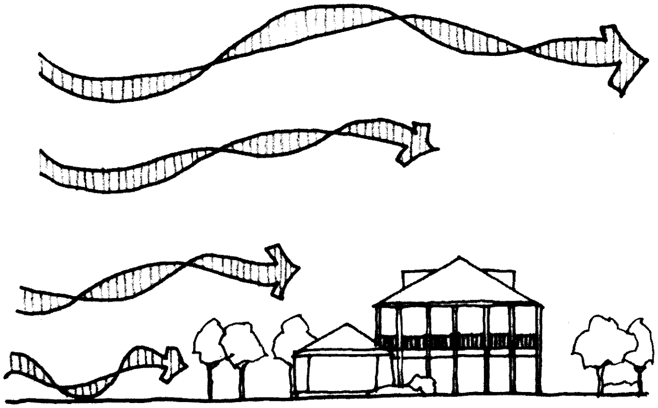
Charleston	@ 32° 53'	w/ 51.53" of precipitation/yr.
Shreveport	@ 32° 28'	w/ 46.11" of precipitation/yr.
Jackson	@ 32° 19'	w/ 55.37" of precipitation/yr.
Savannah	@ 32° 07'	w/ 49.22" of precipitation/yr.
Alexandria	@ 31° 19'	w/ 54.06" of precipitation/yr.
Mobile	@ 30° 42'	w/ 63.96" of precipitation/yr.
Baton Rouge	@ 30° 32'	w/ 54.05" of precipitation/yr.
Pensacola	@ 30° 28'	w/ 62.25" of precipitation/yr.
Lafayette	@ 30° 18'	w/ 57.69" of precipitation/yr.
Lake Charles	@ 30° 07'	w/ 54.84" of precipitation/yr.
New Orleans	@ 29° 59'	w/ 61.88" of precipitation/yr.
Houston	@ 29° 59'	w/ 46.07" of precipitation/yr.
San Antonio	@ 29° 31'	w/ 30.98" of precipitation/yr.
Tampa	@ 27° 57'	w/ 43.92" of precipitation/yr.

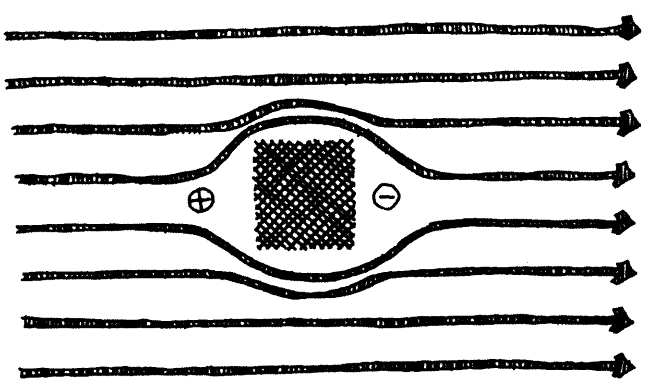
Weather data for each city is include in the Appendix.

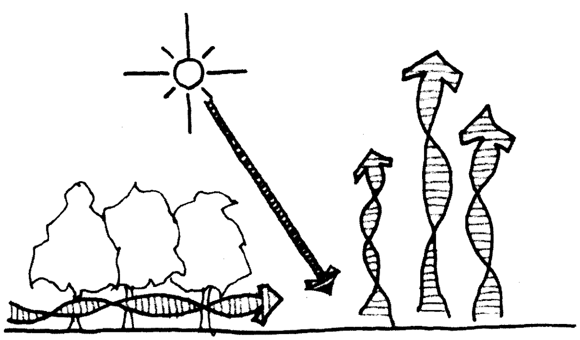
MICROCLIMATE

Each individual building site has its own microclimate. This is understood by site analysis, and having a good understanding of the macroclimate or general climatic characteristics which give an overview of the climate for the region where the site is located. The microclimate must be studied not only for the natural elements, but also for how any man-made elements, such as buildings and landscaping, are affecting and will affect the local climate of the building site.









Sun. The movement of the sun over the site will be the same as it is for the macroclimate. However, all existing elements, whether natural or man-made, on and around the site will have definitive daily shading patterns that need to be studied (see Appendix for *Suncharts* and how to use them). Understanding the sun and shadow patterns for summer and winter can help in either locating the building on the site, or for existing houses that will not be moved, how to use landscaping to help manipulate the microclimate.

Architectural elements, like a roof overhang or a porch, can easily shade the south side of the house when the sun is high in the sky during the summer. It is the east, and more importantly, the west that is more difficult to protect from the summer sun because it is much lower in the sky. Where a horizontal element (roof overhang or porch) is beneficial on the south side, it will take a more vertical element to control the sun on the east and west side of the house. This is where good landscaping can be most beneficial. The best design will block the summer sun heat gain, but allow the winter sun to penetrate the house for the added heat gain.

Wind. The movement of air on the site is more difficult to see or understand than the predicted sun movement. The patterns of breezes at the site will not necessarily be the same as that found in the climatic data charts for the macroclimate. Existing vegetation and man-made structures will affect the movement of air on the site. This is not easy to comprehend unless you build a model and observe it in a wind tunnel. However, there are some basic principles of air movement that can help one to understand what will happen on the site.

1. As a result of friction, air velocity is slower near the surface of the earth. The reduction in velocity is a function of the ground's roughness, including contour changes and vegetation configuration. Ground wind velocities measured at the site are frequently much lower than those measured at the top of an airport tower (these are the figures most likely given in the macroclimate weather data).

2. Air tends to continue moving in the same direction when it encounters an obstruction. As a result of the inertia of the wind, it tends to flow around objects, like water flows around a rock in a stream, rather than reflect off the objects.

3. Air flows from high-pressure to low-pressure areas. For example, cross ventilation is created by a positive pressure being built up on the windward side of a structure and a negative pressure being created on the leeward side. Architectural elements and landscaping can also create positive and negative pressures around the house.

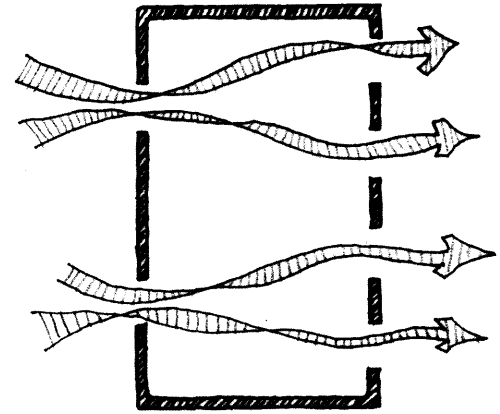
4. Temperature and the density of the air will also affect air movement. For example, air flowing from a forested area to a meadow will tend to rise because air in the meadow is exposed to more solar radiation, making that air warmer and less dense than the cooler air exiting the forest.

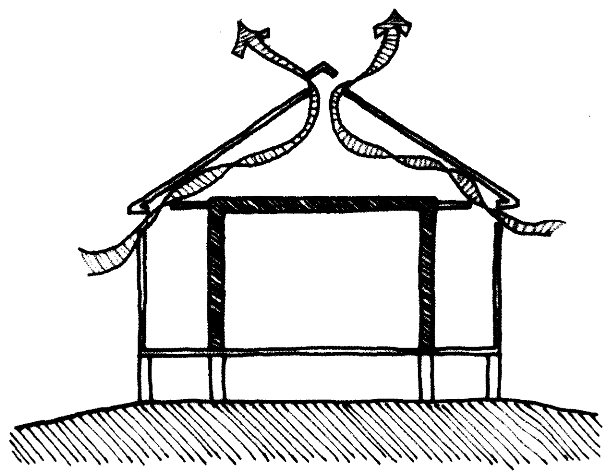
5. When the airflow is channeled and restricted, the pressure rises and the velocity increases. This is called the Venturi effect. Therefore, if you have more openings on the leeward side than you do on the windward side, you will increase the velocity of the breezes passing through the house.

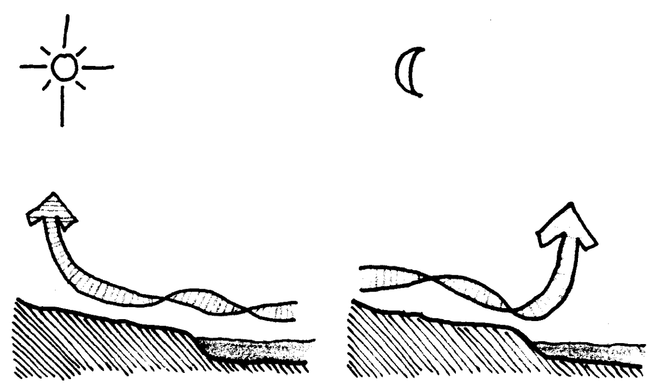
6. Air can also move by the stack effect, which usually takes place inside the structure. In taller areas, hotter air will rise and pull cooler air in below, if there are openings at both the top of that space and the bottom to allow this air movement.

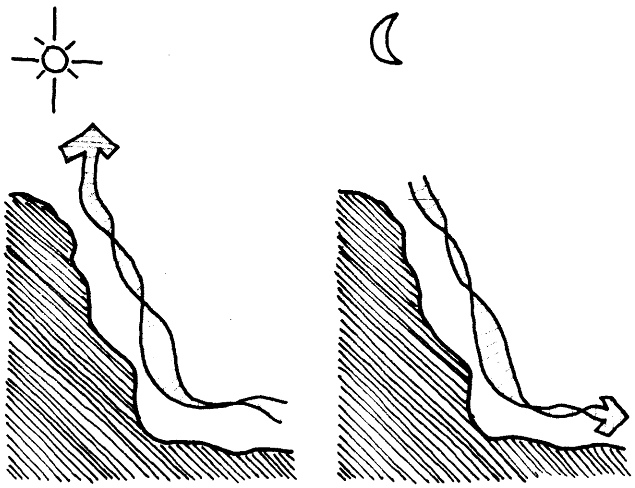
By using these principles and understanding that air moves and acts similar to a fluid, like water, we can visualize wind patterns on different sites and in different conditions.

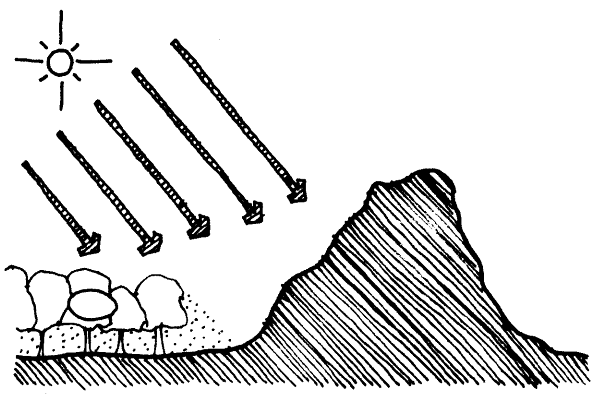
The wind pattern near large bodies of water is generated by the heat gain, loss, and storage variations between land and water. Water will have more stable temperatures because of its thermal mass (higher specific heat value as compared to the earth). The wind is usually moving toward the land during the day when the land is heating up faster and when the water is absorbing solar radiation. At night the direction is reversed, with the breezes flowing from the land, as it cools, to the water, as it radiates stored heat to the night sky.











This is also true for a site located in a valley. The air moves up the valley during the day as the air is heated, and down the valley during the night as the air is cooled. The landscape can be manipulated to build dams that create pockets or lakes of this cool night air, just as fog forms in the cool air pockets of Louisiana.

Humidity. Sites located near large bodies of water or rivers tend to be more humid than inland areas. Likewise, sites that are wooded will tend to be more humid than sites in an open area. Vegetation will increase moisture in the air. Wind direction also affects the humidity level. Humidity has to do with the amount of water vapor in the air. However, water vapor can act independent of air. For any given temperature and degree of saturation, water vapor in the air exerts its own vapor pressure. It flows or migrates from areas of higher vapor pressure toward areas of lower vapor pressure in air or in materials. Moisture, driven by vapor pressure, can even travel through porous materials through which air cannot pass. This can be a major problem in our humid climate.

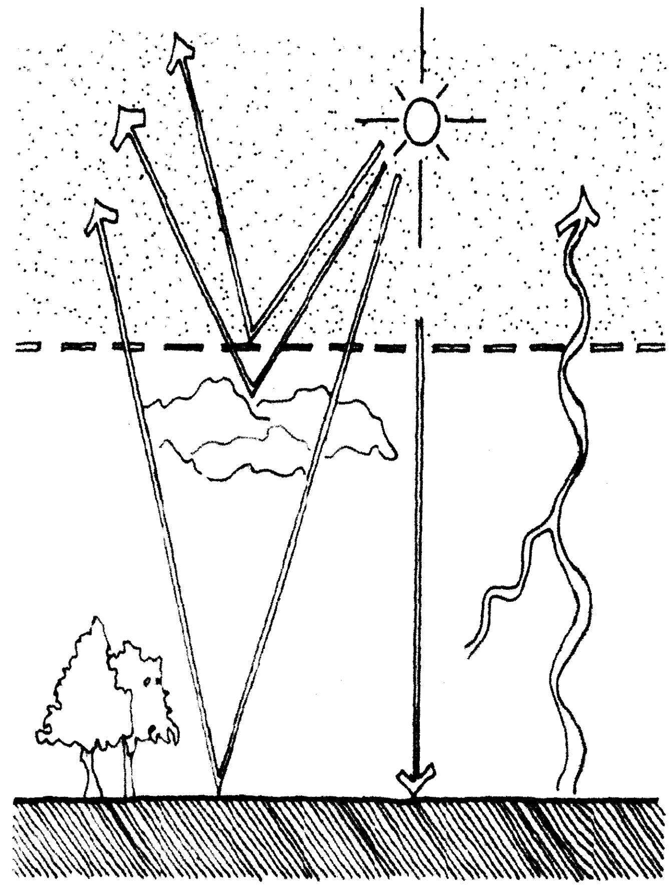
Temperature. The microclimate temperatures of the site will be different from the general data collected at the airport. Again, air temperature is more stable close to large bodies of water, and cooler in forested areas. The shade temperature of a large tree can be 10° to 15°F cooler than the unshaded lawn during a summer day. And sites with a more southern slope will be warmer than a flat site because radiation from the sun is more intense when perpendicular to the surface. Likewise, a northern sloping site would not receive as much radiation and would therefore be cooler.

CHAPTER 4

THERMODYNAMICS

"In the beginning, when God created the heavens and the earth, the earth was a formless wasteland, and darkness covered the abyss, while a mighty wind swept over the waters. Then God said, 'Let there be Light', and there was light. God saw how good the light was. God then separated the light from the darkness. God called the light 'day' and the darkness He called 'night'. Thus evening came, and morning followed - the first day."

Genesis 1:1-5

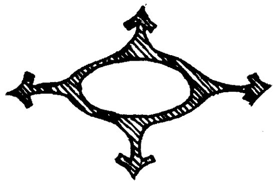


It is appropriate to address energy because most of the elements of trying to stay within the comfort zone with the renovation of a home have to do with adding, removing, reflecting, and shading energy from the structure. We get our energy from the sun, which is created by nuclear fusion. It travels to the earth, some 93 million miles away, by short-wave radiation in about eight minutes at the speed of light.

Solar energy is received in various wavelengths, of which the light that we see is only one part. The short ultraviolet wavelength portion provides energy for plant growth by photosynthesis, but most of it is absorbed by ozone in the upper atmosphere. Radiation in the infrared wavelength heats the earth's surface. Only half of the radiation that reaches the earth's atmosphere penetrates to the surface of the earth, while the other half is either reflected or absorbed by the atmosphere itself.

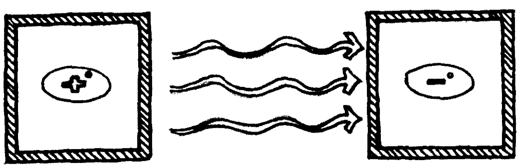
FIRST LAW

The first law of thermodynamics is that energy can be neither created nor destroyed; when one form of energy disappears, another form always appears in equivalent quantity. Heat energy cannot be lost. It

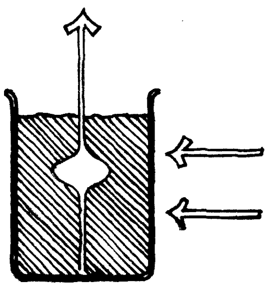


can be converted to another form of energy (electrical, chemical or mechanical) or remain as heat. It can be converted, stored, absorbed, or moved.

SECOND LAW

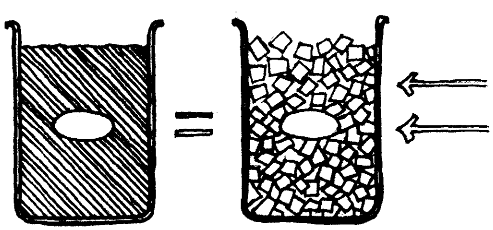


The second law of thermodynamics is that heat cannot pass spontaneously from a colder to a warmer body; when free interchange of heat takes place, it is always the hotter of the two bodies which loses energy and the colder that gains energy. Heat will seek out cold. Heat in a house will constantly move to attain equilibrium throughout the building.

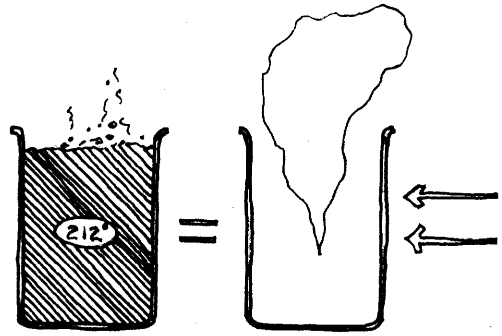


Energy comes in many forms. In our concern about human comfort, the energy we are interested in is heat, which exists in three different forms: *Sensible Heat* – can be measured with a thermometer, *Latent Heat* – the change of state or phase-change of a material, and *Radiant Heat* – a form of electromagnetic radiation.

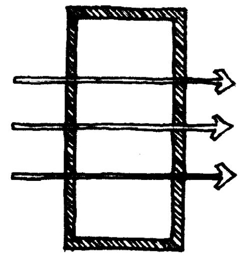
Sensible Heat. Sensible heat is the random motion of molecules. An object whose molecules have a larger random motion is said to be hotter and to contain more heat. This type of heat can be measured by a thermometer. Temperature is a measure of the intensity of the random motion of molecules. In the United States, we measure heat by the British Thermal Unit (BTU) [the British, and the rest of the world use another unit to measure heat]. The amount of heat required to raise 1 pound of water 1°F is called a BTU.



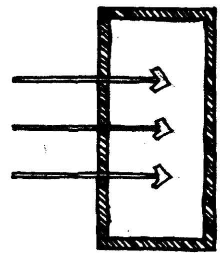
Latent Heat. Latent Heat - By adding 1 BTU of heat to a pound of water, its temperature is raised 1°F. However, it takes 144 BTUs to change a pound of ice into a pound of water and about 1000 BTUs to change a pound of water to a pound of steam. It takes very large amounts of energy to break the bonds between the molecules when a change of state occurs. Latent heat is a compact and convenient form of storing and transferring heat with a mechanical system. However, since the melting and boiling points of water are not always suitable, we use other materials such as "Freon," which has the melting and boiling temperatures necessary for refrigeration machines.



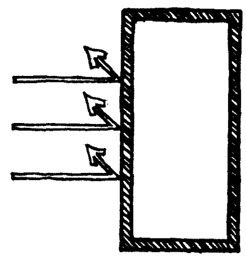
Radiant Heat. It is that part of the electromagnetic spectrum called infrared. All bodies facing an air space or a vacuum emit and absorb radiant energy continuously. Hot bodies lose heat by radiation because they emit more energy than they absorb. Objects at room temperature radiate in the invisible infrared region of the electromagnetic spectrum, while objects hot enough to glow, radiate in the visible part of the spectrum. Thus, the wavelength or frequency of the radiation emitted is a function of the temperature of the object. Radiation is not affected by gravity, and radiates in all directions. However, radiation is affected by the nature of the material with which it interacts and especially the surface of the material. The four possible interactions are:



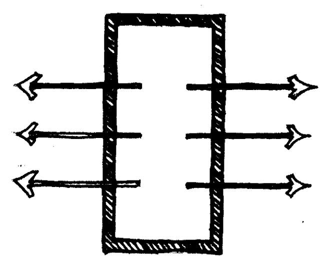
1. Transmittance – the situation in which the radiation passes through the material.



2. Absorptance – the situation in which the radiation is converted into sensible heat within the material.



3. Reflectance – the situation in which the radiation is reflected off of the surface.

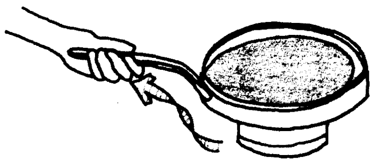


4. Emittance – the situation in which the radiation is given off by the surface, thereby reducing the sensible heat content of the object. Polished metal surfaces have low emittance, while most other materials have high emittance.

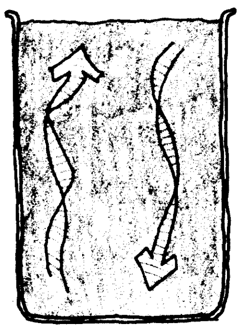
The type of interaction that will occur is not only a function of the material but also the wavelength of the radiation. For example, glass interacts very differently with solar radiation (short wavelength) than with thermal radiation (long-wave infrared). This is explained in the Chapter, under *Greenhouse Effect*.

HEAT TRANSFER

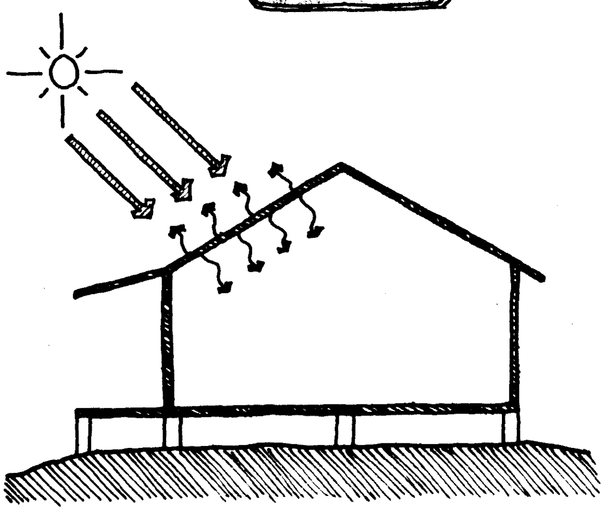
Heat is transferred, from one body to another, by conduction, convection, or radiation. This is very important to understand in the renovation of a house for human comfort.



Conduction. Conductive heat transfer occurs between bodies in direct contact with each other. For example, when you grab the handle of a cast iron skillet, you feel the heat because your hand is in direct contact with the handle, the handle is in direct contact with the skillet, and the skillet is in direct contact with the heat source.



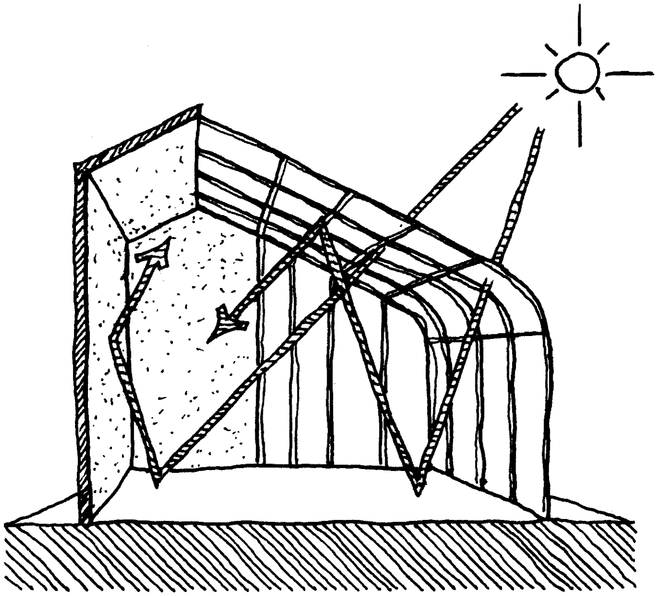
Convection. Convective heat travels through a fluid. As a gas or liquid acquires heat by conduction, the fluid expands and becomes less dense. It will then rise by floating to the top of denser and cooler fluid. A cooler fluid becomes more dense and sinks below the warmer fluid. The resulting currents transfer heat by the mechanism called natural convection. This heat transfer mechanism is very dependent on gravity and, therefore, heat never moves down by convection. Since we live in a sea of air, natural convection is a very important heat transfer mechanism.



Radiation. Radiant heat transfer takes place without a medium. Radiant energy, transmitted as electromagnetic waves, travels at the speed of light until absorbed by a solid or reflected by a radiant barrier, such as aluminum foil. Radiation is always taking place. It is always trying to reach equilibrium – the point that the radiation absorbed equals the radiation emitted.

GREENHOUSE EFFECT

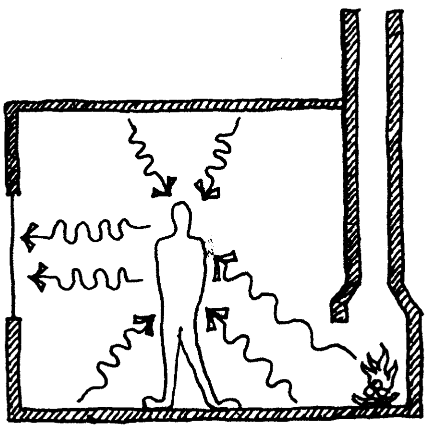
The greenhouse effect is partly due to the fact that the type of interaction that occurs between a material and radiant energy depends on the wavelength of that radiation. The short-wave solar radiation is able to easily pass right through the glass, whereupon, it is absorbed by indoor objects. As these objects warm up, they increase their emission of thermal radiation in the long-wave portion of the electromagnetic spectrum. Since glass is more opaque to this radiation, some of the energy is trapped. The glass has created, in effect, a heat trap and the indoor temperature begins to rise.



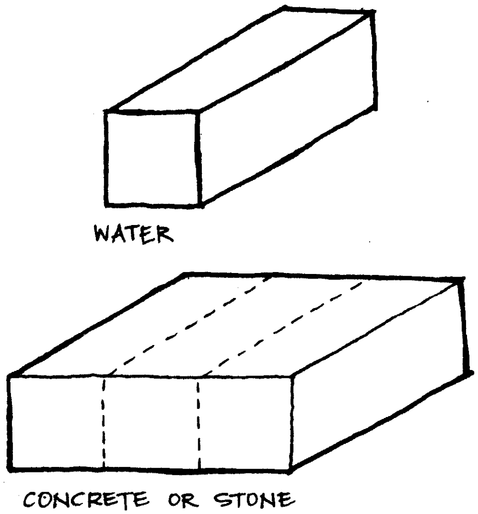
The solar energy that reaches the earth consists of about 5 percent ultraviolet radiation, 45 percent visible light, and 50 percent infrared radiation. To differentiate this infrared from that given off by objects at room temperature, the phrases "short-wave" and "long-wave" are added, respectively. Similarly, ultraviolet radiation has shorter and longer wavelengths. The portion of the ultraviolet spectrum that causes sunburn is blocked by clear glass, but the part that causes colors to fade is not.

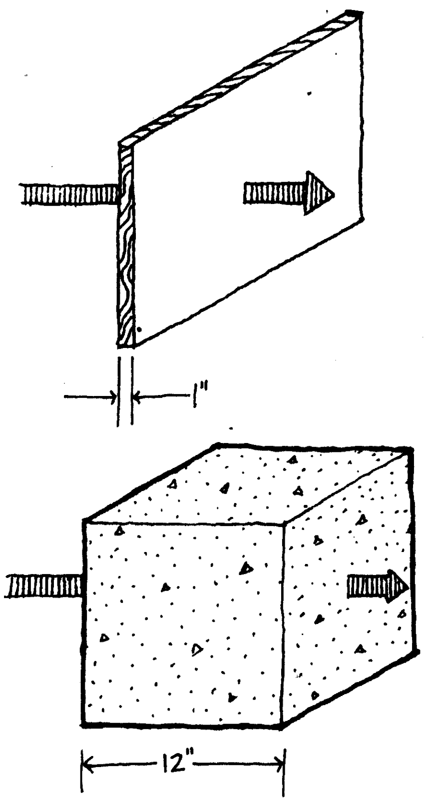
MEAN RADIANT TEMPERATURE

To determine if a certain body will be a net gainer or loser of radiant energy, we must consider both the temperature and exposure angle of all objects that are in view of the body in question. The mean radiant temperature (MRT) describes the radiant environment for a point in space. For example, the radiant effect on one's face by a fireplace is quite high because the fire's temperature at about 1000°F more than compensates for the small angle of exposure. A radiant floor can have just as much of a warming effect but with a much lower temperature because its larger area creates a larger exposure angle. The radiant effect can also be negative as in the case of a person standing in front of a cold window in the winter that allows heat to radiate from the body.



The significant effect MRT has on thermal comfort is further explained in Chapter 2, Human Comfort, under *Mean Radiant Temperature.*





HEAT CAPACITY

The amount of heat required to raise the temperature of a material 1°F is called the heat capacity of that material. The heat capacity of different materials varies widely, but in general heavier materials have a higher heat capacity. Water is an exceptional material in that it has the highest heat capacity even though it is a middle-weight material. In architecture we are usually more interested in the heat capacity per volume than in the heat capacity per pound, which is more commonly known as specific heat. Each volume in the figure, to the side, has the same heat capacity. Water has three times the specific heat value of concrete, stone, or brick.

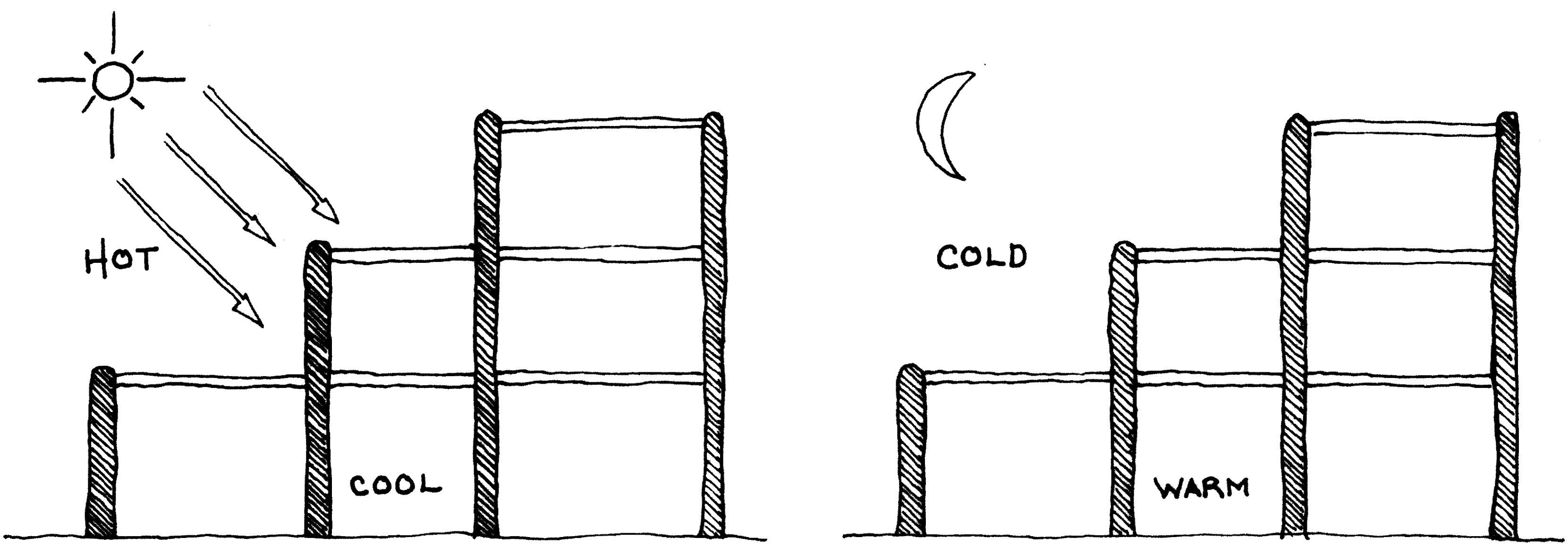
THERMAL RESISTANCE

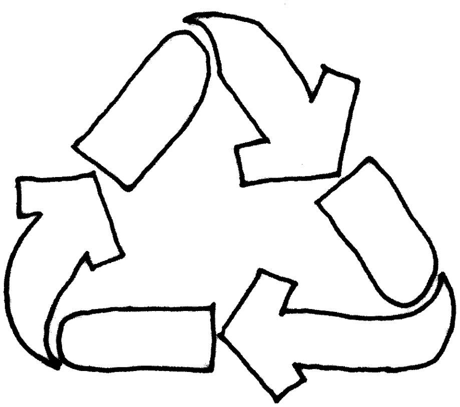
The opposition of materials and air spaces to the flow of heat, mainly by conduction, is called thermal resistance. By knowing the resistance of a material, we can predict how much heat will flow through it and can compare materials with each other. The thermal resistance of building materials is largely a function of the number and size of air spaces that they contain. Most often, thermal resistance is explained for each material in terms of its R-value. One inch of wood has the same thermal resistance as 12 inches of concrete mainly because of the air spaces created by the cells in the wood. Under most temperature conditions, 12 inches of concrete can appear to have more resistance to heat flow than the one inch of wood. To understand this, we must consider the concept of thermal time lag.

TIME LAG

Consider what happens when two walls with equal heat resistance, one inch of wood and 12 inches of concrete, are first exposed to a temperature difference. Let's say that the temperature is 100°F on one side and 50°F on the other side of both walls. Heat will flow through the concrete, but the initial heat to enter will be used to raise the temperature of the massive concrete. Only after the wall has substantially warmed up can heat exit the other side. On the other hand, this delay in heat conduction is very short for the one inch of wood because of its low heat capacity (specific heat value). This delayed heat-flow phenomenon is known as that material's time lag. It is also true that the heat flow from the concrete wall will continue long after the heat in the wood has dissipated.

This is the concept the Native People experienced in their adobe structures to stabilize the temperature of the interior of those structures in the southwest.





CHAPTER 5

SUSTAINABILITY

"I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, so when I came to die, discover that I had not lived."

Walden
Henry David Thoreau

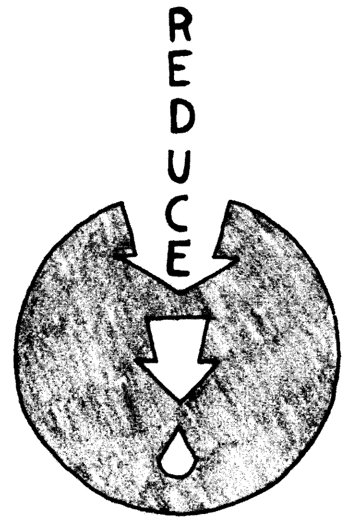
DEFINITION

Sustainability is a more natural way to live and build, and to be less dependent on centralized energy sources using nonrenewable fossil fuels or nuclear energy with the dangerous byproducts of carbon dioxide and radioactive waste. Sustainability means meeting the needs of the current generation without compromising the ability of future generations to meet their needs. A sustainable society conserves, restores, preserves, and enhances nature and culture for the benefit of all life present and future; a diverse and healthy environment is intrinsically valuable and essential to a healthy society; today's society is seriously degrading the environment and is not sustainable.

We really do not have a choice. Just as plant life made a hostile planet safe for life to develop, we must nurture the natural environment and keep it healthy. It is our life source. Nature changes – it is the only thing that is consistent. We have gone through many ice ages and hot periods. The earth is warming at present. This could be a natural process or swing of the climatic pendulum, or it could be from human activity – mainly environmental pollution. Regardless of which it is, human activity in the last 150 years has been detrimental to the natural environment. If it has not caused the warming of the earth, it has helped it happen. All of life will adapt to the changes in their natural environment, or migrate to similar environments, or perish.

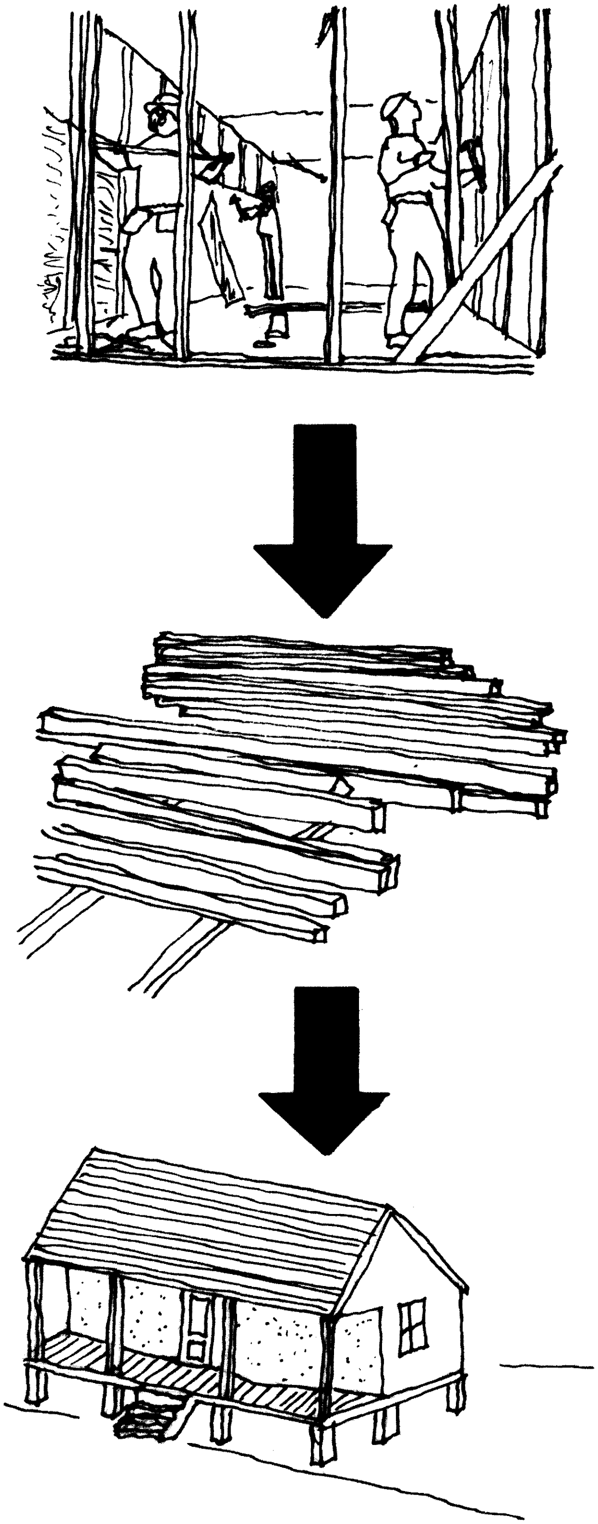
Another way to describe sustainability is by the four R's:

Reduce
Reuse
Recycle
Regenerate



Reduce. Reduce the amount of raw materials needed for the manufacturing process. Lighter and/or smaller products generally require the use of less energy for transportation, storage and construction. Using construction materials that are local will reduce the energy required to transport the material to the job site. Reduce can also refer to decreasing the amount of material used and wasted. Material waste at the job site is a major problem in the construction field today.

Reduce the amount of energy needed to run the structure, much of which will be to keep the occupants comfortable. Good architectural design can easily reduce the energy demand by half. However, that is much easier with new construction than it is with the restoration or renovation of older homes. Energy efficient appliances help to keep the over all energy use to a minimum. Appliances count for 20% of the total energy use in the home. All appliances are rated as to their efficiency by the Energyguide label on the product. The U.S. Environmental Protection Agency and Department of Energy have identified those that are labeled ENERGY STAR® as being the most energy-efficient products in their classes. Paying for the appliance is one thing, paying for the energy to use it over the life of the product in another thing. Look at the life cycle cost of all appliances and you will see that it might benefit the pocket book to pay a little extra on the initial purchase, and save money in the long run. At present the United States has about 5% of the world's population, but we use 25% of the world's energy.



We can also reduce the amount of house we need to live in. Many houses are built with resale value in mind instead of the needs of the occupants. Design and build the spaces that are needed for an enjoyable lifestyle without waste. Efficient use of space makes living in that space so much easier and enjoyable.

Most water reduction can be taken care of with the water fixture design. Look for those with low-flow options. We receive lots of water in Louisiana, and we do not need the added burden of getting rid of even more water from human use.

Reuse. Since reuse is a sustainable activity, the saving of an existing structure is a sustainable act. It can also be a historical one. If the structure has historic value, all avenues should be taken to save the building. Many older houses are built with superior materials. If not, it would not have lasted this long.

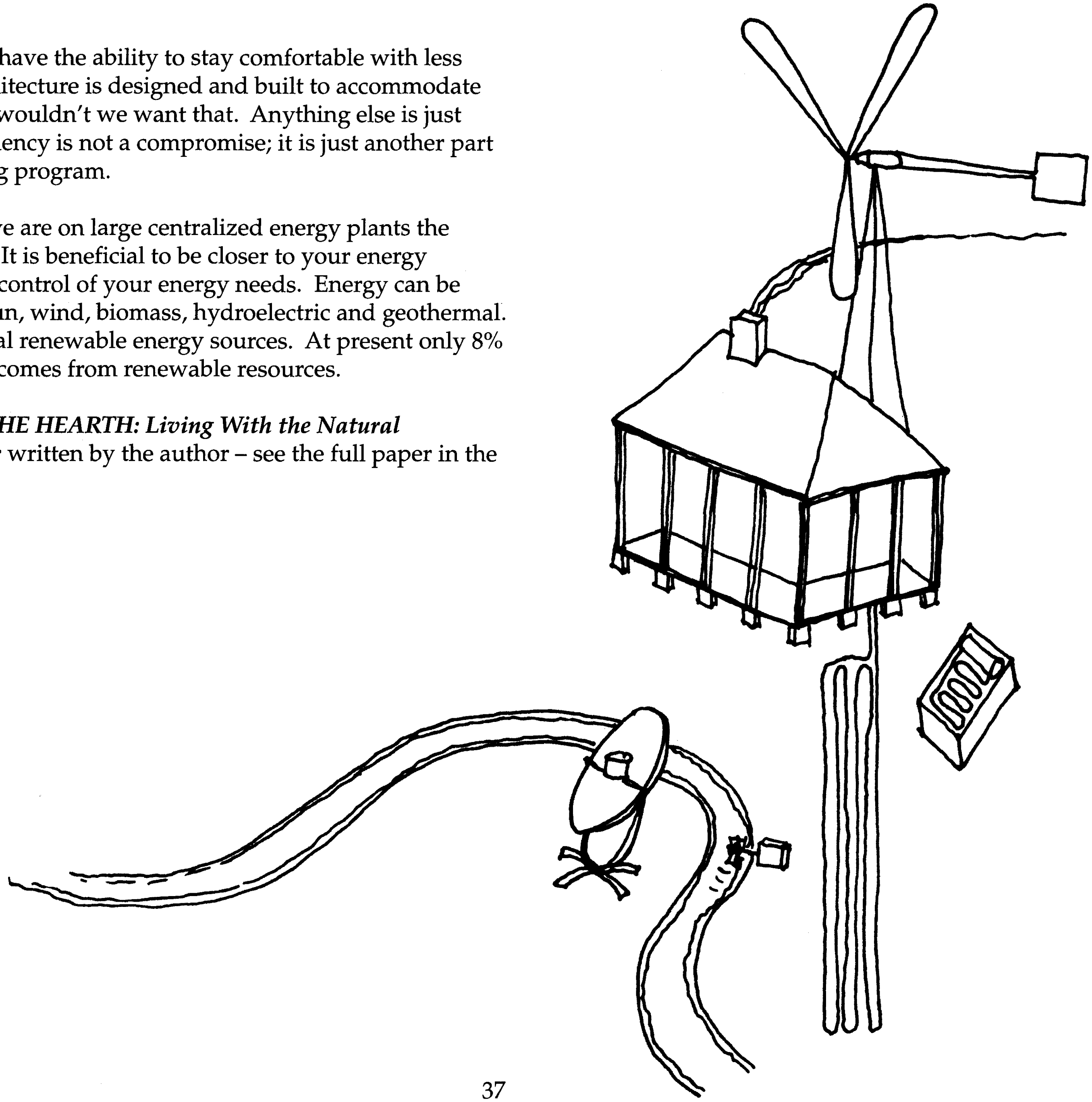
Recycle. If the building cannot be saved or the structure has no historic value (they all do), you can recycle the valuable materials of the building. That is because these older structures were built of mature trees that had superior weathering qualities. The French colonists called cypress "wood eternal". It was easy to work, weathered well, and insect resistant. Long-leaf red pine was another wood that was used and still worth using today. Recycled cypress and red pine are still available today in Louisiana.

Regenerate. Architect Malcolm Wells states in his many writings that we should be trying to regenerate and heal the earth. It would be better if we went out and purchased the worst site we could find to build on, and make it beautiful. However, what we usually do is spend a lot of time and money finding the most beautiful site and making it environmentally and esthetically worse. It is not someone else who will make the world a better place to live; it is we who will have to do it.

Energy Efficient. We have the ability to stay comfortable with less energy when the architecture is designed and built to accommodate that need. And why wouldn't we want that. Anything else is just wasting. Energy efficiency is not a compromise; it is just another part of the overall building program.

The less dependent we are on large centralized energy plants the better off we will be. It is beneficial to be closer to your energy sources, and in more control of your energy needs. Energy can be generated from the sun, wind, biomass, hydroelectric and geothermal. All of these are natural renewable energy sources. At present only 8% of the energy we use comes from renewable resources.

THRESHOLDS TO THE HEARTH: Living With the Natural Environment, a paper written by the author – see the full paper in the Appendix.



CHAPTER 6

RESTORATION & RENOVATION

"When we build, let us think that we build forever. Let it not be for present delight nor for present use alone. Let it be such work as our descendants will thank us for; and let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them, and that people will say, as they look upon the labor and wrought substance of them, 'See! This, our parents did for us'."

Jon Ruskin

The restoration of a building is the process of returning it as nearly as possible to its period form. If the project is a historic restoration, especially if the house is on the National Record of Historic Places, it is recommended that a knowledgeable restoration architect and contractor be involved. Helpful information can also be obtained from the following:

Division of Historic Preservation
Office of Culture Development
Louisiana Department of Culture, Recreation & Tourism
P.O. Box 44247
Baton Rouge, LA 70804-247
(225) 342-8160
www.crt.state.la.us

Louisiana Preservation Alliance
P.O. Box 1587
Baton Rouge, LA 70821
(225) 344-6001
www.lapreservationalliance.org

The Historic New Orleans Collection
533 Royal Street
New Orleans, LA 70130-2179
(504) 523-4662
www.hnoc.org

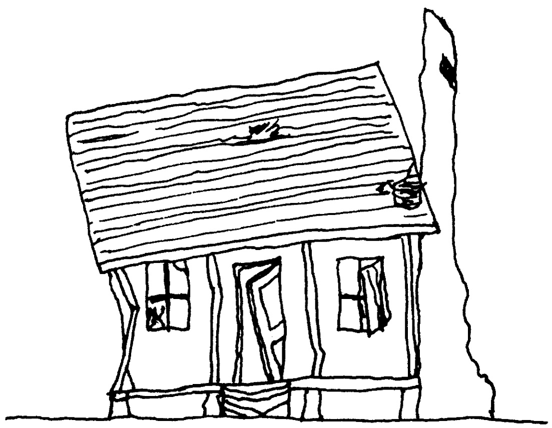
Preservation Resource Center of New Orleans
923 Tchoupitoulas Street
New Orleans, LA 70130
(504) 581-7032
www.prcno.org

Williams Research Center
410 Charters St.
New Orleans, LA 70130
(504) 598-7171
www.hnoc.org

If in the New Orleans French Quarter
Vieux Carré Commission
334 Royal Street
New Orleans, LA 70130
(504) 528-3950
www.new-orleans.la.us/cnoweb/vcc/index.html

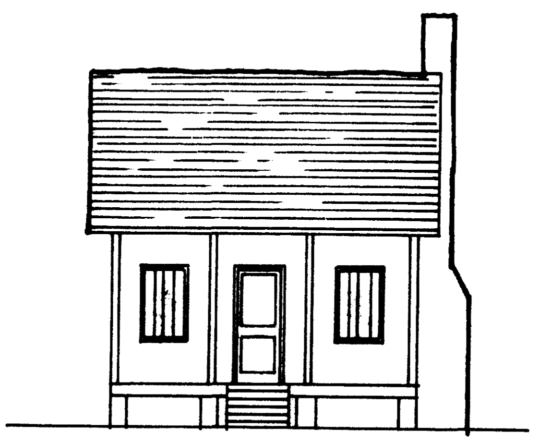
If in New Orleans *other than* the French Quarter
Historic District Landmarks Commission
830 Julia Street
New Orleans, LA 70113
(504) 565-7440
www.new-orleans.la.us/cnoweb/hdlc/index.htm

US Library of Congress
Historic American Building Survey (Measured Drawings)
www.loc.gov/ammen/hhhtml/habshome.html



Historic American Building Survey (HABS) documentation drawings might be obtained from the US Library of Congress on their web site or from the Louisiana Division of Historic Preservation (see references on the previous pages and at the end of this manual). HABS documentation is measured drawings of historic structures that have continually been collected since the depression during the 1920's. The architecture programs in Louisiana universities continue this documentation process today. If the house has been documented by HABS, it can provide very beneficial information to the restoration process.

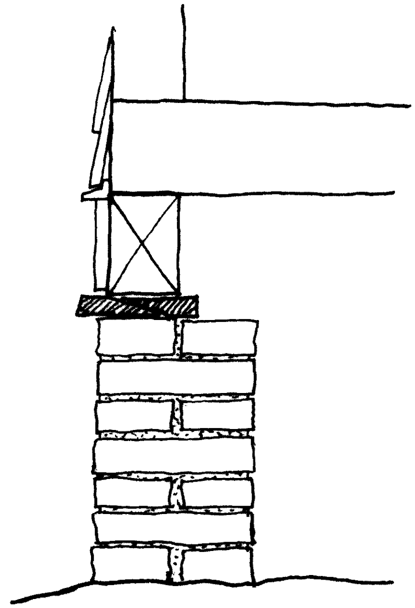
Restoration does not mean that the structure has to be converted to its first original design. The house might have been renovated more than once. It is appropriate to return the house to its original design or one of the period renovations, and not a mixture of different designs. Additions to the historic structure can diminish the historic integrity and value of the house.



Renovation on the other hand means to repair, replace, clean up, or to make like new. In this case there is no historic integrity to protect, and there is more freedom to do as needed to make the house ready for the new owner or use. However, if the exterior is in context with the rest of the houses, it is considered part of the neighborhood fabric. If this is the case, then careful consideration should be given to keeping the exterior appearance to maintain and enhance the neighborhood, and allow the major renovation to be to the interior of the house. This helps keep neighborhoods in tack and livable.

STRUCTURE

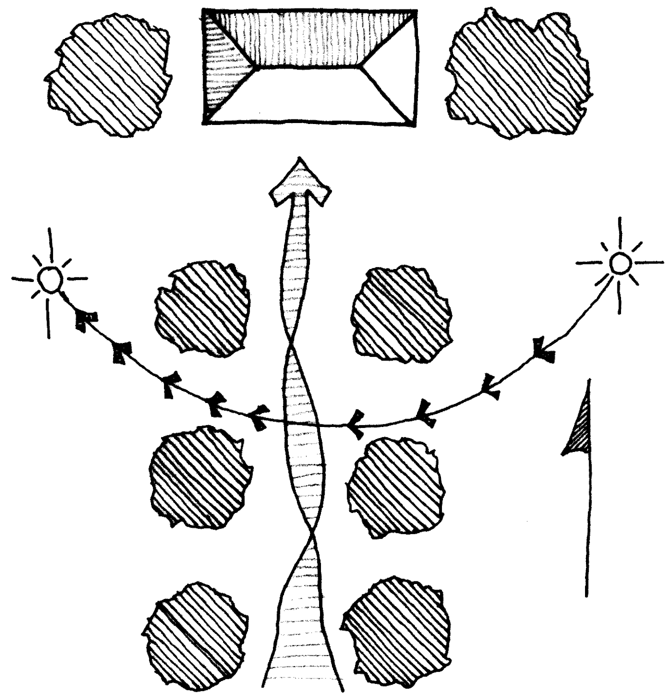
One of the first and major concerns in the restoration or renovation of older houses is its structural integrity. A close look at the ridge of the roof is usually a good indication if there are problems associated with the roof. A closer inspection in the attic might give evidence of problems. Another major problem can be the settlement of the foundation. Most of the older homes in Louisiana are raised off the ground and supported by piers. It is not unusual to see that shims have been added between the pier and the sill to correct settlement problems. Once all site moisture problems have been resolved, the house should be leveled. At this time it might be noted if there are termite shields separating the piers from the sills. This will not stop termites, but it will expose them. A complete investigation for termite damage should also be conducted.

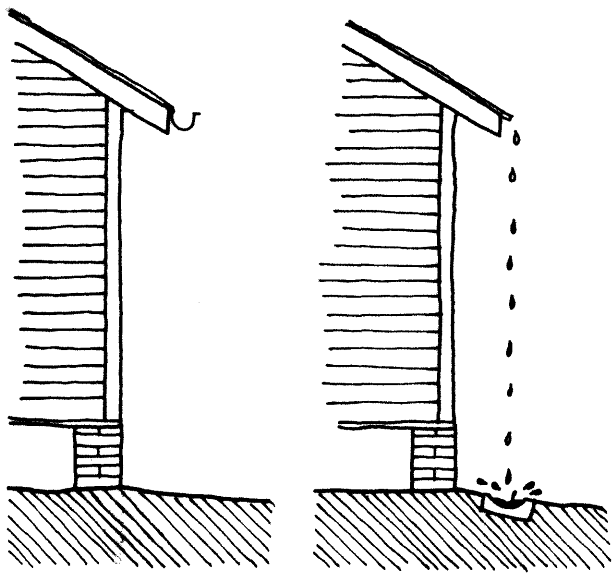


In any case, a complete structural analysis should be conducted and all structural problems should be resolved before moving forward with any other work. If the house is going to be moved, some structural repairs might need to be completed before the move. It is also wise to brace the structure for the move. This is especially true if you are trying to salvage any bousillage, brick between the post or plaster that might be in the house. If the roof, porch(s), or other appendages are to be dismantled for moving the house, everything should be well documented with as-built or as-is drawings, and marked if they are to be put back in the same configuration.

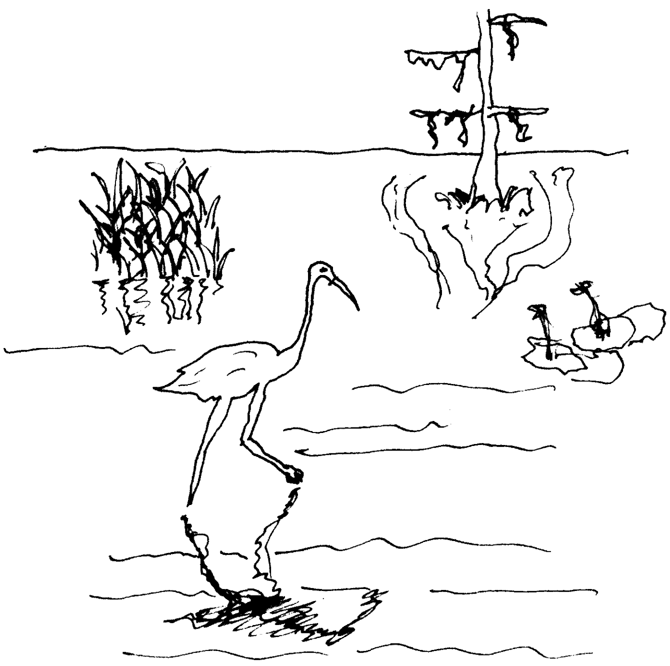
SITE

New Site. If the structure is being moved to a new site, many considerations need to be addressed. Dense vegetation, especially evergreens can be beneficial to block the winter winds if located to the north of the house. Tall deciduous trees to the east, northeast, west, and northwest will help block the summer sun in the morning and afternoon. The afternoon sun during the summer is most critical because this side has the greatest potential for heat gain. An open site to the south will encourage the predominate breezes from spring to fall. Alleys of broad high canopy trees to the south can help cool the air and channel it towards the house. This was a technique used by the French colonists in Louisiana. Trees also help reduce the ambient air temperature of the microclimate associated with the site.



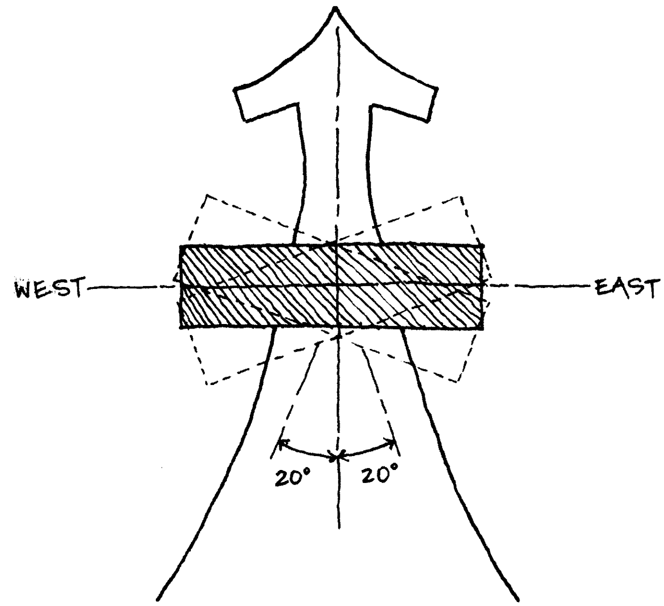


A major concern of any site should be good drainage. This means when rain falls, it should move away from the structure. A 5% slope, or greater, of the ground away from the house should assure good drainage. Gutters at the eave of the roof or on the ground at the dripline of the roof can help direct water away from the structure. Louisiana gets more than its share of precipitation, and much of it comes in the form of storms that produce a lot of rain in a relatively short period of time. The other precipitation comes in the form of those slow, all day garden rains that restore moisture to the soil. Our plant life is here because of the soil condition and climate. And a major player in the coastal environment is damp soil. Historically, there was a high water table and seasonal flooding. Land in south Louisiana has great potential for flooding especially during the hurricane season. Finding a site that is not subject to flooding is an important consideration, one the Native People and Colonists new well.

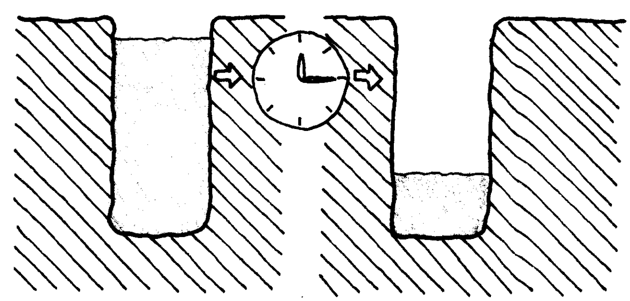


Much of the land that is in a flood zone is considered wetlands. Building on these areas is prohibited by federal law. Wetlands are defined by the elevation of the land and the plant life that grows on that land. Wetlands in Louisiana are protected for two major reasons. One is that it is a major estuary for the sea life of the Gulf of Mexico and critical to fish life on both the salt-water side and inland fresh-water side. And second, it is to act as a cleaning agent for the Mississippi River for the pollutants the upper river valley deposits in the river systems. Significant amounts today are from the runoff of fertilizers, insecticides, herbicides, and defoliants from farmland, and oil from the streets and parking lots of municipalities. When all this is spread out wide and shallow in our wetlands, it has greater exposure to sun and air and this helps clean polluted water. This polluted runoff from our land is helping to create a dead zone in the Gulf of Mexico where no life is present. It would be best to stop this pollution at its source. The other benefits of protecting the wetlands and marshes are that they act as a buffer from coastal storms, is home to many forms of wildlife (a major flyway and winter habitat for migratory birds), and provides for unique recreational activities.

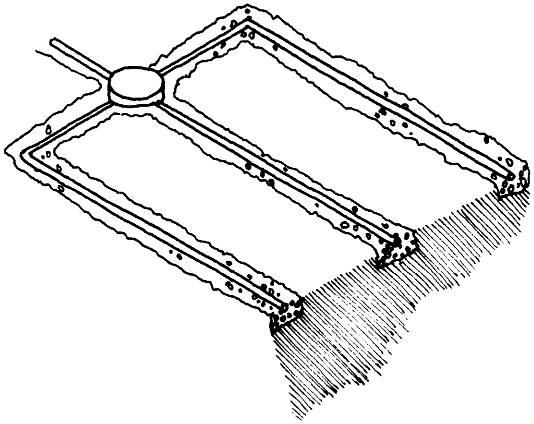
Orientation of the house on the new site can have a significant impact on heat gain, ventilation, and human comfort. If the longer axis is oriented east-west, it will provide a smaller surface for those exposures that are more difficult to protect from the lower angle of the sun in the morning and afternoon. This orientation provides a greater exposure on the north and south facades. The larger south side can be shaded from the high summer sun with a simple overhang or porch. The north side sees very little sun (only at sunrise and sunset during the summer) and provides good quality daylight. This orientation also gives the shortest route for air to pass through the house providing better opportunities for natural ventilation.

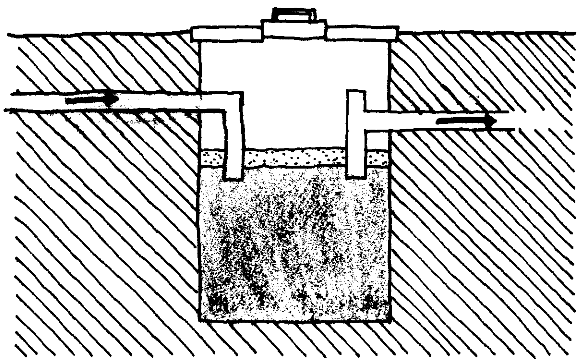


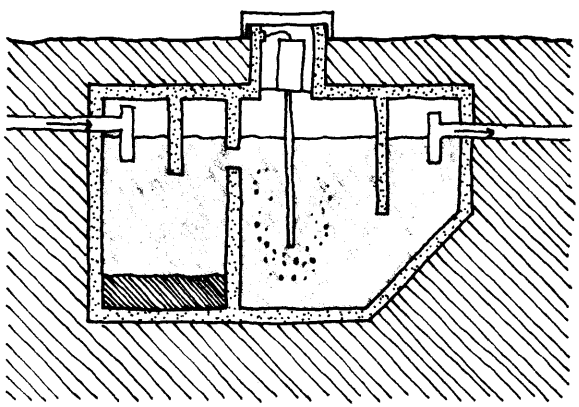
Another major consideration for a new site is the type of soils that are existing on the property. Foundations are designed to support a house based on the loadbearing capacity of the soil. Having soil testing done where the house will sit provides the information needed. A minimum of two shafts (three or more are better) should be drilled within the footprint of the house location. These holes will be about 15 feet deep depending on what the soil engineer finds as they are drilling. Samples are taken to the lab for identification. A report is given to the owner or architect showing the soils loadbearing capacity and the depth of the water table. The report should also give recommendations for supporting the house on those soils. If there are other structures in the immediate area of where the house will be located, they could be studied for support problems and design. This might give you an educated guess as to what is appropriate for your site. However, soils can differ greatly within a very short distance. And you will never know for sure what lies below your site unless it is tested. Adding more piers will help distribute the weight more evenly and carry the load easier. Wider footings under piers also help distribute the load.



Percolation is another test worth taking. This will tell you how well the soils absorb water. This will need to be known if the house is moved to an area that does not provide sewage service. Typically in

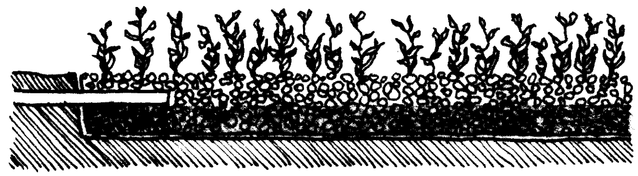




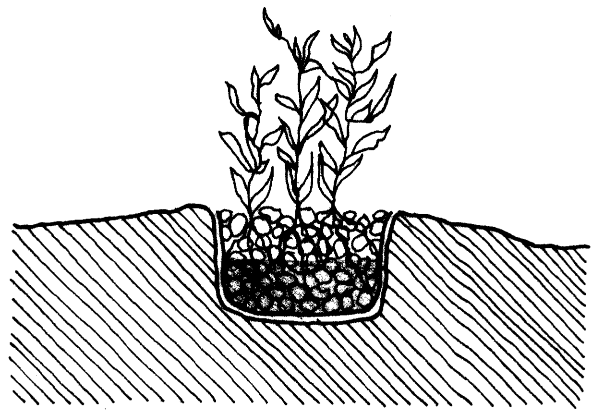


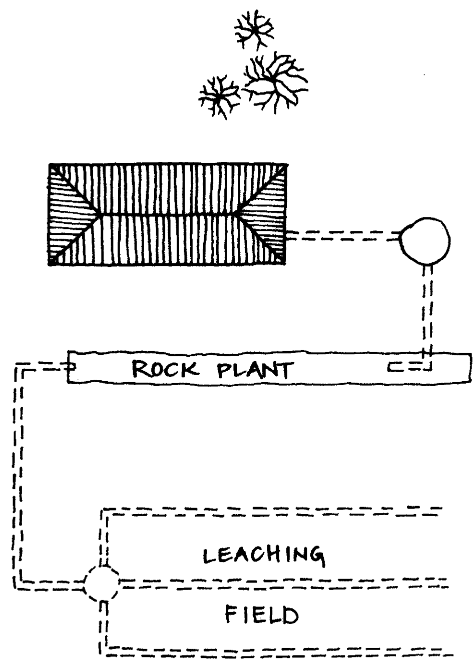
rural areas, sewage was handled with a septic tank and a leaching field that puts the effluent from the tank back into the soil. By the action of microorganisms in the soil, the organic matter is converted into mineral compounds. Anaerobic bacteria in the septic tank digest the solids. They should be kept healthy by not allowing such things as oils (grease) and meats to be deposited in the wastewater drainage system of the house. A grease trap could be used to separate the grease from entering the septic tank. However, a conscious and understanding practice of maintaining this system is important. Yeast tablets are available that can be flushed down the toilet to feed the bacteria to help keep them healthy. Today mainly the parishes in the northern part of the state still allow this type of system with a leaching field.

Today many parishes require that the septic system be a motorized septic tank that pushes air down into the tank for aerobic bacteria to digest the solids – aerobic tank unit (ATU). This is due to the fact that many areas of Louisiana, especially in the southern part of the state, have heavy clay deposits with very poor soil percolation. This aerobic system produces an effluent that is supposedly 95% pure, and you were allowed to discharge this into a lake, bayou, river, canal or even in a ditch up until July of 1998. A new law was put into effect at that time requiring the reduction of the effluent you can discharge into lakes and bayous. The new requirement is to have at least one hundred feet of leaching field or absorption trench between the ATU and releasing the effluent to the environment. Leaching fields in these areas have proven not to work. They will work for a number of years providing a beautiful lawn above. However, at some point, especially during the winter when there is less sunlight, it will provide a soggy and sometimes smelly situation that is not healthy. Follow the fieldline specifications from your local Health Department and double the required length. These ATU systems do not seem to do the job they are expected to do. The effluent discharge should not smell, and many do. It is easy to overload this system, especially if your household has many children, especially teenagers. This is also not a good system when you are trying to be energy efficient. And if the motor goes out, you are discharging raw sewage into the environment that is foul and dangerous. The septic tank cannot be depended upon to remove diseased germs.

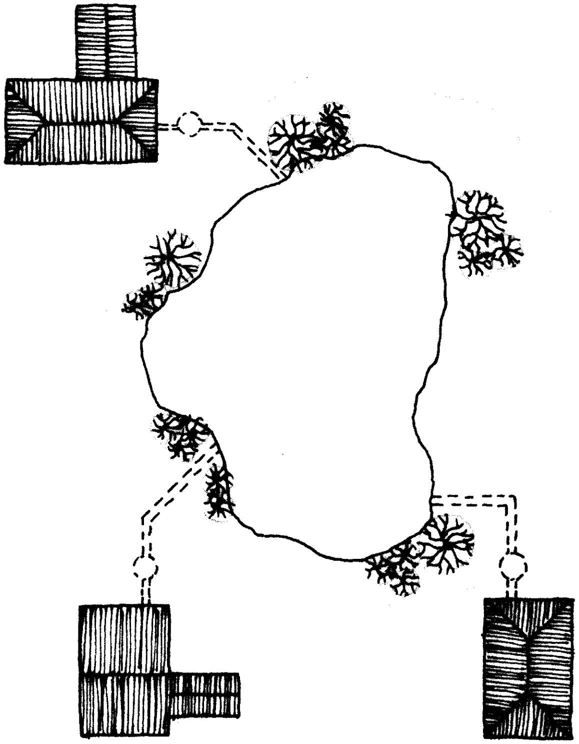


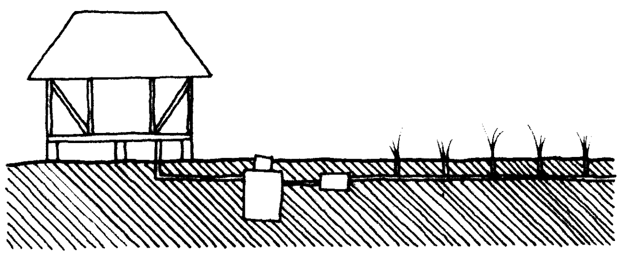
A system that works well, if you have enough land, is a constructed wetland known as a "rock-plant" or "rock-reed" filter system. For a normal size household a trench about 4 feet wide and 80 feet long is sufficient. The hole is about 18 inches deep with a heavy waterproof liner and filled with large rocks. A variety of water succulent plants grow in this medium with their roots feeding off the effluent from the septic tank. The water level is below the rocks, so standing water and mosquitos are not a problem. Get the specifications from the Health Department for the construction of this system and the types of plants required. The septic tank is a large three-compartment unit that discharges the effluent into this rock bed. The plants give up the effluent by evapotranspiration to the air. This system was legal in Louisiana at one time, but the producers of the ATU systems lobbied to shut them down. There were about 40 systems built when this was legal and they are being monitored by the State Department of Health. As of this time they have not been reapproved by the State Department of Health, but are still under study and consideration. However, it is approved and recommended to reduce the effluent from an ATU system. This system works well most of the year, but is not as affective in the winter when the plants die back and less sun is available. If you have the funds, the better system would be to have a large three compartment septic tank with the effluent overflowing into a "rock-plant" which overflows into a leaching field.

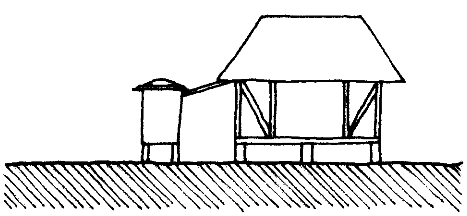




Oxidation ponds are another option. This is a shallow pond designed specifically to treat sewage by natural purification processes under the influence of air and sunlight. The stabilization process consists largely of the interactions of bacteria and algae. Bacteria digest and oxidize the constituents of sewage and render it harmless and odor free. Algae utilize carbon dioxide and other substances resulting from







bacterial action and through photosynthesis produce the oxygen needed to sustain the bacteria in the treatment process. There is a minimum surface area of no less than 400 square feet. Contact the Health Department in your area for code requirements.

Large constructed wetlands can clean septic water for a larger complex than a house, so they can easily accommodate a few houses. This will require acres of land. Follow the Health Departments specifications, to meet code requirements.

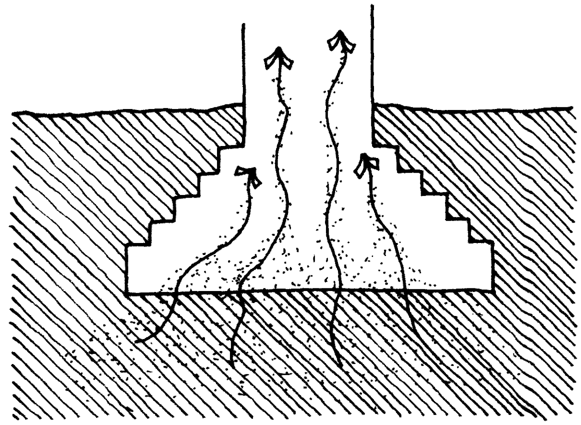
Some parishes are requiring a spray irrigation system with the effluent from motorized tanks. This is especially true around more sensitive environmental areas like lakes and streams. The spray irrigation system uses an electric pump that distributes the effluent to the yard through sprinkler heads. Evaporation and soil infiltration of the dispersed effluent should prevent any runoff from occurring.

Attention also needs to be paid to providing the other utility services to a new site. Check with the local utilities for gas, water, phone, electricity, cable, etc. Well water might be an option, but have it checked for hardness and minerals. It might have to be treated for human consumption. It is suggested for historic purposes, if that is appropriate, that these utilities be brought in underground.

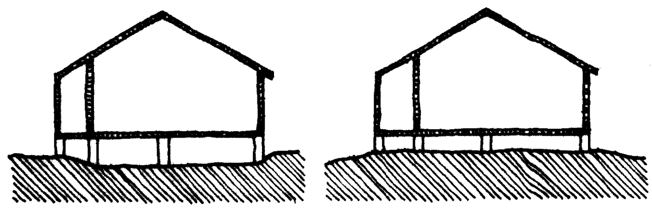
Historically, rainwater was collected and preferred over well water because it was fresh and soft. It is questionable how clean rainwater is today. However, it can be cleaned for potable use or used as is for gardening. Historically, water was also collected in cypress cisterns above the ground with gravity flow, and brick cisterns in the ground that had to be pumped or dipped out.

Existing Site. If vegetation is to be used to augment the microclimate around the exterior of the house, it will have to be planted if it does not already exist. See suggestions for vegetation use under *New Site* previously, for consideration.

Again, close attention to site drainage is a major concern. Many old structures are being compromised by poor drainage. Foundation settlement and rising damp in walls are typical problems in older homes in Louisiana. Rising damp is the capillary action of ground water or moisture up through brick walls that go into the ground with spread footings for support. For pier construction it is not unusual for the ground under the house to be lower than the land outside. This can be due to the natural build up of the earth or plant beds being located around the house. It is necessary for the foundation of the house to stay dry. Soils expand when they are wet and shrink when they dry. Certain soils will move more than others will. Whenever this happens, the foundation it supports will move also. This will result in heaving and settling of the foundation. Also see *Crawl Spaces* later in this chapter.



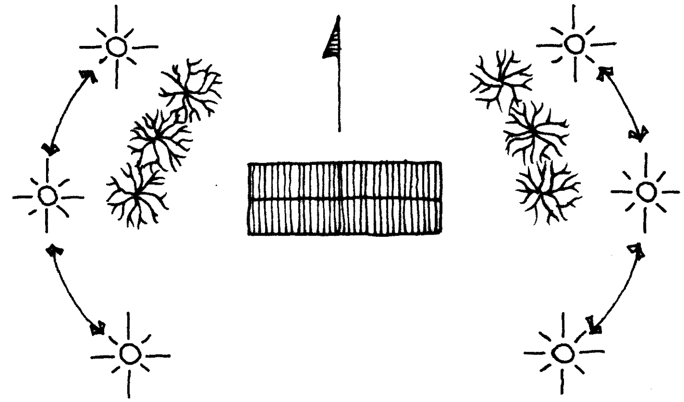
It is important for any drainage and foundation problem to be corrected before any work is started on the house. It will also be very important to take care of any soil moisture problem before trying to correct any foundation settlement problem. Rising damp problems are covered under the *Wall* section below. Review the issues of utilities and sewage treatment under new site above.

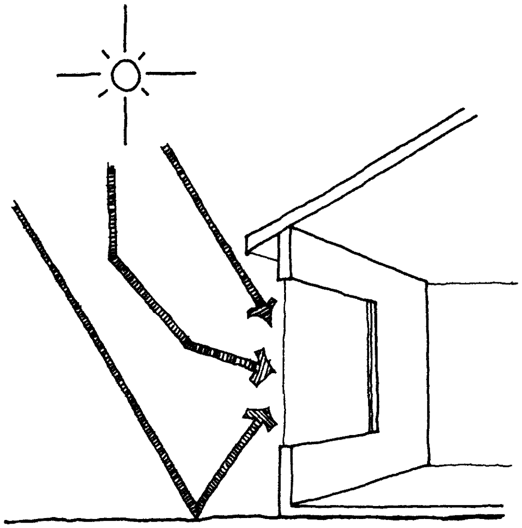


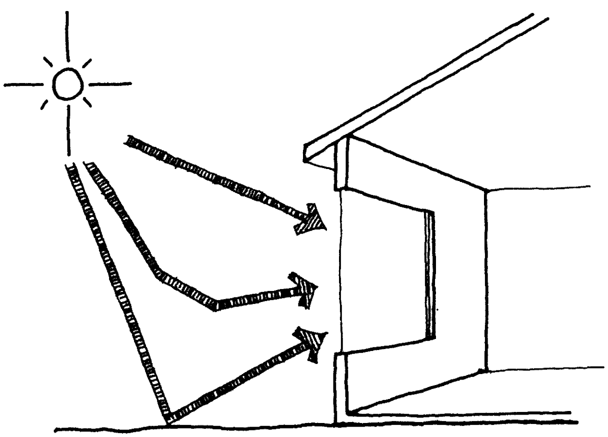
SHADING

The most cost effective and passive strategy for comfort in the coastal states is shading. Shading is protecting, mainly the exterior walls of the house from the heat gain of the sun. Ventilation is also a natural passive strategy that needs to be incorporated with shading. Shading is preventing heat gain, while venting is removing the heat gain.

Of the shading strategies, existing trees are the most cost effective. Whether using existing trees or planting trees, a good understanding of sun movement on the site is important. For an understanding of shading possibility and sun exposure abilities (heat water, winter







interior heat gain, fire wood drying, gardening, greenhouse, photovoltaics, etc.) read Chapter 3 for information on site analysis. See the Appendix for Sungraphs, Sundials, and a Sunpath Simulator to get the sun movement for the location of your site. With these tools you can have a good understanding of how the sun moves on your site.

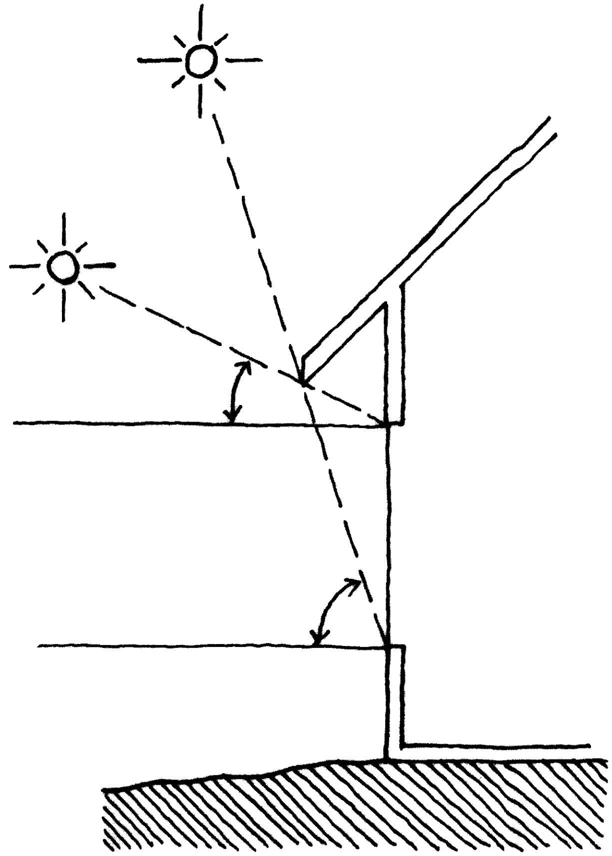
You next want to know when it is that you need to shade. The further north the site, the longer you will want the sun for heating. The more south you are, the more shading you want. Keeping the sun off the glass is most important. This is the weakest link in the insulated envelope. This is where you get the most direct heat gain from the sun. Look at the Weather Data in the Appendix for your area. The months with more than 100 Heating Degree Days of cooling are the same months requiring shading. That is usually 6 or 7 months for most of the Gulf Coast states. Southern Florida would be up to 9 or 10 months of shading required.

Shading on the east and west are the hardest to control architecturally because the sun is lower in the sky. Shading from trees will be beneficial on the northeast, east, west, and northwest. The trees to the northeast and northwest can be shorter or further away. The closer you go to the east and west the taller or closer they will have to be.

Shading of the ground on the east, south, and west is important for ground reflected heat gain. This can be done with very low vegetation like grass or other ground cover.

The south side walls can easily be shaded with a porch, a simple overhang, or awnings. A porch will provide plenty of shading, but will not allow much winter sun in for heat gain. Porch shading was one of the first climate adaptations the colonists used in lower Louisiana. Shutters were also useful to block the early morning and late afternoon direct sun from the interior.

For roof overhang shading, look up the angle of the sun for your area at noontime on the summer and winter solstice, and follow the sizing diagram. Understand that the length of the overhang affects the size and location of the glazing. Adjust the overhang to accommodate your glazing needs.



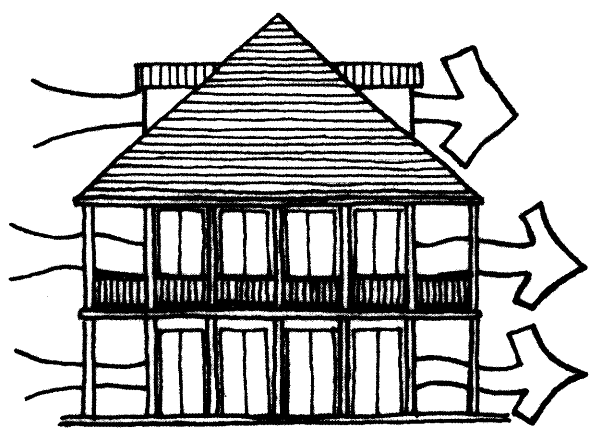
Awnings are most beneficial if they are operable. Therefore, they can shade in the summer and allow the sun in during the winter. Awnings can also have automatic sensors that retract with high winds.

Insect screens can be replaced with solar screens. These screens come in a variety of colors and percent of shading ability. Films can also be applied to the glass. Some films provide a radiant barrier to reduce direct heat gain, while others just darken the glass to prevent the sun from penetrating to the interior. These darkening films cause the glass to become warmer and reduce daylight to the interior. These types of films are not beneficial or recommended.

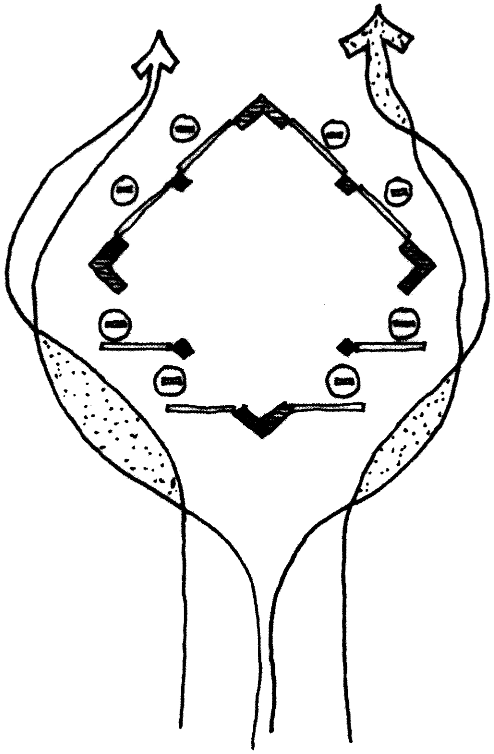
Trellises with deciduous vines can be used on the east and west side of the house for summer shading. These two walls can also be designed to ventilate and incorporate a radiant barrier, but that does not protect the glazing.

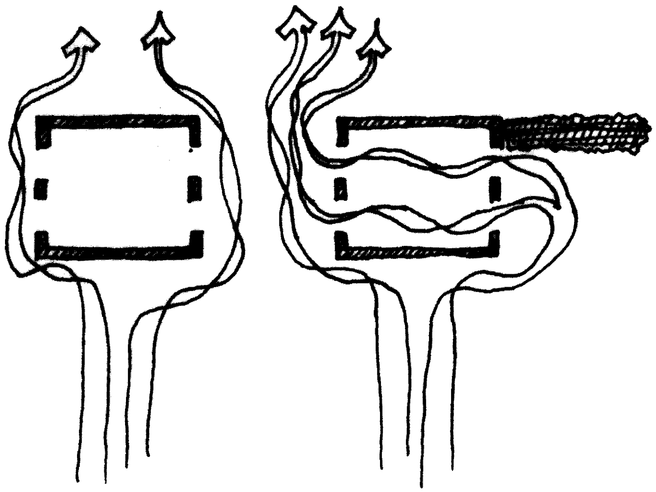
NATURAL VENTILATION

Air movement has the ability to take heat away. This is important to remove heat from the house (see *Wind* under *Microclimate* in Chapter 3), and from its occupants (see *Air Velocity* in Chapter 2, Human Comfort).



French doors, transoms, and higher ceilings were the colonists' strategies to facilitate air movement. Having openings across from each other and facing the prevailing breezes is beneficial. Roof dormer windows helped ventilate the attic, along with a breathable roof finish.





Some older houses have incorporated a cupola at the top of the roof. With openings through each floor, warm air is allowed to rise up to the cupola to be vented out. Sometimes these openings at each floor were designed to be closed during the heating season. The cupola also provides good daylighting. Cupolas can be designed to pull air out of windows on all sides.

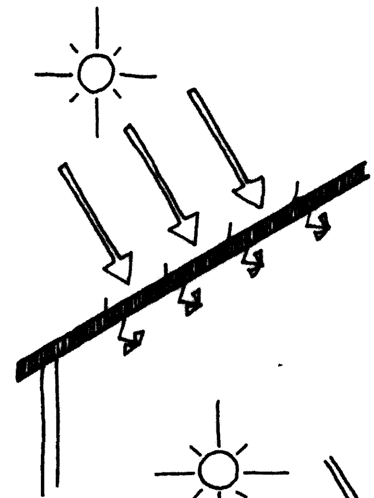
The French were enamored with allées of trees leading to the house. These trees not only cooled the air, but also directed it towards the house. Vegetation can also be used to create positive and negative pressures around the house to facilitate air movement. Air moves from higher-pressure areas to lower pressure areas.

You want as much openings on the leeward (negative pressure) side as you have on the windward (positive pressure) side, or more. For renovation work, you can use casement windows to help create these positive and negative pressures to facilitate ventilation. If there are more openings on the leeward side, you can create a Venturi effect and increase the velocity of air movement through the house. See *Wind* under *Microclimate* in Chapter 3, Climate.

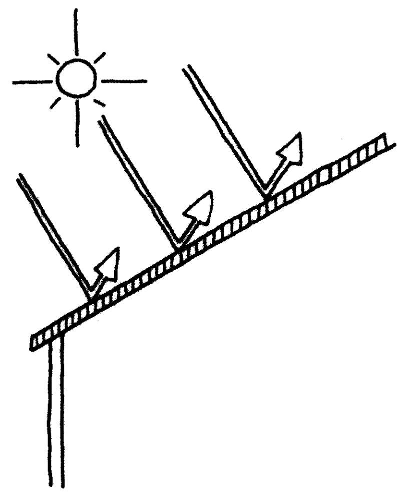
Higher ceilings allow the warmer air to move up and away from the inhabitants. Many of the double hung windows in these older houses allow both sashes to operate. The bottom can be opened for bringing air in and the top opened to let warmer air exit the room. Some windows and doors will have transoms above to allow warmer air at the ceiling to move out of the house.

ROOF

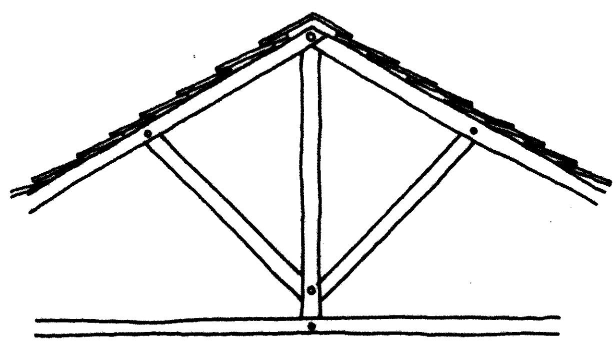
The greatest potential for heat gain is through the roof. Even with trees close by, the sun is so high in the sky during mid day in the summer that very little shading from those trees can be expected. However, trees located a short distance away on the east, northeast west, and northwest can provide some shading to the roof during the morning and afternoon. Orientation is not very effective. A south sloping roof surface will collect more heat than a north sloping roof surface, but the sun usually sees all surfaces of the roof during the day in the summer.



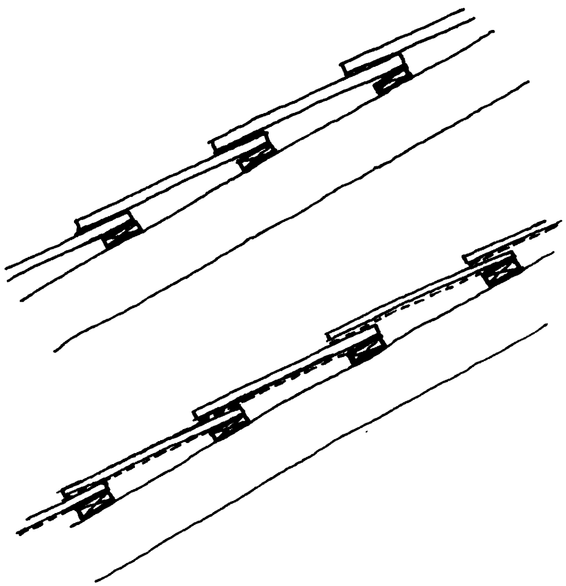
Two strategies to reduce heat gain are roof color and mass. The lighter the color and the more reflective the surface the less heat will penetrate the roof. Darker colors absorb more heat from the sun than do lighter colors. Also massive roof finishes like clay or concrete tile will collect heat due to their specific heat value rather than allowing it to penetrate thorough the roof. See *Time Lag* in Chapter 4 on Thermodynamics for an explanation of how this works. However, heavy roof finishes like clay or concrete tile will require a more structural roof framing system to carry the extra load.



Traditionally in Louisiana most roofs were steep and built with a heavy structure like Norman trusses. These roofs were designed for the heavy snow loads they would have experienced in France. They were also structured to carry a heavier roof finish like slate. In Louisiana this was not needed because there were no snow loads or heavy roof finishes to support at first. However, the steep roof shape worked well to shed our torrential rains. Split cypress shakes were the roof finish of choice, and it required a steep slope to adequately shed the rain. Later, the roof was built lighter with rafters as the structure. These cypress shake roofs breathed. The roof worked well in the reduction of heat gain to the interior habitable spaces. After the New Orleans fires of the late 18th Century, the Spanish administration introduced fire codes that required slate as the finished roof material. This also worked well to seal the attic from the rain, and remains a good finish roofing material today.



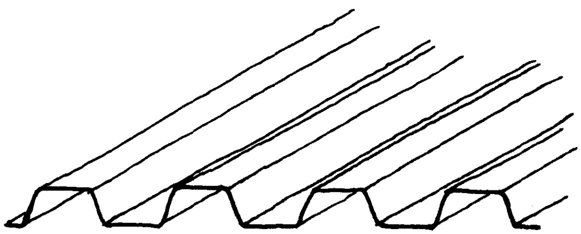
Wood shingles are installed in a few different ways in Louisiana today. Wood shingles can be treated for rot and fire. Whichever material and system of installation is used, make sure you understand



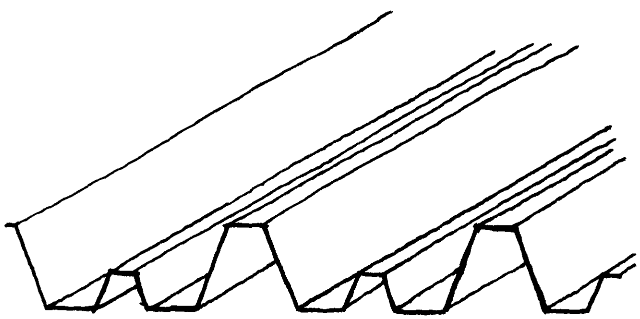
the warranties and specifications of installment given by that manufacturer.

One system that breathes with the attic is where shingles are secured to horizontal purlins perpendicular to the rafters and open to the attic. The same can be done with roofing felt between each layer. However, this does not breathe the same. Or the rafters can be decked, felted, and horizontal strips placed on top to secure the shingles. A new product on the market is a three dimensional fiber designed as a fire-resistant underlayment breather that is placed between the shingles and the deck. This eliminates the need for furring strips and allows for air movement.

There are a number of green roofing products on the market, like shingles made from recycled waste, that are worth looking into. Again, question the manufacturer and get the specifications and warranties. And make sure you follow their recommendations so the job is warranted. Make sure there is a legitimate percentage of recycled material in it. Check to make sure there is no outgassing of this material that is harmful to humans or the environment. Some materials are marketed as being green with only a hint of reality.

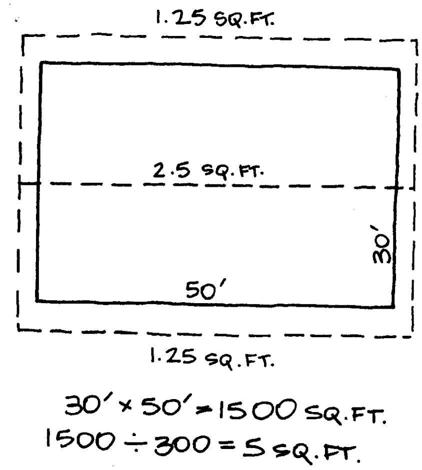


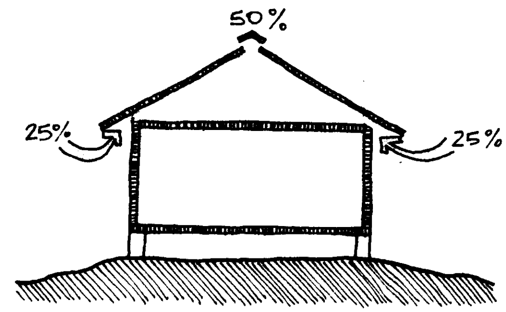
There are also spray-on products that can go over the existing roof. Many of these are highly reflective and also claim to be a radiant barrier. They can be used to extend the life of the existing roof finish. However, this should never be used in a historical context.

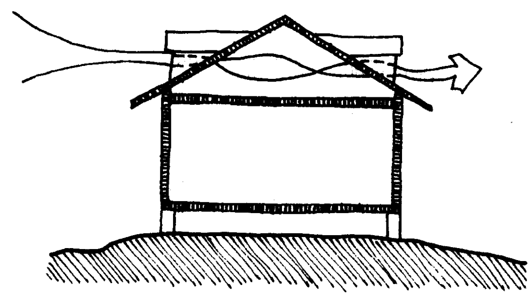


Reroofing with metal is very popular today. However, using the industrial metal panels does not "fit" with the residential look. There are plenty of smaller corrugation configurations that work well with a more residential scale. The more reflective the finish, the less heat gain to the interior. Metal roofing is available in a variety of different prepainted colors today, but white, silver, or galvalume finishes are the best to reflect heat. And for a little extra cost, the 26 gauge thickness is much better than the standard 29 gauge.

ATTIC





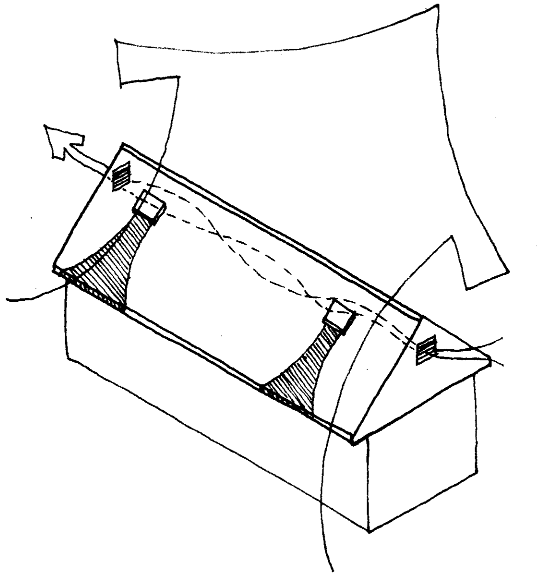


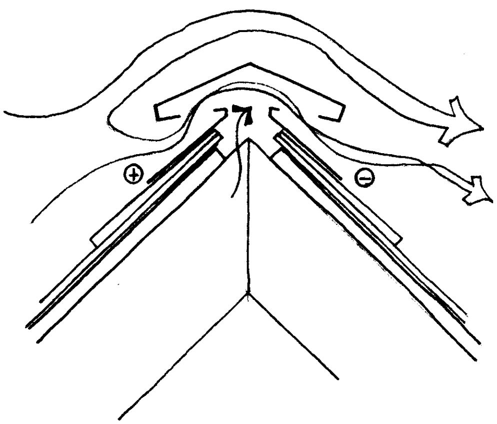
The attic will be the space in the house with the highest temperature most of the year. It is not unusual for attic temperatures to be between 120°F to 160°F during the summer. There is a controversy on how to deal with this potential problem. In the past, insulation was always placed on the attic floor and you might find louvered vents in the gable ends. Larger eave vents were used when attic fans (now called whole house fans) were used. More recent research shows that continuous ridge vents combined with soffit vents are the most effective in venting heat from the attic. The latest research shows that radiant barriers are very effective. Other recent research shows that it might work better to insulate between the roof rafters instead of the attic floor and not ventilate the attic at all.

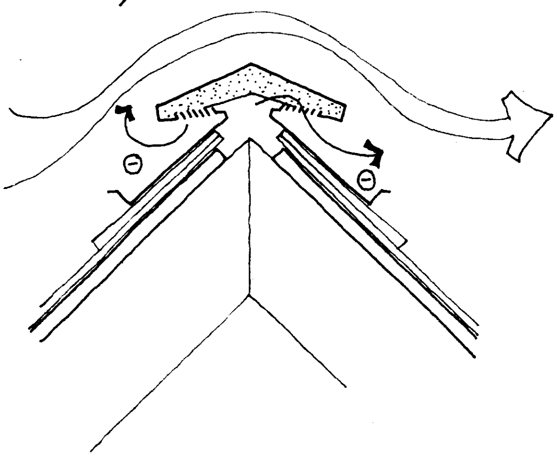
In any case, close attention should be paid to protecting the house from one of the major heat gain problems it will experience. Only infiltration has a greater potential for heat gain to older houses.

Vented. Traditionally attics were naturally ventilated by the way they were constructed and finished. And that would have been with shakes or thatch. Both materials are breathable. No insulation was used to separate the attic from the habitable spaces below. Dormer windows in the roof were another opportunity to vent heat from the attic. Later gabled end roofs would have louvers and windows to ventilate the attic. The lap siding on gable ends could be shimmed at each stud to provide a small strip of opening between the lap siding for ventilation. Insect screen can be placed on the interior. Venting at the eaves was made possible by loose construction or vents. If a whole house fan was used, these eave vents were made quite large.

The rafters were later decked with wide boards, then tongue and groove boards, then plywood, and other composite sheets today. The roof does not breathe through the materials anymore. The next major development was to insulate the inhabitable space from the attic. This



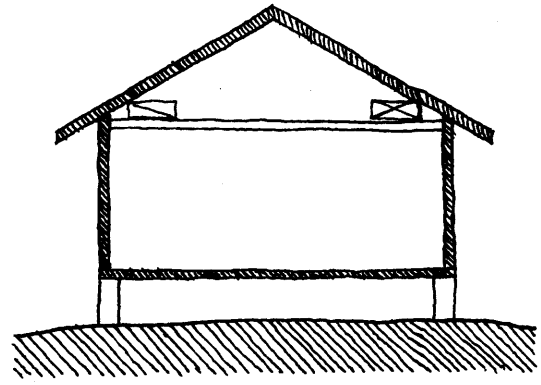




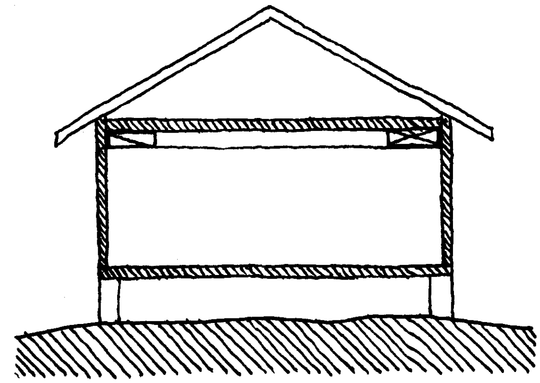
was done at the floor of the attic. The understanding that better ventilation was beneficial to reducing heat gain followed this. Basically, hot air rises and there was a need to exhaust air high in the attic. The major principle for ventilation is to bring the air in as low as possible and vent it out as high as possible, especially on the leeward side of the roof. Turbines work well, if placed as high as possible where the warmest air is found. Louvered vents, high in the gable end, are beneficial if placed on the leeward side where you would normally find a negative pressure. Don't use gable end vents in combination with turbine or ridge vents. Continuous ridge vents seems to make the most sense when there is sufficient length of roof ridge that can be vented, and is probably the easiest to install. They are located at the exact highest point in the attic. The net free vent area (usually about 70% of the total vent area) should be at least 1/300th of the attic floor area. And this should be equally divided between the vents at the top and the vents below at the eave/soffit.

If air can pass through the continuous ridge vent from one side to the other, it will pull some air from the attic. However, if you can pull air out of both sides of the vent then you are making progress, and will have less of a chance for rain leakage. Some continuous ridge vent manufactures provide a baffle to allow this to happen. This type of vent tends to also be a flashing cap that goes over the roof ridge. If for historic reasons the ridge vent needs to be disguised, there are vents that allow the finish material on top of the ridge vent.

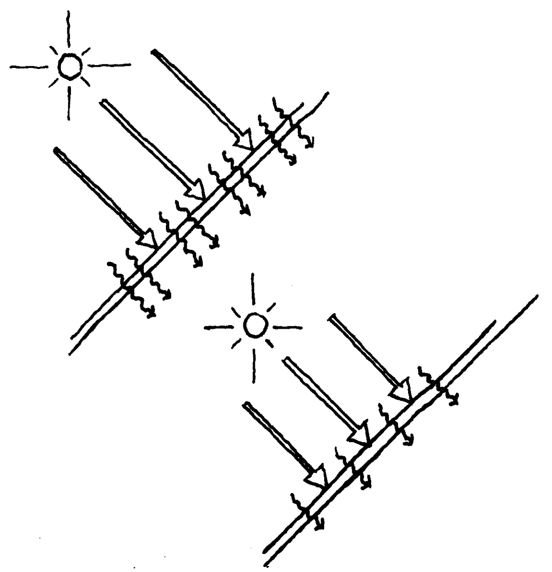
Mechanical Ventilation. What are now called attic fans and power vents are motor driven exhaust fans. They are usually controlled by a programmable thermostat that comes on when the temperature in the attic reaches the setting. They can also be equipped with a humidistat that will automatically operate the vent in conditions of high attic humidity, regardless of the temperature. These fans are very effective in pulling the heat and or humidity out of the attic, but what they usually do is pull air in from both the outside and the conditioned habitable space. This puts a negative pressure on the interior of the house. Now the insulated envelope is trying to pull air in from all exterior surfaces. One of those is the crawl space, the other being the walls. This would be wrong to bring hot and humid air into the conditioned space. This has problems not only for human comfort, but health reasons as well. This creates an environment conducive to bacteria and mold growth. However, attic fans are not recommended. Usually at best, they use as much energy as they save on the air-conditioning side, and they have great potential for creating the above mentioned problems.



If mechanical ventilation is used, make sure there is sufficient eave or soffit vents, and that all penetrations from the conditioned space to attic are sealed. Recessed lighting fixtures into the attic space are not a good idea. However, some are designed to be sealed and insulated. Some are very leaky and require no insulation around the fixture in the attic. The latter is not recommended



Sealed. A sealed attic is somewhat of a misnomer because in reality it is not an attic space anymore. The design is to insulate the rafter space and seal the space against infiltration. Now it is part of the conditioned insulated envelope. In some cases the sealed attic has had energy performance advantages over ventilated attics. This is especially true if the air-conditioning ductwork is located in the attic space. It is not unusual for air-conditioning ducts to leak cooled air to the attic space while the return air is trying to pull this attic air back to the unit. The ductwork will also stay much cooler with a sealed attic. However, it is recommended that you install the ductwork system within the conditioned space, and not in the attic if at all possible.

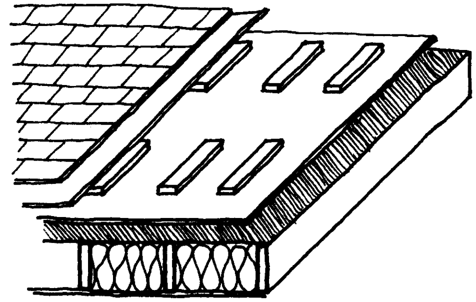


Some manufacturers of composition shingles have had problems with unvented attics and will not guarantee their products. Research test by the Florida Solar Energy Center on two roofs, one with dark gray shingles (solar absorptance of 92%) over a vented attic compared with a dark gray shingles over a sealed attic, have shown 9% cooling energy savings for the sealed attic. The test of vented attics comparing the dark gray shingles with white shingles (solar absorptance of 76%) found savings of 4% for the white shingles. This indicates that combining white shingles with a sealed attic is likely to produce greater cooling energy savings. In addition, these tests found significantly greater savings (17-23%) for white tile and white metal roofing systems. Measured energy performance savings of 9% have also been reported in separate field tests for attic radiant barrier systems.

Measurements also have shown that sealed attics and attics with radiant barriers (see radiant barriers below) have hotter roofs. This occurs because heat cannot readily leave the inboard side of the roof sheathing if it is insulated. For the sealed attic roof with dark gray shingles, the measured top-surface peak shingle temperatures are about 7°F hotter than the otherwise identical vented attic. The temperatures at the bottom of the roof, between the roof decking and the roof insulation, however, are about 23°F higher at peak than in the vented attic. For attic radiant barrier systems, measured peak shingle temperatures are about 2°F higher and peak temperatures at the bottom of the roof sheathing are about 12°F higher. A 2% warmer temperature is not as big a problem to most composition shingle manufacturers.

Other tests comparing white and black shingles have shown that shingle color makes a greater difference in peak shingle temperature than the presence or absence of attic ventilation or an attic radiant barrier system. These tests showed peak temperatures for black shingles (solar absorptance of 97%) to be almost 23°F hotter than peak temperatures for white shingles (solar absorptance of 76%). Thus, if elevated temperatures can result in composition shingle failure, the problems are likely to be much more pronounced for darker shingle products, especially in climates with large quantities of solar radiation like the south and desert southwest.

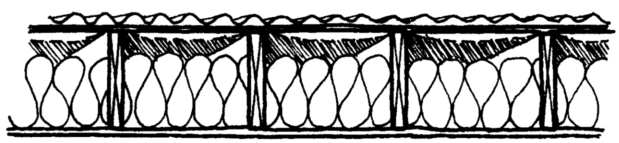
In general, cooling energy savings will be greatest when sealed attic and insulated roof deck construction is used in combination with highly reflective white tile or metal roofing materials. However, if an insulated roof deck and sealed attic are used with composition shingles, consider the following recommendations: (from the Florida Solar Energy Center).



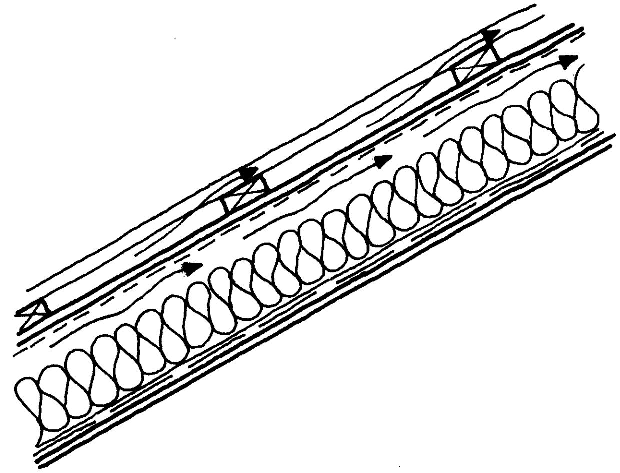
1. Select white-colored shingles that tend to be much cooler under full sun. White colored shingles also produce the greatest cooling energy savings among shingle roofs.

2. Use thicker roof sheathing and high-quality, heavy-grade shingles, preferably from a company that will warrant their product in a sealed attic with an insulated roof deck.

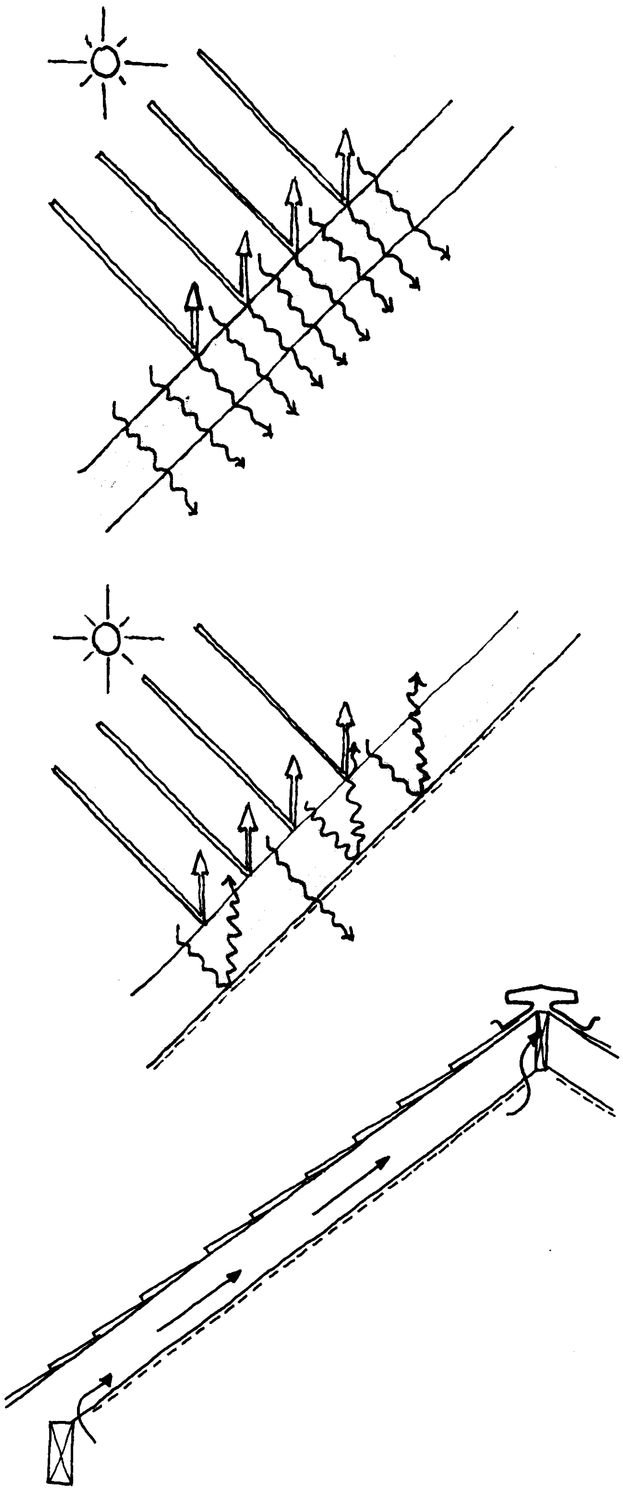
3. Consider using a roof assembly with a ventilated air space above the insulated decking (a double roof or icehouse roof). This creates a vented decking surface on which the shingles are installed. This is the installation recommended by the Asphalt Roofing Manufacturer's Association to reduce shingle temperatures for sealed attics.



Many composition shingle manufacturers claim that their warranty will be voided or severely reduced if the bottom surface of the roof sheathing is not vented. On the other hand, some shingle manufacturers fully warrant some of their composition shingle products for sealed roof applications. Note also that these slightly elevated roof temperatures are unlikely to affect tile, metal or single-ply membrane products. Thus, if you wish to use a sealed attic system and you must use composition shingles as your roof finish, make sure to use a product that does not warn against sealed attic applications.



For new roof construction, oversized rafters could be used to house insulation in the bottom, a radiant barrier on top, and a ventable air space between. In this case an air barrier should be secured to the bottom of the rafter. This could be left as it is for a sealed and



insulated attic or a finish material added over the air barrier for an exposed cathedral ceiling. If a corrugated metal roof is used, it is possible to also vent the open spaces in the corrugation to provide two vented air spaces. Cathedral ceilings are when the bottom side of the roof is exposed to the conditioned space as the ceiling.

RADIANT BARRIER

About 40% of the heat gain through the roof is radiant heat, and up to 100% if there are no attic vents. Radiant heat is transferred by short-wave energy. This is how we get heat from the sun. When short-wave radiation hits a material, most of the radiation is converted to long-wave or thermal energy or it is reflected. Insulation restricts the transfer of thermal long-wave radiation, but not short-wave, infrared radiation.

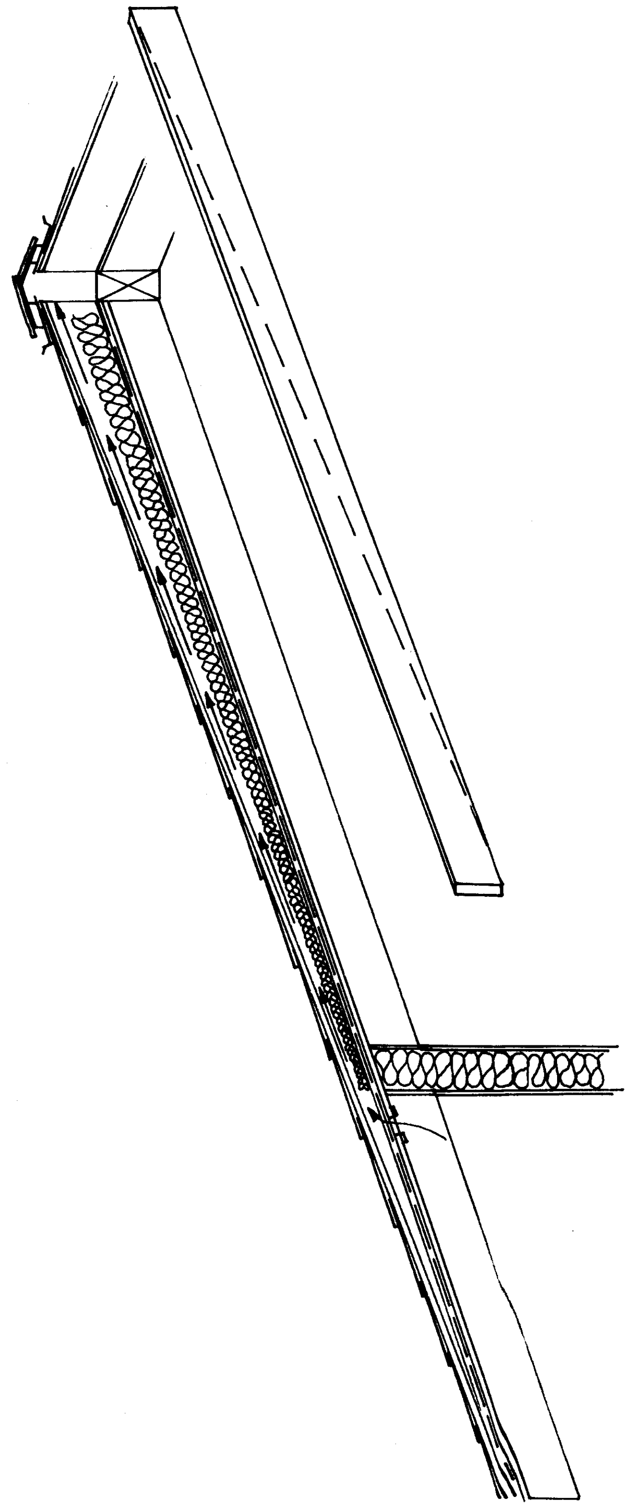
Radiant barriers are very effective at stopping radiant energy. A good radiant barrier is one with a very high reflective value and a very low emissivity value. They can stop up to 95% of the radiant energy. Aluminum foil is one of the most cost efficient materials to use as a radiant barrier. Since it can tear so easily, it is usually laminated to some substrate for added strength. Radiant barriers can also be perforated so they do not act as a vapor barrier.

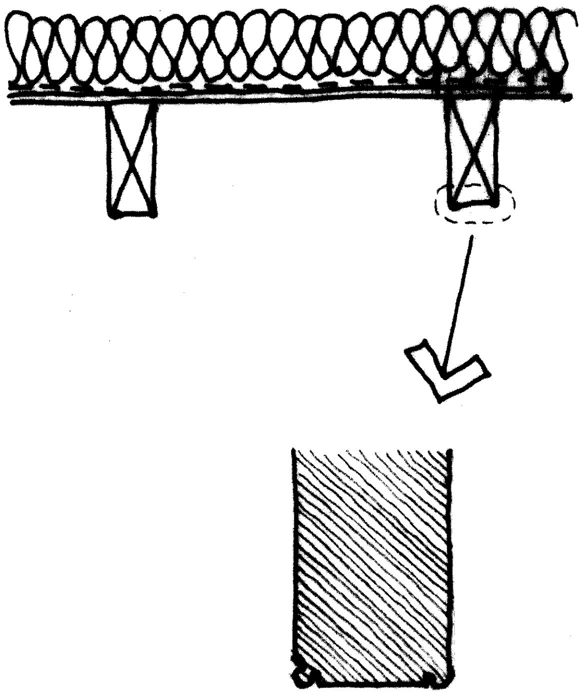
For the radiant barrier to work it must face an air space. For an existing attic space the best method is to attach the barrier to the bottom side of the rafters. It is best that the shinny side face down. In this case there will be less chance for dust to build up on the surface. Dust on the shinny side will reduce its effectiveness. Some radiant barriers have a foil face on both sides. This does not necessarily make the radiant barrier twice as effective since one side can take care of some 95% of the radiant energy. Leave a space at the bottom and the top when attaching the barrier to the bottom of the rafters. This will allow extra airflow between the barrier and roof deck. If roof trusses or excessive bracing prevents attaching the barrier to the rafters, then the barrier can be placed on the attic floor above the insulation and with the shinny side facing up. This is not recommended when the attic space is used for storage. Test have also shown that placing the radiant barrier on the attic floor allows dust to build up on the shinny surface reducing its effectiveness by as much as 50% in only four years.

There are also spray-on radiant barriers that can be applied to the underside of the roof decking. However, these are only about 70% as affective as the aluminum foil sheets, and can act as a vapor barrier.

If the house is being reroofed, then the radiant barrier can be placed on top of the rafters with the shinny side facing down to the attic space. It is not necessary, but if the barrier is drooped between the rafters it will allow for ventilation between the barrier and the roof deck. Roof decking can also be purchased with a foil face on one side. However, there is some debate that this creates a vapor barrier that could present unforeseen problems over the life of the roof. There is also some concern about a radiant barrier raising the temperature of the composition shingles – refer to this discussion under *Sealed* attics.

Here is a technique used in a historic home where the attic was to be used as a conditioned space. What made matters more difficult, were that the homeowner wanted to leave the rafters exposed to the interior. The rafters were topped with wide cypress boards and the bottom stained to match the existing cypress rafters. Roofing felt was placed on top of the cypress boards. The 2X12 boards were ripped diagonally to provide two triangular rafters from each board going from 0" at one end to 11 1/4" at the other. The rafters were placed on top of the felted decking at 24" on center with the small end at the eave and larger end at the ridge. The roof was finished with wood shingles to keep its historic authenticity. This did not change the detail of the eave, but did allow for insulation, ventilation, a continuous ridge vent, and a radiant barrier over the conditioned



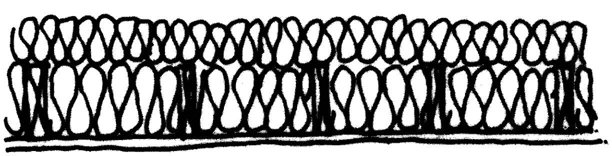


space in the center of the once attic. A continuous ridge vent that allowed a finish material over it was used. The pitch of the roof was raised slightly, but not enough to be noticeable.

CEILINGS

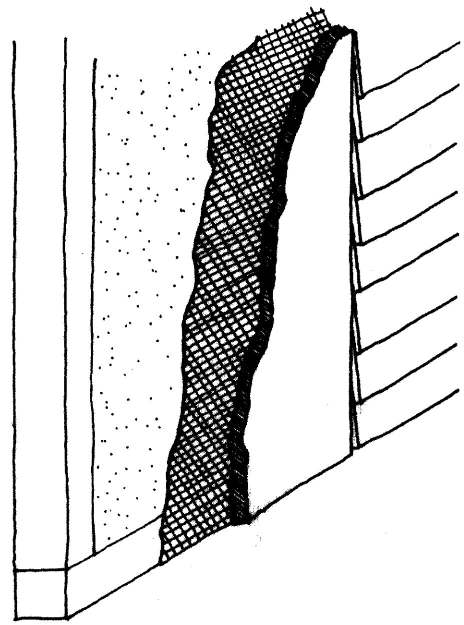
The older houses would have wide planks laid over ceiling beams. These boards and beams would be exposed to the room below. The attic above would be used as a garconniére (the sleeping quarters for the bachelor members of the family) or for storage. This type of ceiling (or attic floor) is hard to seal and insulate. Chances are that cracks will exist between the ceiling boards. A dark air barrier laid on top of the boards would be a good option. Be careful not to create a vapor barrier here. The top of the ceiling boards could be covered with a loose fill, blown, batts, or blanket insulation. A foam insulation on top of the boards would not require an air barrier, but the foam will expand through the cracks and be seen from the space below. This would have to be camouflaged.

Later, beams would be replaced by ceiling joists. It is possible that ceiling joist will not be 16" or 24" on center. If this is the case, blown insulation is a good solution. Make sure that soffit vents are not blocked by the insulation. An inexpensive recycled material like old paneling, cardboard, or left over air barrier could be applied to the bottom side of the rafters to protect the vent openings. Off-the-shelf rigid baffles can be placed between the rafters and attached to the bottom of the decking to assure ventilation.



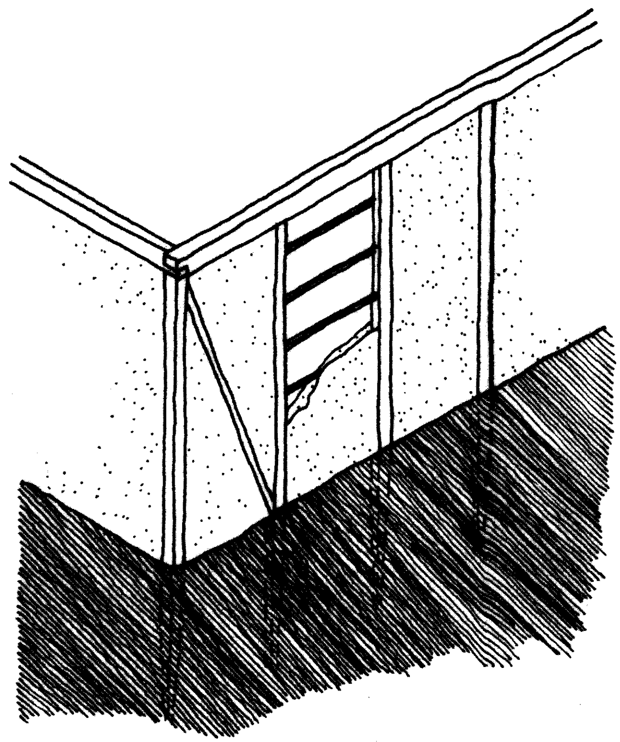
If the ceiling joists are standard spacings, you could lay unfaced batts (sprinkle with a borate product) between the joists, and another layer perpendicular to the first layer. Build up to the R-value recommended.

For batts or blown insulation you might want to put a cover between the joists to prevent insulation dust from falling to the space below. If this cover was continuous, it could be an air barrier to help cut down on infiltration. Use a dark material so it does not show through the cracks in the ceiling boards. Or a thin layer of foam could be applied to seal the ceiling, and blown insulation placed on top of that. If drywall is the finish ceiling then it can be taped and sealed from the interior side. Tape the edge at the wall even though a crown molding might be used to hide that joint.

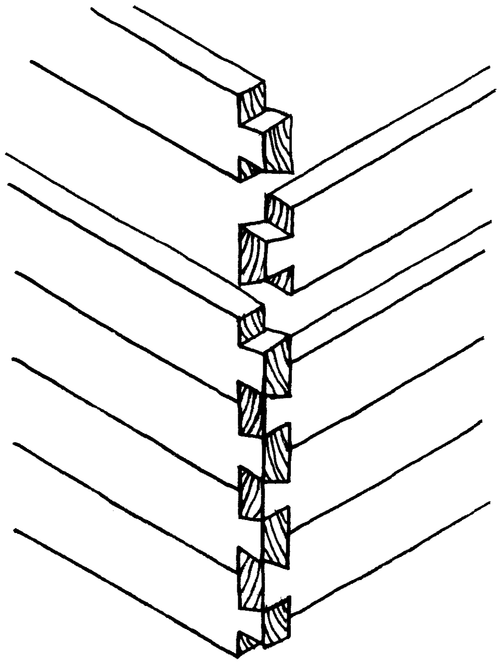


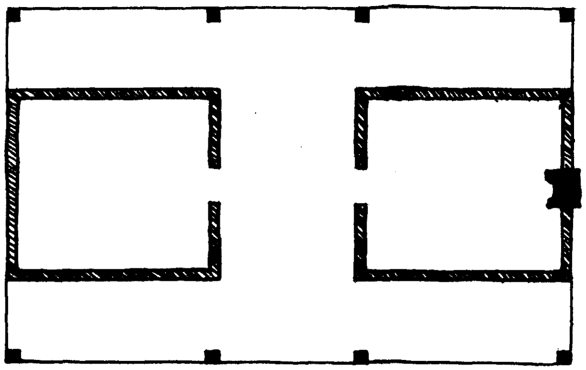
WALLS

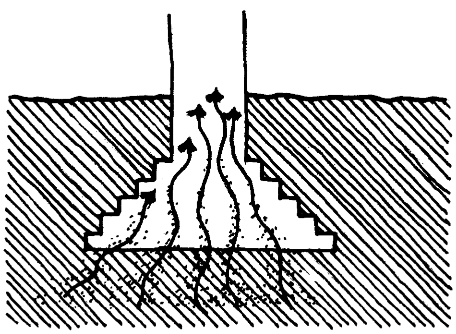
Walls of older houses were constructed in different ways. The ***colombage frame,*** also known as poteaux-sur-solle (post-on-sill), was explained in detail in Chapter 1 under *French Colonial*. Basically, it is a half-timber framing with an infill of briquetté entre poteaux (brick between the post) or bousillage (mud and Spanish moss). The sill that supports the wall is the bottom cord of this framing. It is an integral part of the frame usually being mortised and pegged together. The inside finish of these walls is mainly plaster. However, sometimes the bousillage was just whitewashed as a finish. The only real place to improve insulation values and prevent infiltration problems of this type of wall system is on the exterior.



Typically cypress lap siding would be the exterior finish except maybe for the porch area. Here we might see flush boards and/or a plaster finish. To do anything to the exterior of these walls would mean removing the exterior finish. Then an air barrier/house wrap could be applied to the exterior. Rigid insulation could be added over that, but that would affect the casing at all doors and windows. For historic structures this would not be appropriate. For a renovation where the doors and windows were being replaced, this is a consideration.







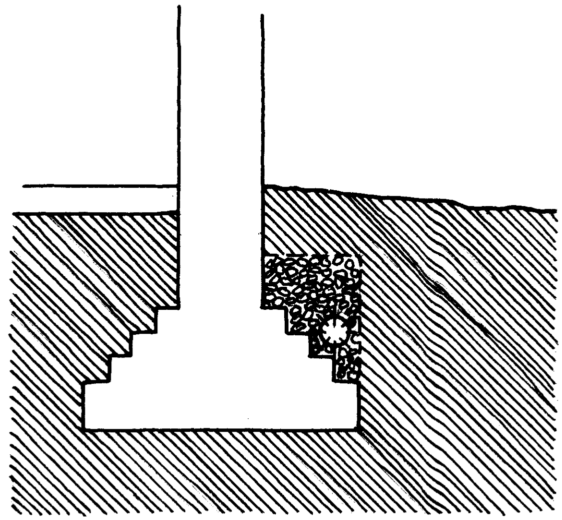
If the interior plaster had to be replaced, an air barrier and rigid insulation could be applied to the interior. This again would affect the door and window casing. And it would be better not to insulate the thermal mass from its exposure to the interior for human comfort. If this is the case, make sure the rigid insulation on the interior is permeable and does not act as a vapor retardant.

Another type of colombage wall construction was known as poteaux-en-terre. Here the upright post (poteaux) was placed directly in the ground (terre). As the Native People of this area did, the French would burn the end of the post that would be placed in the ground. The infill would be the same as the poteaux-sur-solle.

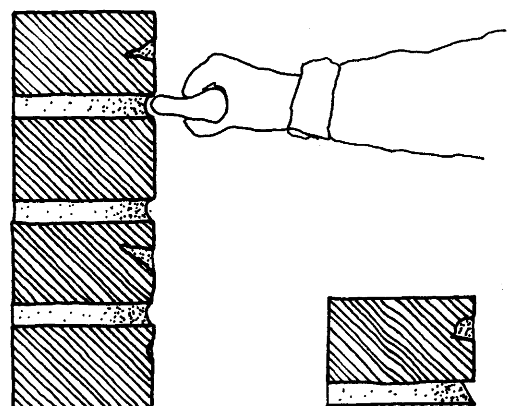
Another type of construction was ***piece-sur-piece*** (board-on-board) which was a technique brought by the French from Acadie (Nova Scotia) and known as the Canadian Style. Here squared timbers, like 3" X 10", would have been placed one on top of the other and connected together with wooden pegs. The corners would have a unique dovetail connection that carried rain always to the exterior. These are a very rare construction types to be found in Louisiana today. Hopefully these types of construction would be restored for their historic value without the contemporary techniques for making them more energy efficient.

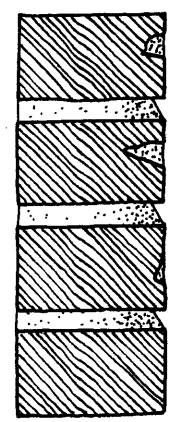
The same can be said for the ***log cabin*** construction of north Louisiana. This was frontier construction of the simplest type. They were in the form of "single pen" (one-room), "double pen" (two rooms), or the "dogtrot" where rooms were separated by an open breezeway. Lean-to roofs could be added to the front and rear for porches. The logs were left round and notched at the corners. Mud chinking would be placed between the logs to help seal the structure against air infiltration. Lime could be added to the mud for strength and waterproofing.

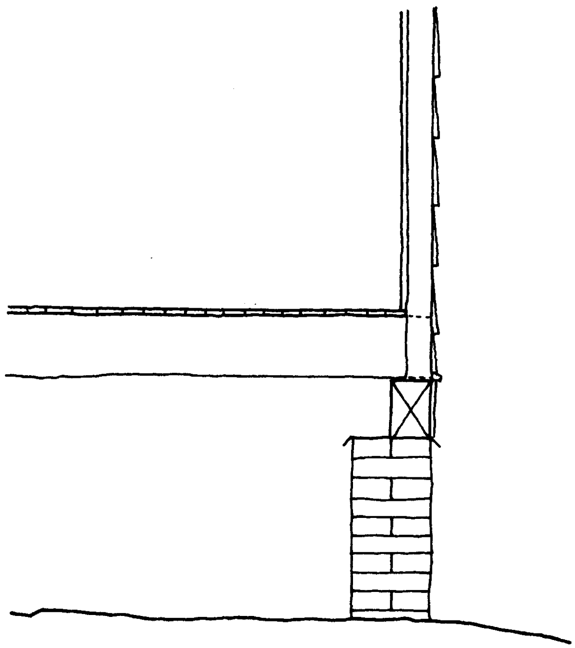
Larger houses could have loadbearing brick walls. Most of the raised cottages with a raised basement were ***brick loadbearing***. These types of walls could also be found on other buildings like kitchens and even slave quarters. It was typical for the bricks, at the bottom of the wall, to step out a few times to provide a wider footing for the earth to support. It was most important that this footing was not exposed to soils that would be changing moisture content. Rising damp, which is the wicking up of moisture from the ground, is a major problem with these walls. In the past it was not a big problem, but a way of cooling the surrounding area and the house above. This was mainly due to evaporative cooling and lower temperatures for the mass walls. Once the house is closed up and air-conditioned, it can become a major problem. One of the main things that air-conditioning does for human comfort is dehumidification. Air-conditioning creates drier air on the interior, and a greater vapor pressure difference between the interior and the earth. This causes an even greater wicking potential for the brick walls. This can be even more of a problem in areas that experience freezing temperatures because the moisture can freeze in the wall causing spalling of the bricks.

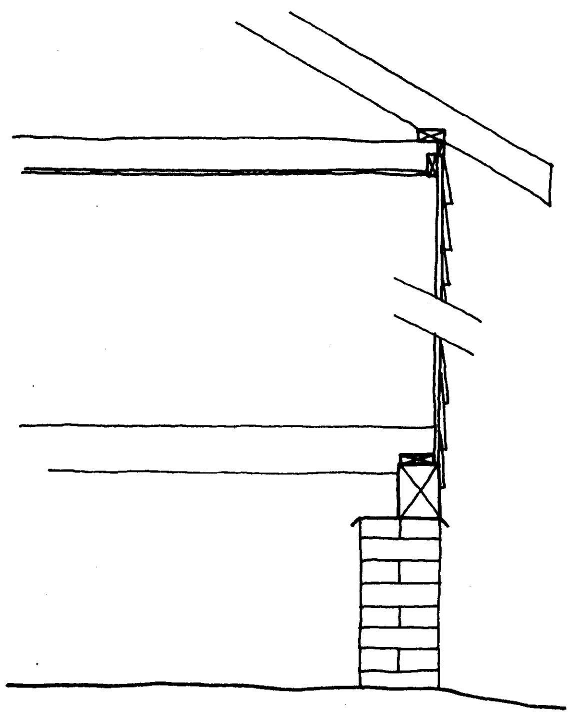


The first action is to eliminate as much of the moisture in the soil as possible. Check to see if there are problems with keeping the foundation dry. Rainwater from the roof needs to be taken to the ground and away from the house. The grade of the earth around the house should slope away from the house at about a 5% grade or better. Some older houses have settled or sunk into the ground making matters worse. Extra foundation support can be added to help stop the settlement, but it would be very expensive to jack these walls back up. Below grade French drains at the perimeter of the footings are worth investigating if there is a place to drain it away from the house. Some of these older houses have brick gutters constructed at the ground level to direct rain water away form the house.









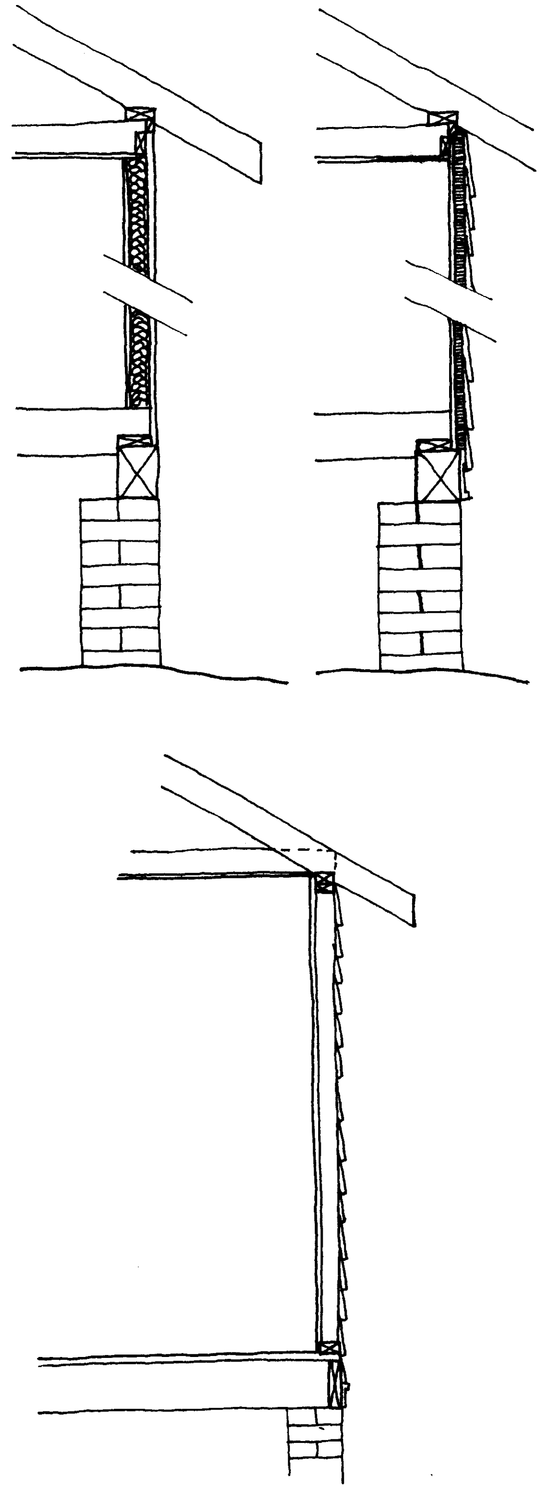
If all the moisture problems have been resolved, there might still be a high water table that will keep the soil moist. The soil will always have some moisture content and the brick will tend to pull that up into the wall. Sealing the interior of the brick wall tends to pull the moisture higher in the wall. If the wall must be painted, use a waterbase paint. Waterproofing the exterior tends to direct all the moisture to the interior surface. However, sealing the cracks and repointing the joints on the exterior are important to keep the rain moisture out. Be careful to use a mortar no harder than the bricks. There are extensive measures if everything else fails and that is a system of drilling holes in the lower part of the wall and injecting waterproofing to try and seal the wall from the footing and moisture in the soil.

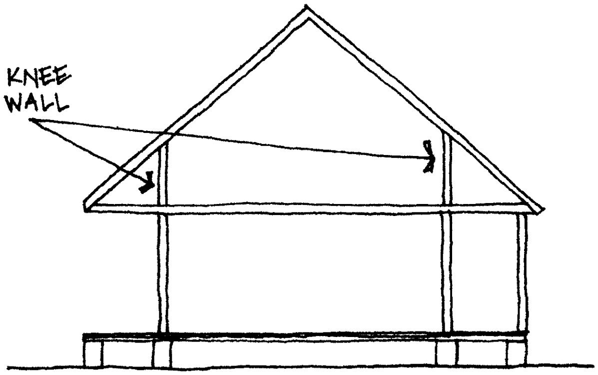
A more typical wall in older houses is of balloon framing. ***Balloon framing*** is when the studs rest directly on the sill. This means that each stud penetrates the finished floor and the subflooring to be supported directly on the sill. Since materials at this time did not have to conform to 4'X8' sheets of plywood or drywall, it is not unusual that studs are not exactly 16" or 24" on center. If the interior and exterior finishes are not to be removed, a dry fill insulation can be blown into the stud cavity. A dense packed cellulose is a good choice. There are some low expansion foams that work well also. This is usually done by either removing lap siding on the exterior or drilling holes in the exterior finish or interior finish at each stud cavity. An investigation should be done to see if there is any horizontal fire blocking that might divide the cavity into different areas. All areas of the exterior wall should be filled with insulation (see *Insulation* in the following pages). Since the studs protrude through the floor, that area needs to be checked to block the cavity from the crawl space. Seal the exterior wall as well as possible including all penetrations to the exterior or through the top plate(s) to the attic space above.

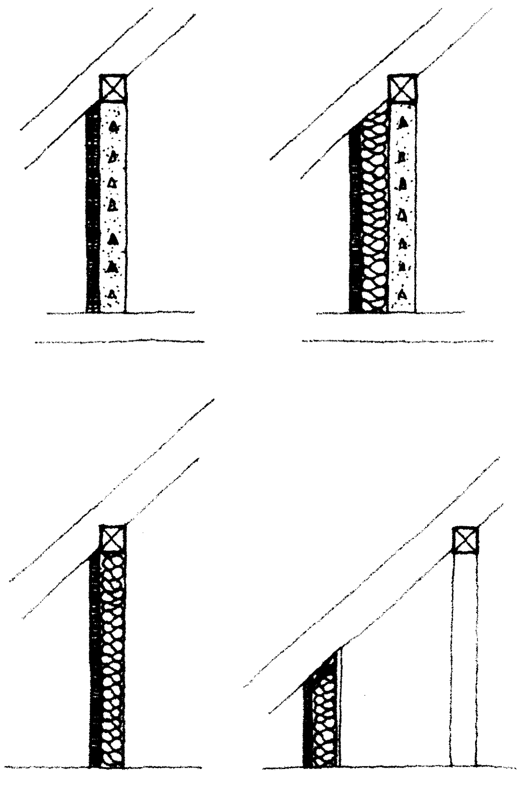
Another type of wall, found mainly in the areas along the Mississippi River, is ***barge board*** construction. This is a type of construction that used wide boards from barges that were built up river to ship goods to the lower delta, especially to New Orleans. This wood was usually not cypress, but pine. These boards were placed side by side and rested directly on the sill with only a 2X4 board horizontally, top and bottom. These boards were the loadbearing wall without the use of any studs. The exterior would have been finished with horizontal lap siding, and the interior left as it was or papered over. Many layers of newspaper can be found, in some of these older houses, between the boards and the wallpaper to try and prevent infiltration and provide for better insulation.

Here you have many options to fill this wall with insulation. If the exterior is not to be removed the insulation will be applied to the interior side of the wall. If the exterior siding needs to be removed, other options of putting the insulation to the exterior are available leaving the barge boards exposed to the interior. If this is the situation then rigid insulation on the exterior would be a good solution. If the insulation is impermeable and the joints taped, then an air barrier is not required. Any insulation is possible on the interior. If the method of insulating requires a framing system it can be constructed on the interior side. Also, consider the interior finish requirements. If the insulation is to the interior, thought has to be put into sealing the wall against infiltration. If batt insulation is used, it should be unfaced friction batts so as not to create a vapor barrier. Sprinkle borac acid or a borate product on all fiberglass insulation. Blown cellulose is a good solution helping to seal the wall against air infiltration.

In ***platform framing*** the exterior wall sits on a subfloor that rest on top of the floor joists which are supported by the sill. This is a much easier framing system to seal when it is built new, and is the major type of wood framing construction used today. This type of stud wall construction is also used today for ***slab-on-grade*** construction with or without a brick veneer exterior finish. The types of older houses we are addressing here for restoration/renovation would not fall in these construction types. However, the same strategies would be used as for the balloon construction described above.







ATTIC KNEE WALLS

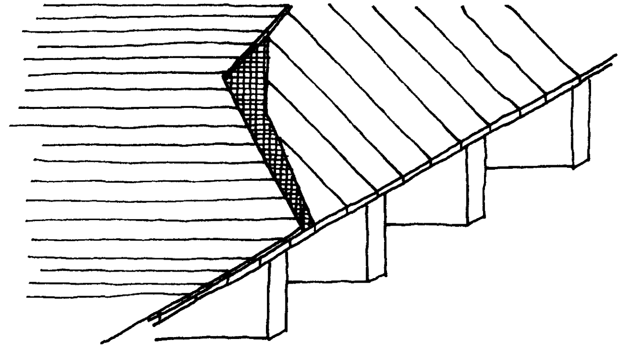
Attic knee walls are short walls under the roof. They usually help support the roof. If the attic is to be used as a habitable space, then the knee wall must be insulated. It will also be important to seal this wall from the attic space behind the insulated wall. It would be best if this attic space was ventilated and had a radiant barrier at the rafters.

Some older homes might have bousillage infill in these walls. If this is the case, rigid insulation could be applied to the back of this wall. If the radiant barrier is not applied to the rafters, the outer sheet of rigid insulation on the back of the knee wall could have a foil face. Tape the insulation boards to help seal the wall. In addition, caulk and foam sealents could be used to help seal the knee wall from the attic. A secondary stud wall could be erected behind the bousillage knee wall to be filled with batts, cellulose or foams. A foil face rigid insulation board can still be placed on the attic side to provied added insulation and provide a radiant barrier.

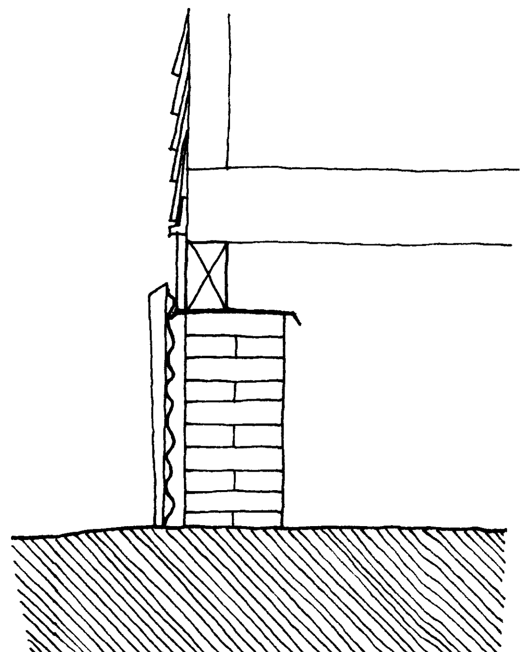
If there is no bousillage in the knee wall, any insulation could be used to fill the cavity. However, chances are that the knee wall studs will not be 16″ or 24″ on center to accommodate batts. In this case, a foil faced rigid insulation board could be placed on the attic side and cellulose, foam, or fill insulation can be used to fill the cavity.

If the knee wall is tall enough, you might get extra storage or a closet by constructing an extra knee wall to the attic side of the existing knee wall. This new wall could be 16″ or 24″ on center to accommodate batts. Again, tape, caulk and/or foam all cracks and edges to seal this wall from the attic space.

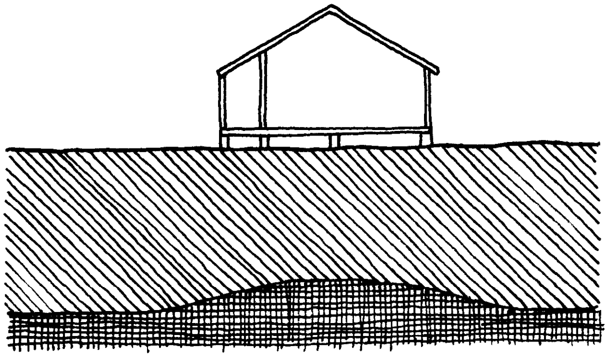
FLOORS & CRAWL SPACES

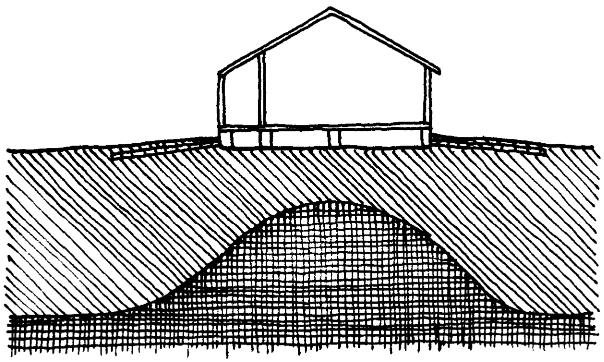


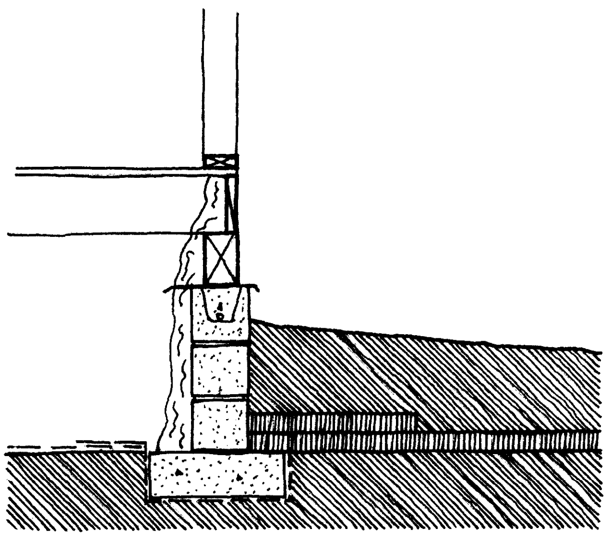
In early colonial Louisiana, some colombage frame sills sat directly on the ground and were known as poteaux-sur-solle construction. Another method of construction during colonial times was poteaux-en-terre, where the upright posts were placed directly in the ground. Whether it was poteaux-sur-solle or poteaux-en-terre, the floor would have been the exposed ground. It did not take the colonists long to realize that this type of construction did not work well in Louisiana with our high water table, torrential rains, and seasonal flooding. Subsequently, sills were raised off the ground and supported by cypress blocks or brick piers. Finished floors would be put right on top of the floor joist. In colonial times this would have been with wide cypress boards. Please see all the structural issues addressed at the beginning of this chapter under *Structure*.



Later, a subfloor would have been installed, usually of 1X6 tongue and grooved (t&g) boards blind nailed to the floor joist at a diagonal. The subfloor would be covered with roofing felt and the finished floor blind nailed perpendicular to the joist. It was typical to have 1X4 t&g long-leaf red pine as the finished floor. This is a very strong floor system especially with the help of the subfloor being at a diagonal. Sometimes you will find the 1X4 t&g pine finish floor alone without a subfloor. During the great depression, we found this to be common place. Traditionally, the floor was not insulated, at least in the southern part of Louisiana. Human comfort benefits from the interior exposure to the cooler temperatures below the floor during most of the year. It is only for a few months in the winter that this is not beneficial. During those times of the year, the crawl space could be blocked from the winter winds. Many materials like corrugated metal roofing – old or new, black board – recycled sugarcane bagasse, plywood, cement board, etc, were used. This is a good idea only if the floor of the crawl space stays high and dry. A vapor barrier can also be placed on the floor of the crawl space to cut down on excess moisture problems. More contemporary solutions are hinged flaps





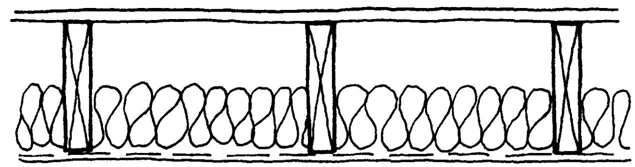


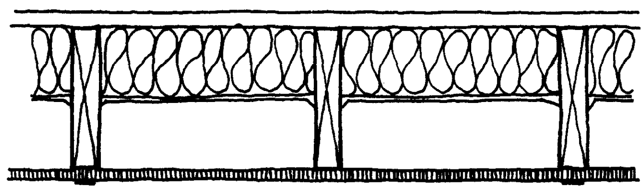
between piers that fold up under the house for most of the year, and lowered (and sealed as much as possible) during the heating season. This skirt will help cut down on infiltration, but mainly will decrease the heat loss due to the north winds blowing under the floor. This might be the best seasonal mode we can put the house in as a temporary solution. Its one of those seasonal dances with the natural environment – make it a ritual.

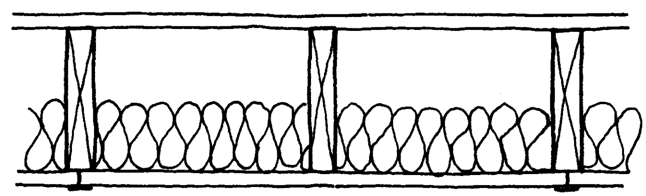
The further north we go in Louisiana, the more we will want to insulate the floor from the air temperatures below. Some research shows that it is better not to ventilate the crawl space and not insulate the floor, but insulate the crawl space wall instead. Construct the crawl space wall to be waterproof and insulated it from the exterior just like the exterior wall. This can only be true for a crawl space that is not subject to moisture problems. The site has to be contoured to assure good drainage away from the house. In fact this crawl space then becomes a plenum for air movement (see *HVAC Systems* later in this Chapter).

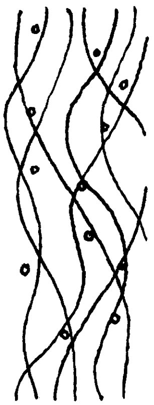
The constant ground temperature is some 30 feet below the ground surface. However, because of the thermal lag of the earth, the temperatures at 15 feet below are cooler during the summer and warmer during the winter than the constant temperature. The constant ground temperature is approximately the same as the average yearly air temperature. Check the *Climate Data* in the Appendix for the city nearest the house site. This constant ground temperature is for an area of earth that is exposed to the sun and night sky. Once the ground is covered by the house, this constant ground temperature is brought closer to the surface under the house. These good temperatures can be brought even closer to the surface of the crawl space floor by providing ground insulation from the crawl space wall to the exterior. This would need to be a closed cell rigid insulation board like extruded polystyrene foam. All the bead-board that comes with computer packaging, or foundry mold scraps, or any salvage material you can find can also be used. It will be covered up so it doesn't matter what it looks like. Berm over the insulation to provide a good slope away from the house. This helps to thermally ground the house to the earth, taking advantage of these comfortable temperatures.

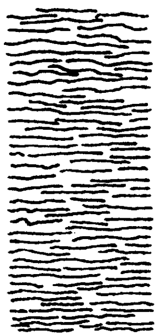
If insulation is used in the floor, there are many options for how this can be done. The greatest potential for moisture, and moisture pressure difference, is from an open crawl space. It might be good to put a vapor barrier at the outer most finish of the floor system to the exterior ground below - only in the most northern part of the state, and there is still debate over using a vapor barrier at all. (See *Vapor Barrier* later in this Chapter). Putting a vapor barrier of 6-to 10-mil polyethylene on the ground of the crawl space is suggested. However, it is most important to make sure that water does not drain toward the open crawl space but away from it. Batt insulation should be installed at the bottom of the joist with an air space between it and the floor or subfloor. It is important to seal the exterior envelope so air does not get into this air space between the insulation and the floor (see *Infiltration* later in this Chapter). If this air space cannot be sealed, then it is best to place the batts against the subfloor. It is very beneficial for batt insulation to be sprinkled with a borate or boric acid product to protect against termites and roaches. Batt insulation will have to be protected from the weather and animals. It is recommended that an air barrier be placed under the floor joist to help cut down on infiltration. A strong polywire or rigid board would work well to keep the animals out. The rigid board could be cement board, firerated insulation board, black board, or a number of other rigid board materials. Some rigid insulation boards can be installed and taped to seal the underfloor from infiltration – if this is done, then the air barrier is not necessary. There are spray-on foams, like Icynene, that insulate and seal the floor against infiltration, but there is a debate weather it is cost effective. Get a bid both ways and compare the R-value and cost. The foam might have to be protected from animals also depending on your environment and location.

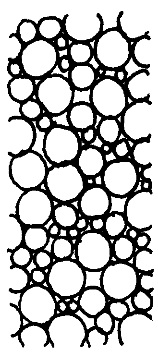


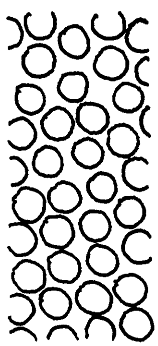












Keep all wiring and plumbing close to the floor or in the air space between the insulation and the floor. If this cannot be accomplished, then keep them below the insulation. If the plumbing and ductwork is installed below the insulation, make sure they are well insulated and protected from animals.

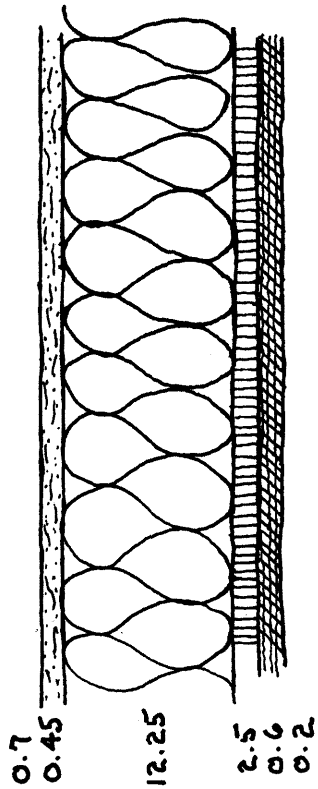
THERMAL INSULATION

Insulation is very small trapped air spaces suspended in some material to help slow the transfer of heat by conduction from one side to the other side. The type of the insulated material will determine how well it resists the flow of energy through the material. There is a value placed on each of these materials and it is expressed as its R-value. The higher the R-value the more resistant the material is to heat flow. The word thermal is used here to define the type of insulation used to retard the passage of heat through the exterior surfaces of the house. This is true for heat moving from the outside in during the summer or vice versa during the winter. Another use for insulation can also be for acoustical purposes.

The foams have the highest R-value, at the highest price, but they work well to also seal the envelope. They might require fire protection, so check local and state codes. They also act as a vapor barrier. However, Icynene is an open cell foam that does not act as a vapor barrier. The next highest R-value is Cellulose. This is recycled newspaper, pulverized, and treated with boric acid for fireproofing. Not only is this a truly recycled product but the boric acid kills termites and roaches. If blown in wet, it also helps seal the envelope. Make sure the insulation is completely dry before finishing the interior. However, it does not act as a vapor barrier. There are other blown insulations and batts that can fill the envelope cavity.

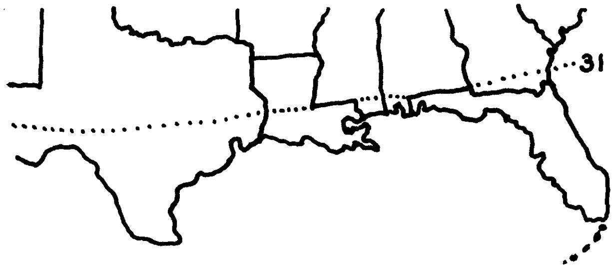
The following chart gives the thermal resistance of a few different basic insulating materials. Expanded tables of R-values for different building components can be found in the ASHRAE Handbooks.

Material	**Thermal Resistance/Inch**	**Physical Format**
Fiberglass	≈3.2	Rolls, batts, blankets, blown
Rock wool	2.2	Loose fill
	4.4	Rigid board
Perllite	2.7	Loose fill
Cellulose	≈3.2	Loose fill
	≈3.5	Sprayed in place
Icynene	≈3.6	Foamed in place
Polystyrene (expanded)	4	Rigid board (bead board)
Polystyrene (extruded)	5	Rigid board
Urethane/Isocyanurate	≈7.2	Rigid board
	≈6.2	Foamed in place



The R-value for the entire envelope skin (wall, roof, ceiling, and floor) must be calculated. This means adding up the total resistance of all the materials that make up that construction. For example:

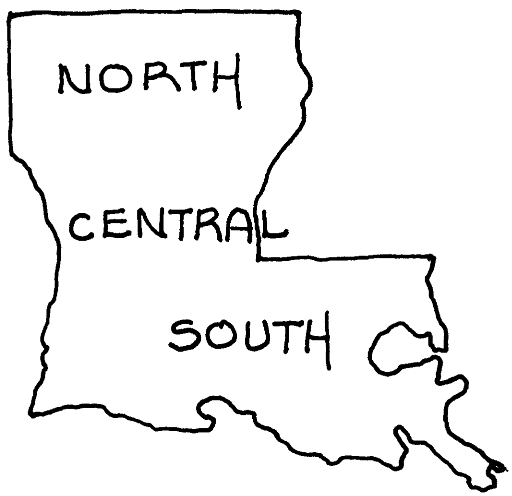
Wall Component:	**R-value**	
Indoor air film	0.7	
1/2" gypsum board	0.45	
3&1/2" blown cellulose	12.25	
1/2" polystyrene board	2.5	
1/2" plywood siding	0.6	
Outdoor air film	0.2	
Total Resistance of Wall		16.7



Check the charts below to see the R-value recommendations for the specific site where the house is located.

U.S. Department of Energy Recommended R-values for New Construction*

North Latitudes	Attic**	Cathedral Ceiling**	Wall	Crawl Space Wall***	Floor	Slab Edge ****
Above 31°	49	38	18	19	25	8
Below 31°	38	38	13	19	13	4



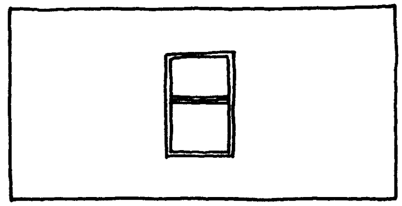
Louisiana Department of Natural Resources Recommended R-values for New Construction*

Louisiana	Attic**	Cathedral Ceiling**	Wall	Crawl Space Wall***	Floor	Slab Edge ****	Knee Walls
North	38	38	19	19	19	10	19
Cent. & So.	30	30	13	13	0	0	19

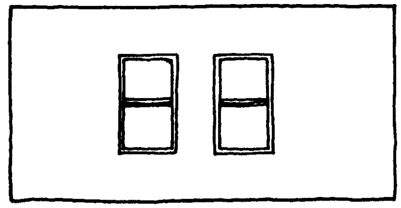
* If using batts, use only the unfaced type so that a vapor barrier is not created. It will be beneficial, for protection against roaches and termites, if a borate product is sprinkled on the batts.
**These numbers tend to be high, especially if a radiant barrier is used.
***Insulate crawl space walls only if the crawl space is dry all year, the floor above is not insulated, and all ventilation to the crawl space from the exterior is blocked. A vapor retardant (6- to 10- mil polyethylene film) should be installed on the ground to reduce moisture migration into the crawl space from the earth below.
****Termites can enter through insulation. Either do not bring rigid insulation up to exterior finish or leave it out altogether.

There are also insulation values for the Model Energy Code based on the amount of glass in the wall:

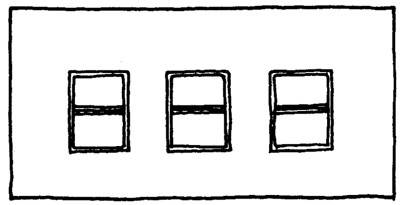
City	Glazing Area %	Ceiling R-Value	Wall R-Value	Floor R-Value	Slab Edge R-Value	Crawl Space Wall R-Value
Lafayette,	8	19	11	11	0	5
Lake Charles,	12	19	11	11	0	5
New Orleans,	15	26	13	11	0	5
& areas with	18	30	13	11	0	5
1500 to 1999	20	30	13	11	0	5
HDD	25	30	13	13	0	6
Shreveport,	8	19	11	11	0	5
Monroe,	12	19	13	11	0	6
Alexandria,	15	30	13	11	0	6
& areas with	18	30	13	11	0	6
2000 to 2499	20	38	13	11	0	6
HDD	25	38	13	19	0	10
Ruston	8	26	11	11	0	5
and areas	12	26	13	13	0	6
with 2500 to	15	30	13	19	0	7
2999 Heating	18	30	13	19	4	7
Degree Days	20	38	13	19	4	7
	25	58	13	19	4	7



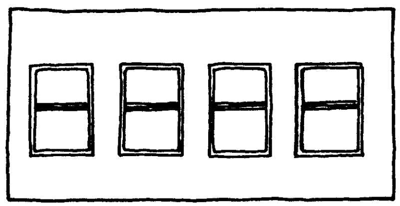
8%



12%

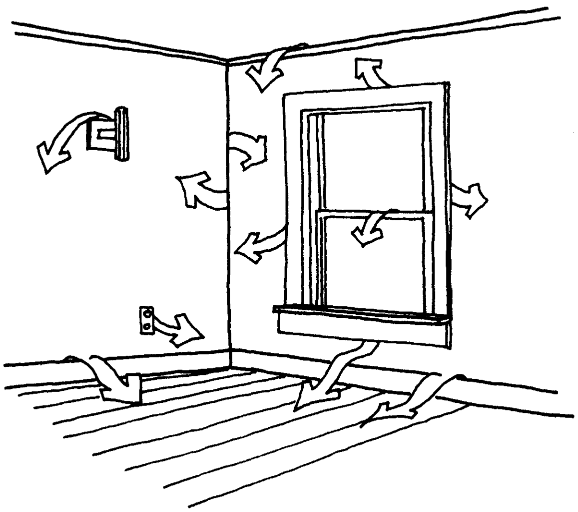


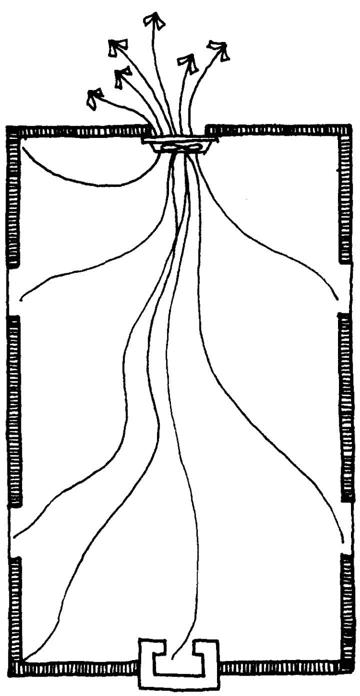
18%



25%

Because of the insulation, there will be a temperature drop throughout the wall. If dew point is reached in the wall, the result will be condensation. Wet insulation has less R-value. This also provides an environment for wood rot and the development of molds. To keep moisture out of the house see *Exhaust Fans* later in this Chapter. It is important to seal the structure against infiltration. Keep in mind, for a hot-humid climate you should never place a vapor barrier on the interior surfaces of the envelope. (See *Vapor Barrier* later in this Chapter.)





INFILTRATION & WEATHERIZATION

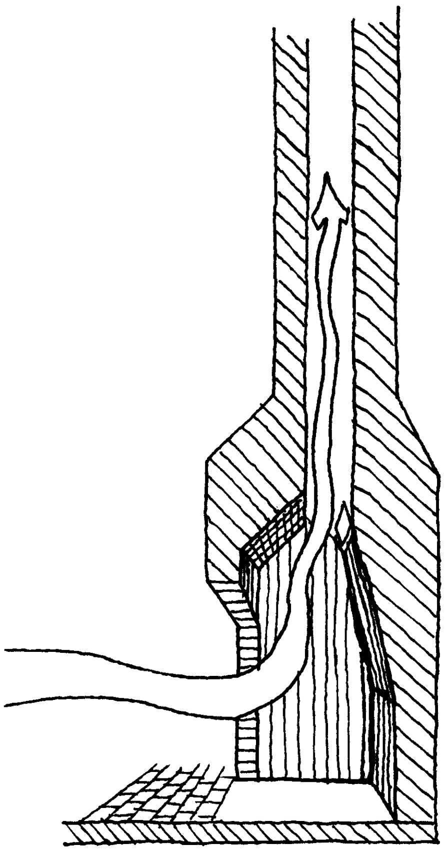
Outside air in the form of infiltration and ventilation imposes a heating and cooling load on the conditioned space and on the mechanical systems that control the temperature and humidity conditions. Ventilation and/or exhaust is used to control air purity, moisture, and odor levels, while infiltration arises from uncontrolled leakage through cracks and crevices around doors and windows, through penetrations of the envelope, through joints between walls and floor, and through the building skin itself.

If building new, it is much easier to seal the structure with air barriers, caulking, foams, and good doors and windows. However, for older houses this is a major problem. The majority of heat gain, heat loss, and moisture problems with old homes in Louisiana are due to infiltration.

All exterior doors and windows should be weather-stripped. Gaskets can be placed behind all electrical switches and receptacles on the exterior walls. Caulk all penetrations through the inhabited envelope like recessed light fixtures, attic hatches, plumbing fixtures, doors, windows, and electrical penetrations. A blower door can be used to test the house for air leakage. This is a door with a fan in it that is put in place of one of the exterior doors of the house, and a negative or positive pressure is applied to the interior. Smoke trails are used to find out where the leaks are. This is probably the best way to find leaks. Your local utility company might have such a device. A similar system can be used to find air leaks in the ductwork system.

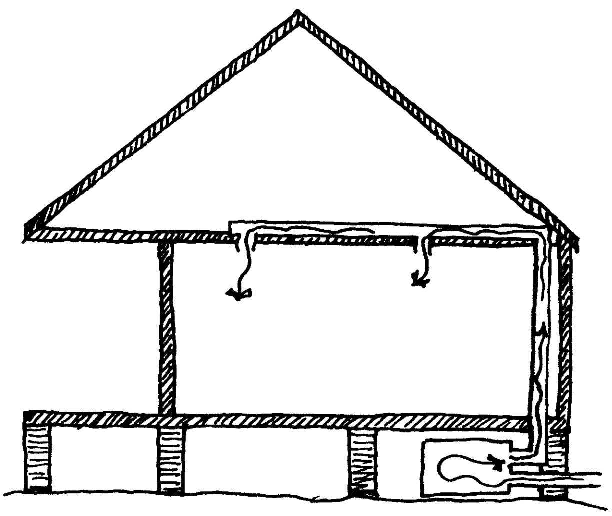
Storm doors and windows can help with infiltration and heat loss. However, they do not fit well with a historic look. If that is not the issue, then they are worth looking into. A rural Louisiana folk technique for a winter season adaptation is to remove the window screen and wrap visqueen around it and hook it back in place. This is not an aesthetic solution; you cannot see out the window, but it will cut down on heat loss and infiltration, and you can still get good daylight through it. Storm windows can also be added to the interior side of the window or door.

When the fireplace is not in use make sure the flue damper is tightly closed. The stack effect from the chimney will pull air out of the house. Likewise, keep the outside combustion air to the firebox closed when not in use.



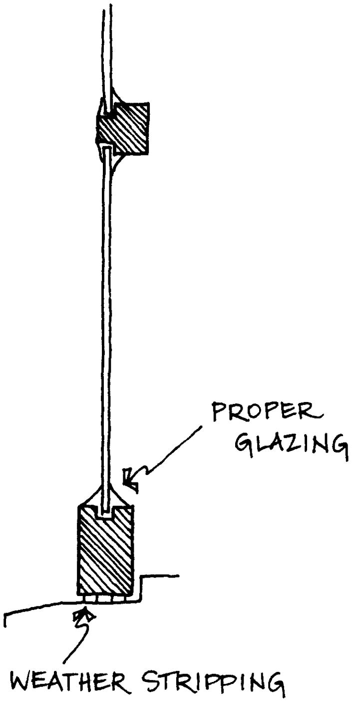
The house should be made as tight as possible against unwanted air infiltration. If fresh air is needed for a healthy interior, it should be brought in by a controlled supply ventilation system. Some of these systems can incorporate a dehumidifier to cut down on the moisture in the fresh air being brought in. A heat exchanger or energy recovery ventilator can also be incorporated into the fresh air intake to cut down on the heat being brought in during the summer or going out during the winter.

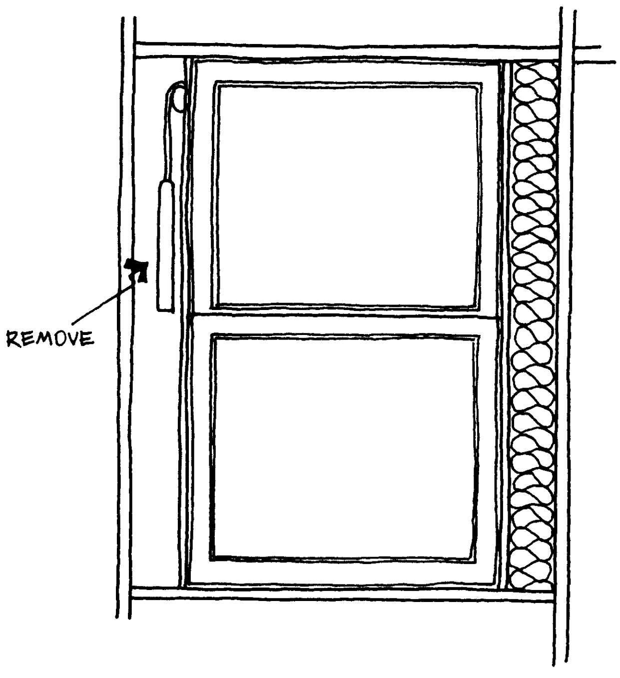
Fresh air is also required for a healthy interior. Somewhere between 10 cubic feet per minute (cfm) and 20 cfm per person is required. The house should eliminate as many interior contaminants emitted from furnishings, building materials and occupant activities as possible. If this is done then the lower end of 10 cfm is sufficient. Heavy interior pollutants can be smokers, damp crawl space, pets, unvented gas appliances, hobby activities, furniture, and finishes with strong chemical content. If this is the case a 20 cfm, or more will be required.



DOORS , WINDOWS, & SHUTTERS

Doors and windows are the major penetrations in the exterior insulated envelope. They need to be of the best quality and installed correctly. That is easier to accomplish with new construction. The majority of the time you will be faced with leaky old double hung windows. However, new replacement windows can be made to replicate the historic style of existing windows on the house.





Many an old window will need to be reglazed. If the panes of glass are old and wavy, then you want to replace broken ones with the same type of glass. Old glass can be salvaged from window sashes that are sold at most antique material places. Make sure that each pane of glass is sealed. (See Storm Doors & Windows in this Chapter under *Infiltration & Weatherization*.)

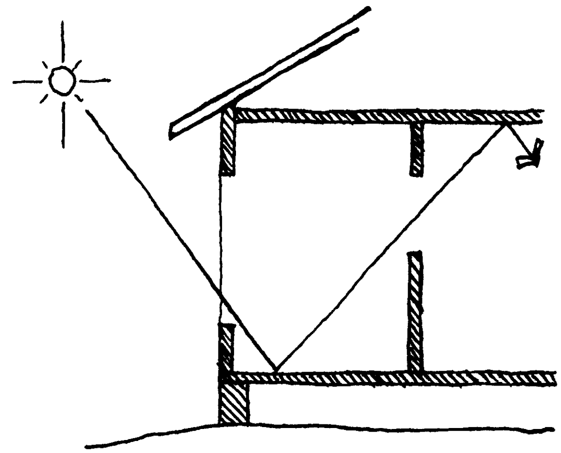
Some double hung windows will have counter weights in the side jamb. It is recommended that these weights and ropes be removed and the cavity sealed and filled with insulation. Stops can be installed to hold the window open at different levels.

If replacement windows are being used, make sure there is a good thermal break between the inside and outside of the frame. Insulated glass does little to stop radiant heat gain, but works wonders to stop conductive and convective heat loss compared to single-pane glass. Insulated glass is available with true divided lights to resemble the historic look. Low-E glass can be used if the window is in direct sunlight. This will help cut down on direct heat gain from the sun, and reduce fading in fabrics and pigments. It is best to shade the glass from the sun on the exterior of the glass. See *Shading* earlier in this Chapter.

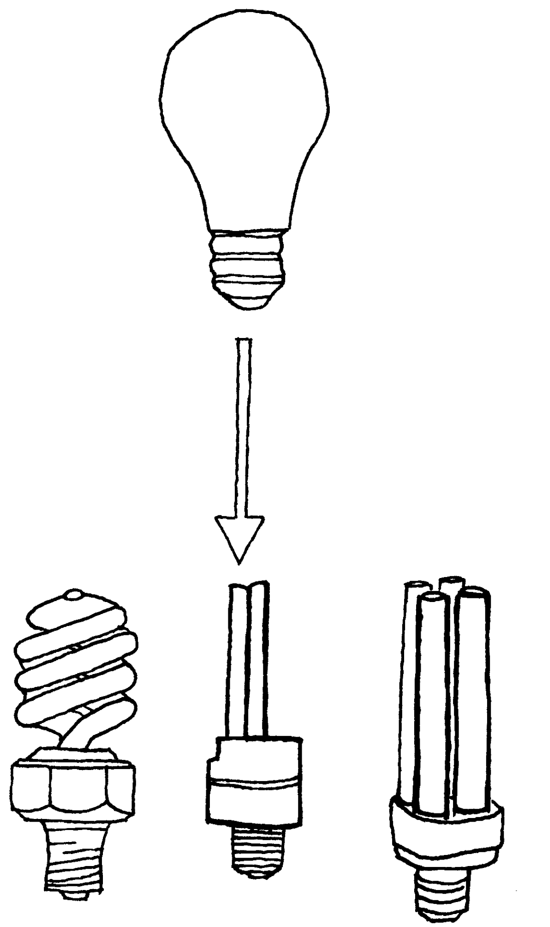
DAYLIGHT & LIGHTING

Daylight was important in early Louisiana. Sunrise and sunset regulated the daily life of colonial Louisiana and the Native Peoples who lived here. Even though lanterns could be used when the sun went down, daylight was the light of the day. Window shape and location was not for the daylight it would give, but for the ventilation it provided. Daylight was the byproduct. However, it was abundant because large openings were needed for breezes that helped provide human comfort. During the day many a task was accomplished on the porch where daylight was at its best.

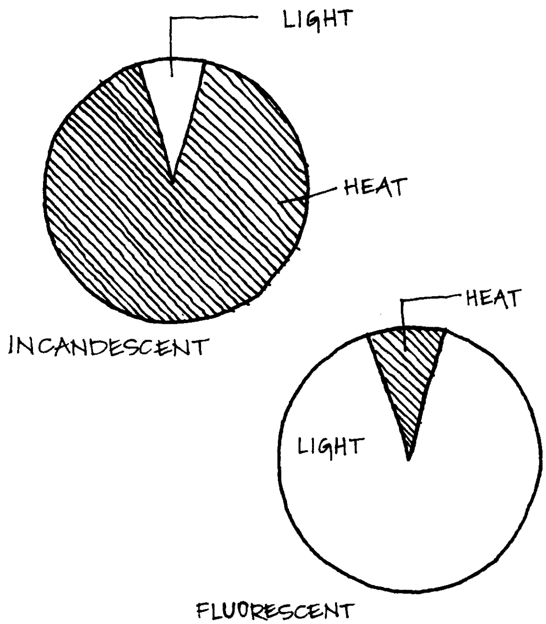
New windows could be added for those areas in the house that lack good daylight. Placing the window as high as possible is best for daylight purposes and the exhausting of air, however, as low as possible is best for incoming breezes. Interior rooms could have windows for borrowed light from well-lit rooms along the exterior wall. Lighter colors for the interior finishes will help distribute the daylight throughout the room.



Increasing your electric lighting efficiency is one of the fastest ways to decrease your energy bills. If you replace 25% of your lights in high-use areas with fluorescents, you can save about 50% of your lighting energy bill. Use linear fluorescent and energy-efficient compact fluorescent lamps (CFLs) in fixtures throughout the house to provide high-quality and high-efficiency lighting. Fluorescent lamps are much more efficient than incandescent bulbs and last 10 to 20 times longer. Although fluorescent and compact fluorescent lamps are more expensive than incandescent bulbs, they pay for themselves by saving energy over their lifetime. Look for the ENERGY STAR® label when selecting lighting products. See the Appendix for a table on the *Purchase and Operating Costs of Different Lighting Products.*

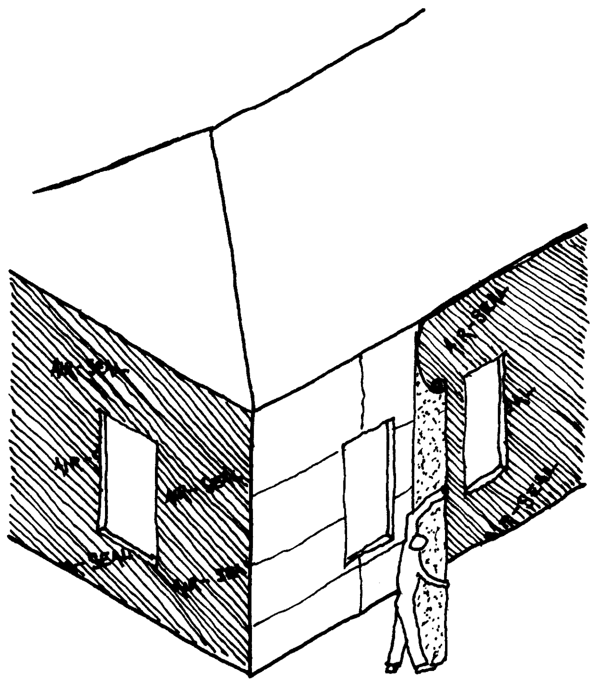


Turn off the lights in any room not being used. Consider installing timers, photocells, or occupancy sensors to reduce the amount of time your lights stay on. Use task lighting instead of high level lighting for the whole room. For example, use fluorescent under-cabinet lighting for kitchen countertops. Use 4-foot fluorescent fixtures with reflective backing and electronic ballasts for the workroom, garage, and laundry areas. Consider using 4-watt mini-fluorescent or electro-luminescent night-lights. Both lights are much more efficient than their incandescent counterparts, and cool to the touch. About 90% of the energy used for fluorescents goes to providing light with about a 10% production of heat. The incandescents are just the opposite; 90% of the energy is given off as heat with only 10% for light. You can think of incandescent lighting as a heater that gives off a little light. Fluorescents are available in a variety of specific wavelengths of the



color spectrum (where incandecents do not), and also come in full-spectrum light.

Outdoor lighting is used for security and decoration. When shopping for outdoor lights, you will find a variety of products, from low-voltage pathway lighting to motion-detector floodlights. Some stores also carry lights powered by small photovoltaic (PV) modules that convert sunlight directly into electricity; consider PV-powered lights for areas that are not close to an existing power supply line. Use outdoor lights with a photocell unit or a timer so they will turn off during the day. Turn off decorative outdoor gas lamps; just eight gas lamps burning year-round use as much natural gas as it takes to heat an average-size house during an entire winter. Exterior lighting is one of the best places to use CFLs because of their long life. Make sure the CFLs used outside are waterproofed and designated for exterior use.



AIR BARRIER

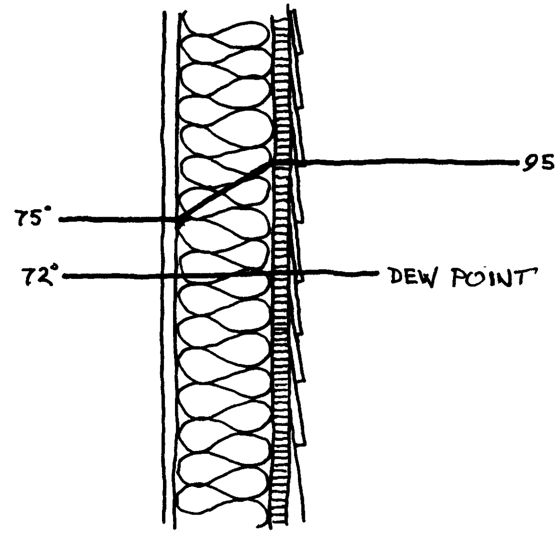
Air barriers are materials that do not allow the flow of air or water through them, but they are permeable to moisture vapor pressure. This means that when vapor is driven by pressure from one side of the material to the other it is free to do so. Air barriers are also known as house wraps, and act as a protector from the weather during construction.

Air barriers are used in Louisiana as a house wrap to prevent air infiltration. It is also being used as a waterproofing, like tar paper or asphalt impregnated roofing felt behind exterior wood siding.

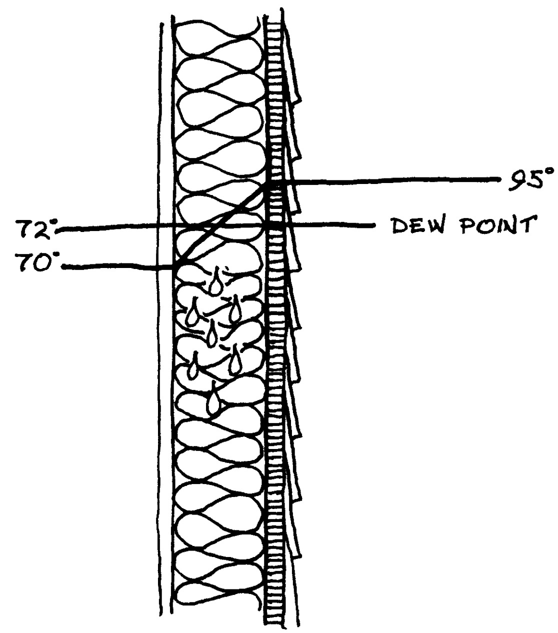
Air barriers are typically used on the exterior of new construction. It is logical to place the air barrier membrane under the siding. The most common air barrier in use today is a white polyolefin sheet material, marketed under a variety of trade names. However, an air barrier could be placed on the interior to help prevent infiltration.

This is not unusual when constructing a cathedral ceiling that is ventilated. It could also be used on the inside of the exterior walls. Make sure all penetrations through the air barrier are sealed.

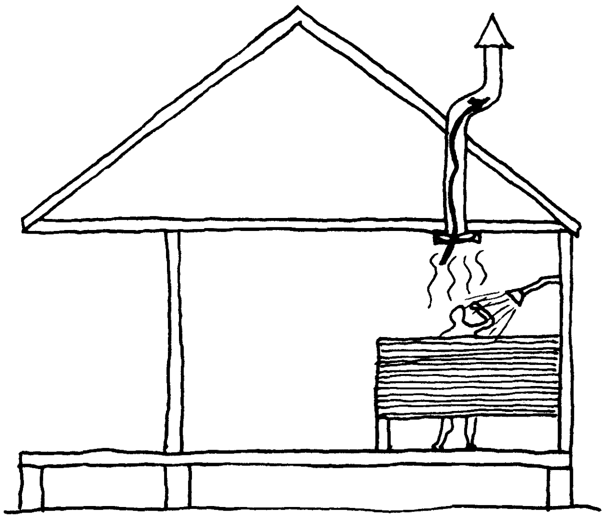
VAPOR BARRIER



Historically vapor barriers were not part of the builder's vocabulary in Louisiana. To the detriment and discomfort of the occupants in the winter, the walls, floors, and the ceiling breathed. Now that envelopes are built tighter and air-conditioning reduces the relative humidity in the house, there is a larger moisture or vapor pressure difference between the interior envelope and the exterior. It is important to keep this moisture migration to a minimum or eliminate it all together because dew point temperature can be reached in the thermal envelope and condensation is the result. Wet insulation reduces its R-value, and even worse, rot and mold can develop.



Vapor barriers are materials that are impermeable to moisture movement. The performance of vapor retarder materials is measured in perms. The lower the "perm", the greater the materials' ability to keep moisture vapor from moving through it. A vapor barrier is typically placed on the interior of the envelope in northern climates where there are long winters and long heating seasons. In warm-moist climates, like south Louisiana, most of the year the exterior is warmer and more moist. Then there becomes a debate as to which side of the envelope does the vapor barrier go on, or should we use a vapor barrier at all. The insulation manufacturers say it should be placed on the "warm" side. At some latitude in Louisiana if not all of Louisiana that would be the exterior for most of the year and the interior during the winter. So do you put a vapor barrier on both sides, or do you not put a vapor barrier at all? The major problem experienced in Louisiana, especially in the south or near large bodies of water where the humidity is higher, is during the summer when the air-conditioning temperature is set too low (72°F and lower). This



creates a greater vapor pressure difference between the interior air and the exterior air, which drives the moisture through the insulated envelope. With the drop in temperature across the insulated envelope, dew point can be reached and condensation is the result.

There never seems to be a problem with moisture in the walls of older homes that do not have a vapor barrier. If a vapor barrier must be used in the Gulf Coast area, put it on the exterior. In hot and humid areas, be careful not to create a vapor barrier on the inside of the insulated envelope. Some examples are polyethylene sheet, faced insulation batts, some paints, foil-faced finishes or backing, vinyl wallpaper, a heavy sealing floor finish, etc.

The major problem is moisture moving through the insulated envelope, so it should be sealed as well as possible. Most moisture problems in the wall have to do with infiltration and not moisture vapor. Moisture generated on the interior of the house, like the kitchen and bathrooms, should be exhausted to the exterior, not the attic, to minimize internal moisture. Clothes dryers should always be vented to the exterior because that air in laden with moisture.

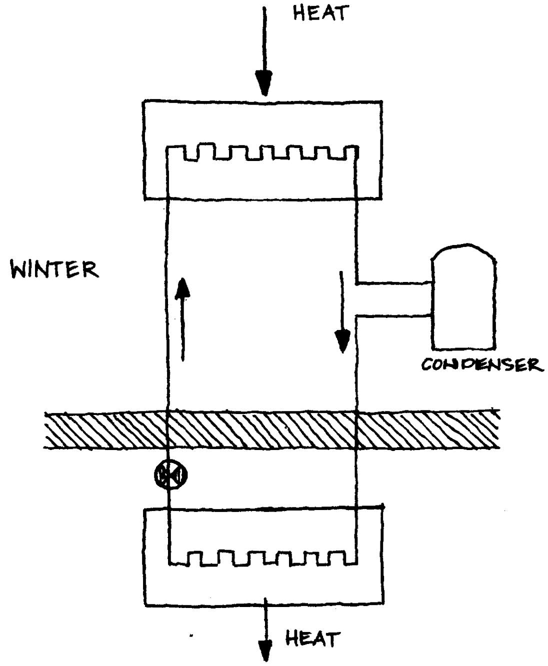
HEATING, VENTILATING, & AIR-CONDITIONING

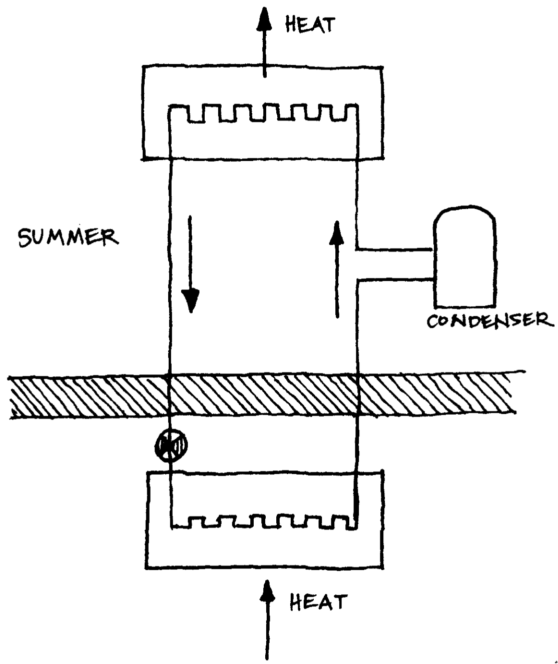
Heating, ventilating, and air-conditioning units of the forced air type are the mechanical system of choice in Louisiana. Only in those areas of the country where air-conditioning is not required, do other systems like base board hot water heating or radiant floor systems makes sense. However, when heating and air-conditioning are required, it does not make sense to separate heating and cooling into two different systems. With a forced air system, both heating and air-conditioning can be accommodated with the same mechanical unit. These units can also be split to use gas for heating and electricity for air-conditioning, but use the same forced air distribution system to supply the conditioned air to all areas of the house. It is very important to also pay close attention to how this supply air is returned to the mechanical unit so that air pressure is equalized.

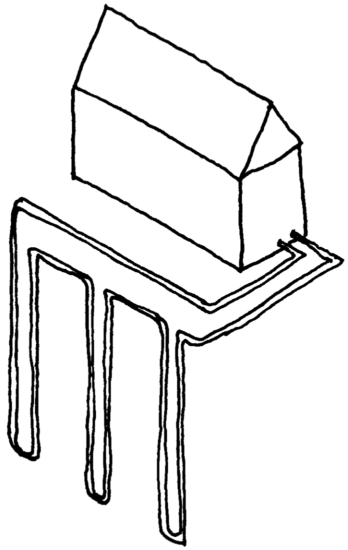
There are different types of heating and cooling systems. One of the most popular is the vapor-compression refrigeration that uses a refrigerant fluid. This fluid is mechanically compressed, passed through a condenser which is located on the exterior to reject heat to the outside, and then through an expansion valve and evaporator to remove heat from the interior. The cold coils are also used to condense moisture from the interior air acting as a dehumidifier.

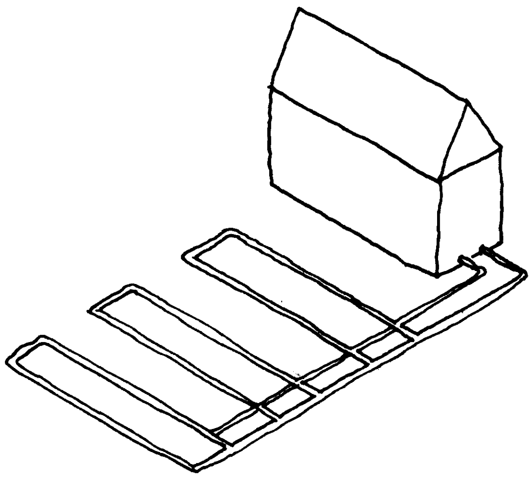
Another system that is gaining popularity is the heat pump. A heat pump is an all electric unit that removes heat from one area and discharges it to another. A heat pump is a reversible air-conditioner. The most popular heat pump today is the air-to-air. It uses air as the outdoor source for heating and cooling, and delivers the heat or cooling to the air indoors. So during the summer it removes heat from the interior of the house and discharges it to the exterior, and during the winter it removes heat from the outside air and discharges it to the interior. It loses efficiency when the temperatures are extreme. For example, when the outside air is below 40°F in the winter, it is hard to extract heat from that, so electric back-up heating coils supplement the heating at this time. Electric coil heating is the least energy efficient method of heating the house. However, a gas back-up is also available.

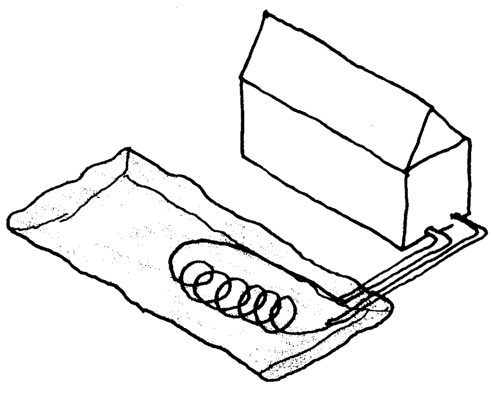
The most efficient heat pump is the geothermal, which uses water to interact with the constant ground temperature. The constant ground temperature in Louisiana ranges from 65°F in the north to 70°F at the coast. The constant underground temperature is very close to the mean yearly air temperature. (Refer to *Weather Data* in the Appendix for your area.) These are very good temperatures to either remove heat from or put heat into. There are a number of ways to use the earth as a heat sink:











1. Wells are drilled and two pipes with a U-joint at the bottom are inserted in each well shaft. The size of the unit determines the number of wells drilled. They are all hooked up in series and filled with potable water as a closed loop system.

2. The same type of closed loop system can be installed horizontally in the ground if there is enough site area to accommodate the amount of pipe needed for the size of the unit being used. A supply and a return pipe are laid in the same trench.

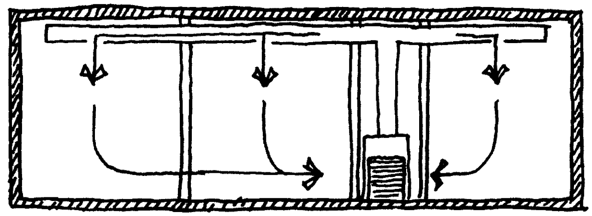
3. A closed loop system of pipe coils in a lake or pond is another option.

4. There are also flat plate heat exchangers that can be placed in a body of water for a closed loop system.

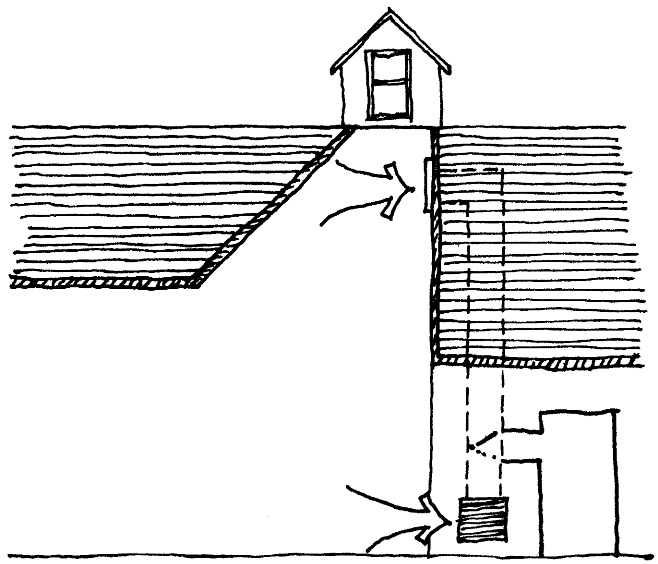
5. The other system is an open loop. This is where a well supplies the water to the unit and then wastewater is discharged to the environment. There is minimal thermal pollution to this water - a rise or reduction of no more than 10°F. However, this is not an environmentally benign system. If too many people did this, it could put a major strain on aquifers that we depend on for our potable water. Less than 1% of all the water in the world is drinkable – it cannot be wasted. It is possible to inject this water back into the aquifer with a discharge well, but check with the local authorities for code compliance. This waste water could also be recycled for some commercial uses.

One of the byproducts of a water source heat pump during the summer is hot water. A heat exchanger can be installed between the heat pump and the water heater to extract this heat. This basically provides free hot water during the air-conditioning season.

Forced air systems supply air through ductwork to the individual spaces in the house and returned to the unit by way of the interior openings. Doors are usually undercut to provide adequate air movement when the door is closed. Typically, ductwork is insulated flexible plastic or rigid sheet metal. The ductwork is usually hidden in the attic or under the floor, but instead, it is recommended that all ductwork be located on the interior of the insulated envelope. There are also high velocity plastic pipe systems that allow the ductwork to be much smaller and easier to thread through old houses. However, these higher velocity systems will make more noise. Unfortunately, many duct systems are poorly insulated or not insulated properly. Ducts that leak heated air into unheated spaces and vice versa can add hundreds of dollars a year to your heating and cooling bills. Insulating ducts that are in unconditioned spaces is usually very cost-effective. Seal the ducts to prevent leaks. Again, if at all possible it is always best to run any ductwork in the conditioned space.



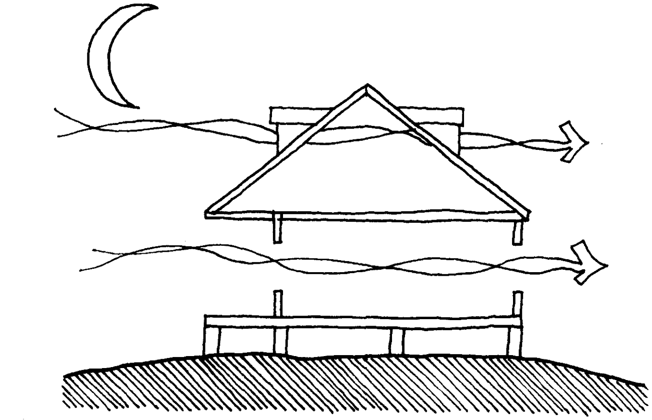
If there is a higher area in the house that collects heat, it would be beneficial to extend a return air register there to pull down this warmer air in the winter. Another return register could be located lower for summer use. It would also be beneficial to have windows that open to a negative pressure in this high area for ventilation and daylight possibilities.

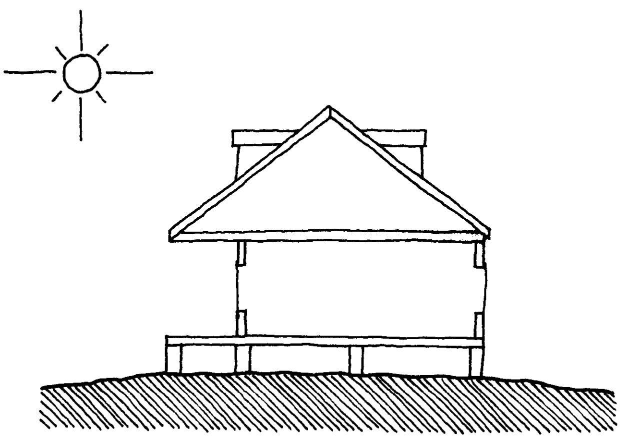


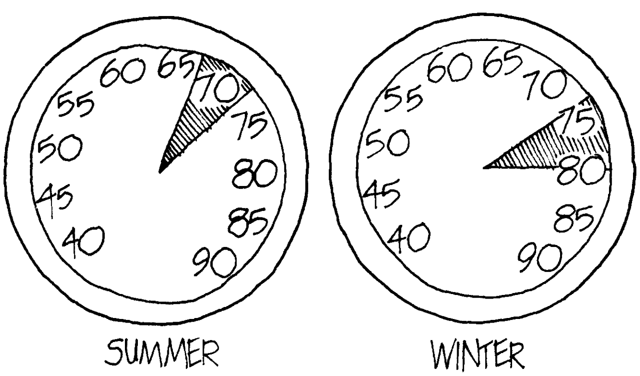
Another consideration is the use of the plenum created by the recommendation of closing in and insulating the crawl space. See the discussion earlier in this Chapter under *Floors & Crawl Spaces*. Air can be supplied or returned in a plenum. A plenum is different from ductwork. Ductwork is sized for the delivery of air at a certain cfm (cubic feet per minute), or velocity of air. A plenum is based on air pressure. Either system has to be designed to adequately distribute and return the conditioned air to the house.

Any gas system will need outside combustion air for the gas to burn and the exhausting of the spent fumes back to the exterior. This could also go through a heat exchanger to make it more efficient.

Make sure that the size and distribution is correctly designed. It is typical to oversize the mechanical unit a little just in case you need the extra comfort in that thousand year situation. An oversized unit will give a blast of cold air, satisfy the thermostat setting, and turn off.







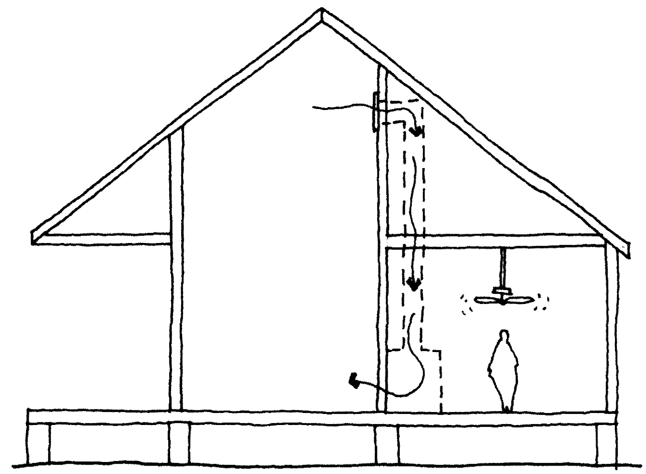
This does not allow the unit to run long enough to condense moisture out of the air. Dehumidification is the major thing we want the unit to do for us. The cool air is great, but we need drier air. It would be better to undersize the unit, which will have to run longer and remove more moisture. The best situation is to size the unit and the air distribution correctly. Use a program or manual that takes into account the orientation of each side of the house and weather the glass is shaded or not, or have it sized by a professional.

Set the thermostat as low as is comfortable in the winter and as high as is comfortable in the summer. Clean or replace the filters on the mechanical system on a monthly basis if needed. Keep the supply registers clean and make sure furniture, carpet, and/or drapes are not blocking them.

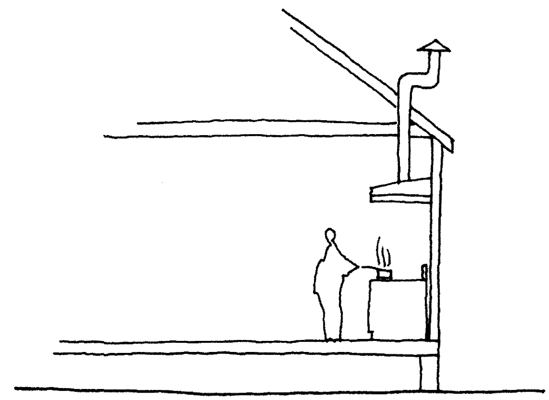
In spring, summer, and fall, open the house at night when it is cool outside and close it during the day when it is hot outside. In the winter, early spring, and late fall, open the house during the day when it is warm outside and close it when it is cold at night. Leave the house open whenever the temperatures and the breezes provide for natural comfort. This is most beneficial in older houses with brick or bousillage infill. These mass materials act as a flywheel to stabilize temperatures. And the human body relates to those mass temperatures much greater than it does to air temperatures. See *Mean Radiant Temperature* in Chapter 2, Human Comfort. The fan of the mechanical system can also be used during this time if air needs to be distributed to the entire house.

Whole house fans can be used to help ventilate the house. This type of fan can also be used to flush the heat from the attic. When a whole house fan is installed, extra attic vent space will be required to accommodate the exhaust.

Ceiling fans are also very cost effective and should be used wherever possible. Ceiling fans cool people and not spaces. Therefore run the fans only when there are people in the vicinity to feel the air movement. Ceiling fans do not work well to redistribute warm air in a higher ceiling area in the winter. It would be much more effective to locate the return air from the mechanical system in that upper space and use the internal fan of the mechanical system to redistribute the warm air to the rest of the house (the thermostat should allow you to use just the fan).

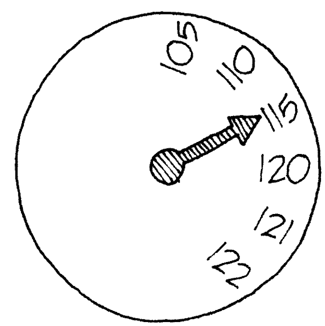


Exhaust fans could be used to take smells and moisture out of the house. They should be used wherever excess moisture is being produced. This would be true for the stove, shower, and clothes dryer. If other activities like unusual hobbies that use harsh chemicals are typical, then an exhaust fan should be provided to such a space. Use these exhaust fans wisely. In just one hour, these fans can pull out a house full of warmed or cooled air. Turn fans off as soon as they have done the job. This heat and moisture should be exhausted to the exterior or a well ventilated attic. The clothes dryer vent should always be vented to the exterior since it will be laden with moisture. This author has a client who ducts attic air to the inlet side of the clothes dryer; drying the clothes while cooling the attic. Or you can use that solar clothes dryer - the clothes line. And have clothes that smell and feel better.

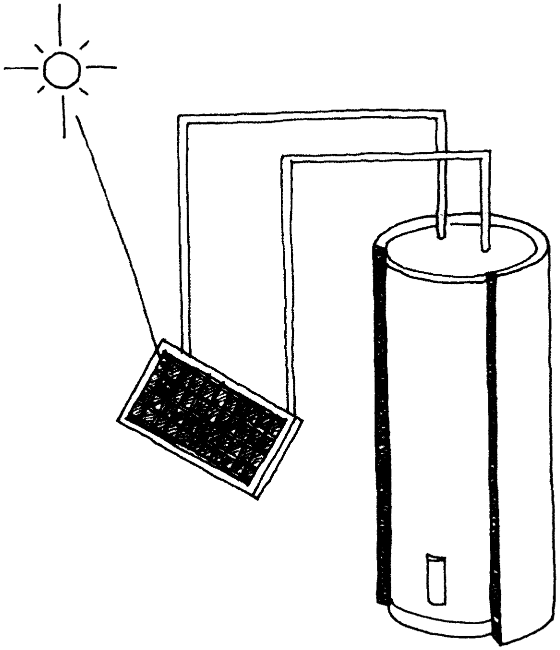


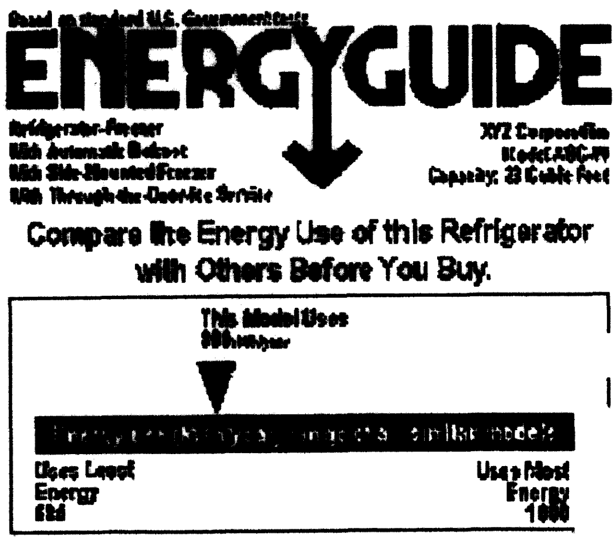
WATER HEATER

Water heating is the third largest energy expense in the house. It typically accounts for about 14% of the utility bill. To improve the efficiency of your water heater you can use less hot water, you can turn the temperature down to 115°F, you can wrap the water heater with an insulated blanket, or you can buy a newer energy-efficient unit (look for the energy labels). Water fixture faucet heads can have a water reducer to cut back on the amount of water being used. Most tasks can use water at 115°F while some appliances have the ability to boost this temperature if needed - like the dishwasher. If the water



HOT WATER TEMPERATURE





tank is warm to the touch, ~~it is losing heat.~~ An insulated water heater jacket will increase the efficiency of such a tank.

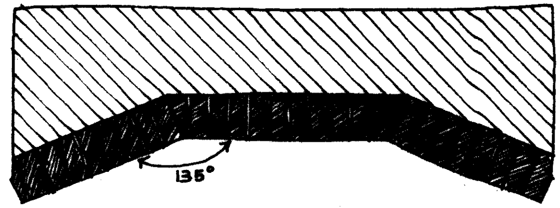
Always repair leaky faucets. Drain a quart of water from the water tank every 3 months to remove sediment that impedes heat transfer and lower the efficiency of the heater. The type of water tank you have determines the steps to take, so follow the manufacturer's advice.

Solar water heating is a very doable thing for all of the Gulf Coast states. We use hot water all year long. To get heat from the sun is a very easy thing to do, and it can be done passively (without using any electricity or gas). The collector has to have a southerly tilted exposure for efficient collection of heat. This can be an aesthetic challenge for historic houses or any house. They tend to look like an afterthought, but do not have to with some creative thought.

APPLIANCES

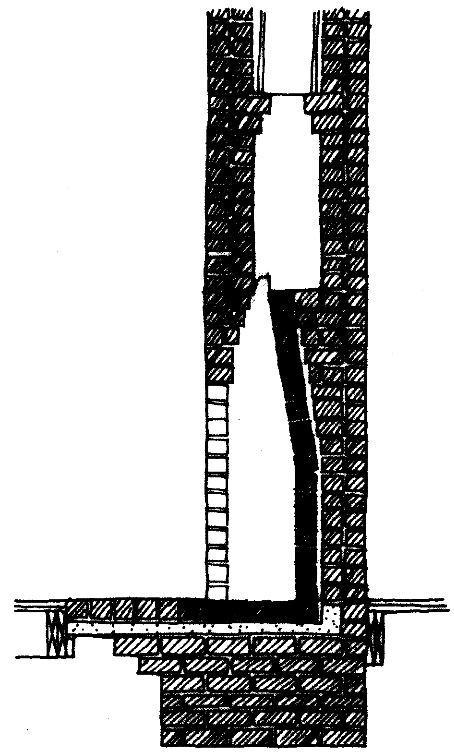
As mentioned in Chapter 5, appliances can account for about 20% of the energy load on the house with refrigerators, clothes washers, and clothes dryers at the top of the consumption list. All appliances are rated as to their efficiency by the Energy Guide label on the product. The U.S. Environmental Protection Agency and the Department of Energy have identified those that are labeled ENERGY STAR® as being the most energy-efficient products in their classes. Paying for the appliance is one thing, paying for the energy to use it over the life of the product in another thing. Look at the lifecycle cost of all appliances and you will see that it might benefit the pocket book to pay a little extra on the initial purchase, and save money in the long run.

FIREPLACES & WOOD STOVES



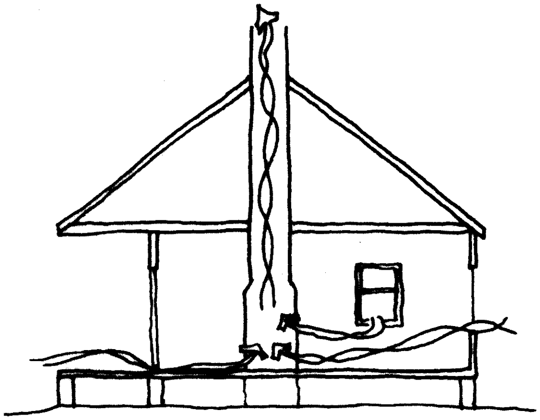
Over the ages designers and masons have tried to solve the problem of the best way to construct a fireplace that does not smoke and gives heat to the interior. This debate and development continues today. The two concepts seem to be at odds with each other. A deeper firebox will exhaust the smoke better than a shallow one. And a shallow firebox will produce more heat to the room than a deeper one.

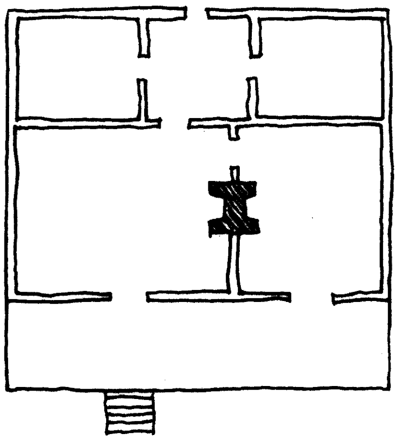
In the past thirty years, energy efficient designers have revisited the work of Count Rumford, an American expatriate who published formulas in the 1790s for fireplaces that were designed to radiate as much heat as possible into the room. The major principles of the design are to make the firebox tall and shallow. This allows a larger fire and brings it closer to the room. The side walls of the firebox are splayed very broadly toward the room, a maximum of 135° to the back wall, so that they radiate more heat into the room.

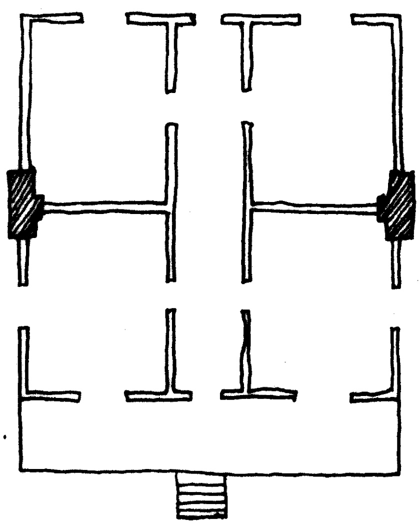


The design of the flue is extremely critical to create a strong draft to assure that the fireplace does not smoke. The general principles are: (1) The cross-sectional area of the flue should be about one-tenth to one-twelfth the area of the front opening of the fireplace, depending on the flue height – larger for a shorter flue and smaller for a taller one. (2) The chimney should be as tall as is practical so as to produce the largest possible convective draft. (3) The flue should be located in the central portion of the house and not on an exterior wall. This will avoid the cooling effect on the flue of outside air because the hotter flue gases can be maintained, the more prone they will be to rise.

The straight back and streamlined throat have a beneficial effect that Count Rumford could never have imagined, by keeping the smoke hotter further up the chimney, more particulate is burned, making Rumford's the only clean burning traditional fireplace.







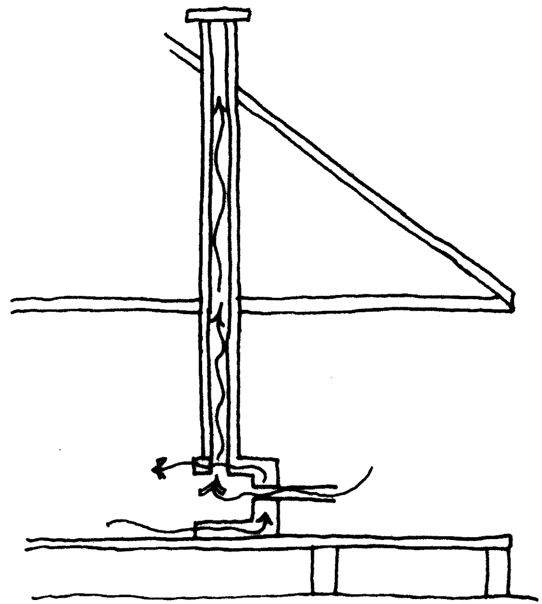
Older fireplaces are not very energy efficient. In fact most will cool the house during their use. This is mainly due to the combustion air that is brought in to the house from outside to feed the fire. Without this air, the fire will not burn adequately and the draft will not be sufficient to remove the smoke. It is also typical that these older fireplaces do not have a damper to close off the firebox from the flue.

If the house is being moved, the fireplace must be taken apart and can be reconstructed to be more efficient. If it is a historic restoration, close attention must be paid to all dimensions so the mantel and other finishes will fit the new construction.

In French colonial homes, it was typical that the fireplace was located on the interior usually between two rooms. Later, as the "Americans or Anglos" moved into Louisiana, the influence was to place fireplaces on each end of the house on the exterior wall. They had a fixation with symmetry where the French could have cared less. An interior fireplace is much more efficient because some 50% of the heat from a fireplace on an exterior wall can be lost to the outside.

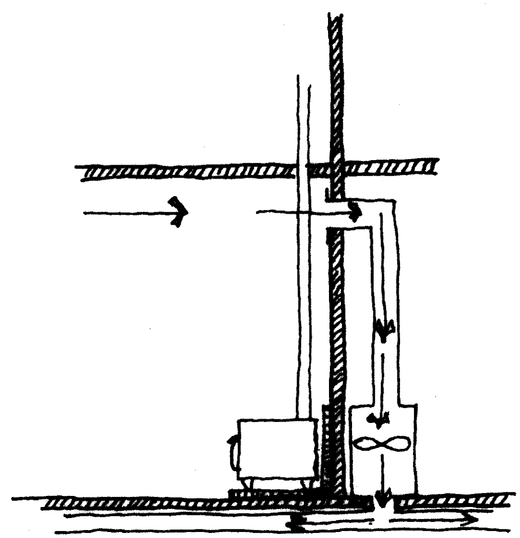
When rebuilding a masonry fireplace provide an airtight damper in the throat above the firebox, and provide for outside combustion air in the firebox or as close as possible to the fire. The outside air should also have an airtight damper which should remain closed when not burning wood. Make sure the new fireplace meets the correct proportions for good design today.

When a masonry fireplace is not being rebuilt the options can be more limited. Many older fireplaces and chimneys were built with softer bricks and a fairly soft mortar like earth and lime. Mortar joints need to be inspected for deterioration throughout the full length of the chimney. These older chimneys did not have a clay tile flue like they do today, and have a much greater chance of sparks from the fire escaping through the chimney. This can be a major fire hazard especially in the attic where it is not seen. Tuckpointing should not use mortar stronger than the bricks. Follow the masonry institute's guidelines for appropriate repair work.



Some older wood burning fireplaces were reworked to burn coal. This usually required that the firebox be made smaller. If this is true, the firebox needs to be restored or reworked to meet the correct proportions to burn wood. Reworking the firebox is a good opportunity to try and provide a draft damper and outside air for combustion. This will improve the heating efficiency of the fireplace.

When historic authenticity is not important, there are a number of choices for energy efficient fireplaces and wood burning stoves. In any case, with the house being weatherized and sealed against infiltration, it is important to privide outside combustion air to the firebox. If a masonry fireplace is desired, look at the more efficient designs like the Rumford (www.rumford.com). There are many good metal heat-circulating fireplaces on the market. Look for the ones with the highest BTU output, outside air, and a catalytic combustor (or other advanced combustion technology) for complete combustion. The greatest heat gain from burning wood is with a stove. Most wood stoves are free standing, but they also come as a built-in to look more like a fireplace.



When a wood burning stove is used, serious consideration should be given to how to distribute this heat to all parts, or at least, other parts of the house. Most stoves provide more heat than is needed for the room it is located. When a forced air mechanical system is used for heating and air-conditioning, the return air could be located high in the space above the stove. In this case, the fan in the mechanical unit can be used to distribute heat to the rest of the house.

Most new wood burning stoves have a catalytic combustor. This is important because it allows for complete combustion which means less polluting smoke leaving the chimney, much less creosote deposits in the flue, and more heat output. Another new system is the wood pellet stove. Pellet fuel is an economical, renewable fuel that costs less than cordwood without the hassle. It is also about one third less costly than electric heat.

Hardwoods in general produce more heat and less creosote (see *Fire Wood* in the Appendix for wood type and heat capacity, wood sources, split and stack, dry vs. wet, buying wood, and cord/face cord definition.)

APPENDICES

THRESHOLDS TO THE HEARTH: Living With the Natural Environment

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INTRODUCTION

Henry David Thoreau wrote in Walden, "I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived."

My belief is that humankind's psyche and soul are closely tied to the natural environment, and that relationship must be nurtured for a fruitful and holistic existence on this planet.

NATURE'S DEVELOPMENT

This planet, early in it's life, was a very hostile place with caustic fumes and toxic ultraviolet rays of the sun. The first life on this planet was probably anaerobic bacteria existing without oxygen. It was in the oceans, which make up three-quarters of the earth's surface, and with its great mass, provides stable temperatures and alkalinity with a richness and constancy of chemical composition, where sunlight penetrates but protects against its harmful ultraviolet rays, that life emerged. Life started as simple as algae. Algae could not exist without the sun. The sun is our life force. But it is the plant world that has allowed life on this planet. Life is dependent on photosynthesis. It was the plants that colonized the earth. It is interesting how close the word plant and planet are to each other. This symbiotic relationship between plant and bacteria created a biosphere around the earth that permitted the evolution from the sea of amphibians, reptiles, mammals and man. In Lawrence Henderson's book The Fitness of the Environment, he states that "Darwinian fitness is compounded by a mutual relationship between the organism and the environment. Of this, fitness of environment is quite as essential a component as the fitness which arises in the process of organic evolution; and in fundamental characteristics the actual environment is the fittest possible abode of life."

Nature is the arena of life. Knowledge of her process is indispensable for survival, and more so for existence, health, and delight. Hypocrites' famous medical work was the first public recognition that man's life, in sickness and in health, is bound up with the forces of nature, and that nature, so far from being opposed and conquered, must rather be treated as an ally and friend, whose ways must be understood, and whose counsel must be respected.

EASTERN SOCIETY

Ian McHarg talks about the traditional society (not necessarily the contemporary society we know today) of Japan in Design With Nature and their integral relationship with the natural environment. "In that culture there was sustained an agriculture at once incredibly productive and beautiful, testimony to an astonishing acuity to nature. This perception is reflected in a language rich in descriptive power in which the nuances of natural processes, the tilth of the soil, the dryness of wind, the burgeoning seed, are all precisely describable. The poetry of this culture is rich and succinct; the graphic arts reveal the landscape as the icon. Architecture, village and town building use natural materials directly with stirring power, but it is garden making that is the unequaled art form of this society. The garden is the metaphysical symbol of society in Tao, Shinto and Zen – man in nature."

WESTERN SOCIETY

The oriental harmony of man-nature has been achieved at the expense of the individuality of man. The western assumption of superiority has been achieved at the expense of nature. The western attitude to nature is confirmed in Judaism where nature is to be conquered as the enemy. This attitude is not true for the Native Americans – they were in the west before religious man made his presence known here.

NATIVE AMERICAN

The American Indian, like the Orientals (and closely related), is another prime example of a societal fit between man and nature. The hunter and gatherer learned to adapt his take to the capacity of the crop and prey. In this evolution, there must have developed a true understanding of creatures and their habitat, and plants and their environment. Hunting has to respond to an understanding of animal life, to breeding seasons, be protective of pregnant females, and cull the surplus males. This is a major step in human evolution.

Mississippian Mound Builders. The debate over which came first, agriculture or settlement is answered at a remote site in northeast Louisiana – Poverty Point. The Poverty Point culture of the Mississippi Mound Builders who lived there some 5 to 10 thousand years ago were hunters and gathers who had a true understanding of the natural environment. Because of this symbiotic relationship, they not only settled and built homes to live in, but built impressive mounds that signify a true community spirit. It is a real misnomer to call these people 'primitive'. They understood, appreciated, and managed their natural environment to sustain a life style that outlasted most high cultures of this planet. The people of this so-called 'primitive society' could promise their children the inheritance of a physical environment at least as good as had been inherited – a claim few of us could make today. Life and knowledge have developed and become more sophisticated and complicated in the intervening centuries, but, whatever excuses we can concoct, it is clear that we cannot equal this claim.

Anasazi. In Chaco Canyon, Bandolier and Mesa Verde are the ruined habitations of early Americans – the Anasazi, while at Zuni, Acoma and Taos they live today. Acoma is the oldest continuing living community in the Americas. These people built an abode that is truly inspirational. It was like they knew physics before it was developed as a science. At Chaco Canyon, the epicenter of this culture, they not only understood the yearly movement of the sun, but they also understood the movement of the moon, which has an 18.6 years repetitive cycle.

This 'primitive' culture developed an architecture that reversed the daily and seasonal ambient temperatures. When it was hot outside the interior of their home was cool, and when it was cold outside the interior was warm. The high specific heat value of earth and/or stone and the thermal lag of heat transferred by conduction were understood. The structures were stepped on the south side to maximize the exposure to the sun, while the north side turned its back to the cold winds. They also had solar zoning in that the next adobe structure was placed at that distance where the winter solstice cast its shadow from the one in front.

It is obvious that these societies of the Americas knew and understood their natural environment, and lived as one with it. And because of this, their lives were richer. Not that they lived the life of luxury, but their life had meaning in that they were forced "to live deliberately". Their life fit into the patterns of the natural environment.

COLONIAL LOUISIANA

Another prime example as to how to live more aligned with nature in a harsh hot and humid climate is how the French colonists in south Louisiana went through a climatic adaptation with their provincial architecture. They brought with them to the New World an architecture that their forefathers had developed over centuries for a colder climate. This worked well for their first colonial settlement on this continent in what is now Nova Scotia, but when they built this same design in the lower Louisiana colony, it proved to be a disaster. They picked the buildings up off the ground, added porches around the exterior, provided higher ceilings, located more doors and transoms on the exterior wall, and other design elements that took maximum advantage of shading and ventilation. They adapted their architecture to the natural environment, once they understood it, for human comfort.

CONTEMPORARTY HOUSE IN SOUTH LOUISIANA

Today we have new materials, new construction systems, and new technology to better climatically adapt our architecture to the natural environment. The crux of this situation is how to do it in a sustainable manner. The author designed and built a home for his family that would allow for a closer relationship with the natural environment.

Site. This endeavor started with the purchase of an abused 5 acres of land. Because of the accumulated junk and trash on the site, the land was purchased at a very reasonable price. An architect friend, Malcolm Wells says that "we should purchase ugly property and make it beautiful. However, most of the time we spend good time and money doing just the opposite."

The property is located in south Louisiana on the Bayou Teche (a main means of transportation for the settlement of the Acadians [Cajuns] in the mid eighteenth Century, and the Native Americans before them) some 25 miles (as the crow flies) from the Gulf of Mexico in a bottomland hardwood forest. Much of the land has been cleared in the area for farming, but the area along the bayou has remained forested.

Old House. An older house was obtained from a client who needed it removed from land that was to be developed for commercial use. Recycling of older architecture is a sustainable start. The roof and porches were dismantled for the move and reconstructed at the new site. The house was oriented for energy efficiency, and renovated for a new family to use.

This house was used as the main residence for some 20 years as the site was cleared of refuse and the land allowed to heal itself. During this time the author developed a knowledge and understanding of the site's natural environment, and plans were developed for the use of the property and a new house which would be built on the natural levy of the bayou. Also during this time salvage material was collected, categorized, inventoried and stored on the land. Once the new house was designed, more specific material was sought for salvage possibilities.

New House. The house is square with the corners pointing to the cardinal points. It is built off the ground with an underfloor plenum. The house is designed like a chimney for ventilation with a cupola at the apex of the roof. The roof is well insulated, contains a perforated radiant barrier, and has two vented air spaces. It overhangs the exterior wall by three feet to protect the glazing from the sun along with positioning the house to take advantage of shading from existing trees and the use of porches. The 2X6 exterior walls are filled with blown cellulose. Cellulose is recycled newspaper, which is pulverized and treated with borax to prevent it from burning. A major side benefit is that borax is a natural product that kills ants, roaches, and termites that are prevalent in this area. A continuous knee wall, of recycled concrete blocks, encloses the underfloor plenum which has fill insulation in the cores not containing concrete and rebar, cellulose blown on the interior surface, and the exterior surface waterproofed. Recycled closed cell rigid insulation was placed on the ground at the knee wall tapering from about 12" at the knee wall to about 2" eight feet out from the house. This was backfilled to create a good ground slope away from the house for drainage.

This exterior horizontal ground insulation is to thermally ground the structure, pulling the constant underground temperature closer to the floor surface in the plenum. The constant ground temperature in this area is 70°F. You have to go down 30′ to reach that, but at 15′ there are even better temperatures – warmer in the winter, and cooler in the summer. This is due to the thermal lag of the earth. Not much has to be done with 70°F to be comfortable in either the summer or winter.

The knee wall supports steel bar joists with recycled metal building siding and roofing for the steel deck which is welded to the joist. This supports a concrete slab with a steel trowel finish, scored and stained as the finish floor.

The geothermal heat pump and water heater are situated in the center of the house, and backs up to the wood-burning fireplace. The fireplace has outside combustion air ducted directly to the firebox with a damper control. The heatpump is connected to a seven feet run of duct that connects the overhead plenum to the underfloor plenum. A simple damper can direct forced air to either plenum and use the other as return air. The heatpump's fan runs constantly at a low speed. The wood burning convection fireplace produces heat that rises to the top of the house. In the winter, the fan returns this warm air from the top of the house and supplies it through the floor. The air moves from the center of the house to the exterior wall while heating the concrete floor. In the summer the cool air is supplied at the higher level, letting the cool air fall to the floor and returned at the exterior wall through the underfloor plenum to cool the concrete floor. The geothermal heatpump uses the pond as its heat exchanger with a closed loop coil of pipe in the bottom of the pond.

The mean radiant temperature of the floor is important. The human body relates to heat gain and loss much greater through radiation then it does by air temperatures through convection. The more comfortable situation is for the mean radiant temperature to be a few degrees cooler in the summer than the air temperature, and the mean radiant temperature to be a few degrees warmer than the air temperature in the winter. Air is a better insulator than a method of supplying thermal comfort to the human body.

Natural ventilation was designed on the basis of "suckulation". That is, the design emphasis is on how to create negative pressure openings high in the house to pull air out of the structure. This is what nature wants to do, allowing cooler air to enter low and letting warmer air rise to be exhausted. The movement of air across the human body removes heat.

The double-pitched roof is what the earlier French would have had as the first response to this hot-humid climate. The interior 40′ square is a steep hip roof without any attic space and open to the great room at the first floor below and a studio at the second floor. A lower pitch roof covers the perimeter 8′ that includes verandas, screened porches, and some conditioned space. Other colonial French influences are the two major walls in the great room which are colombage (half-timber) framed with recycled cypress and infilled with bousillage (a mixture of earth and retted Spanish moss). A Z-scarf joint joins major exposed beams, and exposed recycled cypress beams in the dining room are beaded at their bottom edges, all in the French style.

The design of the house is like that of a sailboat. It has the flexibility of changes with the seasons/winds. The house sails on the natural environment for as long as it can. This amounts to over half of the year when the geothermal heatpump is not required for comfort.

Sailing With the Seasons/Dancing to the Rhythms. Not necessarily the longest, but the harshest time of the year is the winter. Fronts come in from the north and northwest with winds and sometimes rain. The sky after a frontal passage is clear. This gives the ability to collect heat from the sun during the day while the clear skies at night can turn to frost or freezing temperatures. Wood is burned for the major heat source. The heatpump's fan is used at a very low speed, to return warmer air from high above to the underfloor plenum. This heat moves from the center of the house to the exterior wall, transmitting its warmth to the concrete floor. Sometimes the geothermal heat pump and the fireplace are required, while there are many days when added heat is not needed at all. The fan continues to run during these times. The deciduous trees have lost their leaves and the landscape is more open. The dense vegetation is gone and nature exposes herself to the observant eye. The last of the pecans are harvested, and chanterelles are collected after a rain. The camellias are in full bloom. Vegetables from the garden are being harvested and garlic is planted at this time. The migratory ducks and geese fly in formation above. Wood ducks work the wet forested areas, the pond and the bayou. Many types of water birds visit the pond to fish – heron, ibis, cranes, egrets, carmerands and kingfishers visit the pond all year long.

In late winter, the days are warm and the nights are cold. Fronts still move in bringing rain and colder temperatures. On nice days the house is open during the day and closed at night. The last of the kumquats are being eaten from the trees. Japanese magnolias, red buds, blackberries, pears, yellow tops, purple trumpet, wild onions, tear drops, jonquils, and Easter lilies are showing their flowers. The sweet olive is in full bloom and smells wonderful. Robins are everywhere, and there is good fishing in the pond. As the garden is harvested the compost mulch is tilled into the soil preparing the beds for a spring planting.

Early spring has days that are still warm and nights cold, but sometimes the days are warm and the nights cool. For the latter, the house is open at night and closed during the day with the plenum used for return air. The mass floor is cooled by bringing in cool air at the perimeter in the underfloor plenum and pushing it up and out the cupola at the top. All the fruit trees are in bloom, along with the dogwood, wild cherry and many other trees, and the summer vegetable garden can be planted. Live oaks are evergreens but the new leaves are pushing the older leaves off the tree at this time. Almost all of the deciduous trees are showing new leaves. The wild flowers are in full bloom. The Japanese plums are ready to be eaten.

In late spring, the days are warm and nights are cool. The house is opened at night and closed during the day. The pecan trees are the last to sprout their leaves. The Chinese Tallows are blooming and the bees are working their flowers. The garden needs to be kept weed free and the fruit trees fertilized and mulched. A near by rookery is teaming with nesting birds (rosette spoonbills, ibises, cranes, herons, egrets, and ducks) and their baby chicks with the alligators waiting below. The azaleas are in full bloom. Bamboo shoots are driving up through the earth - some are harvested for eating and others cut to control its growth. The garden is being thinned and harvested. The wild cherries are ready to eat – school is over for the summer.

The early summer nights are still cool and the days hot now. The house is open at night and closed during the day. Sometimes the house has to be closed and air-conditioned. Twelve interior and four exterior ceiling fans give a variety of comfort strategies. All of the trees are heavily leafed and there is an unbelievable density to the landscape. The crepe myrtle, mimosa, wisteria, water-hyacinth, magnolias, trumpet vines, day lilies, kumquats, pink sesitive briar, and many wild flowers are in bloom. The vegetable garden is producing lots of good food now. The mama wood duck pushes her babies out of the box and into the pond.

Late summer days are very hot and the nights are warm and humid. The house stays closed with the air-conditioning returning air from the underfloor plenum and supplying cool air high from the overhead plenum. The garden is still producing, but can only be worked early in the morning and late in the afternoon because of the heat. This is hurricane season and an ideal time to harvest firewood. The wood is split and stacked to face the sun and prevailing breezes, and covered on top with salvaged metal roofing sheets and held down with salvaged concrete blocks. The pecan trees are hanging with green nuts. The kingfisher is working the pond. Fishing is good early in the morning and late in the evening.

In the early fall, there are still times when the air-conditioning is needed, but cool fronts start to make their way down with cooler temperatures. This is an opportunity to open the house up at night and cool the mass floor by returning air through the underfloor plenum. It is time to rework the vegetable garden – nonproductive plants are pulled up and the compost mulch tilled into the soil preparing the beds for a winter planting. Cabbage, broccoli, lettuce, onions, celery, spinach, mustard, carrots, radish, chives, cauliflower, shallots, and snow peas can be planted at this time. The French Mulberries have turned from green to purple – it is time to go back to school.

Late fall is a wonderful time when the days are warm and the nights are cool. The house is flushed out at night to cool the concrete floor. Many days are nice to open the house all day to enjoy the nice weather outside. As the nights get cooler the house is closed at night and opened during the warm days. The pecans are harvested at this time as the trees start to loose their leaves. The Chinese tallow tree and the poison ivy vine are the only major fall leaf colors, along with many wild flowers like the goldenrod, mist-flower, purple aster and ironweed. Fishing is good in the pond.

CONCLUSION

Americans spend 80% of their life in buildings. I would say that a great percent of the other time is being in a vehicle. The reality of evolution is that all living things have adapted to their natural environment or perished. Today mankind is realizing that life can be much richer when you stop to smell the roses. As architects we can accommodate this philosophy by designing architecture with the natural environment. The emphasis here is on the preposition WITH. Not only are environmentally responsive buildings more sustainable, but they provide a stage that allows the occupant to dance to the rhythms of changing seasons. A dance that brings mankind a little closer to the wonders of the natural world. A dance that makes life rich, "and not, when (you) come to die, discover that (you) had not lived."

REFERENCES

(1) Cazayoux, E.J., Back to the Future. Proceedings of the 21st National Passive Solar Conference, North Carolina, 1996

(2) Cazayoux, E.J., Louisiana Vernacular Gumbo. Proceedings of 18th National Passive Solar Conference, DC, 1993.

(3) Cazayoux, E.J., Suckulation. USL Monthly News Release, 1988.

(4) Henderson, L., The Fitness of the Environment.

(5) LePage du Pratz, A Description of Building an Indian House. He was an architect and historian who lived at Natchez and New Orleans between 1718 and 1734.

(6) McHarg, I., Design With Nature. The Natural History Press, N.Y., 1969.

(7) Thoreau, H.D., Walden. The Modern Library, N.Y., 1937.

(8) Wells, M., Gentle Architecture. McGraw-Hill, Inc., 1982.

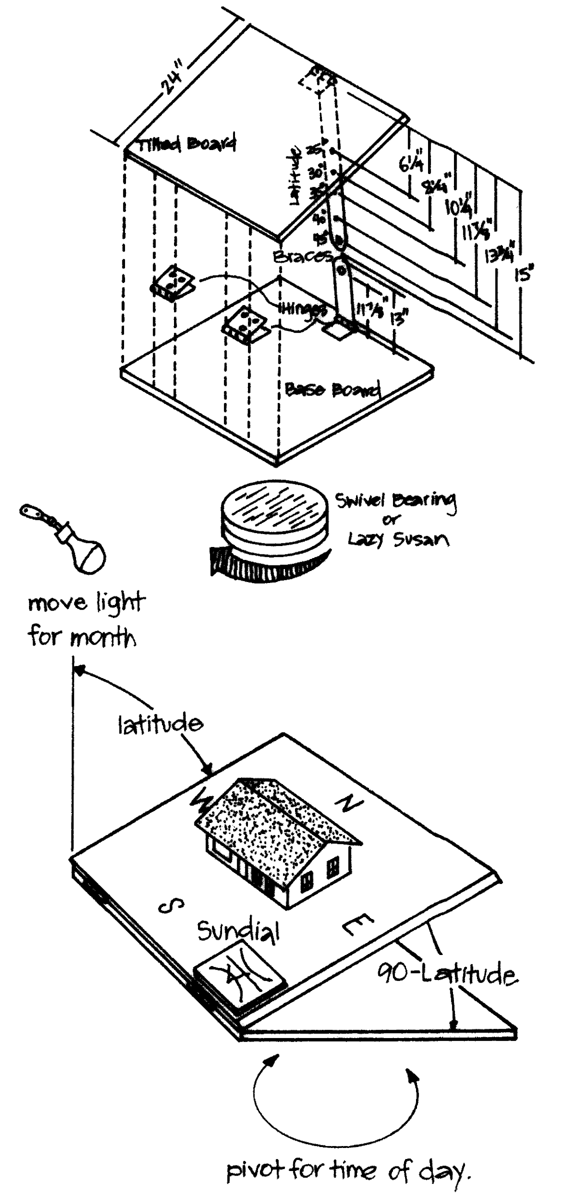
MODEL STAND & SUNPATH SIMULATOR

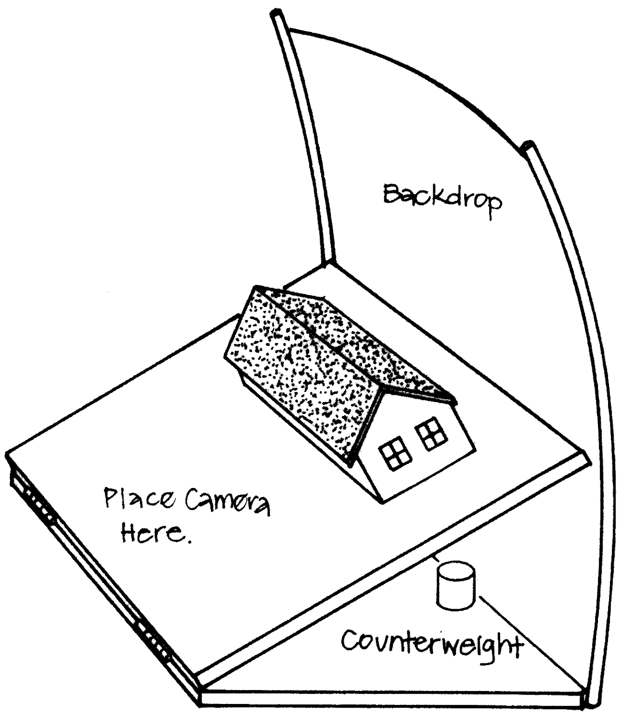
A heliodon is a device that correctly simulates the sun's position or motion relative to a reference surface (simulating a horizontal surface on the earth). This simulation can be accomplished with a fixed light source and a plane (representing the horizontal) tilted at the complement of the latitude in question (90° minus the desired lattitude) and pivoted around a vertical line (zenith).

The time of year, time of day and latitude on the earth can be correctly simulated by the heliodon with simple adjustments. The latitude is represented by the tilt of the reference plane from the zenith angle. The complement of the latitude (90° minus the desired latitude) is the tilt angle of the plane from the horizontal. Although this plane can be changed for different latitudes, when designing a building for a particular location the latitude is fixed. The time of year can be adjusted by moving the light source up or down in relation to the center of the tilted plane. A range of solar altitude angles can be evaluated from low winter to high summer angles. Pivoting the plane around the zenith while its tilt to the horizontal is kept constant can simulate the time of day. While these adjustments sound difficult, they are easily accomplished with two planar surfaces hinged together and pivoted by bearing on one of the surfaces.

Model Stand Construction. The model stand described below is constructed of two square pieces of plywood hinged together with swivel bearings (lazy susan) mounted on the underside center of one of the boards. A brace (or braces) attached to another hinge is needed to tilt one board away from the other. When not in use the stand can be collapsed and becomes only a few inches thick. The parts required for a model stand, which is two feet square, are listed.

The length of the braces for this two-foot wide stand is dependent upon the latitude. For a brace that attaches to the outside edges of both boards the total lengths required are 18 3/8", 20 1/2", 22 1/2",





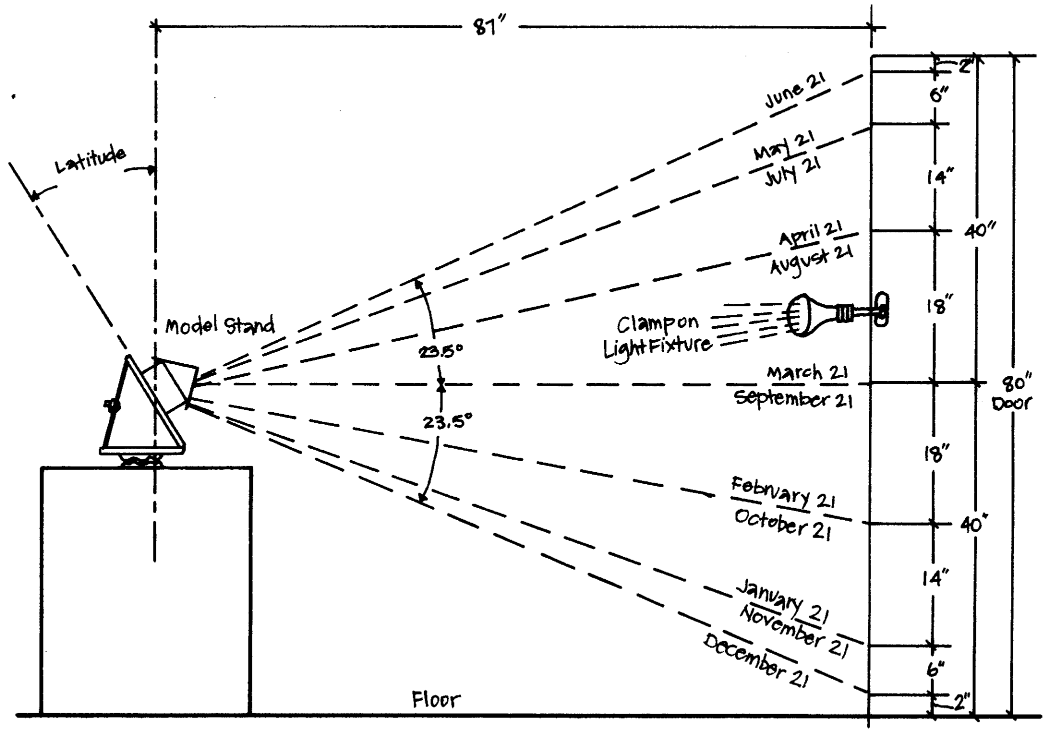
24", and 25 3/4" for latitudes of 45, 40, 35, 30, and 25, respectively. An adjustable model stand can easily be built for all of these latitudes with the two braces as shown, and by using pins or bolts in the appropriate hole. For larger model stands adjust these dimensions proportionately.

Parts List

Qty.	Part	Description
1	Swivel	Swivel Bearing or Lazy Susan
2	Board	1/2" Plywood 2'X2'
4	Hinges	Small
18	Screws	1/2" wood Screws for Hinges
1	Brace	Metal Strap up to 26" Long – Depends on Latitude

Setting up the Model Stand. The model stand should be set up on a box or edge of a table about 40" off the floor. A light source is needed which can be moved up or down to simulate different seasons. A clamp-on light fixture with a flood lamp or bulb and reflector is recommended. One good place to attach the light in any room is the edge of a door. The position of the light to simulate each month is shown for a 6'8" door, 7'3" from the model stand. (Note: the center of the model stand should be at the same height, 40", as the center of the door.) If a door is not used, a small sundial can be attached to the tilted board and the light moved up and down until the sundial shadow indicates the proper month.

The hinged edge of the two boards is the south direction to a model mounted on the tilted board, and top edge is the north as shown. The model can be attached to the tilted board with pushpins, tacks, screws, or tape. It is also convenient to cover the tilted board with a low knap carpet and to use velcro hook tape to hold the model in place. Being nondestructive to the model, this also allows easy repositioning of the model. The model stand can simulate sun motion for any building orientation if the model is mounted on the tilted plane with the correct reference to the south (hinged edge). Scale model trees, trellises, adjacent buildings or other objects can be placed on the model stand with the model to observe their shading patterns.



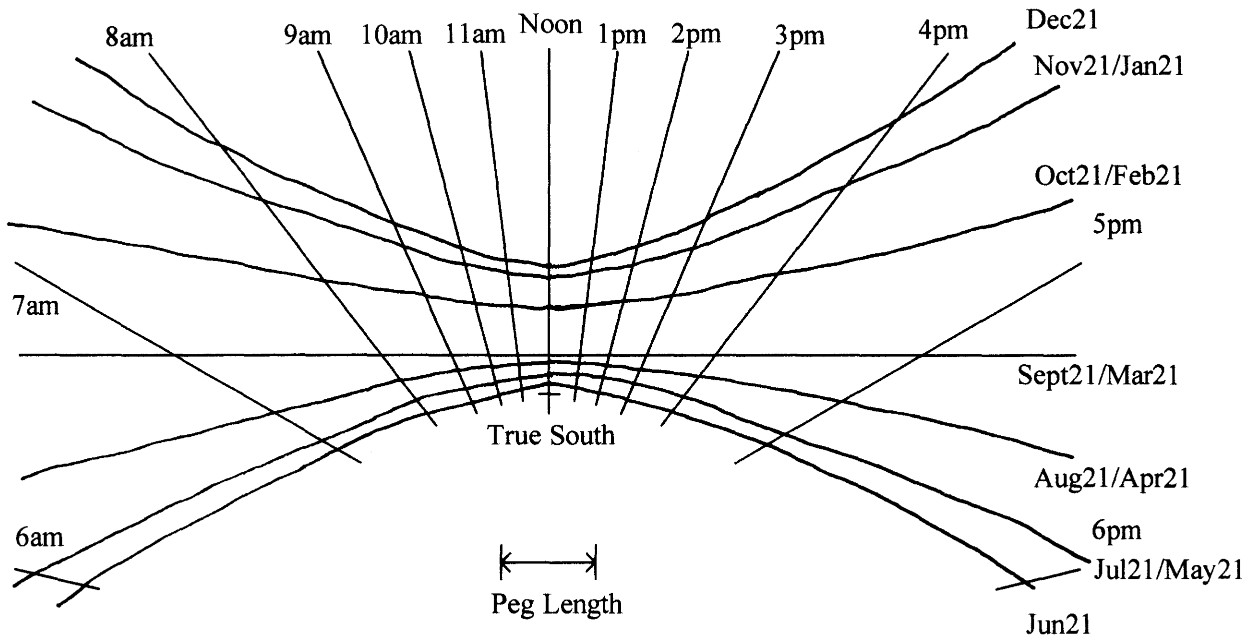
Evaluating Building Designs. Scale models for building can be visually observed while simulating the sun's motion. Three significant building design features can quickly be checked in this manner. First, move the light to its highest position to simulate summer (June 21st). Rotate the model from sunrise to sunset, and see if the windows are completely shaded throughout the day. One may also want to look at spring and fall or late summer months to see how much of the windows are shaded. Secondly, with the light mounted at its lowest position to simulate winter conditions (Dec. 21st), pivot the model stand from sunrise to sunset, and check to see if the south facing windows are completely unshaded. Overhangs designed to shade the summer sun can partially shade windows in the winter if the overhang is too close to the top of the window. This problem is caused by a common design error due to simple overhang formulas. Old school houses built in the 1950's in Louisiana had louvered overhangs that allowed winter sun, but kept out the hot summer sun. These old school houses were also designed for ventilation and daylighting.

Finally, with the light still in the low winter position, remove the roof of the model and again pivot the model stand while watching the penetration of the light (sun) coming through the windows. The parts of the model's interior walls and floors that are lit most of the day are the best locations for thermal mass.

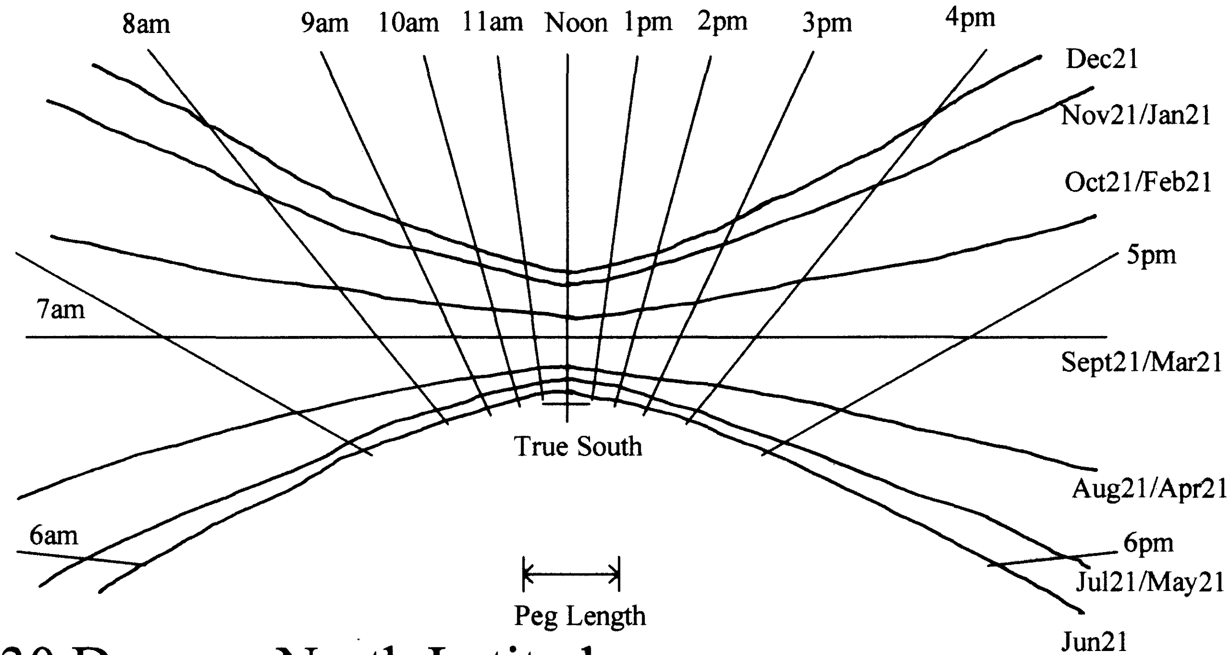
The model should have interior partitions so light that strikes them can be seen. The north-south interior partitions can catch a significant amount of light near the south wall and can be effective locations for thermal mass.

The model stand can also be used to observe daylighting design. To simulate daylighting correctly, the interior surfaces of the model and the outside ground surfaces must have reflectances representative of the room interior and exterior. The light source can be dimmed and adjusted until the light intensity is appropriate for the time of day and year simulated.

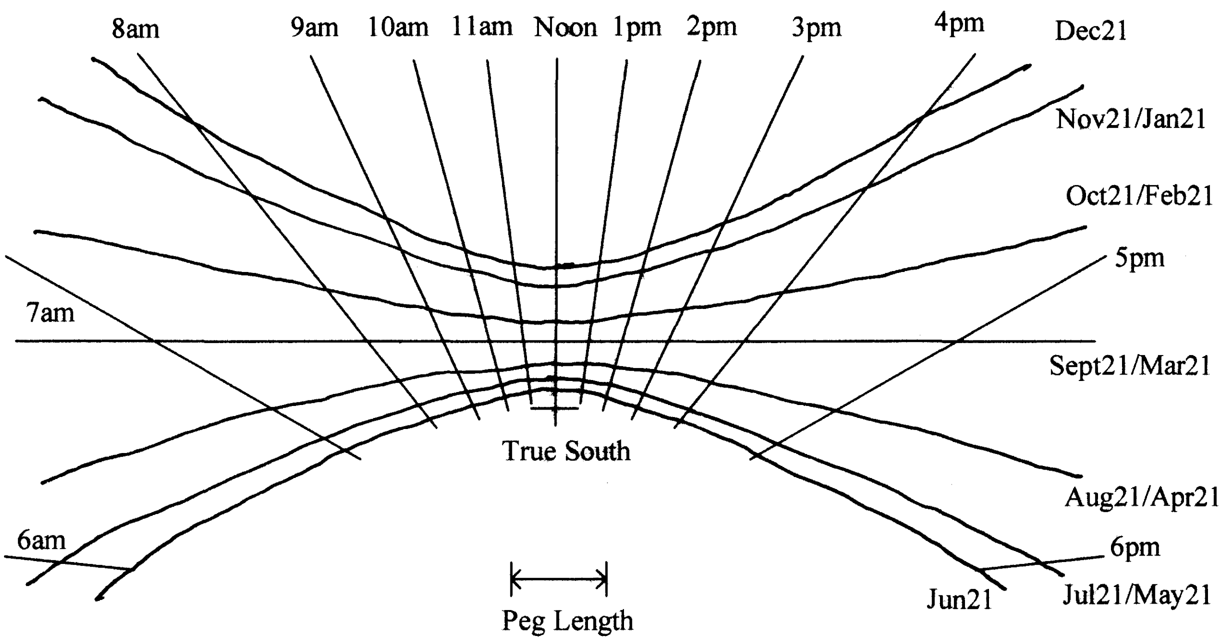
In addition to visual observations, the model stand can be used with still or movie cameras to document different seasons, shading devices, or building orientations. Simply mount the camera with a bolt or spacer, mini-tripod, or camera clamp to the model stand looking in the direction you wish to observe as shown.



28 Degrees North Latitude



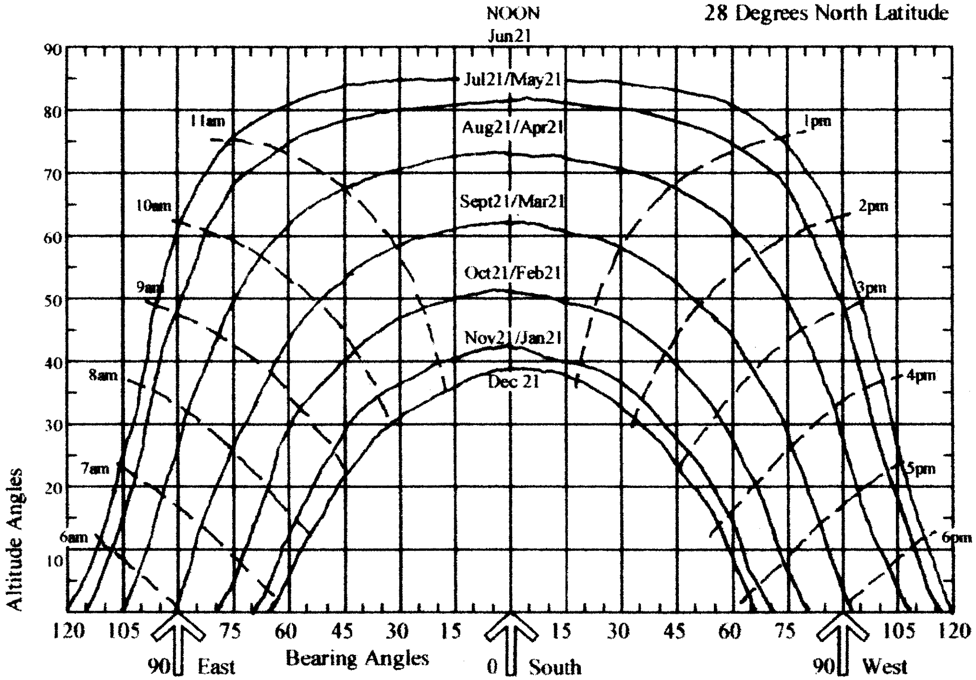
30 Degrees North Latitude



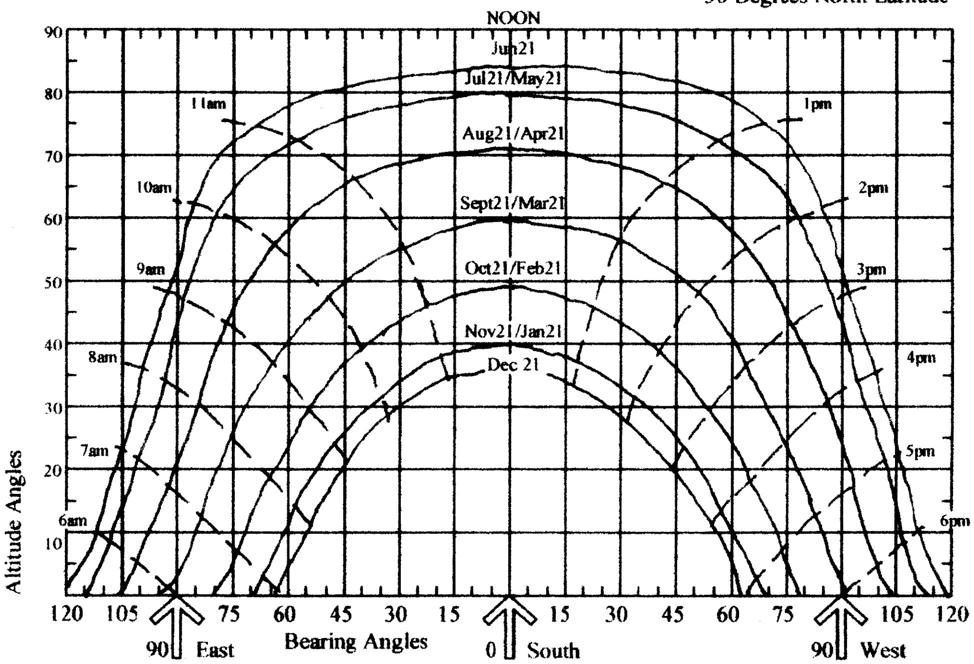
32 Degrees North Latitude

SUNGRAPHS

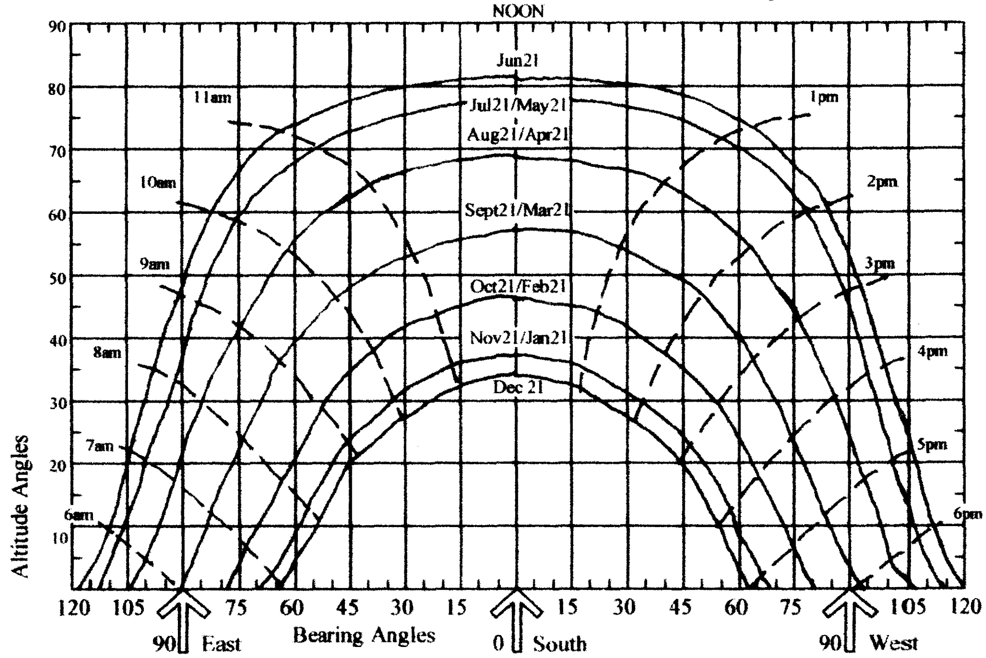
28 Degrees North Latitude



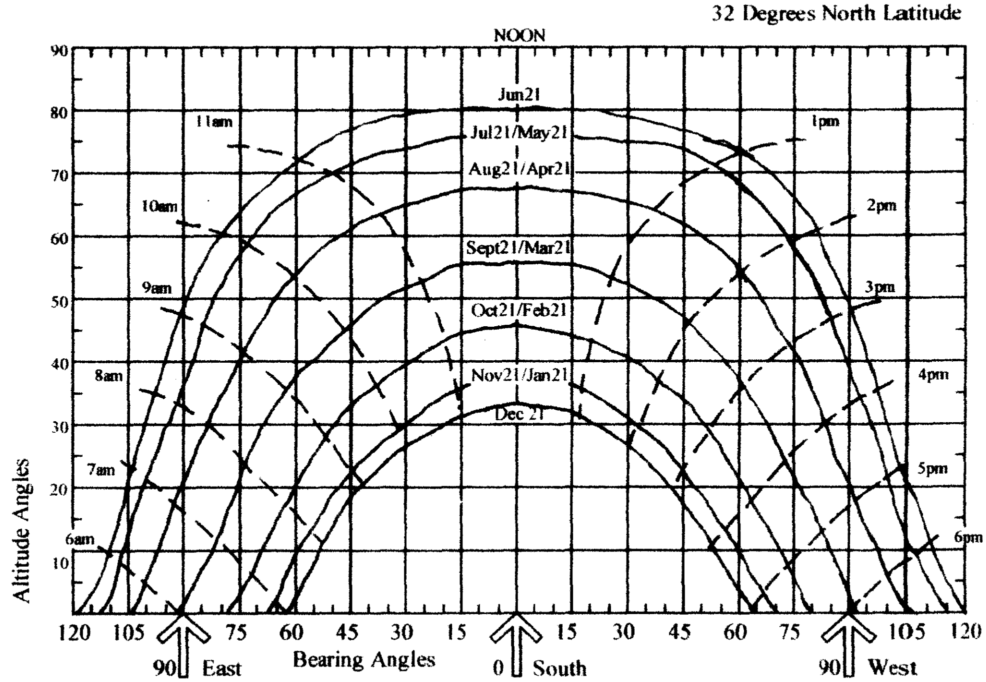
30 Degrees North Latitude



31 Degrees North Latitude



32 Degrees North Latitude



WEATHER DATA

Climatological Data

Latitude: 31° 24' N
Longitude: 92° 19' W
Elevation: 92 Feet

Alexandria, LA

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal °F			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	(a.) 00	(b.) 06	(c.) 12	(c.) 18	Average Speed (c.)	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset (c.)	Percent of Possible
Jan.	58.6	36.7	47.7	10	547	87	88	67	74	7.4		4.68	68	
Feb.	61.8	39.2	50.5	14	420	85	88	58	63	7.6		4.70	60	
Mar.	68.3	44.3	56.3	27	297	87	89	57	58	8.2		4.94	62	
Apr.	76.9	54.1	65.5	86	71	89	92	58	60	7.9		5.14	63	
May	83.7	60.8	72.3	229	0	92	94	57	62	6.4		5.59	58	
Jun.	89.6	67.5	78.6	408	0	94	96	58	64	5.2		3.92	55	
Jul.	91.4	70.5	80.9	493	0	94	96	61	68	4.9	Not Available	5.04	59	Not Available
Aug.	91.8	69.6	80.7	487	0	93	96	59	69	4.6		3.42	55	
Sep.	87.0	64.0	75.5	315	0	92	95	62	73	5.5		3.38	55	
Oct.	79.6	51.9	65.8	117	92	91	93	54	75	4.8		3.27	43	
Nov.	68.6	42.5	55.6	7	289	90	91	58	78	6.1		4.46	54	
Dec.	61.0	37.8	49.4	0	484	86	89	66	78	6.7		5.52	65	
Year	76.5	53.2	64.9	2193	2200	90	92	60	69	6.3		54.06	58	

(a.) 10 years of records
(b.) 9 years of records
(c.) 14 years of records
Based on Record Period of 1941 to 1979

Source:
National Oceanic Atmospheric Administration
<u>Annual Summary with Comparitive Data</u>

Latitude: 30° 32' N
Longitude: 91° 08' W
Elevation: 64 Feet

Baton Rouge, LA

	Temperature Normal °F			Temperature Degree Days Base 65°F		Relative Humidity (a.) % Hour				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	(a.) 00	(a.) 06	(a.) 12	(a.) 18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset (b.)	Percent of Possible
Jan.	61.5	40.5	51.0	17	451	82	85	66	68	9.3	N	4.40	69	Not Available
Feb.	64.5	43.2	53.9	24	335	78	84	58	60	9.6	NE	4.46	63	Not Available
Mar.	70.6	48.7	59.7	44	208	80	85	58	59	9.7	SE	4.94	62	Not Available
Apr.	79.0	57.7	68.4	135	33	83	89	56	59	9.0	SE	5.14	62	Not Available
May	85.2	64.3	78.3	304	0	84	90	57	60	7.9	SE	5.59	58	Not Available
Jun.	90.3	70.3	80.3	459	0	85	91	51	63	6.7	SE	3.92	56	Not Available
Jul.	91.2	72.7	82.0	527	0	87	91	63	70	6.0	W	5.04	64	Not Available
Aug.	91.1	72.1	86.1	515	0	88	92	63	71	5.7	E	3.42	59	Not Available
Sep.	87.2	67.7	77.5	375	0	87	91	61	71	6.8	NE	3.38	56	Not Available
Oct.	80.4	56.6	68.5	163	54	85	88	53	65	6.7	NE	3.27	44	Not Available
Nov.	70.3	46.9	58.6	16	208	85	88	58	68	7.8	W	4.46	56	Not Available
Dec.	63.7	42.0	52.9	6	381	83	86	63	68	8.3	SE	5.52	63	Not Available
Year	77.9	56.9	67.4	2585	1670	84	88	59	65	7.8		54.05	59	Not Available

(a.) 21 years of records
(b.) 29 years of records
Based on Record Period of 1941 to 1979

Source:
National Oceanic Atmospheric Administration
Annual Summary with Comparitive Data

Latitude: 30° 12' N
Longitude: 92° 02' W
Elevation: 35 Feet

Lafayette, LA

	Temperature						Wind (m.p.h.)		Rain	Sky Cover			Sunshine		
	Normal °F			Degree Days Base 65°F		Relative Humidity %									
	Daily Max.	Daily Min.	Monthly Average	Cooling	Heating	Monthly Average	Average Speed	Prevailing Direction	Normal (inches)	Number Partly Cloudy Days	Number Cloudy Days	Number Days with Fog	Number Clear Days	Percent of Possible	Mean solar Radiation in Langleys (Lake Charles
Jan.	61.4	42.0	51.7	22	428	67	9	N	4.72	5	19	7	7	65	245
Feb.	64.3	44.0	54.2	30	318	59	10	S	4.55	6	14	4	8	65	306
Mar.	71.2	50.7	61.0	49	201	59	10	S	4.16	8	15	5	7	90	397
Apr.	78.8	58.5	68.7	142	28	60	9	S	5.10	9	15	3	6	65	481
May	85.1	64.9	75.0	310	0	61	8	S	5.24	12	12	2	8	85	555
Jun.	90.4	70.7	80.6	465	0	59	7	SSW	4.18	14	8	2	8	65	591
Jul.	91.2	73.0	82.1	524	0	68	6	SSW	7.19	16	11	2	4	65	526
Aug.	90.8	72.6	81.7	521	0	64	5	SSW	5.38	15	10	2	7	65	511
Sep.	87.5	68.8	78.2	381	0	61	6	ENE	5.35	11	9	3	9	75	449
Oct.	80.3	57.2	68.8	163	39	54	7	ENE	3.20	9	8	4	14	85	402
Nov.	70.6	48.5	59.6	17	188	57	8	ENE	3.60	9	11	6	10	90	300
Dec.	64.5	43.9	54.2	8	349	67	8	NE	5.02	8	16	7	8	85	250
Year	78.0	57.9	68.0	2632	1551	61	8.4		57.69	122	148	47	96	75	418

Latitude: 30° 07' N
Longitude: 93° 13' W
Elevation: 11 Feet

Lake Charles, LA

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	59.7	41.1	51.1	15	467	85	87	68	75	9.9	N	4.52		62
Feb.	63.4	44.0	54.2	12	328	85	87	63	70	10.0	N	3.59		66
Mar.	70.0	50.7	60.9	45	178	86	89	62	68	9.9	S	3.29		74
Apr.	77.9	58.7	68.2	139	40	88	90	60	66	9.7	S	3.33		76
May	84.0	65.7	75.2	307	0	90	92	61	67	8.4	S	5.67		76
Jun.	89.0	71.6	80.5	459	0	90	93	62	68	7.5	S	4.96		83
Jul.	90.8	73.6	82.5	533	0	92	94	64	71	6.3	SW	5.20	Not Available	83
Aug.	90.8	73.0	82.4	524	0	92	94	63	72	5.9	NE	5.33		81
Sep.	86.8	68.6	78.2	381	0	90	93	62	73	7.0	NE	5.69		71
Oct.	80.2	57.9	69.5	162	35	89	91	55	71	7.8	NE	3.95		75
Nov.	70.8	50.0	60.3	55	193	87	89	60	75	8.9	N	4.26		67
Dec.	63.3	43.6	53.7	18	375	86	88	66	76	9.4	N	5.05		58
Year	77.3	58.2	68.1	2650	1616	88	91	62	71	8.4		54.84		73

Latitude: 29° 59' N
Longitude: 90° 15' W
Elevation: 17 Feet

New Orleans, LA

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	60.8	41.8	52.8	25	450	81	84	66	71	9.4	N	5.05		46
Feb.	64.1	44.4	55.6	17	316	80	83	63	66	9.9	N	6.01		50
Mar.	71.6	51.6	61.7	56	162	81	85	61	64	9.9	S	4.90		56
Apr.	78.5	58.4	68.4	133	28	84	88	59	64	9.5	S	4.50		62
May	84.4	65.2	75.4	304	0	85	89	60	65	8.1	S	4.56		62
Jun.	89.2	70.8	80.4	450	0	87	90	64	68	6.9	S	5.84		63
Jul.	90.6	73.1	82.2	524	0	88	92	66	72	6.2	SW	6.12	Not Available	59
Aug.	90.2	72.8	82.0	512	0	88	92	67	73	6.1	NE	6.17		61
Sep.	86.6	69.5	78.5	393	0	86	89	65	74	7.5	NE	5.15		61
Oct.	79.4	58.7	69.7	157	30	84	88	59	72	7.8	NE	3.05		64
Nov.	71.1	51.0	60.7	61	178	85	87	63	76	8.9	NE	4.42		54
Dec.	64.3	44.8	55.0	23	349	83	86	66	74	9.2	N	5.75		48
Year	77.6	58.5	68.5	2655	1513	84	88	63	70	8.3		61.88		57

Latitude: 32° 26' N
Longitude: 93° 49' W
Elevation: 265 Feet

Shreveport, LA

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	55.4	34.8	46.4	6	623	78	84	63	65	9.3	S	3.88		52
Feb.	60.6	38.0	50.4	8	448	76	84	60	58	9.6	S	3.92		57
Mar.	69.2	45.8	57.4	30	262	76	84	56	54	10.0	S	3.59		58
Apr.	77.1	54.1	65.5	87	69	79	87	56	56	9.8	S	3.75		60
May	83.2	62.0	73.2	239	0	84	90	59	60	8.6	S	5.18		64
Jun.	89.7	69.0	79.9	432	0	84	91	59	60	7.7	S	4.29		72
Jul.	93.0	72.3	83.0	549	0	83	90	58	58	7.1	S	3.67	Not Available	75
Aug.	93.1	71.3	82.6	533	0	83	91	56	58	6.7	S	2.43		75
Sep.	87.3	66.0	76.8	351	0	84	91	58	62	7.2	SE	3.12		70
Oct.	78.7	54.3	66.6	110	63	82	89	54	62	7.3	SE	3.73		70
Nov.	68.0	45.3	55.8	15	264	82	87	59	68	8.6	S	4.45		60
Dec.	58.5	37.3	48.4	8	535	81	86	63	68	9.1	SE	4.10		54
Year	76.2	54.2	65.5	2368	2264	81	88	58	61	8.4		46.11		64

Latitude: 30° 41' N
Longitude: 88° 14' W
Elevation: 209 Feet

Mobile, AL

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	59.7	40.0	50.8	24	492	78	81	60	68	10.1	N	4.76		
Feb.	63.6	42.7	54.3	14	344	78	82	57	64	10.5	N	5.46		
Mar.	70.9	50.1	60.0	38	177	80	84	55	63	10.5	SE	6.41		
Apr.	78.5	57.1	67.2	132	48	82	87	52	62	10.1	SE	4.48		
May	84.6	64.4	74.5	295	0	84	87	53	63	8.7	S	5.74		
Jun.	90.0	70.7	80.1	462	0	85	88	55	66	7.7	S	5.04		
Jul.	91.3	73.2	81.9	536	0	87	89	60	71	7.0	SW	6.85	Not Available	Not Available
Aug.	90.5	72.9	81.7	521	0	88	91	61	73	6.8	NE	6.96		
Sep.	86.9	68.7	77.6	387	0	86	89	59	71	7.9	NE	5.91		
Oct.	79.5	57.3	68.3	157	52	82	85	52	67	8.2	NE	2.94		
Nov.	70.3	49.1	59.0	40	196	82	85	57	71	9.1	N	4.10		
Dec.	62.9	43.1	52.9	21	393	80	83	61	71	9.6	N	5.31		
Year	77.4	57.4	67.4	2627	1702	83	86	57	68	8.9		63.96		

Latitude: 30° 28' N
Longitude: 87° 11' W
Elevation: 124 Feet

Pensacola, FL

	Temperature Normal			Degree Days Base 65°F		Relative Humidity (a.) % Hour				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	59.8	51.4	52.1	25	471	79	81	62	71	9.8	N	4.68	Not Available	48
Feb.	62.9	44.1	54.8	12	331	78	81	59	68	10.5	N	5.40		53
Mar.	69.4	51.3	60.5	42	184	80	83	58	68	10.9	N	5.63		61
Apr.	76.6	58.5	67.3	116	38	82	85	56	66	11.6	SE	3.77		63
May	83.2	65.7	74.6	295	0	84	86	58	67	9.6	S	4.20		67
Jun.	88.7	71.8	80.6	459	0	84	86	60	68	9.3	S	6.40		67
Jul.	89.9	74.2	82.3	530	0	86	88	64	71	7.6	S	6.40		57
Aug.	89.2	73.8	81.9	512	0	87	90	64	74	7.1	SW	7.39		58
Sep.	86.4	70.3	78.4	402	0	84	87	61	71	8.8	N	5.32		60
Oct.	79.1	59.4	69.6	172	39	80	84	55	69	8.5	N	4.21		71
Nov.	70.1	51.0	60.0	51	183	81	84	60	74	8.9	N	3.54		64
Dec.	62.9	44.4	54.0	20	371	80	83	63	74	9.5	N	4.29		49
Year	76.5	58.8	68.0	2636	1617	82	85	60	70	9.3		62.25		60

Latitude: 27° 57' N
Longitude: 82° 32' W
Elevation: 8 Feet

Tampa, FL

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	69.8	50.0	60.4	76	234	84	86	58	73	8.6	NE	1.99		63
Feb.	71.4	51.6	62.2	62	160	83	86	56	69	8.9	NE	3.08		65
Mar.	76.6	56.5	66.7	130	81	82	87	54	67	9.5	E	3.01		71
Apr.	81.7	60.8	71.5	196	7	82	86	50	62	9.2	E	1.15		75
May	87.2	67.5	77.5	384	0	82	86	52	62	8.6	W	3.10		75
Jun.	89.5	72.9	81.3	489	0	84	87	60	69	7.9	W	5.48		67
Jul.	90.2	74.5	82.3	539	0	85	88	63	73	7.2	W	6.58	Not Available	62
Aug.	90.2	74.5	82.3	539	0	87	90	64	75	7.0	E	7.61		61
Sep.	89.0	72.8	81.0	477	0	86	91	62	75	7.6	E	5.98		61
Oct.	84.3	65.2	75.0	304	0	85	89	56	71	8.3	NE	2.02		65
Nov.	77.7	57.2	67.7	147	72	86	88	57	74	8.3	NE	1.77		64
Dec.	72.1	52.3	62.1	84	171	84	87	58	74	8.2	NE	2.15		61
Year	81.6	63.0	72.5	3427	725	84	88	58	70	8.3		43.92		66

Latitude: 32° 07' N
Longitude: 81° 12' W
Elevation: 48 Feet

Savannah, GA

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	59.7	38.1	49.3	16	516	78	82	54	66	8.3	W	3.59		54
Feb.	62.4	41.1	52.6	9	378	77	81	51	61	9.0	NW	3.22		57
Mar.	70.1	48.3	58.8	24	204	78	83	49	60	9.0	W	3.78		62
Apr.	77.5	54.5	65.9	77	47	79	83	46	58	8.5	S	3.03		71
May	84.0	62.9	73.2	266	0	84	85	50	63	7.7	S	4.09	Not Available	68
Jun.	88.8	69.2	79.2	423	0	86	87	55	68	7.2	S	5.66		65
Jul.	91.1	72.4	81.9	521	0	88	89	58	72	6.9	SW	6.36		63
Aug.	89.7	72.0	81.1	496	0	90	91	61	76	6.5	SW	7.46		62
Sep.	85.2	67.8	76.7	348	0	88	91	60	76	7.2	NE	4.47		57
Oct.	77.5	56.9	67.3	135	63	84	87	53	72	7.5	NE	2.39		63
Nov.	70.0	48.1	58.2	36	213	83	86	52	72	7.4	NE	2.19		61
Dec.	62.3	41.0	51.3	14	426	79	82	54	69	7.7	W	2.96		55
Year	76.5	56.0	66.3	2365	1847	83	86	54	68	7.7		49.22		62

Latitude: 32° 19' N
Longitude: 90° 04' W
Elevation: 294 Feet

Jackson, MS

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	55.6	32.7	44.2	8	656	84	87	64	70	8.1	SE	5.24		49
Feb.	60.1	35.7	47.9	6	485	82	87	60	63	8.1	N	4.70		55
Mar.	69.3	44.1	56.7	28	285	82	88	56	58	8.5	SE	5.82		61
Apr.	77.4	51.9	65.5	75	87	84	90	54	57	7.8	SE	5.57		66
May	84.0	60.0	72.2	224	7	87	92	56	60	6.8	SE	5.05		63
Jun.	90.6	67.1	79.1	414	0	88	92	55	60	6.0	SE	3.18		71
Jul.	92.4	70.5	81.8	512	0	90	94	59	66	5.3	SW	4.51	Not Available	64
Aug.	92.0	69.7	81.1	493	0	90	94	58	66	5.2	SE	3.77		65
Sep.	88.0	63.7	75.8	333	6	90	94	58	70	6.0	SE	3.55		63
Oct.	79.1	50.3	64.9	94	104	88	93	53	71	6.0	SE	3.26		67
Nov.	69.2	42.3	55.6	19	295	87	90	57	73	7.0	SE	4.81		57
Dec.	59.5	36.1	48.1	9	542	84	87	62	74	7.7	SE	5.91		47
Year	76.4	52.0	64.5	2215	2467	86	91	58	66	6.9		55.37		61

Latitude: 32° 53' N
Longitude: 80° 02' W
Elevation: 45 Feet

Charleston, SC

	Temperature Normal Daily Max	Temperature Normal Daily Min.	Temperature Normal Monthly Average	Degree Days Base 65°F Cooling	Degree Days Base 65°F Heating	Relative Humidity (a.) % Hour 00	Relative Humidity (a.) % Hour 06	Relative Humidity (a.) % Hour 12	Relative Humidity (a.) % Hour 18	Wind (m.p.h.) Average Speed	Wind (m.p.h.) Prevailing Direction	Rain Normal (inches)	Sky Cover Percent Sunrise to Sunset	Sunshine Percent of Possible
Jan.	57.8	37.7	48.6	15	548	78	80	55	68	8.9	W	3.45		56
Feb.	61.0	40.0	51.1	8	414	77	79	52	64	9.7	SW	3.30		60
Mar.	68.6	47.5	57.3	25	239	80	82	50	64	10.0	SW	4.34		66
Apr.	75.8	53.4	64.7	63	66	81	83	47	62	9.7	SW	2.67		71
May	82.7	62.9	72.5	242	0	86	85	53	68	8.4	SW	4.01		70
Jun.	87.6	69.1	78.1	399	0	87	85	58	71	8.1	SW	6.43		66
Jul.	90.2	72.7	81.1	512	0	88	86	60	74	7.7	SW	6.84	Not Available	67
Aug.	89.0	72.2	80.4	484	0	89	89	63	77	7.3	SW	7.22		64
Sep.	84.9	67.9	75.8	342	0	89	89	61	77	7.7	NE	4.73		61
Oct.	77.2	56.3	66.3	130	74	86	87	54	75	7.9	N	2.90		63
Nov.	69.5	47.2	57.7	35	233	84	85	52	74	8.0	N	2.49		59
Dec.	61.6	40.7	50.4	11	439	80	82	55	71	8.4	N	3.15		56
Year	75.5	55.7	65.3	2266	2013	84	84	55	70	8.5		51.53		63

Latitude: 29° 59' N
Longitude: 95° 21' W
Elevation: 119 Feet

Houston, TX

	Temperature					Relative Humidity (a.) %				Wind (m.p.h.)		Rain	Sky Cover	Sunshine
	Normal			Degree Days Base 65°F		Hour								
	Daily Max	Daily Min.	Monthly Average	Cooling	Heating	00	06	12	18	Average Speed	Prevailing Direction	Normal (inches)	Percent Sunrise to Sunset	Percent of Possible
Jan.	61.0	39.7	51.7	16	468	82	85	63	67	8.2	N	3.29		45
Feb.	65.3	42.6	55.3	11	322	83	86	61	61	8.5	N	2.96		50
Mar.	71.1	50.0	61.9	50	187	83	87	59	60	9.2	SE	2.92		54
Apr.	78.4	58.1	68.3	135	36	85	89	58	60	9.0	SE	3.21		58
May	84.6	64.4	75.4	295	0	87	91	59	63	8.1	SE	5.24		62
Jun.	90.1	70.6	81.0	462	0	87	92	59	62	7.6	S	4.96		68
Jul.	92.2	72.4	83.6	546	0	87	93	58	62	6.9	S	3.60	Not Available	70
Aug.	92.5	72.0	83.2	536	0	88	93	58	63	6.1	SE	3.49		68
Sep.	88.4	67.9	78.7	396	0	89	93	60	67	6.7	SE	4.89		66
Oct.	81.6	57.6	70.1	174	31	88	91	56	68	7.1	SE	4.27		64
Nov.	72.4	49.6	60.5	61	181	86	89	59	72	7.8	N	3.79		52
Dec.	64.7	42.2	54.0	18	374	84	86	62	70	7.8	N	3.45		51
Year	78.6	57.3	68.6	2700	1599	86	90	59	65	7.8		46.07		59

San Antonio, TX

Latitude: 29° 31' N
Longitude: 98° 27' W
Elevation: 809 Feet

	Temperature: Normal Daily Max	Temperature: Normal Daily Min.	Temperature: Normal Monthly Average	Degree Days Base 65°F: Cooling	Degree Days Base 65°F: Heating	Relative Humidity (a.) % Hour 00	Hour 06	Hour 12	Hour 18	Wind (m.p.h.) Average Speed	Wind (m.p.h.) Prevailing Direction	Rain Normal (inches)	Sky Cover Percent Sunrise to Sunset	Sunshine Percent of Possible
Jan.	60.8	37.9	50.6	8	494	74	79	58	55	8.5	N	1.71		47
Feb.	65.7	41.3	54.7	10	332	74	80	56	50	9.0	N	1.81		50
Mar.	73.5	49.7	61.7	64	167	72	79	54	47	9.6	SE	1.52		57
Apr.	80.3	58.4	69.2	161	32	75	82	57	50	9.7	SE	2.50		56
May	85.3	65.7	76.1	326	0	80	87	60	55	9.6	SE	4.22		56
Jun.	91.8	72.6	82.0	516	0	79	87	58	52	9.6	SE	3.81		67
Jul.	95.0	75.0	84.8	620	0	74	87	53	46	9.1	SE	2.16	Not Available	74
Aug.	95.3	74.5	84.5	617	0	74	86	52	46	8.2	SE	2.54		74
Sep.	89.3	69.2	79.6	429	0	78	86	56	52	8.0	SE	3.41		67
Oct.	81.7	58.8	70.6	191	30	77	84	55	52	8.2	SE	3.17		64
Nov.	71.9	48.8	59.9	42	180	78	82	56	56	8.4	N	2.62		54
Dec.	63.5	40.8	53.0	12	409	76	80	57	56	8.1	N	1.51		48
Year	79.5	57.7	68.9	2996	1644	76	83	56	51	8.8		30.98		60

Purchase & Operating Costs – Electric Lights

(recommendations in italics)

	Wattage	Typical Purchase	Lumens	Rated Life (Hours) Cost ($)	Efficacy (Lumens/ Watt)	Electricity Cost for 9,000 Hrs. ($)
Incandescent and Flourescent (cost is for bulb only)						
Standard	60	0.77	870	1,000	15	40
Energy saving (Halogen)	52	0.79	800	1,000	15	35
Compact Flourescent	*15*	*10.00*	*720*	*9,000*	*48*	*12*
Standard	75	0.77	1,210	1,000	16	51
Energy saving (Halogen)	67	0.79	1,130	1,000	17	45
Compact Flourescent	*18*	*12.00*	*1,100*	*10,000*	*61*	*14*
Compact Flourescent	*20*	*14.00*	*1,200*	*10,000*	*60*	*16*
Standard	100	0.77	1,750	750	17	67
Energy saving (Halogen)	90	0.79	1,620	750	18	61
Compact flourescent	23-27	20-25	Comparable	10,000	64	20
Tungsten-Halogen (cost is for bulb only)						
Small lamp	42	2.52	665	3,500	16	28
Medium-sized lamp	72	2.52	1,300	3,500	18	49
Room Lighting (cost is for bult & ballast)						
Incandescent fixture with three, 60-watt lamps	180	30	2,610	1,000	15	121
Flourescent fixture with two 32-watt lamps/electronic ballast	*54*	*42*	*5,500*	*20,000*	*102*	*41*
Three compact flourescent fixtures – 24-watts each	*66*	*90*	*4,000*	*10,000*	*102*	*53*

	Wattage	Typical Purchase	Lumens	Rated Life (Hours) Cost ($)	Efficacy (Lumens/ Watt)	Electricity Cost for 9,000 Hrs. ($)
Exterior Fixtures (assuming 4 outdoor fixtures – cost is for fixture and bulbs)						
Standard PAR lamp	960	60	20,880	2,000	12	648
(2 lamps/fixture)	for 4 fixtures					
Tungsten-Halogen (2 lamps/fixture)	720 for 4 fixtures	70	21,600	2,000	20	486
Mercury Vapor (1 lamp/fixture)	400 for 4 fixtures	120	23,000	24,000	57	270
Metal Halide (1 lamp/fixture)	250 for 4 fixtures	300	20,500	10,000	82	170
High Pressure Sodium (1 lamp/fixture)	*200 for 4 fixtures*	*300*	*22,000*	*24,000*	*110*	*135*

FIREWOOD

"Wood heats you twice, once when you cut it and again when you burn it."

Henry David Thoreau

Wood is a sustainable energy source. Wood is constantly being replenished as forests continue to impound the sun's radiation. In 1845, 90% of all fuel used was wood; in 1945, it was 5% and diminishing. Extensive use lasted until the easy access forests were eliminated and energy demands rose above what could be provided by wood.

The process called "photosynthesis" is as close to magic as we are likely to see. The chlorophyll in plants green leaves and stems takes the elements contained in two inert compounds, water and carbon dioxide and uses the energy of sunlight to turn them into a carbohydrate – the elements are carbon, hydrogen and oxygen. Once you start a log burning, it will continue on its own, in more or less a reverse of the photosynthesis process called combustion, or rapid oxidation. This is where free oxygen is added back into the chemical process, turning the wood back into its basic components of carbon dioxide and water. Most important, the sun's energy that went into making the wood is now released as light and heat.

Wood is sold by the standard cord, a pile of four feet long logs piled four feet high in a stack eight feet long or 128 cubic feet of stacked wood. Since few people burn wood in four feet lengths, most sales are a "face cord" or "rick" – that is, four feet by eight feet face, but into desired lengths. If your face cord were in 16" lengths, you would have 1/3 cord (16" or 1.33' X 4' X 8' = 42.6 cubic feet; divided by 128 = .333 cord).

Dry firewood has high oxygen content, requiring a small amount of air for combustion. This explains why wet (green) wood has less heating efficiency than well-dried wood has. Only increasing the heat appropriating draft can lower the point of combustion for wet wood. Freshly felled wood has high moisture content, containing 50% water and this wetness interferes with combustion. Evaporating water forms around the wood like a sheath of vapor and blocks the entry of oxygen to the fire. This results in a lowering of both the ignition and the combustion rates. If you must burn wet wood, you will need quantities of draft. For dry wood burning, however, the draft must be controlled. When smoke and soot are observed coming out of a chimney, one can be certain that combustion is incomplete. What actually is seen are small quantities of hydrocarbons and free carbon (soot), which are not burned. As a result, much of the heating capacity of the wood fuel is lost. The heat loss is two-fold, in that gases, which escape up the flue and in the unburned and combustible particles. The first principle of fireplace design is to aim at "complete combustion".

Characteristics of Several Wood Varieties.

HARDWOODS (Splits)	WT./CU. FT. DRY (LBL)	EFFICIENCY RANKING
Hickory (Well)	68	1
Birch, Black (Fair)	48	2
Beech (Hard)	45	3
Maple, Sugar (Fair)	44	4
Oak (Fair)	43	5
Ash (Well)	42	6
Birch, Yellow (Hard)	40	7
Maple, Red (Fair)	38	8
Birch, White (Easy)	37	9
Cherry (Fair)	36	10
Sycamore (Doesn't)	35	11
Elm (Doesn't)	34	12

Louisiana species with high heat content are oaks, hickories, locusts, dogwood, hornbeam (ironwood), American beech, ashes, pecan and black walnut. Those with medium heat value include holly, red maple, cherry, American elm, black gum, sycamore, magnolia, tupelo gum, tallow tree and sassafras. And those with low heat value are sweetgum, tulip poplar, black willow, cottonwood, basswood and catalpa.

Coniferous softwoods, such as Douglas fir, spruce, ponderosa pine, larch, and lodgepole or Jack pine contain substantial amounts of volatile resins, which are difficult to burn efficiently and completely. If temperature in the flue is too low to carry unburned, distillate products out, they will condense in the flue. These along with considerable unburned particulate carbon (soot). This build-up must be cleaned out to prevent hazardous chimney fires. Such a blaze burns like a blowtorch and produces carbon monoxide poisoning. A high stack/flue temperature will prevent condensation of the volatile products, which escape combustion. Softwoods also spark, spit and burn faster than hardwoods and send up more smoke.

Summer has the potential to produce hurricane and rain storms that will take down branches and entire trees. You will not find a better time to help a neighbor and, at the same time, collect all the firewood you will need to stay warm in the winter. This wood will be green and laden with moisture. It will take months for this wood to air dry. Nature provides two toos needed to dry wood – sun and wind.

Stacking the wood properly will make a difference in the drying time. Also, split wood will dry faster than whole logs. Stack the wood loosely to allow as much ventilation as possible. The stack should be elongated and perendicular to the prevailing breezes. The wood should be placed off the ground to prevent moisture from being absorbed, this allows for better ventilation and protects against termites. The stack should be out of the rain and bark side down. If it is necessary to stack the wood in the weather, leave the bark side up to shed water, but it will take much longer to dry. You also want the elongated face of the stack exposed to the sun. Using a clear visqueen over the south side will provide a greenhouse effect giving you a solar kiln for faster drying. If this method is used, make sure you allow the moisture to be removed by ventilation. Do not store wood inside or against the house because of the unwanted pests it attracts.

REFERENCES

Allen, Edward & Thallon, Rob. Fundamentals of Residential Construction, John Wiley & Sons, Inc., New York, 2002.

Bradshaw, Vaughn. Building Control Systems, John Wiley & Sons, Inc., New York, 1985

Cazayoux, Edward J., Hebert, Andrew, & Winn, Doug. Natural Louisiana Architecture: Designing for Comfort and Energy, Louisiana Department of Natural Resources, Energy Division, 1989.

Cazayoux, Edward J. Louisiana Vernacular Gumbo, Eighteenth National Passive Solar Conference, Washington, D.C., 1993.

Cazayoux, Edward J. The Climatic Adaptation of French Colonial Architecture into the Louisiana Raised Cottage, Eleventh National Passive Solar Conference, Boulder, Colorado, 1986.

Daspit, Fred. Louisiana Architecture 1714-1830, Center for Louisiana Studies, University of Louisiana, Lafayette, Louisiana,1996.

Gibson, Jon L. The Ancient Mounds of Poverty Point: Place of Rings, Univ. Press of Florida, Gainesville, Florida, 2000.

Givoni, Baruch. Man, Climate and Architecture, Applied Science Publishers, London, 1976.

Lechner, Norbert. Heating, Cooling, and Lighting, John Wiley & Sons, Inc., New York, 2001.

McHarg, Ian. Design With Nature, American Museum of Natural History, Natural History Press, New York, 1969.

Olgyay, Victor. Design With Climate, Princeton University Press, New Jersey, 1973.

Passive Cooling Handbook, Passive Cooling Workshop, 1980.

Rybczynski, Witold. Home, Penguin Books, New York, 1986.

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