COMMONSENSE ARCHITECTURE

A CROSS-CULTURAL SURVEY OF PRACTICAL DESIGN PRINCIPLES

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to my father and his sister, Martha
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# Contents

## Introduction

## Section I - Protection from the Environment

1. Nature as provider of shelter
2. Staying dry
3. Protection from the wind
4. Staying warm
5. Staying cool
6. Staying healthy

## Section II - Accommodation of Human Needs

7. Sleeping
8. Cooking
9. Eating
10. Sitting
11. Bathing
12. Elimination
13. Working
14. Storage

## Section III - The Building Itself

15. Regionality
16. Using the materials at hand
17. Structural systems
18. The roof
19. The wall
20. The floor
21. The chimney
22. The doorway
23. The window
24. The stairway
25. Building systems
26. Expansion
27. Mobile architecture

## Bibliography
"When one has completed the necessary... one immediately comes upon the beautiful and the pleasing."

Voltaire

The straightforward response to both human needs and environmental forces gives folk houses of the world a refreshing quality. Their beauty lies in the strong link between form and purpose and in the absence of cosmetics or redundancy.

A scarcity of resources led history's anonymous builders to achieve a highly economical and practical form of unselfconscious architecture rooted in timeless principles of reason rather than in temporary fashions or whims.

Along with many benefits, advanced technology has allowed us to be impractical, with the knowledge that artificial means are available to overcome inefficiency. Recent shortages of capital and energy resources should force us to recognize that practicality must be an essential element in contemporary architecture. In this respect vernacular folk architecture can teach us a great deal.

Commonsense Architecture depicts indigenous architecture's responsiveness to human needs and to the environment, with examples from all parts of the world. The book is not a treatise against technology, but rather a catalogue of commonsense principles that can help us use technology as an efficient tool instead of as a cloak for inefficient designs.
The first section illustrates how buildings respond to external environmental factors such as climate and predators. The second section describes ways in which various activities such as sleeping and cooking are accommodated within dwellings. And the final section investigates the materials and construction practices used to build shelters. To maintain a purely functional approach to folk architecture, certain cultural influences—religion and politics, for example—have not been discussed. It should be noted, however, that most of these traditions have a rational, utilitarian basis. To insure their continued use, these ideas have gradually been incorporated into the cultural lore that guides builders. In some cases a practice may thrive even after the reason for it has been forgotten.

Commonsense architecture was created in the hope that the wisdom that shaped the vernacular architecture of the past will help us reduce our dependence on resources by reviving our use of resourcefulness.
Section I - Protection from the Environment

Nature as Provider of Shelter

Shelters evolved to give protection from the hostile aspects of the environment, primarily harsh weather and threats from other animals. For some tree-dwelling apes, have constructed crude leaf and twig platforms in the trees to raise themselves above the dangers on the ground and to partially ward off the rain and hot sun.

Chimpanzee in sleeping platform

Arboreal jungle tent used in a biological research program. Amazon jungle, 1980

People have continued this practice of rising above dangers by constructing aerie fortresses.

Appropriate siting can greatly reduce unwanted environmental impacts. Elevation, orientation, and wind protection are carefully considered by both animals and traditional indigenous builders.

Metéora, Greece
Most primitive dwellings show a strong sensitivity to local conditions. Out of necessity they take maximum advantage of the natural amenities to gain increased comfort and protection.

Cliff Dwellings
Mesa Verde, Colorado

Shelter built under a projecting boulder
Portugal

Where conditions were right, builders often chose to create shelters by carving them out of the earth.

Dwellings partly cut into cliffs and partly built out from them
Setenil, Spain

Elaborate facades were added to many dwellings carved out of soft stone cliffs.
Touraine, France
For millions of years many animals have used underground sanctuaries for protection from cold, heat, rain, snow, predators, etc. Early man learned a great deal about shelters from the other animals and saw the value of the burrowed home.

Small ant colony

Dwellings hollowed out of natural cones of porous limestone, or tufa.

Cappadocia, Turkey

Front view and plan of houses cut out of a volcanic stone, called tuff, in Massafra, Italy. The fan-shaped rooms left a minimal hole in the face of the fragile rock and had no dark corners.

House dug into rock cone complete with a finished facade and a chimney

Guadix, Spain
Dwellings dug out of soft loess soil and radiating from a sunken central court (Northern China)

The sunken court concept is still used effectively today.

John Barnard’s Ecology House Osterville, Massachusetts

Some earth-sheltered homes are dug into a hill so that only one wall (usually to the South) is exposed for access and light.

Banked house, American Midwest

In his Coop Homestead plans in 1942, Frank Lloyd Wright proposed sheltering the house with an earth berm.
Staying Dry

Offering protection from the rain is a primary goal for shelters in most climates.

Hut on Ailor Island near Borneo
This simple shelter serves as both a rain hat and sun shade.

House on Flores Island
The steep thatch roof is designed to shed the heavy Indonesian rains.

Japanese House
The metal cap along the peak of the roof protects this often leaky spot in thatch roofs.

Hay Storage shed, Holland

As hay is added the roof is raised with ropes from the poles. The roof sheds the rain, while air can still get in to dry the hay.

Covered interior balconies create living spaces out of the sun and rain.
The small hip segment on this gable roof protects a small porch that can be used in all weather as a place to work and to dry food and clothes.

Covered porch
on Lake Geneva, Switzerland

This house in northwest New Guinea not only gives good protection from the heavy rains but also insures cooling through ventilation.

Kambot House
Sepik, northwest New Guinea

Small roofs, hoods, and cantilevered overhangs are also very effective devices for diverting the rain.

Door hood on Pennsylvania Farmhouse

Pentice, or pent roof, on a barn in Pennsylvania

Cantilevered outshot on barn in Delaware

Here the overhanging upper floor acts as a rain hood for lower level.
In areas where fresh water was a very limited commodity many innovative systems evolved for the collection and storage of rainwater.

**Field Shelter Southern Italy**

The flat roof is used for drying crops and the plaster downspout carries rainwater to a cistern (1800).

Gutters and downspouts are the main tools for water collection:

**Japanese Slung Bamboo Gutter Serving Two Roofs**

**Japanese Wood and Bamboo Downspout (1700's)**

**Japanese Bamboo Gutter and Downspout Hung from Metal Brackets (1659)**

**Log Gutter Fort Clatsop, Oregon (1805)**
Benin House
Southern Nigeria

The central courtyard, or impluvium, acts as a rainwater collection basin that empties into a cistern buried at one corner.

The stone trullo dwellings in Apulia, Italy often have downspouts that carry rainwater into large, roofed cisterns. This water is used both for drinking and for watering crops.

In the American West, the customary water barrel was an above-ground cistern for rainwater.

Sudden rains in the American Southwest are quickly drained from the flat earth roofs by scuppers that usually direct the water into barrels.
Protecting the walls of the house from the rain is important for their preservation, and various design elements have evolved to meet this need.

CZECHOSLOVAKIAN HOUSE
The gable wall is protected by a roof projection and a cantilevered, or jettied, second floor.


PAUL REVERE'S HOUSE
Boston, Massachusetts (built in 1660)

MEXICAN HOUSE NEAR HIDALGO
The panned gable of hand-split shakes protects the soft mud brick wall below.

COTTAGE
Cambridgeshire, England
The sloping pentice boards protect the gable wall.
Siphnos Island, Greece

Plaster over these rough stone walls protects the soft masonry.

Field wall, Greece. The plaster cap protects the stonework below.

Parapet wall, Mexico

Sloping tiles keep the rain from eating away the soft mud brick walls.

Medieval window, England

The drip band around the upper side of the window prevents water from flowing down the wall and into the sash and silla joints.

Drip course, England

The projecting course of bricks keeps water from flowing down the wall and damaging the masonry.

Lacking modern flashing materials, early builders in Wales relied on projecting slates to keep the rain away from the roof/wall junction.
Projecting Loggia, St. Augustine, Florida (1700's)
THE SLOPED FLOOR PREVENTS STANDING WATER FROM ROTTING THE FLOOR.

Bannister Joint, St. Augustine, Florida (1700's)
THE V-JOINT KEEPS WATER FROM COLLECTING IN THE JOINT AND ROTTING THE WOOD.

Porch Post, Virginia (1800's)
THE METAL BASE PROJECTS THE POST FROM WATER THAT RUNS OFF THE PORCH.

Stone Scuppers Keep the Water off the Plastered Walls, of the Stone Trullo.

Japanese Gutter and Downspout
THE WATER FLOWS ALONG THE CHAINS TO THE GRAVEL BED BELOW AND DOESN'T SPLASH THE HOUSE WALL.

Gravel Bed

Stone Trullo
Apulia, Italy (1600's)

Japanese Fence Post (1600's)
THE BASE IS STONE TO RESIST ROT AND THE UPPER PART IS WOOD.
Parasol roof without walls, Samoa

If water vapor is allowed to condense on wood or other plant building materials it will cause mildew and rot. A variety of techniques can prevent this.

In hot, humid areas it is important to promote good flow-through ventilation to prevent condensation.

Open reed wall, Madagascar

As moist air passes through a wall from the warm side to the cold side, it may reach its dew point and condense within the wall, causing mildew and rot. Vapor barriers in modern homes are installed to stop the moisture before it gets into the wall.

The open construction of the exterior wall now protected by the deep roof overhang allows for air flow to dry the hay.

Rot caused by condensation in a cool, moist crawl space is curbed with foundation vents.

Wall section:

Sliding vent, Quebec
Protection from the Wind

House forms that offer little air resistance and create no turbulence reduce the structural and thermal impacts of the wind.

Wind over the rectangular house creates turbulent eddies, while the wind flows evenly over the semicircular one.

Wind

The house below has a roof shaped like a boat's hull that has its bow turned into the wind.

Lean-to wind shelter. Aksehir, Turkey

Normandy Farmhouse

New England saltbox (1800's)

The saltbox houses of New England let the cold north winds glide over the long, sloping roof.

The terrain around this contemporary earth-sheltered home is contoured to create a minimum of air turbulence.
The backstrip by this Arab tent breaks the hot, sandy desert winds.

Rocky Mountain tepee with wind screen

Inuit igloos often had a wind-screen wall by the entrance

Early Japanese builders often placed stones on the wood shingles to prevent the wind from blowing them off.

In Ireland, a rope net weighted with stones secures the thatch.
This rope band keeps the wind from pulling up the edge of the thatch roof.

Sussex, England (1699)

Rain draining off the roof compacts the soil in the wall to make the house more resistant to the wind.

Black House
Hebrides, Scotland

Wind pressure on an unbraced frame (A) can push it over, but diagonal bracing at the corners (B) will form rigid joints that can resist the lateral force.

The diagonal braces on the corner of this building help it resist the lateral wind pressure.

Hronsek
Czechoslovakia

Four massive external solid masonry buttresses brace this building in France against the wind.
Staying Warm

The earliest human settlements were centered in subtropical regions that had adequate food and water resources and arable land. As settlements spread to the more temperate regions, the problem of staying warm during the winter became critical. Caves offered limited protection, but as civilization grew, more successful ways of dealing with the cold were found.

The choice of the dwelling site was very important. The intention was to maximize the natural advantages of the site — such as terrain, geology, hydrology, vegetation, etc. — and minimize the impact of the cold.

The Anasazi Indians at Mesa Verde built their dwellings into rock cliffs. These niches faced south for the warming sun and gave sanctuary from the cold winds.

Hill Dwellings, Pakistan

In the mountains of Pakistan the people build their houses on steep, south-facing slopes to give shelter on the north and to capture the sun's warmth. This practice also leaves the entire river valley free for cultivation.
Another very effective way to reduce a dwelling's exposure to the cold is to use building shapes that maximize the space contained while minimizing the exposed surface area.

**Sphere**
- **Volume**: 36 units$^3$
- **Surface Area**: 52.7 units$^2$
- **Volume/Surface Area Ratio**: .68

**Hemisphere**
- **Volume**: 36 units$^3$
- **Surface Area**: 62.78 units$^2$
- **Volume/Surface Area Ratio**: .57

**Cube**
- **Volume**: 36 units$^3$
- **Surface Area**: 65.4 units$^2$
- **Volume/Surface Area Ratio**: .55

**Rectangular Solid**
- **Volume**: 36 units$^3$
- **Surface Area**: 96 units$^2$
- **Volume/Surface Area Ratio**: .38

By clustering many dwelling units in a single mass, the exposed surface area can be significantly reduced.

Some bees and wasps use hexagonal tubes in hive building. This shape encloses a good deal of volume and allows tight packing of the modules for minimum exposure.
A simple, effective, and low-cost way in which to reduce the impact of the cold is to use the earth to temper the house. Slightly below the frost line soil will remain at about 50°F. year-round.

Banked house, Chester Co., Pennsylvania

By building into a slope the lower floor is protected by earth on three sides.

Temporary mountain shelter, Parachinar, Pakistan - earth and rocks are piled up around part of the structure.

Eskimo earth-sweatered dwelling, Canada - earth covers both walls and roof.

Farmhouse, Northern Iceland - built into hills with earth shielding the roof and walls.

Log-end cave house, West Chezy, New York — only one wall is exposed, while earth protects the rest of the house.
Where geological conditions were favorable, many builders chose to completely shelter themselves with the land by digging into it. These troglodyte dwellings became very elaborate and not at all cave-like.

Existing rock crevices were expanded and varied structures and facades added.

Kivas were circular stone structures sunken into the ground, with a wood ceiling that supported a layer of earth. Originally these were ceremonial buildings, but later dwellings took this shape also.

Troglodyte dwellings Northern China

These homes, carved into soft loess, left the surface free for farming.

Ceremonial Kiva
Mesa Verde, Colorado
(1200)

UNESCO Headquarters
Paris
While the first step taken to insure staying warm is to minimize the dwelling’s exposure to the cold, the second is to maximize the structure’s ability to gain and hold heat from natural sources, primarily the sun. Siting, orientation, materials used, zoning of spaces, and placement of openings are all major considerations in achieving effective solar heat gain.

Plan of Pueblo Bonito, New Mexico (A.D. 919)

The Pueblo Indians at Pueblo Bonito oriented their living complex so that it took maximum advantage of the winter sun from dawn (1) to dusk (2) while providing shade from the hot afternoon sun in summer (3).

Roman House (A.D. 50)

This plan offered a protected sunny court plus a large southern exposure for the main living space.

Plan of Quebec House (1832)

Note the predominance of windows on the south side for solar heat gain.

Jacobs House, Wisconsin
Frank Lloyd Wright used the same orientation principles here in 1943.

Plan of Swiss House

The zoning of spaces in this house puts the major living areas on the sunny South side while storage and other less used spaces are on the North.
South Dakota Farmhouse
EARLY 20TH CENTURY

This house is oriented so that the major living space has a warm, protected southern exposure. The kitchen/work bl on the left/west) shades much of the south wall from the hot afternoon sun in the summer.

Compass termite mound
AUSTRALIA

These tall (up to 13 feet) blade-like mounds are oriented on a precise north/south line. The termites spend the mornings on the east side and then move to the west (with the sun) in the afternoon.

Colonial Saltbox House
NEW HAMPSHIRE (1860's)

The majority of first- and second-floor windows faced south for solar heat gain while most of the north side was roof to offer protection from the north winds.

Wall of public baths
POMPEII (80 B.C.)

This south-facing glazed wall added a large amount of solar heat to the bathing spaces inside.

Entrance
(by ladder)

Section through Acoma Pueblo
NEW MEXICO (AD. 900)

Storage spaces (1) and sleeping areas (2) take up lower and north-facing parts of building with the main living area (3) being above and facing south.
The desire for solar heat and natural light put great emphasis on the design and use of windows.

**Roman Heliocaninus Ostia (1st century)**

The glazed south wall added intense heat to the public baths while also keeping in the warm moist air.

**Guada, Portugal**

This structure's beveled sash and sills serve the same purpose.

**Early Greece**

Projecting solaria added heat and light to homes.

**Tucson, Arizona**

This contemporary house uses a sunspace for direct solar gain.
THERMAL MASS

In hot, arid areas, dense heat-absorbing materials can moderate the large daily temperature fluctuations by absorbing heat during the day and slowly releasing it at night.

The degree of temperature variation outside (A) is greatly reduced inside (B) because the peak effect of the day’s heat is delayed by the thermal mass to a time when it is counterbalanced by the cool of the night. Thus the building helps cool itself during the day and heat itself at night. This time delay in thermal effects is called the thermal lag.

Materials traditionally used in this way include mud, adobe, stone, brick, tile, and concrete.

Mud and stone
Matakam house
Northern Camaroon

Adobe Pueblo
New Mexico
Some other methods of storing heat in thermal mass materials:

**Brick Thermal Wall Greenhouse (1700's)**

**Drumwall**
Albuquerque, New Mexico
(Water-filled drums behind glass) (1975)

**Morse Wall** (1881)

**Trombe Wall**
(or Tromwall) (1981)

Water can store more heat than other materials, but special chemicals designed to change phase (from solid to liquid) at certain temperatures can do even better.

**Water Columns**
Concord, New Hampshire
(1980)

**Phase-Change Ceiling Panels**
In Experimental House, Massachusetts (1985)
Natural Insulation

Many early dwellings were protected by a blanket of earth to act as an insulator.

Early Armenian Dwelling
This earth-sheltered structure accommodated both humans (on the right) and animals.

Mandan Earth Lodge
Upper Missouri Valley

Inuit Igloo, Canada
Both ice and snow act as insulators against the sub-zero temperatures and harsh winds.

Farmhouse, Hokkaido, Japan
The roof is strong and steeply pitched to carry the load of a deep blanket of snow for insulation.

Log Cabin
Quebec
A layer of earth on the ceiling acts as insulation.
Insulation

In cold weather, additional layers of heavy felt blankets, or mundaas, were placed on the yurt for extra insulation.

Kirghizian Yurt

In some instances hay bales were used as structural elements, and they also provided good insulation.

Hay Bale Barn, Nebraska (1910)

Hay bales were (and still are) used as insulation around house foundations in New England. In the Midwest, manure is sometimes used for this purpose.

New Hampshire House (1850)

Wasp's make paper with which they build their nests. The thin shell with many air pockets insulates as well as 16 inches of brick.

Wall of Paper Wasp Nest

Early home builders filled the cavity between inner and outer walls with paper or straw for insulation. Builders today use fiberglass, cellulose, foams, and other materials.
Stopping heat loss caused by the infiltration of cold air

Chinking of mud plus skins hung on the inside wall stopped up the air leaks between logs.

Log cabin wall
U.S. (1800's)

Simple Exterior Solid shutters

New York (1906)

Briefly heating an 16200 after construction forms an ice layer inside that seals cracks. Skins hung inside help insulate, too.

Inuit 16200, Canada

Many 16200s have the entrance below the living level so that the warm air (which rises) does not escape.

Early farmhouses in the midwest and easter u.s. had a "double entry" - the attached space acted as a buffer to prevent direct loss of heat.

Revolving doors reduce heat loss by eliminating paths for direct air flow between inside and outside.
**Insulating the Openings**

Exterior Panel Shutters, Virginia (1700's)

Futurasan Shrine, Nikko, Japan
The exterior shutters (A) here are solid for insulation while the interior ones (B) are translucent to admit natural light. Metal brackets from the ceiling hold them open.

Sliding Indian Shutters
York, Maine (1800)

Bifold Interior Shutters
Philadelphia (1850)
These fold back neatly into the wall.

Icenhose Window
Shaker Village, Hancock, Massachusetts
Early use of multiple glazing to cut down heat flow

Contemporary House
Vermont
Panels are lowered over windows at night to reduce heat loss.
In review, to best retain heat and protect
against cold, builders must:
1) Minimize the structure's exposure to the cold;
2) Minimize the heat loss from the structure
by using various insulating techniques;
3) Maximize the natural heat gains from sun
and earth.

After these guidelines have been followed there
may still be a need for additional heating. This can
be supplied by a variety of means.

Some ants heat their colony by taking turns
sitting out in the sun soaking up its radiant heat
and then going back inside to act as living portable
heaters. Wasps and bees can heat their hives with
the increased body heat generated through the muscular
exertion of flexing their abdomens or flapping their wings.

The early human
shelters relied primarily
on two heat sources:
1) Fire
2) Body heat from
people and animals

European Longhouse (1100)
The animals in the byre
helped to heat this primitive
shelter.

Onandaga Longhouse
North America, 15th century
The fires and the numerous occupants combined to
heat these large (up to 125 feet in
length) communal dwellings.

Heat production of average person:
Seated - 110 watts *
Light work - 170 watts
Heavy work - 440 watts
* For comparison, a 100-watt incandescent light
produces approximately 96 watts of heat.
The brush turkey builds its brooding mound by gathering a large pile of plant material, placing the eggs on top, and covering them with sand. The fermentation of the plants generates the heat to incubate the eggs.

A single whale oil lamp in an igloo can maintain a comfortable temperature.

Early Indian dwellings in the Southwestern U.S. relied upon an open firepit for heat with a smoke hole in the earth roof.

Early settlers in Jamestown built huts that had walls of wattle (sticks with interwoven twigs) and daub (mud), and roofs of thatch. The houses had open hearths and no chimneys except for the short outlet at the roof.

Jamestown, Virginia (ca. 1608)
Throughout history the most common fuel used for space heating has been wood.

Japanese Ro

For centuries in Japan wood has been processed into charcoal, which is then burned in hearths set into the floor (ros) or in portable hibachis. Charcoal combustion yields very little smoke, so chimneys were not built.

Dutch Hearth, 17th century

The wide, deep hearth with its cantilevered hood brought the fire's warmth right out into the room.

English Hearth

16th century

The big hearth had space enough for a nice warm work space and a window.

Quaker Fireplaces

19th century

The corner fireplace radiates heat well throughout the room, and this back-to-back scheme allows two fireplaces to share one chimney, thereby reducing the amount of construction that is required.

Hooded Fireplace with a Brick Hearth

New Mexico (19th century)
In this heating system the hot gases from the fire weave under the dwelling floor before going out the chimney. The entire floor then acts as a radiant heater. The Romans used a similar system but were able to heat all six surfaces surrounding the space.

The Russian masonry stove consists of a small firebox and a winding flue within a large masonry mass. This thermal mass stores the heat and gives it up slowly. One small fire per day keeps the house warm.

The Austrian Kachelofen uses thermal mass principles like the Russian stove and is usually tiled. The loading door is often behind the wall in an adjacent room or hallway.

In this house in Brewster, Massachusetts the chimney is centrally located so it can give its heat to the interior spaces rather than to the outdoors.
The invention of the wood stove allowed the heat source to be moved out into the room. Such a central location gave balanced radiation and convection throughout while the long run of stovepipe to the chimney served as an additional radiator of heat that was previously lost up the chimney.

Natural convective currents rather than fans were the driving forces behind the distribution of the wood stove's heat. Grates were usually placed in the ceiling above the stove to allow warm air to rise to the second floor.

The somewhat spherical shape of the old potbelly stove made it a very effective radiator.

In order to yield as much heat as possible, many wood-stove designs incorporated large heat exchangers to extract heat from the hot flue pipes.

Because of their great thermal mass, soapstone stoves heat up and cool down slowly, which results in a relatively even heat over a long period.
Another method of effectively distributing heat is to transport the heat source to where it is needed.

Japanese Portable Kerosene Heater (used now)

Portable Charcoal Brazier used in Athens, Greece (400 BC)

Contemporary methods of distributing heat with fans and pumps have permitted houses to become spread out and fragmented. This results in a spatial configuration that is much less efficient to heat than the old centralized plan (see house plan to the left).

One of the most rapidly developing heating technologies is solar. A basic active solar system consists of a collector, a distribution network, and a heat storage reservoir. The collector absorbs the sun’s heat and transfers it to a fluid (usually air or water). The heat is then either stored or used immediately to heat the house or the domestic water.

Most contemporary solar homes combine active systems (those needing energy input) and passive systems such as attached greenhouses, extra south glazing, thermal mass, and many more.
The above bioclimatic index outlines the relationship between temperature, humidity, and human comfort. When conditions are above the human comfort zone, it is necessary to introduce a cooling influence such as shading, ventilation, or added moisture.

This information has many important housing design implications in areas where cooling is required. These guidelines vary with the climate:

A) Hot Arid Climate: 1) Take advantage of the broad daily temperature variation by using materials that absorb the day's heat for re-radiation at night and by trapping and holding cool night air, 2) Give plenty of shading, and 3) Minimize daytime ventilation

B) Hot-Humid Climate: 1) Site, orient, and construct the house to take maximum advantage of natural ventilation, 2) Use porous non-heat-absorbing materials, and 3) Supply adequate shading.

The ways in which the human body dissipates heat:

- Radiation - 44%
- Convection - 32%
- Evaporation - 21%
- Conduction - 3%
Finding Cool Sites

Beyond the advantages previously mentioned, the cliffs at Mesa Verde, Colorado offered shade from the hot summer sun but admitted the sun's needed warmth in winter.

Cliff Dwellings
Mesa Verde, Colorado (1200)

Here, the shade offered by trees is augmented by a suspended, grass-covered net to shield the hammock.

Columbia

Locating dwellings by rivers offers fresh water and trees for shade, and the valley traps the heavier cool air.

New Mexico

In areas where wind is the primary cooling agent, it may be advantageous to put the house on an exposed hill.

In addition to supplying an all-important sanctuary from clouds of mosquitoes, these houses, placed in trees out in the water, were cool retreats from the tropical heat.

Orinoco Delta, Venezuela (1600)
Shading

Early man, like the apes, relied chiefly upon the plants around him to create shade.

In this case, a lean-to of branches and leaves protects the hammock occupant from rain and sun.

Primitive lean-to

The Navaho summer shelter, or ramada, has a simple pole frame and a roof of poles and brush. It gives shade while letting the cool breezes flow through.

The Yokut Indians of Southern California built pole and brush shade roofs over whole groups of huts.

Yokut Pule Lodge, California

In many warm climates shelter takes the form of an umbrella to protect from the rain and to give shade from the sun.

Senurbo outdoor kitchen, Ivory Coast
In Asia the tent has evolved over thousands of years into a very highly developed and sometimes elaborate shelter from sun and rain.

Chinese Military Pavilion

Some buildings have projecting upper stories that, in addition to adding more space, create a covered walk below and shade much of the lower recessed wall.

Section of Casa Isolani

Casa Isolani, Bologna, Italy (1200)

Another way to keep the sun from overheating a building is to create a highly textured facade so that the protrusions actually shade the rest of the wall.

Dogon House
Sanga, Mali

Mousgoum Homestead
Northern Cameroon
Using Vegetation for Seasonal Shade

Trellis, or pergola, over doorway

Trani House
Apulia, Italy

Wire lattice used as a trellis for vines shading court

Shaded Court, Granada, Spain

An old New England tradition is to plant husband and wife trees to give summer shade to the house's south side when it is most vulnerable in the morning and evening.

Framhouse
New Hampshire

In many areas elaborate iron grillwork is used as a lattice for vines to shade the house.

Double-trellised house in New Orleans, Louisiana
In most warm climates, a great deal of the activity takes place outside. The need to supply shade in outdoor public places spawned a wide variety of shades and sunscreens.

Canvas awnings, or toldos, unfurled between buildings, Seville, Spain.

Rigid frames roofed with spaced poles also shade streets and walkways effectively.

Covered street, Taos, New Mexico.

Simple pole-supported awning, Mykonos, Greece.

Wood lattice sunscreen, African Bazaar.
Covered porches have been used for thousands of years as a shady sanctuary from the hot sun.

Double House
San Antonio, Texas

Arcades can provide both shade and protection from rain and snow.

Dordogne, France

Porch roofs supply shade and can also be used as additional living or sleeping areas.

Santa Fe, New Mexico

Some houses have porches that wrap almost entirely around them.

Hacienda, Venezuela
The raised balcony, or loggia, is a very common sight in warm climates. These structures create relatively private living spaces that are exposed to the cooling breezes. They also can shade the lower floor.

Loggia, Pedraza, Spain

Projecting Balcony Afghanistan

This loggia is partly windowed, partly open, and partly fitted with louvered shutters.

Mykonos, Greece

This loggia faces a serene, shaded court and also shelters the porch below, which acts as the entrance.

Charleston, South Carolina
Shading the Openings

In a warm climate, it is important to design openings that admit the cooling winds but not the heat of the sun. One way to do this is to recess the window or door so that the depth of the wall shades much of the opening.

Reblo window, New Mexico

Doorway, Afghanistan

Shading devices such as roofs, shutters, awnings, lattices, and louvers are also effective.

Horizontally hinged shutters double as shades.

Kavalla, Greece

Afghan window, Maidan Valley

This window combines shutters, lattice screens, and louvers for good ventilation and plenty of privacy.

Jeddah, Saudi Arabia
For centuries louvered shutters have been used as a means of shutting out the hot sun but allowing the cooling breezes to flow through.

Doorway with louvered shutter, Fossacesia, Italy

Contemporary louvered awning shutter, Florida

Adjustable, vertical-axis louveres, or vanes, are also very effective shading devices.

Contemporary house, Rio de Janeiro

Other shades:

Exterior, metal roll shade, Luxembourg

Projecting sunscreen, Nara, Japan
Placing the screens or louvered shutters away from the windows causes less interference with the air flow through the house.

Contemporary House
San Antonio, Texas

Contemporary House with Pulley-Operated Shutter/Shade Panels
Sanibel Island, Florida

Properly designed overhangs can offer shade from the high summer sun (1) in temperate areas and admit the low winter sun (2).

The roof of this African house shades the window and the grass patch prevents sunlight from being reflected inside.

Contemporary Overhang
Los Angeles, California
Ventilation

Open and elevated houses are built in hot, humid areas partly because they take excellent advantage of the cooling breezes.

Raised platform, Seminole building, Florida

Tree house, New Guinea

The open planning of villages is also essential for good air flow.

Air movement through a Bari village, Sudan

Open Samoan hut

Note the open second floor in this two-thousand-year-old clay model of a Minoan house.

Open porch, New Orleans (1800's).
In the Greek village of Verria, homes facing the same street had roofs of different heights for enough separation to ensure good air flow.

Verria, Early Greece

Flat tiles can be arranged in simple patterns to create grilles that admit air but not sunlight.

Ksar el-Barka, Mauritania

Lattice walls of reeds and poles are used in many parts of the world to permit ventilation.

Southern Tanzania

The open plan of Japanese houses allows excellent ventilation. Even with the sliding fusumas closed, the louvered transom above lets air flow through.

One of the most widely employed devices that gives shade and also allows ventilation is the louvered shutter.

Multiple shutter, Macao

Portisol shutter, Dubrovnik, Yugoslavia

Lever-operated louver panel to open or close transom vent

Shaker Door, Hancock, Massachusetts (1830)

In addition to being shaded by the loggia roof, this doorway has louvered shutters and a glass transom vent for good air flow.

Favrie House, New Orleans (early 1800's)
THE HIGHLY DECORATIVE OPENINGS IN THIS SMITHY INSURE GOOD THROUGH-VENTILATION.

BIDA, CENTRAL NIGERIA

TRADITIONAL JAPANESE HOUSES ARE EQUIPPED WITH BAMBOO CURTAINS THAT SCREEN THE SUNLIGHT BUT LET AIR PASS THROUGH.

NUMAZU, JAPAN

STONE VENTILATION GRILLE GUANAJUATO, MEXICO

DOOR WITH GRILLE FOR LIGHT AND AIR VERACRUZ, MEXICO

THIS DOOR HAS TWO SMALL, GLAZED SASHES THAT CAN SLIDE DOWN TO MAKE OPENINGS FOR VENTILATION.

SHAKER DOOR CANTERBURY, NEW HAMPSHIRE (1831)
Induced Ventilation

The natural tendency of warmer air to rise can be used as the driving force to ventilate buildings. The venting of warm air at the top will draw cooler air in at the bottom.

Cupola on a New Hampshire Barn

Cupola

Barn Air Flow

American Top Hat Barn

Open Vent

Warm Air

Cool Air

Warm Air Rising Out Draws Outside Air Through an Underground Channel Where It Is Cooled Before It Enters the Kiva.
For millions of years, termite colonies have used thermal currents, or thermosiphoning, to drive their cooling and air purification systems.

Air heated by the colony rises to the top (1) and then flows into the transpiration tubes (2), which act like cooling fins. As the air is cooled, it sinks to the bottom of the colony (3), and the cycle continues. Fresh air is also absorbed through the thin walls of the tubes.

For centuries in the Middle East, builders have used a form of cooling tower in homes. Sunlight heats up the tall tower, and as the warm air inside rises, it pulls cool air in behind. Sometimes this air is drawn over water for additional cooling by evaporation.

In this contemporary solar house, the heat generated by sunlight in the greenhouse causes the air to rise and escape, and as it does it pulls cool air into the living areas.
Channeling the Wind

Devices that cool houses by directing the wind inside have been used for centuries.

Egyptian House with Wind Scoops
Middle Kingdom

Peruvian Wind Scoop
(PRE – A.D. 700)

Wind Scoop with Trap Door
West Pakistan
(Used since 1500's)

Roofscape
with Wind Scoops

Sind District,
West Pakistan

Wind Scoops on Rooftops

Herat, Afghanistan
Thermal Mass

As the graph on page 33 shows, the proper use of heat-absorbing, or thermal mass, materials in hot, arid climates can heat a house during the night and cool it during the day. The earth is such a large mass that its temperature stays relatively constant year-round and can help warm a house in the winter and cool it in the summer.

Partial plan of Roman summer cave

Other solid materials provide thermal mass:

Badakshan domed, mud house, Afghanistan

Mud and stone walls

Matakan house, Cameroun

Mud and stone Dogon cliff dwellings, Mali

Stone cliff dwellings, Mesa Verde, Colorado (1200)
This house consists of five huts with thick adobe walls grouped to form a central court, which is shaded by a trellis.

Mesakin Gisrur cluster dwelling Sudan

The grouping of many dwellings in a single, solid structure provides a large thermal mass and also leaves a minimum of surface exposed to the heat.

Dammuso House
Pantelleria, Italy

Adobe Pueblo
Taos, New Mexico

Vaulted Houses
Greece

Roof pond cooling

Day

NIGHT

This contemporary cooling system uses a pond of water as a heat sink on the roof. Insulated from the sun during the day, the pond absorbs heat from the house. Uncovered at night, it can lose its heat to the sky.
Using Courtyards to Trap Cool Air

The tendency of cooler air to sink permits an enclosed court to effectively trap the cool night air in hot, arid areas.

Court of Subterranean Dwelling, Tunisia

This African house has an enclosed courtyard, or "gyaase," to give shade and privacy and to hold cool air.

Ashanti House, Ghana

In many areas, a number of dwellings are built around a central court, which becomes a sanctuary from the heat.

El Oued, Algeria

The courtyard is kept much cooler if it is fully shaded by either the surrounding buildings (see above), by vines (see page 47), or by trees.

Tree in Enclosed Courtyard, Venezuela
Evaporative Cooling

Water will evaporate as it absorbs heat from the surrounding air. This process, which results in the air being cooled, can be used to help cool houses in arid climates.

A water-soaked cloth in the window cools the incoming air. India

Dining pavilions built over water. China

Wind

Cupola vent

Warm air out

Fountain

Yard, Iran (1400)

In Iran some buildings have towers to catch the wind and direct it inside, where it is cooled as it passes by a fountain or pool. The wind also helps to draw the warm air out at the cupola (see page 60).

A fountain or pool in a courtyard will help cool the air, and the enclosure will prevent the loss of that cool air.

Plan of house with court and pool, Venezuela
Removing Heat Sources

One very simple way to cool a home is not to heat it. This means trying to remove the thermal impact of such primary functions as cooking and bathing.

For centuries, one approach has been to remove the cooking work from the house and to create a separate summer kitchen.

Summer Kitchen, Curieni, Romania

Plan of a Farmhouse in Pennsylvania (1709)

Here, the kitchen is attached but not within the living area of the house.

Chimneys are major heat sources. Separating them from the house lessens their effect and also reduces the fire hazard.

Parish Mansion, Virginia

To help cool homes today, the heat produced by appliances such as stoves, refrigerators, clothes dryers, and water heaters should be kept away from the living areas.
Staying Healthy

People have always had to defend themselves against the environment. Their shelters quickly became their primary defense. It gave refuge from pests, predators, and humans.

This tree dwelling provides an escape from the leeches on the wet ground.

Sakai tree house, Malaya

Grouping dwellings in protective circles is another way of gaining security and privacy.

Plan of Garuns (compound upper Volta)

This Japanese portable frame with mosquito netting projects infants very effectively.

In the Alps, most of the food storage buildings are raised on piers incorporating flat rocks as rodent guards.

Some species of ant have special doorkeepers with enlarged heads. They plug the entrances and admit only the residents, who know the proper antenna tap code.
THE EAGLE USES ITS AERIE AS A SECURE REFUGE FROM PREDATORS AND AS AN OBSERVATION POST FROM WHICH TO KEEP A SHARP EYE ON ITS DOMAIN.

LIKE THE EAGLE, MAN OFTEN BUILT REFUGES IN HIGH, STRATEGIC POSITIONS.

THE ANASAZI INDIANS OF THE AMERICAN SOUTHWEST USED LOFTY CRAGS IN SHEER CLIFFS AS DEFENSIVE POSITIONS AND LOOKOUTS, WHILE THE RIVER PLAIN WAS LEFT OPEN FOR AGRICULTURE.

THE WHITE HOUSE CANYON DE CHELLY ARIZONA

WHEN LACKING A LOFTY SITE FOR A BASTION, THE NEXT BEST THING WAS TO CREATE A HILL, USUALLY WITH TIERED, FORTIFIED WALLS.

KUMAMOTO CASTLE, JAPAN
In Medieval Europe there was a pronounced need for fortifications. In some villages, defensive towers became a dominant architectural feature.

Village in the Caucasus, U.S.S.R.

A maze of narrow, winding streets would make anyone attacking very vulnerable as they moved through the city.

San Gimignano, Italy

Limited access and narrow, winding streets gave Mt.-St. Michel a strong defense.

Mont-Saint Michel, France

Some entire villages became walled fortresses.

Harman, Romania
The use of more durable materials is a very important part of a strong defense. In this castle wall, for instance, the resistance to fire is increased with the use of tile, plaster, and stone.

Himeji Castle, Japan

In the same castle, some of the doorways are metal-clad and thus impregnable.

Thatch and board houses in the Spanish settlement of St. Augustine were burned to the ground by Carolina colonists. In rebuilding the town, tabby, a mixture of lime mortar and shells, was used to make the buildings more resistant to fire.

Tabby and shingle house, St. Augustine, Florida (1710)

Protecting the windows:

Solid exterior shutter, Pennsylvania

Sliding Indian shutters, New Hampshire
Protecting Against Intruders

This ingenious floor has special clamps in which the flooring nails can slide, producing a chirping sound. Anyone walking on the floor would cause the chirping and thus no one could sneak up on the emperor.

Nightingale Floor
Nijo Castle, Japan

One of the best security measures is to design the entrance to a dwelling so that anyone coming in is practically defenseless. Many African dwellings' doorways have high thresholds and low lintels, which force people to bow as they enter. This puts them in a vulnerable position.

Another effective way to limit access is to remove the means. This drawbridge can be withdrawn into the castle.

Rothesay Castle
Scotland (1312)

Early Pueblo dwellings had ladders through the roof for access. The ladder could be drawn up for security. Entering by descending a ladder also made an intruder very vulnerable.

Section through Acoma Pueblo, New Mexico (A.D. 900)

Metal door and window grilles can bar access but still admit light and air.

Window grille, Venezuela
SECTION II - ACCOMMODATION OF HUMAN NEEDS

SLEEPING

Due to poor night vision, people are very vulnerable creatures in the dark, so early shelters were simply protected places in which to sleep. Very soon, though, builders went beyond crude shelter and began to pay attention to comfort.

**Neolithic Dwelling**
Kohn Lindenhal, Germany
The earth floor was sculpted to create seats, beds, etc.

The air at the top of a space is warmer (warm air rises), so sleeping shelves in igloos are built up off the floor.

**Inuit Igloo, Canada**

In some Japanese homes, a pit, or ro, containing hot coals is covered by a wooden frame and is used to preheat the bedding, or futon.

**Some Masonry Stoves Have Built-in Platforms That Can Be Used as Cozy Sleeping Shelves.**

Traditional Finnish stove with grandmother shelf.

**In Other Areas Staying Cool Is a Primary Goal, and Often the Roof Becomes a Cool and Safe Sleeping Loft.**

Garunsi Hut, Upper Volta
In Japan the bedding, or futon, is stored in a closet, or "oshiire," and brought out as needed at night. This saves space, because during the day no room is just an unused bedroom, and at night any room can become a bedroom.

Closet ("oshiire") for storing futons. Japan

Over the centuries people have devised many ingenious ways to secrete beds for privacy, security, or just aesthetics.

Two-tiered Breton cupboard bed with sliding doors.

Partitioned and curtained bed alcove.

Holland, 17th century

The two small lean-tos at either side of this house were added as extra sleeping spaces.

Nantucket whaler's house, 18th century.
Cooking

Early shelters were simply for sleeping, but in cooler climates there was a need to bring the fire inside to cook and add warmth. The earliest hearths consisted of simple open firepits, from which the fireplace evolved.

Early Japanese sand hearth with kettle arm

Norwegian fireplace with adjustable kettle holder

Japanese kettle holder (the wood block on the rope locks the height adjustment)

Japanese charcoal fireplace
As the fireplace became integrated into the structure of the house a hood was built to capture the smoke, and the fireplace grew into a dominant central element.

Plan of an English fireplace (1500's)

The hood over this fireplace covers both the fire and an inglenook, which has a small window. One side of the hood is supported by a short wall called a hek, which also buffers the entry.

This corner fireplace has a hood of wattle and daub (see page 121) supported by a lintel that was made from the crook of a tree.

Double-arched, massive corner fireplace
Taos, New Mexico (1834)

Arched hood
Living room fireplace, Copenhagen
Gradually the open fireplace evolved into an enclosed firebox that was much more efficient at transferring heat to the cooking vessels.

The Spanish masonry stove, or fogón, has several small fireboxes under a tile cooking surface.

Spanish fogón
St. Augustine, Florida
(1987)

A hood to carry off the smoke was a welcome addition.

Stove with hood,
Venezuela

Early Japanese stoves had cooking recesses and a rice steamer.

Japanese stove

The Austrian kachelofen doubles as a cookstove and the main source of heat. Its tiles hold heat for long periods.

Austrian kachelofen
The hemispherical oven exposes a minimum of surface area for heat loss (see page 27) and it also gives a very even radiant heat within. These reasons, plus the fact that it is easy to build, have made it the favored form for centuries.

A small fire inside heats the stone slab for cooking piki wafers.

The Shakers built large ovens with several revolving racks for high-volume baking.

A sheet metal reflector oven focuses a fire’s heat onto the rack at its center.

This teapot has an efficient and practical shape: maximum surface area exposed to the stove’s heat and the minimum area exposed to the air (due to the hemispherical shape).
The use of tables, chairs, and utensils for dining has occurred only in the last several centuries and, in many countries, is even now not observed.

**House of Carol, Pompeii**

This house has a U-shaped inclined dais that was used for dining. The food was served from the center area.

**Section through dais and service area**

In some older Japanese homes there is a recess, or "horibotsu," in the floor under the table into which hot coals are placed to warm the feet of the diners.

**Japanese "Horibotsu"**

The seating arrangement in the ancient monastery on Mt. Athos accommodates large numbers of people and allows easy service access at the end of the table.

**Eating tables at the monastery on Mt. Athos, Greece (A.D. 950)**

The front of this cupboard swings down to make a table.

**Cupboard/Table, Alps**
SITTING

Even in Neolithic times, builders were creating raised platforms for sitting, working, and sleeping.

At Çatal Hüyük the plastered dais was covered with mats, cushions, and bedding.

Çatal Hüyük
Anatolia (6000 B.C.)

African villages very often have a shaded resting place where people can quietly gather and chat or just sit.

Resting Place, Dahomey

Ur Platform, China

This is used as a dais for sitting and reclining.

Raised sections of the floor in many Japanese buildings are used for sitting.

The three-legged stool

On very uneven floors it still sits flat.

Japanese Pavilion
Shugakuin Imperial Villa

80
BATHING

As the house evolved from a crude shelter into a home, bathing received more attention.

This terra-cotta hip bath was found in an elaborately tiled bathroom.

Hip bath, Olynthus (A.D. 300)

The long drain spout on this triangular terra-cotta sink extended through the wall and emptied into a sewer.

Basin, Olynthus, Greece (A.D. 300)

The use of portable tubs saves the space taken up by a permanent bathroom and allows one to bathe in the warmth of the kitchen.

Shaker bathing tub Sabbathday Lake, Maine (1878)

Early Japanese tubs were made of wood with a metal-shielded bottom under which a fire was built.

Japanese bath tub

Older Japanese homes kept the heat and messy fire of the bath separated from the living areas. The toilet was also separate, but for a different reason.
When possible, most domestic activities in hot climates are done outside, including bathing.

For privacy while washing, low-walled cubicles are attached to these dwelling complexes built of mud.

In Japan, bathing receives a great deal of attention and is practically an art form. As shown in this contemporary plan, the Japanese believe in separating the bath and the toilet.

Some early wood-fired Japanese tubs were inside while the fire was outside. The water circulated through ports in the wall.

The Japanese wash outside of the tub, either by ladling out water or using a shower nozzle, and then they get in the tub to soak. The same water can be used several times and a circulating heater keeps it very hot.
ELIMINATION

With the establishment of more permanent shelters came the need for a system to deal with sewage. For centuries in China, human waste has been considered a very valuable commodity. It is collected, composted, aged, and then used as a high-quality fertilizer, called night soil.

One of the more primitive waste disposal systems is the outhouse.

The outhouse is simply a sewer pit topped by an enclosed toilet seat. Periodically, lime is added to the pit to reduce odors and when it is full, it is covered with earth, a new pit is dug, and the outhouse is placed over it.

Where to situate the outhouse:
1) Put it downwind from the house;
2) Keep it away from any water sources;
3) Place the woodpile between it and the house so that commuters can bring in some wood on their return trip.

Indoor facilities:

When the marmot excavates its burrow, it digs a short, spur tunnel that is used as a toilet.

In 3000 B.C., the residents of Olynthus had an underground, brick-lined sewer system that even had lines serving each sentry's post on the city wall.
In cold climates, a trek to the outhouse is not too popular, so often a privy is built into a corner of the barn.

"Das stillen Örthchen" (lit. "the smallest room")
Matten, Switzerland
(17th century)

The toilet was first brought into the house as simply a bucket with a seat. The bucket was emptied daily at the dung heap.

Switzerland (1693)

Personal hygiene has always been very important to the Japanese, which is evident in the fixtures that they have developed.

Most of the world's cultures favor the squat-type toilet because it is simple, it promotes a natural position, and it is very sanitary.

Japanese Privy (ca. 1870)

This modern Japanese toilet has two water-saving features: 1) With its dual flush mode, little or more water can be used as necessary, and 2) water refilling the tank can be used for washing one's hands.

Contemporary Japanese Toilet

Japanese urinal, or "Asagaowa" (lit. "morning face"; it is supposed to resemble the flower of the morning glory) (ca. 1870)
As civilization went beyond the hunting/gathering phase and the complexity of domestic life increased, it became important to have space in the shelter for necessary tasks and for storage.

The circular compound of huts protects and defines an inner yard that is used as an outdoor living area, a work space, and a safe place to store things.

The flat roof has been used in a variety of climates for centuries as a practical and safe place for working, sleeping, drying produce, and keeping animals.

In many areas, the shape of the house is manipulated to create both open and shaded exterior areas.

Under these vaults are shaded outdoor living and working areas.

Ostuni, Italy
Early dwellings in temperate climates usually housed all activities under one roof to conserve heat.

English Longhouse (Pre-1100)

Some later homes split the dwelling and the byre and created a protected, partially covered court between them that served a variety of uses.

French Farmhouse Plan

Peasant dwelling and barn, France

New England builders connect the barn and house with a chain of work spaces. This minimizes the necessity of going outside in winter.

New England Farmhouse (ca. 1800)

Loggias provide living and working space that is sheltered from both the rain and the sun.

Court and Loggia, Greece
Storage

CULTIVATION OF CROPS BEGAN AT LEAST 10,000 YEARS AGO AND WITH THIS SHIFT TO AN AGRARIAN SOCIETY CAME THE NEED TO STORE FOOD. THE GRANARY BECAME THE MOST IMPORTANT BUILDING IN THE SETTLEMENT.

Clay Pot Granary, Sudan

The granary was usually the first structure built in a settlement and was the most meticulously crafted.

Mud and Thatch Granary, Mexico

This elaborately carved stone granary has large flat stones at the top of each supporting post as a rat guard.

Stone Granary, Galicia, Spain

Large wooden granary, Elmali, Turkey (19th century)
THE IMPORTANCE OF RICE TO THE JAPANESE IS CLEARLY EVIDENT FROM A LOOK AT THE TILE AND STUCCO, FIREPROOF STRUCTURE, OR "KURA," WHERE IT IS STORED. THIS FORTRESS-LIKE BUILDING PROTECTS THE RICE FROM BOTH MOISTURE AND FIRE.

"Kura", Japan (ca. 1800)

DETAIL OF THE VAULT-TYPE DOOR ON A "KURA."

THIS ELEVATED STRUCTURE OUT OF THE REACH OF SNOW AND ANIMALS, SERVES AS A STOREHOUSE AND TEMPORARY SHELTER FOR THE LAPPS.

Raised Storehouse, Finland

CORN CRIBS USUALLY HAVE OPEN, SLAIDED WALLS TO ALLOW AIR TO FLOW THROUGH AND DRY THE CORN. SOME HAVE ADDITIONAL STORM FLAPS TO KEEP OUT DRIVING RAIN.

IN THIS EXAMPLE NOTE THE RAIL GUARDS ON THE POSTS AND THE STEP THAT IS RETRACTED WITH A COUNTERWEIGHT TO PREVENT ANIMALS FROM REACHING THE CORN.
Highrise storehouse
Medenine, Tunisia

Root cellar
Quebec (1650)

Root cellars were usually built above ground to stay dry and then earth was piled over them to maintain a constant, cool temperature for storing potatoes, beets, turnips, etc.

Root cellar under barn ramp
Pennsylvania (1830)

A wet ground - cellar is an underground store room adjoining a well. Pools of well water cooled milk, cider, etc.

Springhouses keep the spring water clean and supply a pool of cool running water to chill milk, etc.

Springhouse, Pennsylvania (ca. 1800)
Section through the stone wall of a trullo dwelling showing a built-in storage niche

Apulia, Italy

A simple and versatile way to store clothes is in a wardrobe. These movable pieces are still very popular in Europe.

The Japanese are noted for their simple yet elegant designs, such as this utensil holder, made of notched bamboo.

The Shakers truly believe in "a place for everything, and everything in its place." This series of attic closets and drawers in Canterbury, N.H. attests to that.

Another favorite storage method was to hang things on pegs on the walls.

Adjustable candle holder

Chair (hung upside down to keep dust off the seat)
Section III - The Building Itself

Regionality

Over the course of history, the environment has been the strongest determinant of what form shelter will take. In order to be successful, a shelter must be built to counter local negative environmental conditions, and it must be constructed with available materials. These two factors are chiefly responsible for the distinctly regional quality of pre-industrial indigenous architecture. This section of the book examines the materials and techniques that builders used to achieve the goals mentioned in the previous sections.

Ireland: Temperate climate, stone and thatch available

Siberia: Cold climate, wood available

New Mexico: Warm, arid climate, clay available for adobe

Arabia: Desert climate, wood available for cloth

Indonesia: Hot and humid climate, plant materials available
Using the Materials at Hand

Palm fronds and grass supply weaverbirds with the materials necessary to create their intricately woven, spherical nests.

The earliest man-made shelter was most likely a roof of sticks, branches, and leaves bridging a trough in the terrain.

This aboriginal shelter in central Australia is made of arched branches with a leaf covering. The floor is slightly scooped out.

The Bambuti people of the Ituri forest in the Congo use large leaves to cover twig frames as a simple shelter.

The Dinka tribe of the Upper Nile uses some local materials in place. The twig and thatch roof of this hut is supported by the trimmed branches of a tree.
On Lake Titicaca, in Peru, the Uru Indians have used totora reeds to create floating islands upon which they build their houses. The houses themselves are also built entirely of reeds.

This primitive Australian hut is made of large sheets of bark bent over a simple stick frame.

For centuries, the Japanese have been displaying their mastery of the craft of thatching.

Takavama, Japan

The bound bundles of straw can be made into roofs (above) or walls (left). Thatch is used throughout the world because grass is so universally available and is replenishable.

In Norway, sod has long been used as a durable, insulating roof material. It is often placed over a layer of bark, which keeps water from seeping into the house.
Log House with Sod Roof

Osterdal, Norway (17th century)

The well-digger jawfish builds a hideaway from which to strike at prey by digging a hole and reinforcing it with pebbles and shells.

Perhaps the earliest form of man-made stone building is the dolmen: a structure of stone slabs used as a burial chamber.

This pre-Dynastic Egyptian house was created within a boulder formation.

This trullo dwelling is built of unmortared stone, which is corbeled to create a vaulted interior.

Murgia, Italy (ca. 1600)
The most widely available building material is the earth itself. For millions of years, animals have been living in burrows for protection from cold, heat, moisture, and predators.

Many burrows are even equipped with short tunnels used as bathrooms.

3,000 years ago, people carved burial chambers into these cliffs of soft rock. During the Middle Ages they were converted into dwellings.

Carved cliff houses, Anapo Valley, Sicily

In northern China, a very large number of people live in subterranean dwellings carved into the loess soil and radiating from sunken courtyards.

Underground dwellings near Lo-yang, No. China

Many elaborate, multi-level dwellings have been carved from the soft tufa cones of Cappadocia.

Cappadocia, Turkey
Another way to use earth for shelter is to cut sod blocks and use them like bricks to build walls.

**Sod House**
**American Midwest** (ca. 1840)

The animals hunted by the plains Indians supplied them with food and shelter. The demountable pole frames of their tepees are covered inside and out with hides.

**American Plains Indian tepee**

The Tekna tribes of Southwest Morocco use the hair from sheep, goats, and camels as the raw material for their tents. These portable and easily erected tents are well suited to the Tekna's nomadic lifestyle.

**Tekna tent**
**Morocco**

In a sub-arctic climate, snow is one of the few materials available. Many tribes have used snow blocks in construction for centuries. The blocks, easily cut and shaped, are laid in a spiraling pattern.

**Inuit igloo**
**Canada**
Structural Systems

Our Paleolithic ancestors might have taken refuge in some natural lean-to shelters of trees fallen against a dank or gully. Later, they learned how to build them themselves.

The next step may have been a lean-to roof resting on a crossbar.

The more common, circular dwelling may have originated with a lean-to radiating from a tree.

Neolithic man built pithouses that had a circular frame roof over a shallow pit.

Pithouse, Pan-po, China (4000 B.C.)

The rectangular pithouse was a more rational form; the circular was more intuitive.

Tenchu-Gongen pithouse, Japan

The next phase was the differentiation of wall and roof.

English cruck building (1500)
Stone Structures

Mortarless stone vaulting appeared in Egypt and Mesopotamia before 3000 B.C. and was of the corbeled, trullo type.

Trullo House, Murgia, Italy (1400's)

The Aegean cultures of Greece and Crete made extensive use of the stone lintel because of the durable stone available to them.

Stone lintel, Greece

The triangular arch marked a transition from the lintel to the arch.

Window lintel, Tigre House, Ethiopia

Vaulted, unmortared stone structures appeared in Europe also.

Stone Oratory, Ireland (6th or 7th century)

A common building type is a mixture of massive stone walls and a light, easily constructed frame and thatch roof.

Farmhouse, Scotland (18th century)
VAULTS AND DOMES

The stickleback fish builds a vaulted nest by constructing a solid, semi-cylindrical mass of plant material and then tunneling a hole through it.

For centuries, various cultures have used plant materials to frame and cover vaults.

Indian frame vault, America

Vault framed with joined bundles of reeds and covered with reed mats, Iraq

Airship hangar, France (1916)

More recently, concrete has been used to build thin-shelled vaults

Concrete dome, Virginia (1964)

Contemporary domes are often of precast concrete sections bound by a band, or tension ring, around the perimeter.

A very ancient, intuitive house form is the dome, or beehive shape.

Khoisan hut, South Africa
Post and Lintel

It is easy to see how the later Greek monumental architecture evolved from this simple, primitive hut, which has tree trunk posts and timber roof framing.

Greek Hut (Pre-3000 B.C.)

The capital atop each column spreads the support of the column along the architrave.

Architrave

Capitol

Abacus

Echinus

Column

Ancient examples of stone construction using massive lintel blocks can be found throughout Central and South America.

Machu Picchu, Peru (ca. 1500)

Where posts and beams are used in Pueblo architecture, a zapata is usually added, like a capital, to spread the support of the post.

Santa Fe, New Mexico (ca. 1860)

In Holland, wood post and beam construction is used to support masonry walls while providing large openings for store windows.

Amsterdam, Holland (ca. 1850)
THE FRAME

A FRAME STRUCTURAL SYSTEM WITH A SKIN OF ROOF AND WALLS HAS SEVERAL ADVANTAGES OVER SOLID BUILDINGS. IT IS LIGHTER, CAN BE ASSEMBLED MORE QUICKLY, IS OFTEN DEMOUNTABLE, USES MATERIALS MORE ECONOMICALLY, IS EASY TO ALTER AND EXPAND, AND CAN FLEX TO RESIST EARTHQUAKES.

FRAME OF BOUND POLES
VENEZUELA

MORTISE AND TENON JOINT

THE CORNER BRACING HELPS A FRAME STRUCTURE TO RESIST LATERAL FORCES SUCH AS WIND AND EARTHQUAKES (SEE PAGE 25).

THE HALF-TIMBER STRUCTURE HAS WALLS OF STONE, BRICK, PLASTER, OR WATTLE AND DAUB (SEE PAGE 121), WHICH FILL IN THE AREAS BETWEEN THE TIMBERS, LEAVING THEM EXPOSED.

HALF-TIMBER HOUSE, DENMARK
The Cantilever

This overhanging, or jetted, second floor adds space upstairs and also protects the lower wall from the weather.

Kent, England
(15th century)

This bracket, called a dresssummer, supports the jetty.

(England)

Side view of a compound bracket, which is common in Japanese Architecture.
(c.a. 1500)

This upper floor area is cantilevered over a river and is supported by diagonal braces.

Luxembourg

Overshot Barn; Tennessee

Garrison Style

Massachusetts
(17th century)

102
Molded Structures

The Potter Wasp builds small clay pots to protect its eggs. It gathers small balls of clay, which it moistens, fashions into flat, narrow strips, and uses to build up the wall of the pot. It then lays an egg inside suspended over a collection of paralyzed insects that will be food for the larva. The top is then corked with a ball of clay. When the young wasp is large enough, it breaks out of its pot.

Semi-spherical clay hut
Afghanistan

The round mud hut of the Massa tribe in the Sudan is built of successive courses of mud, laid and shaped by hand, forming a cylinder and topped with a thatch roof.

Soma structures built by the Honokam Indians of Arizona were constructed by building up courses of hand-shaped mud two to three feet high.

Casa Grande, Arizona (ca. 1250)

The Spanish technique of using board forms to hold the poured wall while it cured was used in the construction of tabby walls. (See page 91.)

Tabby wall
St. Augustine, Florida (1750)
The Roof

Perhaps the first man-made roof form was the lean-to. It is a simple, intuitive answer to the need for shelter.

"Banab," or rain shelter, of the Southern Guiana Indians (the frame gets a cover of brush.)

One of the earliest and simplest roof forms is the cone. Of all the shapes that can be built using straight members, the conical roof offers a maximum of floor area with a minimum of exposed surface area.

Penobscot Indian tepee

Usable living space can be increased when the conical roof is raised on outer walls.

Wai Wai dwelling
British Guiana

This example shows an interesting combination of gable and conical roofs. The gable allows for a large interior space and the conical ends minimize surface exposure there.

Jibaru Jivarja, Ecuador

The gable roof allows for better through-ventilation and also permits easy linear expansion of the structure. (A circle is more difficult to expand than a rectangle)

Seminole Lodge
Differentiating the Roof and Wall

In simple, primitive dwellings there is no differentiation between the roof and the walls.

The Churuta hut of the Venezuelan Indians is made by placing a circle of poles in the ground, then bending them into a double curve and binding them at the top.

The Masai build their huts in a similar way except that twigs, woven between the sapling poles, create a vertical wall. Above which the saplings are bent to arc across to the other side. The house is later plastered with a mixture of mud and dung.

The added supporting poles around the perimeter of this house suggest the beginnings of a separate wall system.

In this house, the wall structure is plainly separated from the roof. This results in the elimination of the unusable low-ceilinged space at the perimeter.

House forms that avoid the transition from wall to roof are still popular today because they are easy to build, use fewer materials, and offer good protection from the weather.

A-frame house, Vermont
Wood Roof Structures

Where available, wood has always been a popular building material because it is easy to shape and is relatively light. In some primitive buildings it was laid in courses or corbeled like stonework.

Log Dome, Pakistan (viewed from below)

Because of its fibrous nature, wood is able to resist bending forces better than materials such as stone, which fracture easily. For this reason, wood has been favored for centuries as a good material to span the living space and support the weight of the roof and snow.

Mandan House, American Northern Plains

Bending force

Prehistoric Pit House with Pole Roof

The same framing system used in the prehistoric pit house above is the most common roof construction technique used today. It consists of rafters spanning from the wall sill or beam to the ridge. Modern framing usually includes a board at the ridge.

House Frame Pennsylvania (ca. 1700)
Vaulted and domed roofs

In areas where heavy timber was not available for use as straight roof beams the vault arose as a substitute. By simply securing one end of a sapling, bending it, and securing the other end one can create an arch. A series of these forms a vault. It is no surprise that this is, perhaps, the most widespread roof form.

Alternative materials, such as stone, clay, or brick, are strong when being compressed but weak when being bent. A horizontal roof beam experiences bending, but in a vault or dome all the elements are under compression, so it is a form that is particularly suited to those materials.

Barrel vaulted houses
Greece

This structure, called a "casella," has an inner corbeled stone dome covered with earth and an outer stone surface.

Casella; Apulia, Italy

Conical domed roof of hand-molded clay
Northern Cameroon

Mud brick sail vaults built on rubble stone walls
Caravanserai; Oum, Iran
Trusses

In a simple gable roof, the downward forces from the weight of the roofing and any snow will cause bending in the rafters and exert an outward force at the base of the roof.

Trusses give the rafters additional bracing and tie the base of the roof together so that it doesn’t spread and collapse.

Kingpost Truss
England (ca. 1700)

Queenpost Truss
England (ca. 1800)

Crown Post Truss
France (ca. 1300)

Scissors Truss

Malay Lashed Truss
Roofing Materials

Vegetal roofs:

Roof of palm leaves laid shingle style
Johore, Malaysia

Kirdi hut with roof of piled grass

Multi-layer, built-up thatch roof
Sudan

Thatched cottage
France (ca. 1885)

Thatched roof with a partial hip on a gable, called a jerkin head
Hampshire, England
THATCH:

VIEW OF UNDERSIDE OF REED AND THATCH ROOF WITH BAMBOO RAFTERS

Katsura, Japan (ca. 1630)

SECTION THROUGH BAMBOO SUPPORTED THATCH ROOF (JAPAN)

BAMBOO

STEEP ROOFS DIVERT HEAVY, TROPICAL RAINS

GRASS THATCH HUTS INSIDE A STONE ENCLOSURE (MARQUESAS ISLANDS)

SECTION THROUGH ROOF SHOWING OVERLAP ON STONE WALL

ROPE STITCHING TO PREVENT WIND FROM LIFTING THE THATCH

Sussex, England (ca. 1699)

HAT-LIKE CAPS ON THATCHED ROOFS GIVE ACCESS TO GRANARIES.

Dormer windows in a thatched roof

Kent, England

110
Stone roofs

Stone roof and wall
Borgome, Italy

Detail of interlocking slates at the roof ridge

Penalba de Santiago, Spain

Slate roof with terra-cotta tile to seal the ridge
Chamonix, France

Slate roof with rocks to prevent wind damage
Switzerland

Some cut slate patterns
Squard
Beveled

The trullo structures of Apulia have an inner stone vault and an outer roof of stones that are slightly tilted to divert water.

Apulia, Italy
Tile Roofs

Mission Tile Roof
Mexico

Mission Tile
Mexico (ca. 1800)

Pantile Roof
Netherlands (17th Century)

Tiled Gable and Shed Roofs
Provence, France

Japanese Yedo Tile

Tiled House, Hakodate, Japan (ca. 1880)

Vaulted Roof Under Construction; Note the Rectangular Brick-like Tile Blocks.

Tunisia
Wooden Roofs

In areas where tree bark can be harvested in large sheets, it is often used as a roofing material. In this example, poles secure the bark.

Bark covered hut
New England Indians
(ca. 1600)

Thick slabs of bark can also be used like mission tiles (see page 112).

Logs themselves have sometimes been used for roofing, as in the scoop-log roof (right), or the split log roof (left).

Split log roof
Helsinki, Finland

Roof of hand-split shakes
North Carolina
(ca. 1750)

Shakes are made by splitting a log with a froe and a maul.

Roof of shaped boards
Horiuji, Japan

Board roof, or "Hisashi"
Kyoto, Japan

Log house with shingle roof
Czechoslovakia (1903)
Roofs of Earth

For weather protection, the next best thing to digging into the earth is to pile earth on top.

Sod-roofed cabin, Copenhagen, Denmark

When properly packed and finished, and kept free of standing water, a roof made from mud can be impervious to rain and can insulate the dwelling.

Herringbone pattern of ceiling boards supporting an adobe roof.

San Antonio, Texas (ca. 1860)

Stick and pole structural system supporting a roof of caliche, a soil with a high lime content.

Casa Grande, Arizona (ca. 1250)

Adobe roof

Taos, New Mexico (ca. 1600)

White wash

Nevada soddy (ca. 1886)

The builders of the sod houses of the plains states used sod to construct the walls and also as a covering for the wood roof.
THE CUBITERMES TERMITES USE SOIL PARTICLES CEMENTED WITH EXCREMENT TO BUILD THEIR LARGE, MUSHROOM-SHAPED COLONIES. THE DOME-D ROOF ACTS LIKE AN UMBRELLA TO DIVERT THE HEAVY TROPICAL RAINS.

CUBITERMES COLONY

ALASKAN ESKIMO WINTER HOUSE WITH EARTH COVERING

ONLY THE TWO SMALL GABLE ENDS OF THIS EARTH-COVERED HOUSE ARE EXPOSED TO THE WEATHER.

Greece (1976)

MANY OF THE OLD BUILDINGS IN ICELAND HAVE THEIR WALLS PROTECTED FROM THE COLD BY LARGE MASSES OF EARTH. SLICES OF TURF ARE COURSED IN A HERRINGBONE PATTERN AND ALSO CARRIED UP OVER THE ROOF.

OLD CHURCH ICELAND

CONTEMPORARY EARTH-SHELTERED HOUSE

LYME, NEW HAMPSHIRE
Other Roofing Materials:

**Skins:**

INUIT TUPIQ
The Inuit summer dwelling, or "Tupiq," is made from seal-skins stretched over a wooden frame and held secure by guy ropes and rocks around the perimeter.

**Plains Indian Tepee**
A skin membrane is attached to both the inside and the outside of the poles.

**Fabric:**

Moor Tent from Mauretania
Fabric made of goat hair is stretched over a few poles and staked with the opening downwind.

**Yurt from Kirghizistan**
Multi-layer goat hair fabric is tied over a wooden frame.

**Metal:**

Tin roof
Elkhorn, Montana (ca. 1890)
It went up quickly but was a poor insulator.

**Copper clad roof**
Nikko, Japan (ca. 1500)
It weathers well and takes on a nice patina.

**Other:**

Dulles Airport, Virginia
Cable-supported concrete roof

Air-supported tennis court enclosure of synthetic fabric, Boston
THE WALL

As the wall became a separate structure from the roof it also took on separate functions. Beyond insulating the house, the roof is built to keep out rain, snow, and sun, while the primitive wall deals with wind, animals, and neighbors.

In its simplest form, the wall is a light vegetal membrane that offers privacy, shade, and protection from wind and rain.

Air-Turreg tent with movable walls of woven straw

Woven walls offer shade and rain protection but allow some air flow, which is essential in humid climates.

Wall of saplings laid between pairs of perimeter posts

Roll-down woven wall panels

Bamboo and reed wall Fiji Islands

Herringbone weave

Upper Volta

Stilt house with split bamboo walls

Pilot dwelling Kenya

Gilbert Islands

South Dahomey
The Log Wall

The insulating properties of solid wood and the prevalence of forests in cooler climates promote log wall construction in those areas.

Plan of a "srub"

Russia has some of the earliest log structures. They are based on a unit called a "srub," a simple square formed by four tree trunks. The Norwegians extended the sides by joining several logs end-to-end.

Cross sections of common log treatments:

- **Russian (untrimmed)**
- **Norwegian (2 sides squared)**
- **Alpine (4 sides squared)**

Log cabin with chinking to seal the gap between the logs.

**Indiana (ca. 1850)**

**Yakut Vertical log wall with covering of mud**

**Siberia**

**Yukaghir log house with a sod roof**

**Siberia**

**Log storehouse Alvdal, Sweden (ca. 1753)**
The more primitive log joints are made by cutting a small saddle out of the top and bottom of each log.

V-notch

Saddle joint

Shaping the log so that it has a peaked upper surface and cutting V-notches in the bottom creates a joint that will reduce rot, because it does not trap water.

Hewn logs with a saddle notch

This joint combines the simplicity of the saddle joint with the draining advantage of the V-notch.

Double-den or double-pen log house

(Center hall gave added ventilation)

Plan

Wilson, Arkansas

As timber-shaping technology improved, tighter and more complex joints were used.

Square notch

Diamond

V-notch

Dovetail

Double notch

Indented V-notch
Wood Walls

Advances in wood sawing and milling technology greatly refined the wood framing systems and also brought about the extensive use of sawn boards as a siding material. A variety of types arose in an effort to create a tight wall with rot-resistant joints.

Edge Lap  Clapboards  Beveled  Rabbeted or Ship Lap

The siding and roofing of many old barns had slightly open joints to let the barn breathe. In the rain, the wood swelled and closed the gap.

New Hampshire Farmhouse with an attached shed (ca. 1840)

Horizontal boards with recessed batten - by Frank Lloyd Wright

Farmhouse Wall Bern, Switzerland
WATTLE AND DAUB

The use of mud plaster (daub) over a matrix of wood, reed, or bamboo strips (wattle) to build walls actually predates the Egyptian culture.

Hungarian Peasant House

The earliest form of mud-plastered wall construction was probably Jacal (mud over vertical pieces planted in the ground).

Jacal Wall, Keet Seel, Navajo National Monument, Arizona

Horizontal wood strips lashed to posts and then plastered with mud that has been mixed with straw to hold it together.

Venezuela

The bamboo mesh in this wall has been left unplastered in one section to leave a window with a grille.

Japan

A more advanced use of the wattle and daub is in half-timber construction. The wattle is framed into the timber structure, then plastered, leaving the timbers exposed.

England
In other half-timber construction, masonry fills in the wall area between the timbers.

Brick infilled half-timber house
Newgate, York
England (ca. 1380)

A very common, primitive type of wall is that of hand-formed mud courses.
Northern Ivory Coast

Cob (mud mixed with straw for added strength) was a favorite building material in many parts of England.
Stone ended cob house
Devon, England

Walls of tabby, a mixture of lime, sand, water, and aggregate (broken shells) are common in older homes in the Southern U.S. The walls were formed by pouring the tabby between form boards (see page 103).
St. Augustine, Florida

122
Some wasps build tubular nests by fashioning small mud cylinders and then layering them to create the arched shape of the nest.

For over 8,000 years, cultures the world over have built with mud bricks. The shaping of the bricks was originally done by hand and later with molds. Durability was increased by firing them.

After the arrival of the Spanish in America, the Pueblo Indians began building with adobe bricks rather than with hand-shaped or puddled adobe.

Because of their square and regular shape, bricks are often used in conjunction with stone to make solid, square corners, door and window jambs, flat or arched lintels, sills, and chimneys.

Flint cobble and brick house
Norfolk, England
TUMBLED BRICKWORK SERVES AS BOTH A STRENGTHENING AND A DECORATIVE ELEMENT.

Province du Nord, France

BRIICK WALL WITH CUT STONE QUOINS GIVING ADDED SOLIDITY AT THE DOORWAY

Val d'Oise, France

DECORATIVE WALL TREATMENTS COMBINING AREAS OF STONE AND BRICK

Bray, France

Normandy, France

A COMMON PRACTICE IS TO REINFORCE THE CORNERS OF BRICK STRUCTURES WITH LARGE, CUT STONE QUOINS.

Brick, stone, and thatch house; Tithe, Hampshire, England
As well as being an efficient way to enclose space (see page 27), the stone beehive hut does not require the complex fashioning of corners in stone.

Stone Age beehive hut, Ireland

Massive (note scale figure) and intricately shaped and fitted stones

Sacsahuaman, a stone age Indian fortress; Curico, Peru

Where a variety of stone is available, it often inspires decorative patterns.

Chaco Canyon, New Mexico (ca. 1100)

Slate and boulders
Northern England

Walls of green slate with quoins and lintels of slate placed on edge

Elterwater, Cumbria, England
The cornice, window jambs, and triangular arch are of cut stone, while the wall is of slate with bands of rubble stone.

Stone Segmental Arch
Pennsylvania (18th century)

Extended wood lintel for added tensile strength

Pueblo Bonito (ca. 1050)

Cut stone lintel or flat arch

England (ca. 1618)

Squared blocks, cornicework, and semicircular arches—all cut from local sandstone.

Tight-fitting polygonal stonework

Hot Springs, South Dakota (ca. 1871) Kyoto, Japan (ca. 1600)
In eastern Portugal some houses have a stone wall system consisting of huge granite slabs as much as twelve inches thick surrounded and held in place by smaller stones. Granite slabs are also used for roofing and paving.

To make a thick, solid stone wall, several tiers, or wythes, of stone are built and tied together at intervals with binding stones. Sometimes these stones protrude and are used as shelves or stairs.

The Inca Indians of Peru were accomplished stone masons and developed the technique of using copper cramps to hold stones together. The method they used may have been to pour molten copper into prepared holes in the stones.

Another technique employed by the Incas was to use long stones protruding from the walls as supports for the floor joists and roof rafters.

Peruvian Andes 15th century
Hybrids:

A trademark of indigenous architecture is the use of a variety of materials in ways that take best advantage of their particular properties.

The builders of this primitive, decaying house built a solid foundation of stone, a light frame of wood, a waterproof roof of thatch, and an upper, weathertight wall of wattle and daub.

This Norwegian house has a firm stone foundation, a solid first-floor barn and storage area of logs, an upper living area with timber framing and light plank walls, and an insulating roof of sod over bark.

A barn in Hagi, Japan with a massive stone base, lower and gable walls of boards over a timber frame, open-slatted wall in loft for ventilation, and a tile roof.
An old Swiss farmhouse with lower walls of stone; over that, a timber frame with wattle and daub infill, and a tile roof with deep overhangs.

Bernese farmhouse
Switzerland

A garden wall with a combination of stone, edge-lapped boards with exterior battens, plaster over bamboo, and tile.

Hagi, Japan
Pole frame with rock infill and pantile roof

Greece

Cottage with stone base, end walls, and semicircular arches, upper wall of half-timber construction, and roof of shingles.

Josselin, France
Other Wall Materials

The early settlers in the American Midwest had few building materials available so they often used blocks of sod to construct walls and to cover the roof.

Sod House; Nebraska (19th century)

Another simple, effective, and inexpensive system is the stovewood wall. In woodpile fashion the logs are stacked and mortared like stone-work. Note the log quoins that reinforce the corner.

Stovewood Wall; Canada

In the late nineteenth and early twentieth centuries tin was used extensively as a cheap, weather-resistant covering for barns and homes.

Tin Shingles and Panels; Maine

Cedar shingles have been widely used for centuries as both a roof and a wall material because of their excellent weather-resistant qualities.

Shingled house; Hingham, Massachusetts (1720)

130
Barn with walls made of bales of hay staked together and roof made of straw.

Nebraska (ca. 1910)

English wall tiles are lapped like shingles, leaving the nails and joints protected.

Japanese flat tiles are nailed at the corners and then the joints are plastered.

The double wall

Bottles are laid in mortar. They admit a beautiful light but insulate poorly.

In a slip-formed stone wall rocks are placed between the form boards and concrete is poured. Later, the form is slipped up to hold the next course.

In many areas substantial heating can be supplied by the use of glass on the south walls to trap solar heat inside the house.

Contemporary passive solar house with attached greenhouse.
New London, New Hampshire
THE FLOOR

THE SIMPLEST AND MOST COMMON FLOOR SURFACES FOUND IN PRIMITIVE DWELLINGS ARE OF PACKED EARTH AND ARE SOMETIMES COVERED WITH LEAVES, STRAW, SKINS, OR WOVEN HATS.

A FLOOR OF Poured MORtar AND AGGREGATE MIXTURES, SUCH AS TABBY, GIVES A SURFACE THAT IS MORE DURABLE, CLEANER, AND DRIER. WHEN WORN, A NEW LAYER IS Poured ON TOP.

ST. AUGUSTINE, FLORIDA (CA. 1700)

FLAT STONES ARE USED ALL OVER THE WORLD TO CREATE VERY DURABLE FLOORS AND PAVEMENTS.

APULIA, ITALY (CA. 1600)

EARLY WOOD FLOORS WERE OF RIVED BOARDS RESTING ON LOG JOISTS THAT HAD BEEN MADE FLAT ON THE UPPER SIDE WITH AN Aaxe OR A BROADAXE. THE BOARDS WERE TRIMMED OR SHIMMED AT THE JOIST TO KEEP THE FLOOR LEVEL.

TONGUE AND GROOVE

SPLED AND TONGUE-AND-GROOVE BOARDS TIE THE FLOOR TOGETHER FOR GREATER STRENGTH AND FOR LESS WARping.

The Chimney

Many primitive dwellings have no outlet specifically for the smoke from the fire. In the communal houses of the Wairö Indians, the smoke inside helps to keep pests out, and it also protects the thatch from insects as it filters out.

Wairö "Haioca" (communal house)  
Brasil

Pan-P'o dwelling, China (4000 B.C.)  
Note the smoke hole at the peak of the earth-covered roof.

Stone slab  
used as a rain hood over the smoke hole (Zuni Pueblo, New Mexico)

House in Anatolia, Turkey (6000 B.C.)  
In many primitive dwellings an opening in the roof acts as the entrance, the source of light, and the smoke hole.

Stone slab hood over smoke hole  
St. Augustine, Florida (ca. 1965)

Short chimney made from old clay pots  
Zuni Pueblo, New Mexico

Adobe fireplace and chimney  
New Mexico  
(ca. 1850)

During the last several centuries the fireplace and the enclosed chimney have replaced the fire pit and the smoke hole in most areas.
The fireplace itself is always made of some mineral material, but chimneys have been built with a variety of materials.

The log chimney's interior is plastered with mortar to protect it from the heat of the fire.

Log Chimney
Indiana (ca. 1850)

This large wooden chimney forms a funnel-shaped hood over a walk-in stone fireplace.

Switzerland

This brick chimney is set out from the wall to reduce the fire hazard and the heat input during summer.

Virginia (18th century)

This massive chimney serves a large first-floor and a small upstairs fireplace plus a bake oven.

Virginia (19th century)
Combined smokehouse and springhouse with a stairway built into the chimney

Chester County Pennsylvania

Like curved walls (see page 125), round chimneys save the difficult task of making corners when working with flat stones, such as slate.

Plastered, round, stone chimney with slate rain shield (northern England)

Shingled chimney with rain hood (Alps)

This chimney is integrated with the stuccoed stonework of the house.

Chester County Pennsylvania

A section taken through the vaulted hallway of this house shows how the two fireplace flues are joined in one chimney.

Ash Lawn, Virginia (designed by Thomas Jefferson)
The Doorway

The simplest doorways are simply holes in the wall, like this prehistoric door opening carved from a stone slab.

Malta

Using tapered jambs can reduce the size of the stone lintel and can also make the opening appear taller.

Mycenae, Greece (1325 B.C.)

The shapes of the openings below allow people to put their hands on the side and swing their legs over the high threshold and also permit someone to enter while carrying a wide load.

Mesakin dwelling, Sudan

Pueblo Bonito, New Mexico (11th century)

Narrow, recessed doors reduce the amount of sunlight entering and heating the interior.

Mykonos, Greece

Many African dwellings have small raised openings that minimize the passage of the sun's heat and also deter animals from crawling in.

Northern Cameroon
Doors for Security

Massive wood door with heavy, metal reinforcing plates and hinges

Tower of London (ca. 1097)

At the entrance to its nest in a dry bank the trap-door spider constructs a silk-hinged door by cementing soil particles. It closes under its own weight to neatly cover the nest's opening.

A pair of heavy wood doors ("porton") used to close off the plaza ("zaguán") of a hacienda and containing a smaller, inset door, which is used more often

The small (4 feet high) mother-in-law door gives access to and from boats in the canals.

Amsterdam

The ancient practice of entering the house via a fully enclosed courtyard has remained popular for centuries for reasons of security and privacy.

Charleston
South Carolina (19th century)
Privacy with ventilation

Doorway with protective decorative grille in the transom opening, which permits ventilation.

Morelos, Mexico

Sliding, slatted frame in the transom can be left open or closed.

Japan

The traditional door in Japan is a sliding panel. The exterior ones, or shoji, are of wood covered with rice paper, while the interior ones, or fusumas, are of wood covered with a solid material or cloth. Above the fusuma is often an open space, or ramma (usually having a decorative grillwork), for ventilation.

Covered doors give privacy while allowing good ventilation, and the transom window lets in light and/or fresh air.

Bermuda
Doorway with wood lattice screen in both the doors and the transom for light and ventilation

Venezuela

Dutch door with bottom closed to keep animals out and children in and with top open for light and air

Pennsylvania

Solid lower door and bi-fold upper doors for a Dutch door effect, plus a transom window

Greece

Grilles allow air and view through the doors, which enclose the "paguan."

California

The small glass inserts in these shows can be slid open for ventilation or can be covered by small sliding panels of translucent rice paper for privacy. As windows they offer a nice view for people seated on the floor.

Japan
This door, made from a large slab of wood, has two projecting lobes, or harrs, which rotate in holes in the lintel and threshold. These harre-hung, or pintle, doors were used in the Near East more than 6,000 years ago.

Lintel, or "kamoji", with routed tracks for the fusumas

Japan

Cloth used for privacy and shading in doorway

Apulia, Italy

Doors with rain hood

Bucks County, Pennsylvania (19th century)

Plan of doorway showing how the double doors fold away into the jambs

Vische, Italy (15th century)

The corner braces stiffen the door frame and also define the arched opening.

Vasilov, Czechoslovakia (1839)
The Window

The ancestor of the window is the ancient wind eye, an opening in the roof through which smoke could escape.

Mud and thatch hut with wind eye
Northern Nigeria

Roof window for light and ventilation
Takayama, Japan

A variety of roof windows, or dormers, evolved to bring light and air into the loft spaces.

Hampshire, England

Kent, England

Saint Augustine, Florida (18th century)

Half dormer

Dormer window with a hipped roof
Williamsburg, Virginia (1930)
Dormer window in a gambrel roof

West Medford, Massachusetts
(18th century)

Dormer with long, catslide roof

Ephrata, Pennsylvania

Hipped gable roof with a small window in the gablet to bring light and air into the loft

England

Eyebrow windows bring light and air to upper level without requiring a full-height wall.

New Hope, Pennsylvania

The angled barn floor admits light to the lower level from windows above the floor timbers.

The Pueblo Indians sometimes made diagonal holes at the floor/wall junction to admit light to interior spaces.

Zuni Pueblo, New Mexico
Builders discovered very quickly that with beveled jambs, a window of width \( x \) could admit much more sunlight (s) entering at an angle.

**Primitive window with squared jambs**

**Medieval beveled window**

**Recessed window with angled exterior jambs and lintel**

**Alps**

**Window with angled interior jambs and sill**

**New Mexico**

**Weaver's window**

**Windows having angled stone and wooden frames admit extra light for weaving. England (1600's)**

**Beveled and vaulted interior window frame**

**Pennsylvania**

**Angled jambs, scalloped and vaulted top, and deep sill with seats**

**Michoacan, Mexico**
Cabin wall with the logs beveled at the window to admit more light.

Savo Province, Finland

Plan

The scalloped recesses in this wall allow a view to the side for people watching from inside.

Arcos de la Frontera, Spain

This recessed wall band allows a similar sideways view through the small section of glass at the side of the window.

Spain

Metal grilles give security while admitting light and air.

Guanajuato, Mexico

A variety of windows with angled jambs create interesting light patterns inside this chapel.

Chapel at Ronchamp, France
The most common device for protecting the window from both weather and attackers is the shutter.

**Board and Batten Shutter**
Berk's County, Pennsylvania

**Panel Shutters with Diagonal Board Backing**
Peach Bottom, Pennsylvania

**Arched Panel Shutters**
Covering a window that has a variety of opening modes
Siberia

**Split Shutters for Partial Shading Along with Ventilation**
Deadwood, South Dakota

**Louvered Sliding Shutters**
Nagasaki, Japan

**Horizontally Hinged Shutter Set**
Kavalla, Greece

**Horizontally Hinged Outer Solid Shutter, or "Sutoni," and Inner Translucent Shutter**
Japan
**Interior Shutters**

A bared window with interior panel shutters reinforced with a board-and-batten backing and having a small inset door, or wicket, out of which one can peek.

Saint Augustine, Florida (18th century)

Sectioned window having small shutters within the larger, full-length, interior shutters.

Michoacán, Mexico

Upper and lower bi-fold interior shutters.

Canterbury, New Hampshire (1811)

Shutters that slide vertically from below the window.

Canterbury, New Hampshire (1831)

Double sliding Indian shutters, which slide into the wall.

Wilnot Flat, New Hampshire (19th century)
LOUVERED SHUTTERS
FOR SHADE,
PRIVACY, AND
VENTILATION

ITALY (14th CENTURY)

PENNSYLVANIA
(19th CENTURY)

LATTICEWORK IS WIDELY USED
IN WINDOWS AS A SUNSCREEN
AND TO GIVE SOME
PRIVACY.

WINDOW
WITH GRILLE
AND LATTICE

VENezUELA

WINDOW WITH
AN ELABORATE WOOD LATTICE

KANAZAWA, JAPAN

THE JAPANESE SHoji
SCREENS, WHICH ARE COVERED
WITH TRANSLUCENT RICE PAPER,
GIVE PRIVACY WHILE ADMITTING
NATURAL LIGHT.

SHoji SCREEN
JAPAN

THE TRANSOM ABOVE THIS
WINDOW LETS IN SOME
LIGHT EVEN WHEN
THE SHUTTERS
ARE CLOSED.

HOLLAND
Enclosed balcony with awning windows on the front and casement windows on the sides to allow greater flexibility to meet different weather conditions.

Valetta, Malta

The upper sash of this second-floor window pivots for good air flow and easy cleaning.

Cumbria, England

The pointed upper sash extends this double hung window up into the triangular arch.

Cumbria, England

This tilted double hung window brings light in through the small wall area between the roofs.

Grantham, New Hampshire

Corner window
Holland
Combination of wicket (window within a window) and casement windows with vertically and horizontally hinged shutters

Thick walls allow the windows to be recessed either from the outside for weather protection or from the inside to create a seat or a shelf.

Deep sill with a window seat

Pennsylvania

Sill shelf

Czechoslovakia

Window trusses held only with thumbscrews allow easy removal of sash for cleaning.

A transom simplifies the building process by putting a door and a window under one lintel.

New Hampshire

New York

This small window was placed in the roof to bring natural light to the stairway and hall.

Pennsylvania
The Stairway

Since Paleolithic times simple stairways have been built by chopping a series of notches into long logs.

Salish underground tribal building

Canada

Norwegian log stair

Twin notched logs with stair treads between

Pennsylvania

Notched timber ladder with hand runs

Taos, New Mexico

Lashed ladder for roof entrance to Pueblo dwelling

Kanazawa, Japan

Ladder stair with handrail

Canterbury, New Hampshire
Builders in many areas have chosen to put the stairway on the outside of the structure to save the limited interior space.

Iron Age "chipuro" shelter
Apulia, Italy

Stone house
Lemnos, Greece

Stairway of stones projecting from a masonry wall
Switzerland

Steps of cut stone blocks
France

External stairways are especially popular in warmer climates.

Intertwining network of stairways
Sperlonga, Italy
This arched stairway has a ramp for pack donkeys beside steps for people and leads up to a tank room above the cisterns.

Guanajuato, Mexico

Years of repeated whitewashing gradually soften the sharp angle at which wall and step meet.

Siena, Italy

Stepped pedestrian ramp alongside a stairway leading to a balcony crosswalk.

Mykonos, Greece

A stile lets people cross a fence but keeps livestock in, and it is much easier to use than a gate, especially when carrying something.

Ephrata, Pennsylvania
Arched adobe stairway with storage below
San Antonio, Texas (19th century)

Contemporary spiral stairway with double turn
New London, New Hampshire

Spiral stairway sculpted by Wharton Esherick using tenoned oak log treads and driftwood railings
Paoli, Pennsylvania

Stairway with storage drawers
Richterswil, Switzerland (ca. 1758)

Entrance to contemporary house built of mud
Building Systems

UNITIZED ROOF FOR EASY CONSTRUCTION AND TRANSPORTATION TO THE SITE

THIS STRUCTURAL ROOF PANEL IS BUILT ON THE GROUND, BY LASHING TOGETHER PALM LEAF RIBS, AND THEN HOISTED UP AND THATCHED.

DETAIL OF LASHING

CAMEROON

IN TIMBER FRAMING, WHOLE WALL SECTIONS, OR BENTS, ARE ASSEMBLED ON THE GROUND, TILTED INTO POSITION, BRACED, AND THEN FRAMED INTO THE OTHER BENTS.

UNIONVILLE, PENNSYLVANIA

FORM BOARDS HAVE BEEN USED OVER THE CENTURIES AS MOLDS FOR BUILDING WALLS OF MUD, TABBY (SEE PAGE 103), PACKED EARTH, STONES (SEE PAGE 131), AND CONCRETE.

IN TRADITIONAL JAPANESE HOUSES, THE FLOOR PLAN, SHOIS, AND FUSUMAS ALL FOLLOW A MODULAR GRID BASED ON THE TATAMI MAT (SEE PAGE 132).
Expansion

The intuitive, circular form of the Neolithic beehive hut (right) precludes the simple expansion of the interior space.

But the rational, rectangular form offers the possibility of easy, linear growth (left).

Carib Indian structure, Guiana

Another way to expand a dwelling is to build additional units that interface with the existing structure.

House compound, Cameroon

Vertical growth, as in the termite mound (above), is another effective mode of expansion.

The early houses of St. Augustine, Florida were often expanded vertically by adding another floor above the tabby-walled first floor.

Other common expansion techniques are the lean-to (left) and the el (right).

Rhode Island

Vermont
Mobile Architecture

**Tepee Cover**

The tepees, drawn by horses after their introduction by the Spanish, usually consisted of tepee poles between which the tepee cover (left) was carried with various belongings.

**Tepee Cover**

**Teavoiis**

The wall panels of many yurts collapse like a scissors gate for easy transportation.

**Wall of Mongol Yurt**

The large Bedouin tents are made to be easily carried by camels.

**Bedouin Tent**

The bow-top English gypsy van has provisions for sleeping, cooking, eating, and sitting while traveling, and it protects against bad weather.

**Plan of Gypsy Van**

The wood and wattle- and-daub sleigh huts of the Bulgarian nomadic shepherds are large enough to house entire families.

**Bulgarian Sleigh Hut**
Whether because of limited available land or too high a price for it, people in many parts of the world have chosen to live on the water in everything from converted barges to dwellings built on artificial islands.

Floating village built on a platform of bamboo

Yellow River, China (ca. 1668)

The Chinese emperor Wu-Ti (140 - 86 B.C.) had a floating wooden fortress that measured 600 feet on a side and garrisoned 2,000 men plus their horses.
Bibliography


Commonsense Architecture
JOHN S. TAYLOR

Vernacular folk architecture, with its straightforward responses to both environmental forces and people's needs, has much to teach us. *Commonsense Architecture* provides a catalogue of examples: pen-and-ink drawings of hundreds of different buildings and design details, accompanied by a hand-lettered text that explains the principles at work.

The author first illustrates how buildings respond to external environmental factors such as climate. In the second section, he describes ways in which various activities such as sleeping and cooking are accommodated within dwellings. The final section investigates materials and construction practices.

Thousand-year-old earth-sheltered houses built in China, passive solar heating ideas used by the Pueblo Indians over nine hundred years ago, natural air-conditioning systems built in the Middle East in the thirteenth century, modular building techniques used in Japan for centuries—these are just a few of the refreshingly practical design ideas here, developed by history's anonymous builders. They illustrate ways of making efficient and economical use of material, capital, and human resources—working with natural forces rather than against them.

A native of southeastern Pennsylvania, John S. Taylor received a Bachelor of Architecture degree from the University of Virginia in 1971. He returned to Pennsylvania to go into business as a designer and contractor and to teach. After moving to New Hampshire in 1975, he developed and taught an energy education program called "Energy Perspectives." He now designs passive solar houses and continues to teach part time.

COVER DESIGN BY JAY J. SMITH