An Appalachian House: Site viewed from highest hill on property

An Appalachian House: The Design and Analysis of a Passive Solar House

By Robin Rogers

A thesis submitted to the faculty of Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree Master of Architecture.

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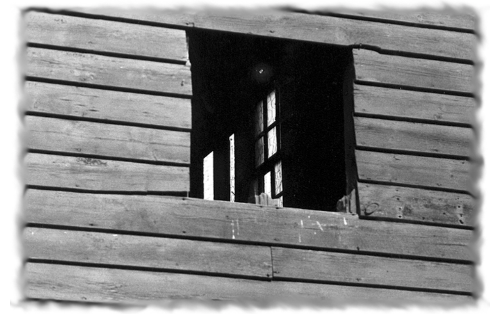

Windows through a barn window.

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Some of the pencil drawings were done for the Nature Conservancy and are of endangered species in Virginia.

An Appalachian House: Looking northwest from the highest point of elevation on the site.

Abstract

This project is a proposal for the design of a house situated on a plot of land within the town limits of Blacksburg. It incorporates ideas drawn from many sources, particularly from this region of Appalachia — its geology, architectural heritage, building materials, history, Blacksburg's Comprehensive Plan, housing, agriculture and energy resources. An introduction discusses some ideas on architecture followed by chapters which provide the basis upon which the design was developed, then, a description of the house design and drawings followed by an analysis of the environmental responsiveness of the design using a computer program called "Energy Scheming."

Hostas.

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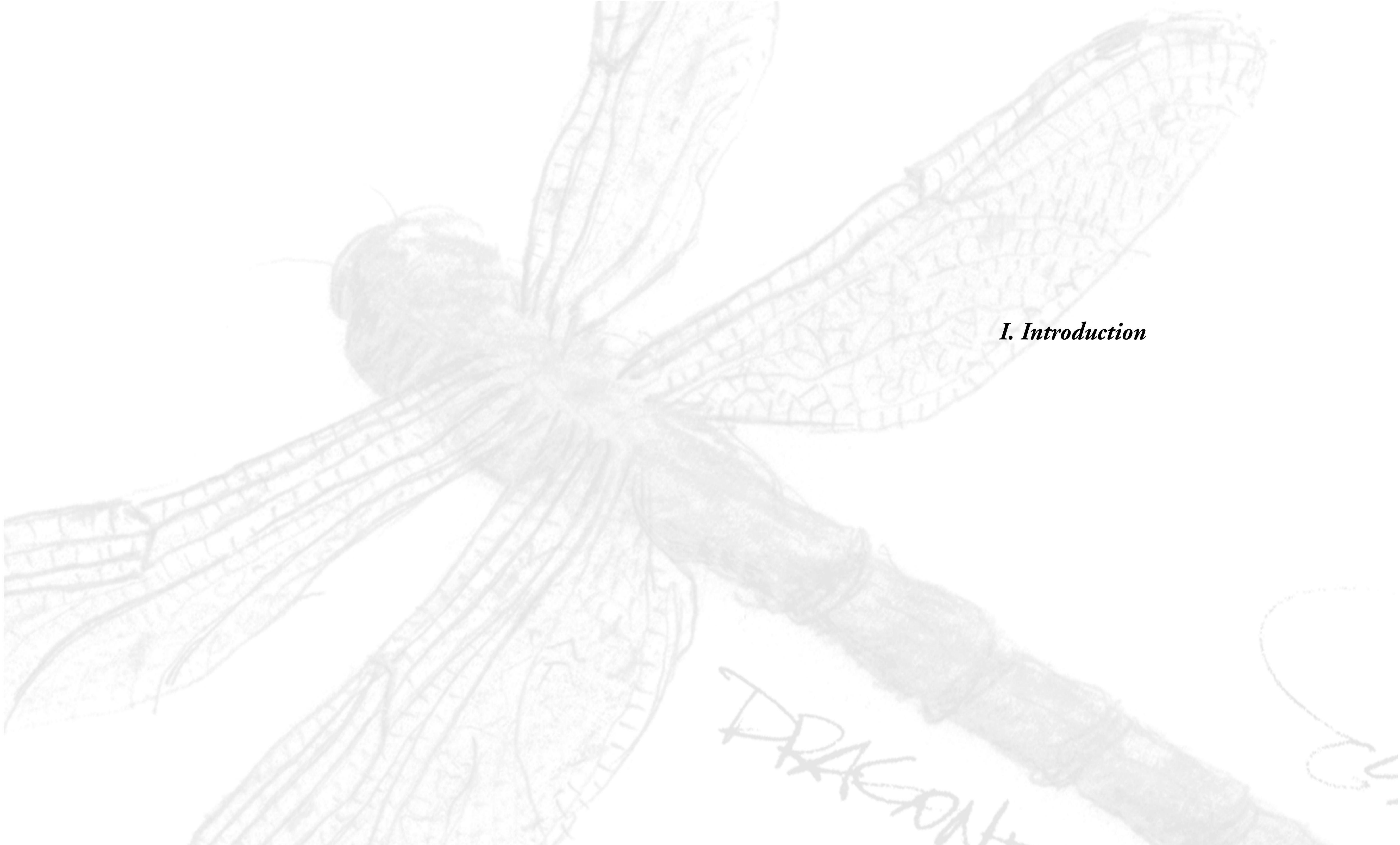


I. Introduction

"Only those who are their absolute true selves in the world can fulfill their own nature; only those who fulfill their own nature can fulfill the nature of others; only those who fulfill the nature of others can fulfill the nature of things; those who fulfill the nature of things are worthy to help Mother Nature in growing and sustaining life; and those who are worthy to help Mother Nature in growing and sustaining life are the equals of heaven and earth."

Confucius (551-479 BCE) [1]

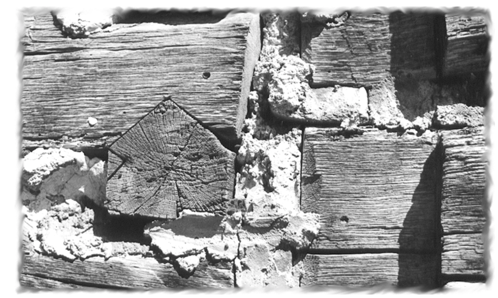
I. Introduction

In this thesis project, there is an attempt to gather together the separate strands that constitute living in an Appalachian region — the wealth of physical, historical and biological material, its agricultural character, architectural heritage, the ability of the land and climate to support a particular lifestyle, and sometimes the adoption of practices in living which do not negate life itself, such as protection of the land, water, air and people through responsive building – and then make a house from them, and finally, qualitatively fit the house into its environs.

Architecture, as a composite of human engineering, science, art, nature, and spirit, as well as of the regional characteristics listed above, becomes a tie that binds all. However, its product is also a separate thing that exists unto itself, while simultaneously being an integral part of its surroundings.

Several architects recognize this duality in the nature of buildings, and their architecture and writings support the quest for achieving a building that addresses many architectural issues; for example, Charles Moore, et al, wrote in **The Place of Houses** [2] that *"A good house is a single thing, as well as a collection of many, and to make it requires a conceptual leap from the individual components to a vision of the whole."* Glen Murcutt noted that *"Harmony is about disparateness, about disparate sounds, which when put together make a pleasing whole... not monotony, not sameness."*

This particular project brought forward several primary concerns related to the actual architectural "building" of the individual components in the design, and called into



question the several challenges of architecture, which in this design dictate:

- Accessing our primal needs (i.e. the functional — shelter, water, food, air) and desires (i.e. the aesthetic — art, music, spirit) to release the image and then build a structure that is conducive to fostering well-being in people.
- Transcending the mundane and humbling the sublime, which is done differently in different places. This thesis addresses the search for expression in architectural terms of Appalachia — its distinctive geography, geology, people, climate, topology, history.
- Developing the responsivity of the design, wherein the entire house provides some solutions to issues introduced in later chapters — acid rain, fossil fuel consumption, sustainable lifestyle, solar access, regional characteristics. Equally essential are ideas that are less quantifiable — access to spirit, nurturance of human desires and dreams. These all must be addressed in such a way as to present a cohesive form that carries the individual components, but becomes a whole expression of diverse ideas.

Other critical issues emerged, as well, regarding the basic concepts of the project, which required:

- Integrating the sometimes discordant issues of function versus aesthetic, need as opposed to want, practicality compared to vision, to create this single thing called "house." As architecture does not allow for the separation of any of these issues, to be "whole" means to acknowledge the symbiotic relationship between what we see and what we do not see.
- Finding, utilizing and promoting the harmonious interaction of the explicate order of the universe — that which we can define, see, explain, sense.
- And then, discovering architecture as the vehicle for the expression and experience of both the implicate and explicate orders of the universe, allowing a dialogue between the essentials of human nature.

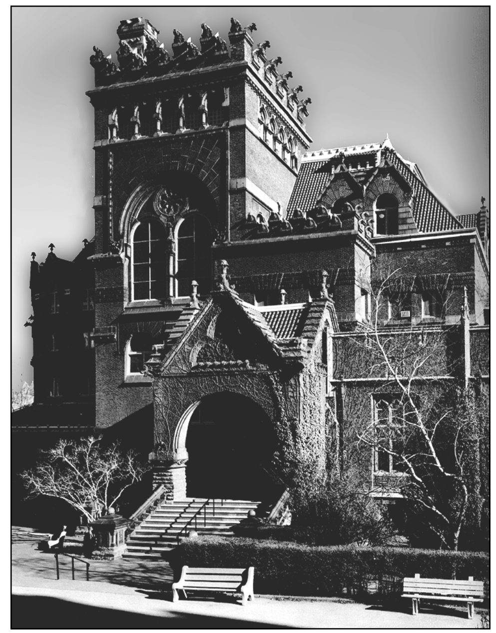
These concerns have in some ways been addressed outside the realm of architecture, and the answers proposed contain ingredients that are applicable to the process of architecture. For example, the physicist David Bohm in **Wholeness and the Implicate Order** [3] laid out the entire universe as a single undivided whole in which there is no fundamental status of separate, independent parts; the interactions between different entities constitute a single structure of indivisible links. He explained that *"each element that we can abstract in thought shows basic properties that depend on its overall environment..."* The eminent scientist Jacob Bronowski in his Siliman lectures at Yale also supported the idea of a "holistic universe," saying, *"...I hold that the universe is totally connected, that every fact has some influence on every other fact... we cannot extricate ourselves from our own finiteness* [4]." These ideas relate to the statements by both Murcutt and Moore, and, although their views seem to reflect a universe of many diverse elements, architecture provides a unifying element for both.

Bohm did, however, see the universe as primarily composed of two orders: the implicate, which is the unseen, and the explicate, or outwardly manifested realm Another architect, Louis Kahn, was not far afield from Bohm's picture of the universe; the crucial questions asked earlier were expressed and, to an extent, answered by Kahn whose view of architecture we could say associates "Silence" with the implicate order and "Light" with the explicate order of things — both laying the foundations of architecture [5]. Bohm further proposed that information of the entire universe is contained in each of its parts, similar to a holographic image, and that these parts stipulate an unbroken whole. Each part carries the implicate order of the whole and the whole itself is an unbroken image of itself. So, while we perceive isolated parts that seem disconnected and unrelated, this is perhaps an illusion that betrays the unity of an implicate order

Another explanation is that there exists a sort of paradox that can perhaps be aptly illustrated in one aspect of quantum physics. Physicist Banesh Hoffmann wrote that space and time exist because of the fundamental particles of energy and matter, which transcend the concepts of space and time [6]. *"They are deeper and more fundamental, more primitive and primordial."* For example, attempting to study temperature or pressure in a single molecule is impossible; both temperature and pressure are crowd effects where the action of many molecules together produces the effects of hot, cold, tight, loose. Hoffmann compares it to the individual letters of the alphabet which on their own do not have the quality of poetry, but strung together in a certain descriptive cadence they can make us weep. Maybe, he writes, the fundamental particles of the universe lack the quality of existing in space and time. Or as Bohm proposes, maybe they are part of a whole and cannot be judged singly. Using this reasoning for architecture, we could say that a building cannot be judged solely by its components, or its function, or its location, or its aesthetic, but rather by the combination of all those things into one cohesive form.

I see architecture in this way — a building cannot really be isolated from its surroundings, whatever they are. Architecture does not exist as a thing unto itself, though many buildings are made as if they were. The materials must not only join together in a cohesive form, but the form must coalesce with its environment. The independent parts are completely dependent on each other to achieve architecture.

Even the process has a structure that is codependent. Kahn saw that each phase of making a building is inextricably linked with the other, forming a circle that begins with the unmeasurable, progressing through the measurable when being designed, and in the end is unmeasurable, when the spirit of its existence takes over. In slightly different language, Kahn supports Bohm's theories of a sort of holographic universe, but in relation to architecture. He saw all material in nature as "spent Light," and viewed Light as the "source of all being," and without material quality. Then, the resulting mass of material from the spent light casts a shadow, which belongs to Light. The symbiosis is evident in this scenario, and Kahn further shows that Light is attainable through structure — a building's wall is where light is stopped.



Frank Furness Building at the University of Pennsylvania [1]

These considerations became a backdrop to the design for a dwelling. The other things that affect us — the materials themselves, the spirit of the architecture, typology, the environmental impact of our actions, the availability of materials in close proximity to the site, the soil's ability to support life, the temperate climate — are the building blocks of this project.

A house was designed for the site because it is basic to every human life — now, and was in the past. On studying for the design of this dwelling for Appalachia, I noticed a complexity that developed through the ages of North American architecture, beginning from the sort of subsistence architecture of the strictly utilitarian houses of more primitive peoples to the contemporary idea of "home," which continues to provide the basic necessities of the "hut" but ostensibly carries with it a greater purpose or vision. That study also led to a question comparing earlier times with today: do we *imagine* that we expect more from a house today than our primitive progenitors who carved and painted and scratched images on the walls of caves in Europe? The famous female figure Venus of Laussel of France, for example, dates to somewhere around 18,000 BCE, and was carved on the wall of a dwelling cave. Is it decoration? communication? spiritual recognition? shrine? fertility prayer? What we know for certain is that the image was placed there by human hands to augment, for some reason, what was already extant in the natural cave home. Decoration of or creation of *home* could have been the cradle of creativity, and thus the beginning of architecture.

Obviously, simple shelter alone was not enough for primitive people, and it seems to be not enough for us as modern humans. If we assume that a dwelling, at its most basic, provides protection, then what does Venus supply? Others have answered this far more eloquently than I, but I would say that she feeds an innate need in us to connect with some universal truth — the synergism of which we are all part, and that Bohm asserts in his views of the holographic universe. This is where a house — or any building — becomes a home. Architecture — an act of

Venus of Laussel [2]

creating a house and home — is the bridge between our physical environment and the more nebulous chorography of spirit (Olivier Marc's heaven and earth distinction might apply and is discussed in a later chapter) [7]. A vestigial image of the ancient "home" hovers in our consciousness like a tree within an acorn — the cavern, with all its simplicity, still beckons to us from our castles, our monuments, our gigantic houses; the complexity we crave and perceive is a modern manifestation of that same, simple ancient desire to decorate the cave wall and live with our environment in a harmonious way, to create something that is beautiful and functional. We may not even understand why we prefer "beauty," if it is an intentional act or the natural expression of a beautiful spirit, as Campbell asked (he also asked *"Is the beauty of the bird's song intentional?"*)[8], but we can certainly at least acknowledge an aesthetic sense in human creations. This is where that expressive element of design comes into play.

Also in this project, another unifying, coherent element of thought is comprised of a group of more concrete ideas that could be loosely represented under the umbrella of "sustainable architecture." James Steele has defined sustainable architecture as *"an architecture that meets the needs of the present without compromising the ability of future generations to meet their own needs"* and is best defined by the people involved as needs tend to differ from society to society [9]. Wherever we are, we live, we cultivate, we eat, we breathe, we make, we do, and throughout we interact, on some level, with architecture. To me, through the architecture with which we live, there is a responsibility to make an attempt at sustainability – sustainability is in keeping with the idea of a holographic universe where the parts are codependent upon each other and also depend on the effect of the "whole." In June of 1993, the World Congress of Architects met in Chicago and declared, in part, that: *as the world's architectural and design profession (they) would commit to placing environmental and social sustainability at the core of (their) design work.[10]*

Sustainability is a global issue that can be addressed on a local level; in Blacksburg, Virginia, it spans over a range from the macro-environment of its Appalachian Mountain region, to the unique small, rural, university town features, and to the micro-environment of the site within that region. Recently the town commissioned a study of itself, looking forward over the next fifty years; a certain continuity of thought is present in the report: a desire to preserve the natural, pristine beauty and intimate quality of life in Blacksburg [11]. This idea goes hand in hand with sustainability and, in fact, is a necessary precursor to sustainable action. Through architecture, many of the stated desires of the town citizens can be addressed or even met.

From a wide selection of architects who have dealt with some of the sustainable architecture issues put forward here, three were used as primary models: Frank Lloyd Wright, Glen Murcutt and Michael Reynolds. Wright's well known views on organic architecture have heavily influenced thinking about modern architecture in general, and in particular his solar hemicycle designed for the Herbert Jacobs family in Wisconsin was an appropriate model for my design. Murcutt uses his architectural expertise and knowledge of various Australian environments to create buildings that respond on an intimate level with their surroundings, but are not necessarily comprised of "sustainable" materials. Reynolds, a more contemporary architect currently practicing in New Mexico, approaches architecture from a position of global sustainability, using recycled materials to create housing that is self-sufficient. Each of these architects has proved a measure of success in "passive solar" homes that combine the practicalities of techno-focused design with aesthetic design. The passive solar aspect became important to the overall design.

Earthship by Reynolds [3]

When I owned a house, I realized my basic nature (and possibly that of most animals) is guided by a sort of heliotropism such as in plants — either upset by an inaccessibility to the sun, or in a constant search for solar access. I also discovered that my idea of house includes some universal ideas of livability, which encompass the issues addressed in this thesis. So, as part of the sustainability issue, the seeds of interest were sown in "solar" architecture, though I hesitate to call this project merely a passively heated solar house, even though the house functions as a passively solar heated one. Clearly, the solar aspect is only one element in a vast array of other considerations. Its prominence in the project shows the *immensity* of the material of sunlight rather than any overriding hierarchy with solar at the top. While bringing large amounts of natural light to the inside of the house, and a certain desire to utilize a readily available natural energy source, it became necessary to address the issue of solar gain.

As a further exploration into the concrete elements of the design, the modeling of this house for its energy efficiency was done on a computer with a program called *Energy Scheming*. It helped provide a look at the house as a functional building rather than as a mere assumption of passive solar architecture, and allowed the opportunity of making minor changes to the design to promote greater environmental responsiveness, but without sacrificing the design.

The whole process of developing the design presented an opportunity to bring together many seemingly isolated ideas, and allowed an attempt to create something out of these strands. I see architecture as one of the few endeavors that transcends and combines all aspects of our existence; it is the thing that binds all — aspirations, dreams, our physicalness, our spirits, our lives, our deaths — together in a cohesive form. In an attempt to reconcile the two sometimes-opposing sides of architecture, it was necessary to go back and forth between the "building design" and the "design of the building." The final design eventually arose from that realm of unquantifiable spirit that Kahn called *"the unmeasurable,"* combined with the practicalities that he called "the measurable."

Olivier Marc wrote that in recent times architecture has lost much of its stature as what he describes as the *"richest mode of human expression"* and that only its concepts have survived, imprinted on the human spirit. Said he, *"If architecture is once again to become creation, must not the barriers between conscious and the unconscious, the objective and the subjective, the inside and the outside, be torn down, so that the architect may discover the foundation of future expression inside the human psyche, which throughout the ages has given birth to form?" [7]*

The disparity between the dualities that Marc laments mirror those encountered in this project of struggling to find an expression of the marriage of art and science. In partial answer to the questions raised, this thesis progresses through discussions of habitation, the land, the region, the cultivation of plants on the land, housing, ecology, and the computer modeling of a single dwelling in Blacksburg. It is an unfinished product in the sense that the attempts at integrating all the various ideas have fallen short of my expectations; however, this report documents the various steps on the path toward achieving an architecture – through the design of a dwelling — for Appalachia, but without an absolute, final destination.

II. Design Principles and Contexts

II A. Principles of Design

II A 1. Habitation

II A 2. Agriculture

II A 3. Energy and Ecology

II A 4. Passive Solar Design

II B. Contexts

II B 1. Appalachia

II B 2. Blacksburg and the Town Comprehensive Plan

A house whose inside is as open and manifest as a bird's nest... where to be a guest is to be presented with the freedom of the house, and not to be carefully excluded from seven eighths of it, shut up in a particular cell..."

Henry David Thoreau
Walden [12]

II Principles of Design
II A 1. Habitation

Olivier Marc asked the question *why* did humans leave earth homes such as caves and grottoes for a more precarious habitation? An evolutionary demand, an inner compulsion, he says. In his ruminations on the matter, he arrives at what he considers the threshold of creativity — where the ancient humans were

confronted with a challenge for which there was no external model and so began to find a correlation to an image *within.* From here, he extrapolates, humans sought to create a replica of their own mother's womb and, so, *house* was born into existence.

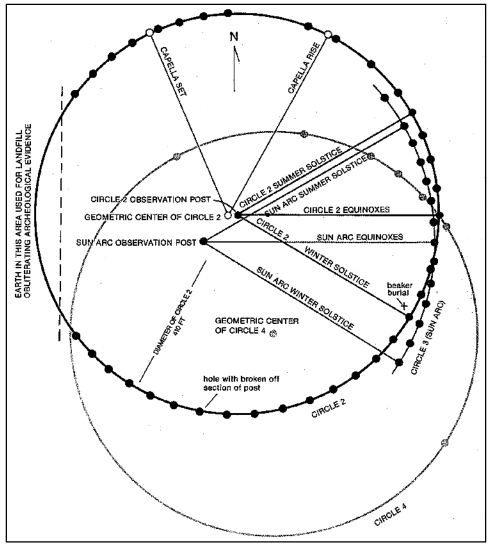
In a slightly different approach to the question of "house," architects Charles Moore, Gerald Allen and Donlyn Lyndon in their book **The Place of Houses** ask *"Did nature provide the conceptual model for the hut before the necessity of shelter forced men to build themselves huts?"* They in part respond by quoting Sir William Chambers' writings on primitive architecture: *"at first, they (primitive peoples) most likely retired to caverns, formed by nature, in rock, to hollow trunks of trees, or to holes dug by themselves in the earth. But soon, disgusted with the damp and darkness of these habitations, they began to search after more wholesome and convertible dwellings. Animal creation pointed out both materials and methods of construction; swallows, rooks, bees and storks were the first builders. Man observed their instinctive operations. He admired, he imitated, and, being endowed with reasoning faculties and a structure suited to mechanical purposes, he soon outdid his masters in the builder's art [2]."* So, while nature apparently provided the model for both Marc's and Chambers' scenarios of primitive peoples' move from original earth shelters to houses, one seems to have been extrinsic and the other from an intrinsic source.

Whichever inference we understand to be true, it seems undeniable that the homes of the early builders were *"part of a harmonious whole... land, man and dwelling were indissolubly bound together,"* as Marc writes. *"There existed then a secret contrivance between our ancestors and their environment which made it possible for them to play with the elements, to grasp the sun at the right moment, to send the wind away in winter, to canalize subtly the summer breeze, to tame light and shadow. They were firmly fixed to the place and were part of a whole composed of subtle harmonies [7]."*

In this agreement between the primitive architect and the environment, there was little margin for error in coping with natural forces: gravity, heat, cold, wind, snow, rain, and flood, according to James Marston Fitch in **Shelter: Modes of Native Ingenuity**. *"The primitive architect works in an economy of scarcity — his resources in materials and energy are severely restricted."* Perhaps because of this implicit order of lifestyle *"(primitive architecture) reveals a precise and detailed knowledge of local climatic conditions on the one hand and, on the other, a remarkable understanding of the performance characteristics of the materials locally available,"* he adds [13].

In eastern North America, before the introduction of Europeans, the probable ancestors to certain tribes of the Native Americans of today possessed fairly sophisticated building and agricultural skills, as mentioned later in Chapter II B 1 on Appalachia. Their societies, which flourished throughout the large area east of the Mississippi River, used their knowledge of the materials of their environment to create an extensive series of ancient villages that reached a pinnacle of population and geographic extent around 1400 CE. Known as Cahokia, the site lies across the Mississippi from present-day St. Louis, where remnants of a large settlement, including huge pyramidal earth mounds and buildings thought to have been constructed primarily of upright log construction have been found.

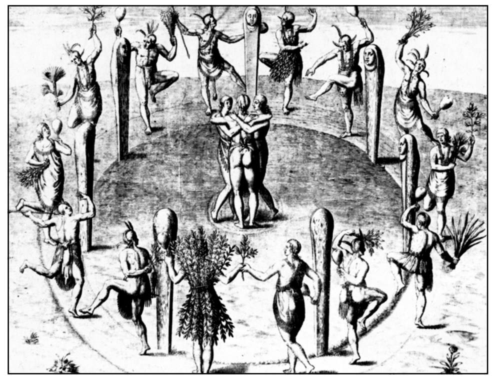
Also uncovered there is a mammoth



"Woodhenge" at ancient site of Cahokia near St. Louis [2]

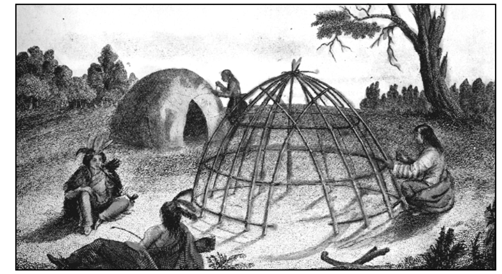
wooden, circular structure, dubbed "Woodhenge," comprised of four overlapping circles with diameters of 410 feet each; the structure marks the entire solar year — a working solar observatory. Archeological evidence suggests the habitation by these peoples in the immediate region of Appalachia near Blacksburg, and in nearby West Virginia and North Carolina their presence is marked by the remains of the palisaded walls adopted by "white" settlers. Old paintings of eastern coastal Virginia portray similar circles to those at Cahokia, writes Joseph Campbell in his **Historical Atlas of World Mythology** [14], suggesting the presence of this early society even on the coast of Virginia and North Carolina. The people who left these telltale signs have mostly vanished, along with much information about how they lived.

The more recent primitive builders in North America had, or in some cases have, dwellings that are very site or lifestyle specific, using local materials that are responsive to each particular environment. For example, the Inuit of the far north construct domed igloos of plentiful arctic ice and snow in a form that exposes the least surface area with maximum resistance to cold winds, providing an effective low-heat capacity wall enclosure for their winter homes (which melt away in warmer weather); in summer they lash wood together to frame a skeleton over which are draped seal skins to form a tupiq or tent. The many tribes of the Plains erected teepees in tripod or tetrapod configurations with long wood poles, stretched with buffalo or other animal hides hunted locally; these structures were suited to the nomadic existence of the people who could put up or take down a teepee in less than an hour. The Navaho, who were seminomadic, constructed hogans of wood, brush and earth, circular in plan, for winter living; rectangular ramadas, also of wood, functioned as open sided summer shelters. In the southwest, large communal, multistoried, semipermanent dwellings are built by the Pueblo Indian tribes using adobe brick or stone; cedar beams are usually employed in these additive and cumulative structures with very thick walls which insulate against the summer desert heat and winter cold. In the northwest, the coastal Indians built large, elaborate, communal dwellings of cedar planks from the huge virgin coastal forests. The agrarian tribes of the northeast, which extended into Virginia, lived in communal long houses, which could reach 125 feet in length; built of curved timber, these buildings were covered in woven grass mats or tree bark to shield from the wind and rain. Also, in Virginia the native structures were known as wigwams; they were circular in plan, constructed with bent saplings and covered with bark or woven grass mats [15].

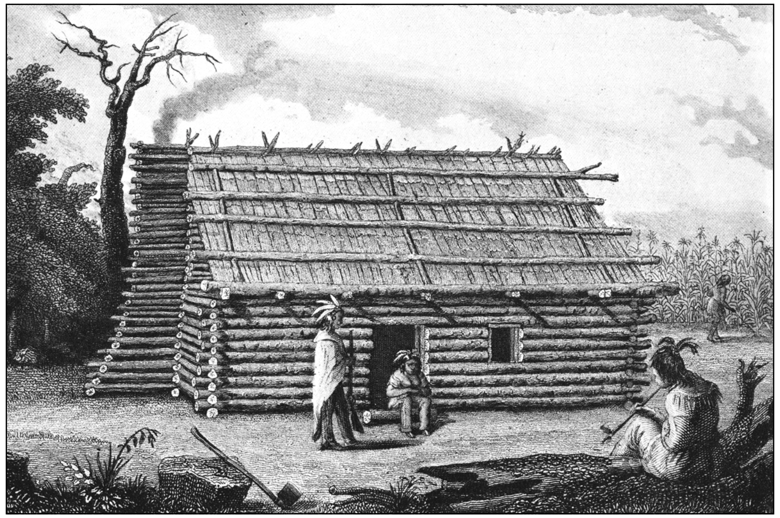


Painting of early "sun circle" [2]

Mostly rejecting the primitive building styles of the natives, when the Europeans arrived, they brought with them the architecture of their homelands — predominantly the various wood frame building methods of the British Isles, Scandinavia and western Europe. However, in **Folk Housing In Middle Virginia** [16], Henry Glassie notes that log construction was unknown in England (although log construction was prevalent in Norway from at least 1200 CE [17]) and was not a major part of the domestic architectural traditions of the early Anglo-American colonies; even so, the construction of small log cabins became prevalent in the Appalachians, apparently reaching Virginia by way of Pennsylvania, traveling through the Great Valley southward and presumably moving westward from the valley into the mountains. Glassie's observations seem to suggest that later, log construction moved eastward to Middle Virginia, and light timber framing, which originated in the Tidewater region of Virginia, moved westward into the mountains. NOTE: *Even much later in the 1980s, the study of common houses by Jakle, Bastian and Meyer found that the homes in one of their study towns, Woodstock, Virginia, along the eastern edge of the Appalachians more closely*



Wigwam [4]



Log cabin of Creek Indians [2]

resemble those in another study town in Pennsylvania than any southern town, thus supporting at least part of this idea — although the homes are not log. Woodstock is situated along the Great Valley Pike that shuttled emigrants from Pennsylvania southward and then westward through Virginia. [18]

“One room log cabins came to symbolize pioneer settlement (1700s) in the forested areas of eastern America...” where there was an abundance of building material and arable land beneath the trees according to the authors of **Common Houses in America’s Small Towns** [18]. Constantz says the first homesteaders in the Appalachians erected log cabins on gentle slopes, near water and with fertile soil. Later settlers moved to higher elevations, “strategically located with protection against westerly winds but exposed to maximum sunlight.” Alan Gowans writes in **Styles and Types of North American Architecture** [15], “Log cabins, however temporary their builders’ dwelling intentions, were often informed by traditional folk-building principles of proportion and quasi-symmetry related to traditional vernaculars of the British Isles.” The builders adopted the ubiquitous square volume for most cabins and houses; usually sixteen feet to a side, it became a “minimal unit of housing” or single bay cube, used repetitiously for expansion, in houses along the eastern escarpment of the Appalachians, according to Glassie in **Folk Housing** [16]. (The style is what Steven Holl in Pamphlet Architecture No. 9 would label a “one room house” or “single pen”, a basic unit which was constructed in different materials depending on the region or period in which it was built and which was usually constructed of log in the Appalachians Mountains [19].) These log cabins were considered *“utilitarian homesteads”* even though Gowans says this is a contradiction in terms, as the *“idea of home obviously involves implications of permanence, roots, and psychic if not physical comfort.”*

Later architecture in the region mostly abandoned log construction in favor of light timber framing. While the indigenous people bent timbers into barrel vaults and covered them with bark, the European immigrants *“began with the same natural resource, but they served it more savagely, turning wood not into houses, but into lumber — and then into houses,”* observed Glassie. In addition, he wrote, *“the Virginia house was, through and through, a thing of wood.”* Thomas Jefferson agreed but lamented, *“It is impossible to devise things more ugly, uncomfortable and happily more perishable,”* and “*wretched”* but *“fortunately short-lived”* when writing of these light framed timber houses [20]. In the Appalachians, many of these early dwellings were constructed with irregular massing ,mainly of indigenous materials, and could be considered some variation of the “southern cabin” whose most distinctive feature is an outside chimney on one or both sides of the house, with the addition of a porch across the front in the mid-eighteenth century. One early form important to this region is the saddlebag house, usually asymmetrical in plan with a central chimney, and introduced as part of the frontier log building tradition, according to Jakle, et al. Using Woodstock, Virginia, again, as an example, the saddlebag house in particular comprises a relatively large percentage (15 percent) of the pre-1920 architecture there, almost certainly arriving in Virginia from the north via the Great Valley [18].

In **Styles and Types of North American Architecture** [15] Gowans writes that eventually, although we cannot know when precisely these structures began to be elaborated into visual metaphors of ideas, by the

time North America was settled by the transplants from across the Atlantic, buildings above stark subsistence level began to betray traces of preferences for particular proportions and combinations of masses and voids which constitute "rightness," helping to create distinctive building styles. In his book, however, he does not address a particular style or type as endemic for the Appalachian region. Glassie notes that in Middle Virginia, about 1750, the house's appearance became "correct" and exhibited a practical aesthetic which actually anticipated the efficiency of the repetitive shapes of the industrial revolution. Also, he writes, beginning about 1760, the buildings changed from organic to geometric symmetry, and from extensive to intensive forms [16].

As a result of these changes, several departures from the square and asymmetrical single-pile dwelling styles (i.e. log cabins) eventually emerged, asserting themselves in the traditional and familiar two-story farmhouse, also known as an "I" house. In the "I" house, lower level windows were symmetrically placed on either side of a central hall and doorway, upper level windows were balanced and symmetrical above; chimneys capped both ends of the house, and all was topped by a symmetrical gable roof. This style has a floor plan which Glassie says suggests withdrawal and a facade that reeks of impersonal stability [16]. Jakle, et al, note that this form spread westward into the Appalachians and into the lower south, again, from Pennsylvania, and is evidenced by its presence in Woodstock where it comprises almost 17 percent of the pre-1920s house types [18].

In the region surrounding Blacksburg today, there are many examples of these early forms of dwellings, including log cabins, "I" houses, and saddlebag houses. Roanoke architect J. Daniel Pezzoni, in his architectural overview for the town's bicentennial history, writes that Blacksburg's first generation of buildings was served by log construction and it took thirty years for the first brick house to be built; nearly all of the town's surviving stock of ante-bellum houses are built of logs. Probably the oldest surviving house in town is a small log structure built in 1840, located on Roanoke Street. In comparison, the existing house on the site was built in 1850 and is wood frame constructed [21]. While the examples given are by no means exhaustive of all the styles in the area, they are mentioned to give some background showing that the historical precedents for housing styles in Appalachia are somewhat varied and

House on Glade Road site

sometimes of questionable origin.

In fact, there seems to be no true "vernacular" architecture of the Appalachian region. Rather than use the vernacular as a model for the Appalachian house design, the precedents are modern architects such as Frank Lloyd Wright, Glen Murcutt and Michael Reynolds, all of whom practice (or practiced) design that is focused on integration of building and environment on a variety of sites. Using their basic approaches to regional architectural methodology (site, materials, climate) as a guide, these have then been applied to this project in Appalachia.

Blacksburg example of "I" house

The small landowners are the most precious part of a state. Cultivators of the earth are the most valuable citizens.”

Thomas Jefferson
Notes on Virginia [20]

II A 2. Agriculture

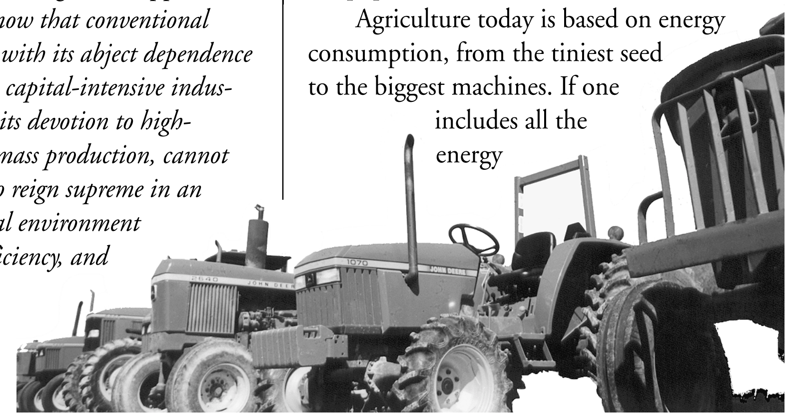
As outlined in the Town of Blacksburg’s Comprehensive Plan [11] (discussed in Chapter II B 2.), there is a strong desire to retain agricultural uses on land within the town limits, especially in the mostly rural

Tom’s Creek Basin. What sort of agriculture is not specified, but if we look at agriculture in general, some ideas begin to emerge that would satisfy the requirements for this area of town that lies within the region of Appalachia.

“It seems certain now that conventional large scale agriculture, with its abject dependence on fossil fuel energy, its capital-intensive industrial technologies, and its devotion to high-volume, standardized mass production, cannot continue indefinitely to reign supreme in an economic and biological environment where adaptability, efficiency, and conservation are ever more important assets... Big agriculture is headed for eventual extinction because, like the dinosaurs of a previous transitional era, it is thermodynamically maladapted to existence in a changing world.” So writes J. Tevere MacFadyen in **Gaining Ground** [22], his treatise on the survival of small farms in the modern era. In numbers, small farms still make up a larger percentage than the huge megafarms — 78 percent of all farms in 1984 were small family run businesses — however, they took home only 19 percent of the total agricultural income. One out of every 30 people lives on a farm in the US.

Wendell Berry, one of the most vocal proponents of a “new” agriculture, wrote in **The Unsettling of America** [23], *“as farmers became more and more dependent on fossil fuel energy, a radical change occurred... the farm became a factory.”* Since 1950 the average farm size has more than doubled to more than 400 acres. The top six percent of all farms produce 40 percent of our food. Only three percent of the population are farmers (1994).

Agriculture today is based on energy consumption, from the tiniest seed to the biggest machines. If one includes all the energy



costs to grow, ship, process and prepare food for the table in the US, nearly ten units of energy are spent to obtain one unit of food energy. Another alarming statistic shows the United States to be the leader in per capita energy used for agriculture; we use twice the energy of other industrialized nations, and the developed countries already use sixteen times the energy per person per year for agricultural production than so-called third world countries. *“Clearly, such inequity cannot be sustained indefinitely,”* according to Judith Soule and Jon Piper in **Farming in Nature’s Image** [24]. MacFadyen makes a case for the smaller farms being more sustainable, more self-reliant, more regionally oriented and a more decentralized system of food and fiber production and distribution that provides fuller employment and reduced environmental pollution, among other benefits [22]. *“It actually costs more today to ship a carrot from California to New York than it does to grow it in New York in the first place,”* he wrote in 1984. He also states, *“Society as a whole presently subsidizes*

An Appalachian House: Site for house

agriculture's energy use by tolerating environmental degradation."

"Sustainable agriculture" is a relatively new term to describe a relatively old method of growing. Basically, it is a system of agriculture that is ecologically, economically and socially viable with the end goals of: affordable, high quality and productive foods; non-depleting and non-damaging to natural resources; promoting a healthy environment; providing good livelihood to the farmers; using solar energy and natural biological processes for pest and fertility management; and lasting a long time, according to the *ATTRA (Appropriate Technology Transfer for Rural Areas) booklet Summary on Sustainable Agriculture*. USDA Secretary Dan Glickman issued a memorandum (Fall 1996) that stated in part that the USDA supports *"policies, programs, activities and education in sustainable development, including sustainable agriculture, sustainable forestry and sustainable rural community development..."*

Nancy Jack Todd and John Todd write in their book **From Eco-Cities to Living Machines** that *"an ecological farm will be comprised of diverse interacting components derived from horticulture, orchardry, livestock husbandry, entomology, aquaculture, bioshelters, and field crops all linked to create exquisite three-dimensional landscapes."* [25] Their vision of a "new" agriculture is based on: bio-intensive (deep) soil management; intensive planting techniques; aquaculture; bioshelters; small plot grains; livestock and poultry; and agricultural forestry. In their view, ecological agriculture reflects the natural world using many diverse elements in establishing the symbiotic relationships leading to productive, healthy systems. They cite K. A. Dahlberg, who in 1987 wrote in **Conservation Biology**, that *"Biological theories and concepts clearly suggest that genetic and biological diversity are the source of resiliency and regeneration of natural living systems. They are thus both prior to and more fundamental than what are termed as renewable resources... they are the ultimate source of regeneration for societies and their resource hierarchies."*

The move towards sustainability is often initiated with an increase of biological and economic diversity on the farm by adding new crops or integrating livestock with crops or developing new marketing strategies for farm products, among others. One model for the mixed use or diverse farm occurs in the mountains of Nepal. Admittedly somewhat different in character from the Appalachians, these small mountain farmers have adopted a subsistence-oriented mixed farming system characterized by diversity and self-reliance — two goals promoted by US sustainability advocates that could have applications here. The three main components of the Nepalese farms — crop production, livestock and forestry — have produced consistently successful results for year-round food and continuous employment, according to Yamun Yadar in **Sustainable Mountain Agriculture Vol. 1** [26]. Using the forest as a reservoir of firewood, fodder, compost, timber, poles and food, the farmers grow a great variety of crops and raise various species of livestock.

Another process suggested for farming in Appalachia uses nature as a structural model for agriculture. Based on the temperate deciduous forest ecosystem, an agricultural system would recreate sustainable features of the forest, such as woody understories. J. Russell Smith proposed planting nut and fruit bearing trees on denuded hillsides resulting from deforestation in the Appalachians, including establishing a perennial understory that would fix nitrogen, hold the soil and provide grazing and haying capabilities. The Native Americans of the area practiced a sort of agriculture that mimicked the natural dynamism of the forest as described in **Farming in Nature's Image** [24]. Small parcels of 20 to 200 acres were cleared and farmed for eight to ten years until the soil fertility was reduced. The abandoned site would lie fallow for ten to 20 years, allowing the natural successional vegetation to restore the soil fertility.

So, while the town of Blacksburg has expressed a desire to maintain agricultural uses in certain areas of the town, it has not actively pursued the means by which they intend to promote this. This project presents one idea for a small farm and dwelling place that are in agreement with the needs of the town as stated in the Comprehensive Plan.

On the ground the inhabitants rarely show themselves: having already everything they need up there, they prefer not to come down. Nothing of the city touches the earth except those long flamingo legs on which it rests and, when the days are sunny, a pierced, angular shadow that falls on the foliage.

There are three hypotheses about the inhabitants of Baucis: that they hate the earth; that they respect it so much they avoid all contact; that they love it as it was before they existed and with spyglasses and telescopes aimed downward they never tire of examining it, leaf by leaf, stone by stone, ant by ant, contemplating with fascination their own absence.”

Italo Calvino
Invisible Cities [27]

II A 3. Ecology and Energy

Therapist Thomas Moore describes ecology as the mystery of discovering, creating, and sustaining the experience of home. The word itself, he explains, is derived from two fundamental Greek words: *oikos* which refers to house, home, and used for any dwelling; and *logos* which has a range of meanings, the favorite of which for Moore is the “quintessence” or mysterious essence of a thing. He then suggests that ecology, on a very basic level, has to do with the soul's constant longing for and establishment of “home” [28].

On a grand scale, Earth is home to us, and we make our livings within the context of the shelter of nature and all that it encompasses. There is a common perception that our entire planet is a delicately balanced ecosystem which is suffering a dissolution as a result of our wanton disregard of the effects of human actions on almost every aspect of this gigantic ecosystem; for example, we spew dangerous chemicals into the air with all sorts of combustion devices, wash pollutants into our streams and oceans from fertilizers or pesticides or paper processing, kill our lands with practices that cause erosion or death to organisms essential to life, and annihilate entire communities of living creatures. Beginning perhaps with Rachel Carson's groundbreaking work **Silent Spring** [29] in the 1960s, we have been warned of the inherent dangers of our technologically advanced lifestyles. In **More Other Homes and Garbage** [30], published in 1982, the authors noted *“the demands made on the environment are often beyond nature's regenerative capacities. Humankind's narrow understanding of conservation and our shortsighted technological approach to satisfying only our immediately perceived needs have begun to seriously deplete stored reserves.”* They added that with then current consumption of fossil fuels, pollution of water systems, and the deterioration of fertile soils, there would later be catastrophic effects to *“every dependent organic system.”* The Todds reiterated in 1994 in **Eco-Cities** [25] an idea they had presented in 1984: *“the natural world cannot indefinitely withstand the onslaught of the current life styles of the industrial nations.”* In June of 1992 thirty thousand world leaders, scientists, political activists, corporate dignitaries and many other concerned citizens of the earth would gather in Rio de Janeiro — the largest meeting of world leaders in history, known as the Earth Summit — with environmental issues at the forefront of their discussions.

Moore sees human abuse of earth as a symptom of homesickness that will be relieved when we have discovered that earth offers the soul relief from its search for home. *“What is called for is a radical shift in paradigm, a true postmodern way of living that reevaluates fundamental modernistic assumptions, explores intelligent and sensible alternatives, and focuses more on the heart and the imagination than on the mind with its literalistic applications”* [28]. While I disagree with him that of all human activities *“only religion and art touch the soul,”* I believe his prescriptions for doing everything artfully and conducive to a sense of the sacred will impart those qualities to our lives which ultimately lead to reverence of “home.” Architecture, in my view, can fulfill Moore's idea that soulful education in ecology might begin with an evocation of home that begins with the pragmatics of living, but then goes deeper to satisfy the soul.

With the notable exception of nuclear power, the energy we use on earth is all derived from the sun: plant growth, upon which we are totally dependent for sustenance, is totally dependent upon the sun which provides the energy for photosynthesis — all the food we eat, animal or vegetable, is sun-derived; fossil fuels are the partially decayed remains of plant matter which have slumbered for hundreds of millions of years encumbered below the surface in coal veins,

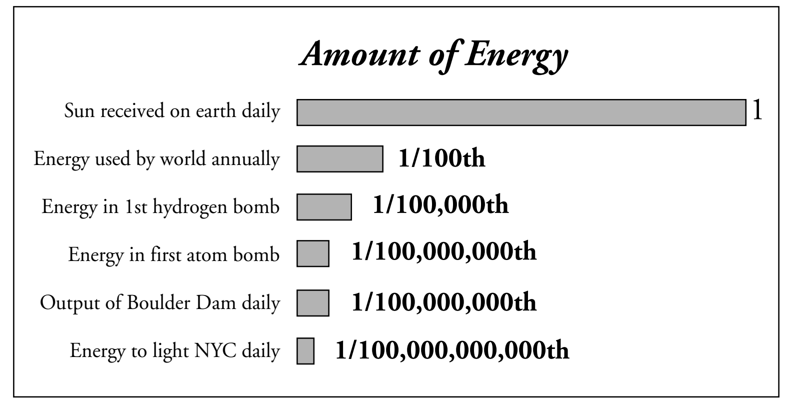
An Appalachian House: Site at sunset, looking west

petroleum deposits or large pockets of natural gas; wind energy used to pump water or power sailing ships is the result of sunlight warming the atmosphere and planet surface, causing the air to move; hydroelectric power also is dependent upon evaporation and wind currents induced by the sun.

Fossil fuels and uranium-dependent nuclear power are considered to be finite, nonrenewable sources of energy. Even though there is a possibility of using a more abundant uranium isotope in "breeder" reactors, the problems associated with nuclear power generation, including disposal of its toxic byproducts, pose enormous risks to society. There has also been some research into using fusion to convert the deuterium in sea water to helium, thereby releasing an exorbitant amount of energy — one gallon of sea water could theoretically produce the equivalent energy of 300 gallons of gasoline. But, these solutions are not forthcoming. Robert W. Noes points out in **The Sun Our Star** [31] that there are distinct advantages to using solar power as a fuel. First, its collection is possible virtually anywhere on earth, minimizing transportation issues as sunlight is collected and used in the same location. Second, solar energy, with the exception of wood burning, is essentially nonpolluting. Also, the "mining" of solar energy is environmentally benign — safe.

There are some liabilities associated with the use of solar energy; for example, it is a dilute energy source. The maximum sunlight collected on a cloudless day in full sun amounts to about 1 kilowatt per square meter, and it cannot be harvested with 100 percent efficiency. The nonconstancy of sunlight also poses challenges to its collection; at nighttime or on cloudy days and during seasonal changes, the rate at which the sunlight can be collected is adversely affected making it necessary to store the energy (in such materials as stone, water or concrete) [32].

In **Mechanical and Electrical Equipment for Buildings, 8th Edition (MEEB)** [33], the authors reprint a table of comparable energy quantities to the daily arrival of solar energy on earth. If the daily solar energy received at the surface in a single day is equal to one, then the use of energy of all humankind in one year equals one-one-hundredth; the first hydrogen bomb would equal one one-hundred-thousandth; the first atomic bomb would equal one one-hundred-millionth; the output of Boulder Dam in one day is also the equivalent of one one-hundred-millionth; and the energy it takes to light New York City for one night is one one-hundred-billionth the energy the earth receives each day from the sun. It makes sense to focus attention on harnessing some of this energy for living. Also, while the sun is basically a safe energy source, there are many problems associated with the other fuels we use.



Combusted fossil fuels are primarily responsible for acid rain in our immediate region. Emissions high in sulfur from industry in the midwest, particularly municipal power plants, are picked up by westerly winds, carried to Appalachia where the air is forced to rise, cool and finally condense. As the condensate falls to the ground, it cleans the air of sulfur, becoming sulfuric acid in the process, according to George Constantz in **Hollows, Peepers and Highlanders** [34]. The area suffering the most acid deposition is an oval that reaches southwest from New York to Tennessee, across the Appalachian Mountains. "Acid rain" is directly attributable to our consumption of fossil fuels. In addition to harming or killing vegetation, this acidic precipitation also changes our soils by dissolving heavy metals which can be lethal to many living things. Our water, too, is adversely affected by a shift to acidic conditions which causes certain fish populations to experience reproductive failures while allowing a few resistant species to dominate. Also, amphibians such as the spotted salamander have high egg mortality rates in water with high acid content.

As documented in **Tales of the Earth** [35], at the 1988 consumption level of crude oil, all reserves in the world will be gone in 100 years. In the United States alone, our energy consumption has increased thirty-six times since 1850, while our population has increased only twelve times. Worldwide energy consumption, primarily of fossil fuels, is rising 3 percent annually. These fuels are non-renewable; it took the earth a half-billion years to create them. Natural gas has a longer life expectancy at about 160 years, and coal even longer still, perhaps as much as 500 years. However, coal is by far the dirtiest to burn.

Along with the rapid depletion of fossil fuels, we also get the result of their combustion: the greenhouse effect. The United States heads the list of worldwide offenders, producing almost 18 percent of all harmful greenhouse gases. As an aside, one of the other factors contributing to the US lead, in addition to the fossil fuel emissions, is the methane gas produced by livestock. There are also emissions of sulfur dioxide which some scientists say will counterbalance the greenhouse effect; Officer and Page, authors of **Tales of the Earth**, offer that this would be a dubious achievement of harmony by pollution and waste [35]. In what seems a sad bit of irony, farming uses more petroleum than any other industry, primarily in the form of fertilizers and biocides, report the Todds in **From Eco-Cities to Living Machines** [25]. They also report that agriculture yields are now dropping despite an increase in fertilizer use.

Then there's the added problem with the way we cool ourselves. Sunlight powers the creation and destruction of ozone, a colorless gas, 97 percent of which resides in the upper stratosphere. There, ozone acts as a shield to dangerous ultraviolet radiation from the sun, too much of which can cause serious damage or death to living things on earth. Our protective ozone layer has been interrupted by the introduction of chlorofluorocarbons (CFCs) in the atmosphere. These CFCs are produced primarily for cooling various aspects of human existence such as food (refrigerators) and indoor air (air conditioning units). Formerly, CFCs were also used as propellants in spray cans but were subsequently banned in the United States in 1987 when a substitute propellant was found, according to Charles Officer and Jake Page in **Tales of the Earth** [35]**.**

Ninety percent of the energy consumed in the US in 1850 was supplied by wood. By 1970, 75 percent was oil and gas. Wood is a renewable source of energy and can be burned somewhat efficiently and cleanly with the introduction of catalytic converters and so-called secondary combustion woodstoves. A woodlot can produce a limited supply of wood each year, however; it will do so for centuries if properly managed, according to **Mechanical and Electrical Equipment for Buildings** [33].

Blacksburg

On a local level, forty percent of energy use in the town of Blacksburg goes for transportation; the next largest portion is consumed by buildings. The town is looking toward increasing the energy efficiency of existing and new buildings in the future, discussed in the town Comprehensive Plan [11] in Chapter II F. Also, *"land use patterns (such as properly oriented, infill, compact, and mixed use development) can enhance use of natural heating and cooling and reduce resident's transportation energy needs."* In view of the town's stated needs and current statistics on energy use and its effects, lifestyles that are conducive to efficient use of resources should be mandatory.

Now in houses with a south aspect, the sun's rays penetrate into the porticoes in winter, but in summer, the path of the sun is right above the roof so that there is shade. If then, this is the best arrangement, we should build the south side loftier to get the winter sun, and the north side lower to keep out the cold winds."

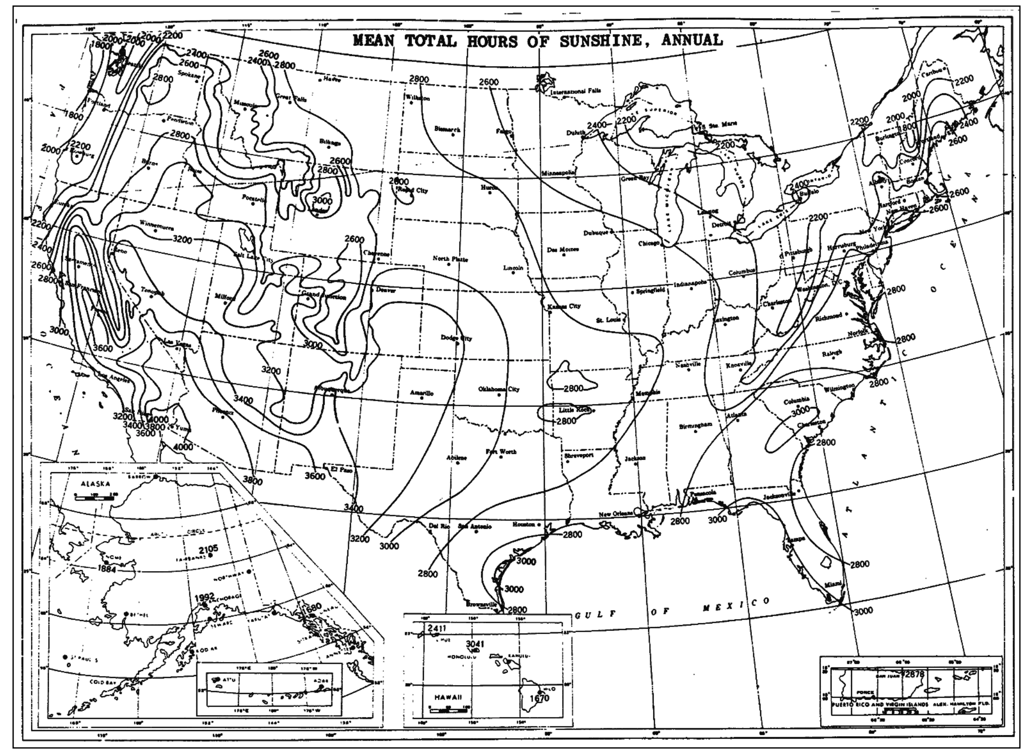
Socrates, 360 BCE [32]

II A 4. Passive Solar Design

In From **Eco-Cities to Living Machines** [25], the Todds report that *"in many areas solar heat is best suited for space heating and has been used for this purpose with efficiency for thousands of years."* They further state that in 1994 there were more than a million solar buildings in the United States. *"The implementation of renewable energy strategies and sustainable design concepts into the practice of mainstream and large-scale architecture... is beginning to be made."* And they quote *Time* magazine in an April 1993 article which announced the coming of age of "green architecture" — environmentally sound buildings *"are cheaper to operate and offer a healthier environment for workers."*

In **MEEB** [33], the authors point out that buildings constructed before 1950 relied heavily on sun for light, sometimes for heat, and thermal masses and breezes for cooling. Today, they write, solar collection devices have *"reintroduced the significant architectural impact of heating"* mainly through the visual images of large glass areas, thermal masses, and sloping solar collectors. In their discussion of energy in architecture, they make two assumptions: *"buildings that encourage their users to directly experience the natural environment will both facilitate energy conservation and enrich the user's architectural experience"* and *"designers can have a positive impact on society through energy and nonrenewable resource conservation."* They have noticed a trend back to renewable and local fuel sources, where the external skin and internal organization of a building works with the surrounding climate for passive heating, cooling and lighting.

Utilizing passive solar energy requires attention to several basic points as outlined in **More Other Homes and Garbage** [30]: solar insolation (the amount of usable sunlight striking the earth in a given location); climate (takes into consideration latitude, season and weather patterns); site orientation (south facing slopes are preferred for regions with cold winters); solar penetration (glazing on south face of building allows sunlight to completely penetrate during winter, and partial penetration during spring and summer); shading devices (used as protection during warm periods); heat transfer (materials



Mean hours of sunshine

such as stone absorb heat from sun to reradiate at cooler times of day); materials choices (glass should be chosen for both its insulating and transmission qualities, masonry should be thick enough to properly transfer heat); prevailing wind patterns (to be used for venting a building).

The authors also point out that in passive solar homes, earth sheltering combines the advantages of solar heating and natural lighting with the climate-moderating effects of earth mass, as the earth helps protect from temperature extremes and infiltration due to wind.They also mention the benefits of including an attached greenhouse on the south side which can provide additional heat as well as an area for growing plants year-round [30].

Using Dodge City, Kansas, as an example, **MEEB** [33] describes the climatic factors associated with the city which occurs at about the same latitude as Blacksburg. The authors write that the winter maximum temperature is about 43 degrees F with 58 percent relative humidity, indicating a need for a backup heat source in a passively heated solar building. In summer, the maximum nighttime temperature is about 67 degrees F with 78 percent relative humidity and daytime maximum temperature of 91 F with 42 percent rh; they offer several strategies for cooling in a passive building: high thermal mass, natural ventilation and high mass with night ventilation.

The **Passive Solar Energy Book** [36]provides rule of thumb solar direct gain guidelines for several areas of the country; Blacksburg would be considered in a "temperate" climate. The glazing versus floor area ratio in temperate climates, where winter temperatures average 35 to 45 degrees F, should provide .16 to .25 square feet of south-facing glass for each one square foot of space floor area. **MEEB** [33] carries a similar recommendation of .11 to .23 for Roanoke, Virginia — in close proximity to Blacksburg, but generally a few degrees warmer. These recommended amounts of glazing will admit enough sunlight to keep the space at an average temperature of 65 to 70 degrees F during much of the winter. Also, a solar window can be oriented as much as 25 degrees to the east or west of true south and still intercept over 90% of the solar radiation incident on a south-facing surface. To prevent daytime overheating and large space temperature fluctuations, a portion of the heat gained during the daytime can be stored for use at night by locating a thermal mass (such as masonry) within each space. In addition, wood frame construction on single glazed windows transmits 10% less heat than metal, and recessed windows further reduce heat loss; double glazed transmits 20% less [36].

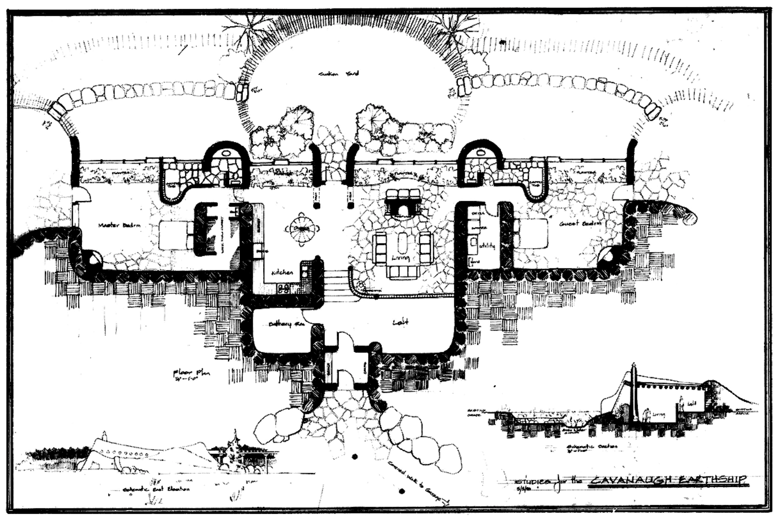
Perhaps one of the best known "solar" designs is Frank Lloyd Wright's solar hemicycle employed in the residence for Mr. and Mrs. Herbert Jacobs in Middleton, Wisconsin. Based on a six-degree sector of a circle, the building forms an arc concave to the sun, surrounding the land with its center in a sunken garden at the front of the house. Herbert Jacobs reports in his book **Building With Frank Lloyd Wright** [37] that the solar hemicycle successfully addresses the environmental issues acknowledged by Wright. During storms with high winds that damaged or destroyed nearby buildings, the Jacobs' house withstood the test of force; Jacobs estimated that the wind force was cut in half due to the airfoil effect of Wright's design. The heavily bermed north side of the house protects from cold north winds, although the site is mostly assaulted by brisk winter winds from the southwest which tend to pile snow at the outer edge of the sunken garden around which the house curves. Massive stone masonry walls form a thermal mass for holding and releasing heat during the nighttime, and cooling the house in summer by absorbing excess heat during the day. Even in below-zero weather, Jacobs says the supplemental heating system would shut off by nine o'clock in the morning and not resume until late afternoon. Large expanses of single-pane glazing (the Jacobs opted against double-pane glass for financial reasons) caused heat loss at night, but were insulated by drapes of fabric made by the owners. Operable windows and doors provide ample ventilation and air circulation. As in Wright's second generation Usonian houses, the Jacobs house has a forced hot water floor heating system embedded in the concrete, fired by a furnace. A large fireplace, while providing some heat when in use, acts as another thermal mass, being part of the rear rock wall [37].

Wright's Jacobs house, the solar hemicycle [5]

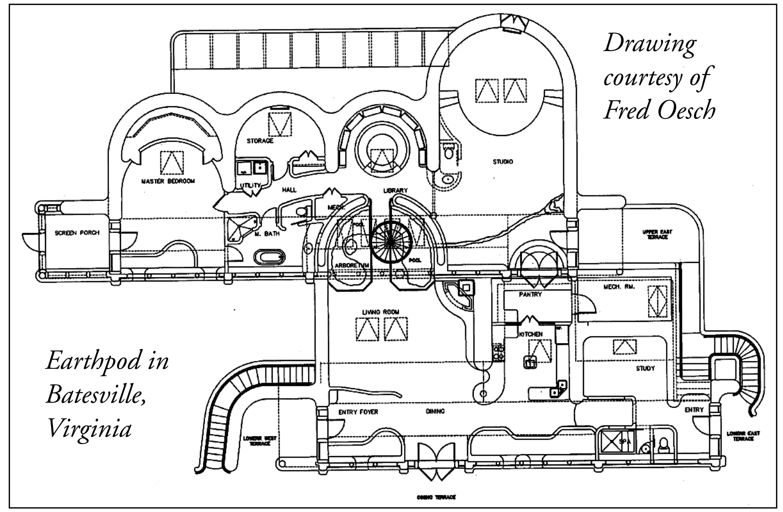
Since Wright's time, many passive solar homes have been built, particularly during the fuel oil shortages of the 1970s. Michael Reynolds is a contemporary architect who emerged during that time and became a pioneer in modern solar architecture, also combining the use of recycled and inexpensive materials. An architect in Taos, New Mexico, he has developed a residential architecture which is responsive to and independently provides what he terms the “necessities” of life: shelter, energy, food, water and air. He sees modern housing as energy consumptive, non-sustainable, and pollution generators for which there needs to be an alternative. He writes, *“This (modern unsustainable) housing times 1 billion (population) is going to kill all of us and make our planet uninhabitable.”* His method has been to eliminate many of the “systems” dependent upon sources outside the building in conventional housing in an effort to have his houses *inherently* provide those same systems.

Reynolds calls his designs “Earthships,” and says they are buildings *“which emit no pollutants, deal with their own waste, are partially covered with earth, and require no outside systems.”* Reynolds’ designs incorporate many ideas towards achieving a sustainable lifestyle; they use both passive and active solar systems for heat and cooling, and some electrical needs; they provide a space and environment for growing food year round; sewage and greywater systems are integral elements of the house; in many cases, water is collected in a cistern for use within the home; the materials of construction are often recycled, and usually easily accessible and from renewable sources. In addition to the very practical considerations of his homes, the designs for which he has refined after more than twenty years of trial and error, he has made an effort to address the aesthetics of his buildings and has adopted local vernaculars in his houses, such as adobe construction in northern New Mexico and stone in Montana [38].

Reynolds’ ideas have been adopted by designer/architect Fred Oesch near Charlottesville, Virginia. He is, incidentally, a graduate of the Virginia Tech architecture department. He focuses on sustainable building techniques and energy efficient housing and has recently finished building a 4,000 square foot home using Reynolds’ methods of recycled tire and rammed earth construction to create a passive solar house in Batesville, Virginia. Oesch calls this house an Earthpod.



Reynolds’ Earthship plan [3]



Drawing courtesy of Fred Oesch

Earthpod in Batesville, Virginia

While the design for the Appalachian House in this thesis does not utilize such features as a sunken garden or recycled tires, the influences of Wright and Reynolds are evident in the form of the house’s seating in the landscape, and the way the materials are used. As Wright usually did, this design includes a land use plan, albeit on a larger scale to include all 54 acres of the site.

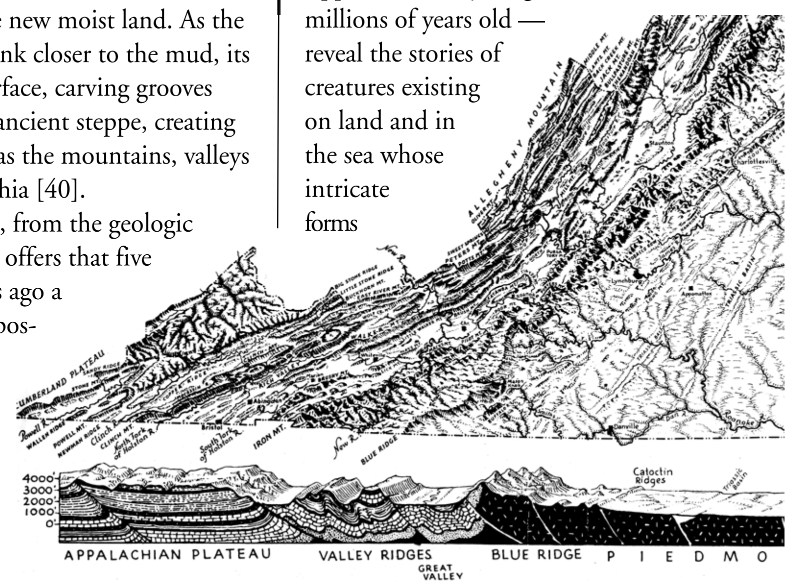
We find the dirt road, and head into the hills; their contours of uneven beauty showing dark masses of shadow and brilliant sunlight that roll in silent swells against the skyline. We feel small and insignificant, like the persons in a Rousseau painting... We walk silently towards the mountain that had been scarred on the north by a quarry from whose chalk face we hear no noise, but whose even sides destroy the beautiful contours of a green hill that lies in solid shadow with white blooms of laurel showing at the wood's edge."

John C. Rogers,
Beyond the Mountain,
Writers in Revolt [39]

II B Design Contexts
II B 1. Appalachia

An old Cherokee myth tells us that long ago, during the eons only our ancestors remember, all beings dwelt in the skies. Earth had no land — only vast oceans on an endless watery world. There came a time that the sky was so crowded with people and animals that water beetle was sent down to find land. Beetle immediately brought mud up from the bottom of the ocean and heaped the wet soil into large piles until it formed a mass of solid sludge on the surface of the planet. While the earth lay in a soft and pliable state, a great buzzard flew down to fan the mud with its giant wings to dry the new moist land. As the bird grew tired and sank closer to the mud, its wings brushed the surface, carving grooves and upheavals in the ancient steppe, creating what we know today as the mountains, valleys and ridges of Appalachia [40].

Another scenario, from the geologic scientific community, offers that five hundred million years ago a shallow inland sea deposited vast quantities of mud, sand, and gravel, gradually accumulating layers more than 20,000 feet thick. Under the tremendous pressure of their own weight and through the chemical action of the water above which cemented the particles together, the huge masses of sedimentary deposits were transformed into the rocks which lie beneath us — sandstone, shale, limestone. In some areas, the sedimentary rocks were subjected to great heat and pressure, becoming crystalline in structure; sandstone metamorphosed into quartzite, limestone became marble and shale transformed into slate and schist. In the oldest of these series of rocks, known as the Ocoee series, there are no traces of life — no fossils. Not that there wasn't life, but rather the forces of nature brutally swept away its traces. In some areas of what is known as "New" Appalachia, the younger rocks — mere millions of years old — reveal the stories of creatures existing on land and in the sea whose intricate forms were captured in fossil portraits sealed by the ocean within our rocks [41].



Ridges and valleys of Appalachia

George Constantz writes in **Hollows, Peepers and Highlanders** [34] that scientists are still coaxing the stories out of the rocks and trees in Appalachia, where older strata overlie younger layers, where pieces of Africa cling to North America, and where surface layers have been shoved many miles westward by sheer geologic force. In Appalachia, we are in fact perched at the suture where two megacontinents collided 570 to 248 million years ago. The resulting corrugated topography, called the Ridge and Valley Province, is made up of roughly parallel mountain ridges alternating with deep valleys, cutting a diagonal from southwest to northeast across the continent, roughly following the Atlantic shoreline from Georgia to Maine. Today in one area of Appalachia the archaic rocks display an apocryphal message that belies their original configuration: just south of the town of Blacksburg, Virginia, Price Mountain stands as a reminder of the ancient slow, but steady, geologic conflagrations which shoved *newer* rock below *older* rock; its mass of Mississippian rocks literally pokes through the layer of surrounding, much older Cambrian rocks [42].

In **The Appalachians** [41] Maurice Brooks informs us that these mountains were formed before the Mesozoic age of the great reptiles. As their rocky peaks were thrust skyward 500 million years ago, the first primitive fishes appeared on earth. It wasn't for another 200 million years that terrestrial organisms actually began occupying the Appalachians. It was also around this time that the African and North American plates began separating, forming the Atlantic Ocean, but leaving our mountains intact.

Life now in these Appalachian hills is diverse. The green blanket which covers even

the tallest peaks (there's no timberline here) has more varieties of trees than all of Europe — 130 different varieties. There are 1900 seed bearing plants in the region. According to John Bakeless in **The Eyes of Discovery** [43], probably in this area, as in the Shenandoah Valley of Virginia, the hills were neutral hunting grounds of many tribes. Although the natives burned level ground to keep it free of trees to better see game (buffalo, deer, elk), the mountains were uninhabited and undisturbed save by wildlife.

Today, the forests are puny reminders of the great forests that greeted the settlers and provided for the natives. But back in the days of towering chestnuts that soared 130 feet above the heads of the western explorers, a small settlement was begun amid the lush canopies and understories of a great broadleaf deciduous forest. The small frontier settlement evolved into the town of Blacksburg, Virginia, set upon a high plateau of softly undulating hills, enveloped by the misty blue mountains. Systematic logging since those olden times has cut virtually every stand of virgin lumber on the eastern seaboard, leaving the extant trees young and small in comparison. Even so, the mountains continue to be a rich provider of materials for shelter and energy — stone and timber and water and fresh air — sustenance for life.

Near the town, on the eastern boundary of the Appalachians, between the Ridge and Valley Province and the Blue Ridge escarpment in southwest Virginia lies the site for the Appalachian house. Still within the town limits, it careens southward off Glade Road towards a small creek that drains into the Tom's Creek Basin and eventually to the New River. West of Blacksburg, north of Price Mountain and southeast of Brush Mountain, this site lies within view of Price Mountain, and rests atop the *older* geologic formation, comprised mainly of interbedded carbonates, especially Rome shale. It is sheathed in good soil, the kind of rich forest earth that became exposed when the trees were removed from the land probably almost two hundred years ago. The house is designed to become part of this site.

An Appalachian House: The site on Glade Road

Settlement in Appalachia

Europeans began moving into the Appalachian Mountains in the early 1700s. Prior to that, humans have occupied some parts of this region for 12,000 years or so, having come from the north and the west after their ancestors migrated across the Bering Strait as long ago as 40,000 BCE. In **The Sacred Geography of the Mound Builders** [44], Maureen Korp provides a picture of these nomads as possessing fire and stone tools, and foraging and hunting for their food; they lived on hills and rises of land, she says, perhaps *"burrowing into earth lodges in the winter."* Evidence of these ancient dwellers upon American soil are scattered throughout the country; known as teepee rings, the circles of stones marking these paleo-Indian campsites number in the millions.

Susan Bracey, in her **Life by the Roaring Roanoke** [45], a regional Virginia history, writes that the early "Virginians" were primitives who survived by hunting while constantly on the move. *"In time, they were joined or succeeded by other immigrants who brought with them the mysteries of agriculture, and a more settled way of life."* The traces left behind suggest fairly sophisticated agricultural societies dotting eastern North America. These indigenous peoples constructed mounds as burial grounds — an estimated 10,000 in the Ohio Valley alone (into which the nearby New River drains), usually adjacent to their villages. In southwest Virginia, according to Howard MacCord [46], author of many archeological studies in the state, there were many native Americans in the area until around 1600; then, mysteriously, they went away. Evidence of these peoples is scattered all over the region; throughout the mountains, says MacCord, are small stone mounds that were apparently burial sites for individuals and that date back as much as 2000 years.

In one settlement thought to be the most important and largest cultural, religious and

Native stockaded village [13]

trading center of North America for hundreds of years, the population could have reached 75,000. Known as Cahokia, the village was possibly a pottery and flint hoe manufacturing center where the people lived in round, oval or rectangular houses made of wattle and daub. Noone knows why the community died out, but their influence spread as far south as Florida [14].

Constantz reports that one thousand years ago the Mississippian Mound Builders were growing corn, beans and squash, and dense populations of the Late Prehistoric Village Farmers lived in permanently stockaded villages and practiced intensive agriculture, also using irrigation techniques [24], a view echoed by Korp. The remains of the northernmost settlement of these people is found in Lee County, Virginia, southwest of Blacksburg. MacCord says pallisaded villages were predominant all through this region; he notes that a curious footnote to their history is that although they were presumably built to protect their inhabitants, none of the pallisades was ever burned, which would be expected in an offensive. Some of the settlements included houses that were "perfectly round," built of posts set in the ground in spaced pairs that slanted outward from the base; materials included willow for the walls, and slabs of bark or thatch for the roofs. Sites have also been found as close as Radford and Ellett, and Bland and Scott Counties, according to MacCord [46].

Physical map of region

Over the hundreds of intervening years, little of the original native life in the region has survived the onslaught of European domination, and the tribes of aboriginal peoples who utilized the Appalachians have mostly faded into the uncertain depths of our collective memory. So while the ancients remain somewhat of a mystery, we find clues in the lives of the more recent tribes of several hundred years ago; in Bracey's history [45] she talks of a tribe called the Occaneechi who lived and controlled trade from an island in the Roanoke River somewhat to the east of the Blue Ridge. Also, in Lula Porterfield Givens' book on the early history of Montgomery County [47], she writes that although a tribe of Toteros lived on the upper reaches of the Roanoke River (near present-day Salem), *"few Indians ever lived in this section continuously for it had been set aside by the Indians as a hunting ground,"* a view disputed by MacCord. Givens and Bracey also assert that a major Indian thoroughfare passed this way, used for traveling hostile war parties and trade; it was called the Indian Road or the Great Indian Warpath, or the Warriors' Path, and the Europeans used it to their advantage when staking new claims in the New World, renaming it the Great Wagon Road of the Great Valley [45] [47].

Eventually a small settlement was established near a small creek several miles west of this road. It came to be known as Blacksburg, Virginia.

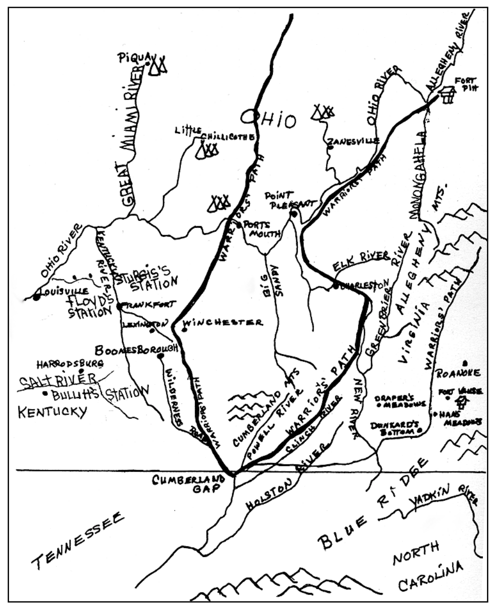
Blacksburg, Virginia, cabin

“Blacksburg can stand as a symbol as well as a place. Early settlers had reason to view it as a very Garden of Eden.”

Peter Wallenstein,
A Special Place for 200 Years
[21]

II B 2. Blacksburg and the Town Comprehensive Plan

In 1671, an exploration party searching for riches and a passage to the western ocean was sent to western Virginia, and provided the first written account of “white” men in the area. Seventy years later in 1742, another expedition ventured to southwest Virginia on Indian trails and, on the present site of the Virginia Tech campus, killed buffaloes and used their hides to make boats. After floating the Wood’s River (now New River) near present-day Blacksburg all the way to the Mississippi River, the party eventually reported impressive stories of river lands. This aroused great interest and instigated the formation of land companies, such as the Wood’s River Land Company [21].



Old map of Southwestern Virginia [7]

Soon thereafter, about 1748, a representative of WRLC established a settlement of one-story log cabins called Draper’s Meadows on the present-day site of Smithfield Plantation. The site lies near the aforementioned primary Indian footpath, the renowned Great Indian Warpath, which traversed the Great Valley from North Carolina to Philadelphia. Draper’s Meadows was connected to this great path by a secondary trail known as the Indian Road which led west (following Catawba Road), continuing past the settlement (along Tom’s Creek) and across New River. A massacre by invading Shawnee Indians from the Ohio River Valley destroyed the small outpost in 1755, and it wasn’t until 1772-1773 that Draper’s Meadow was repopulated when Colonel William Preston built Smithfield on his plantation in what is now Blacksburg (on a part of the Virginia Tech campus) [47].

Ariel view of original sixteen squares of Blacksburg

The town of Blacksburg was established in 1798 when the land on which it was founded (38 acres) was deeded by William and Jane Black, and the General Assembly appointed trustees out of the two dozen or so people who then bought land in the town. The original sixteen-block area continues to represent the heart of the town bounded by present-day Draper Road, Jackson Street, Wharton Street and Clay Street [21].

Early landowners in this frontier farming community were required to *“build a house not less than 70 feet square, fit to reside in with brick or stone chimney, in from two to five years; if not the title ceased.”* Made of logs and without floors, few nails were used in construction of these simple homes [21].

The town also consisted of one store, one log meeting house, one blacksmith shop, one tannery and one tavern. according to the *Montgomery News Messenger*, Christiansburg, Virginia, dated Thursday, May 30 1957.

Blacksburg Today and the Comprehensive Plan

Today Blacksburg is a university town with a population of 35,000, inclusive of the Virginia Tech enrollment of approximately 23,000 students. It has retained its rural character but has many advantages usually associated with a larger, more urban center. To secure Blacksburg's "small town character" and "livability" as the town grows, the citizens and government began a comprehensive study of the current and future needs of the community, and, in 1996, the town's Planning Commission published the Blacksburg Comprehensive Plan [11] based on this study. Looking forward to the year 2046, it is intended as a comprehensive reference on the town as it is now and how it is desired to be in fifty years, serving as a guide for land-use decisions and a blueprint for community programs, initiatives and investments in the community's infrastructure. The Plan articulates objectives and strategies for the town in the areas of natural environment, urban design, housing, transportation, utilities, information technology, community services, parks and recreation, public safety, and economic development. Following are discussions of pertinent material from the Plan:

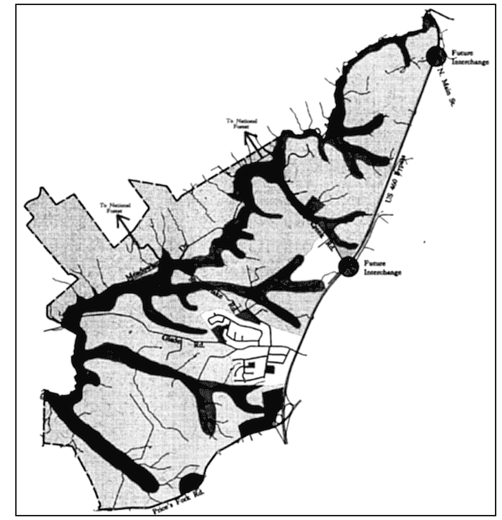
An Appalachian House: Creek on site that flows to Tom's Creek

Water and the Tom's Creek Basin

Spread over a high plateau on an eastern continental divide, Blacksburg's self-contained watersheds receive little surface runoff from outside the town boundaries; Tom's Creek is one of five major stream systems in the town. The Tom's Creek Basin covers approximately 6.05 square miles comprising one-third of the town's total land area and one-half of the town's existing open land. Almost ninety percent of the area is comprised of parcels in excess of five acres; eighty percent is comprised of parcels in excess of ten acres.

The pattern of future development in Tom's Creek Basin is deemed critical to the preservation of open space and agricultural land use within the town limits; any *"development that does occur should be designed in a way that preserves the natural and agricultural character of the basin."*

Some recommendations for the future of Tom's Creek Basin include: as new residential developments are designed, ensuring that regulations and development pressures do not force agricultural uses from the area; making improvements to Glade Road, one of four major roads dissecting the Basin; although there are none currently, designing any future commercial developments so that they do not compromise the rural character of the area and will cater to the needs of local residents without attracting significant traffic to the area; encouraging residential site design clustered on half the site, leaving the remainder in permanent open space; installing a sewer system for the Basin in fulfillment of a condition of its 1973 annexation.



Tom's creek basin future use map from Comprehensive plan [8]

Soils and Agricultural Land

Fully one-half of the land in the town is either prime agricultural land or moderately well suited to agricultural uses. Approximately 6,200 acres are vacant or used for low intensity agriculture. There are concerns about the increasing trend of the "suburbanization" of agricultural lands surrounding Blacksburg. In 1980 half of the developable land in town was also prime agricultural land; since then 19 percent of that land has transitioned to residential development. In addition to loss of farmland and woodlands, this growth pattern contributes to such suburban sprawl problems as increased road traffic along corridors such as Glade Road.

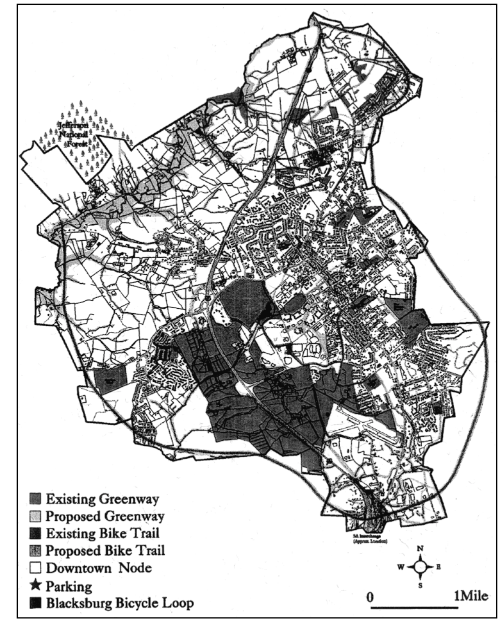
The Town's agricultural zone allows one dwelling unit per acre, and, according to the town's Plan, the ordinance does not adequately protect agricultural land; however, the town is able to implement the State of Virginia's Agricultural and Forestal District designation to *"encourage the development and improvement of the Commonwealth's agricultural and forest lands for the production of food and other agricultural and forestal products. (It is) also designed to conserve and protect agricultural and forestal lands as valued natural and ecological resources which provide essential open space for clean watershed protection, for wildlife habitat, and for aesthetic purposes."*

An Appalachian House: Steep slope on site

Also within the town's boundaries are relatively limited isolated areas of karst topography and steep slopes which pose potential hazards for development where the ground is underlain by soluble carbonate rock such as limestone or dolomite. These types of geologic features are susceptible to dissolution resulting in sinkholes, caves and underground streams, and can present unbuildable sites greater opportunity for groundwater contamination. The site on Glade Road contains portions that fit the steep slope category, and across the road from the site on a separate plot of land is a sinkhole.

Open Spaces

Nestled among the surrounding forested hills and mountains, Blacksburg is considered to be naturally beautiful. There is a strong desire to preserve the quality of its natural environment. There is some concern over development pressures which are becoming stronger as the population increases and



Greenway plans for Blacksburg from Comprehensive Plan [8]

causing the built environment to encroach on open space areas. Also, by more intense adjacent uses, the quality of open space is in jeopardy. Many landowners are forced to develop their land because farming operations are less viable, or property that has been owned by a single family is divided among surviving members after the death of a principle owner and consequently developed.

The Comprehensive Plan, in its initiative for providing and maintaining open space, identifies primary themes to be considered: conservation of farmland; protection of water resources; protection of scenic views; and preservation of rural community and landscape, among others.

In addition, the town would establish "greenways" throughout the community to protect biological diversity, maintain the connections between natural communities and provide wildlife corridors. Besides bike trails, city parks and campus areas, the town would "preserve and enhance all streams, wetlands and water features."

Blacksburg would continue to use existing open space techniques such as planned unit developments and rural residential zoning, particularly to preserve the rural character in the area of Tom's Creek Basin. The town would further identify undeveloped areas with combinations of slope and soil that have development constraints and consider these as open spaces. There would be incentives for landowners to continue farming operations, as well.

In the future, there is a possibility of establishing a non-recreational riparian buffer system based on a particular area's depth to water table, flow of groundwater, soil moisture, drainage ways, contaminant potential, link to corridors, hydraulic gradient, and habitat conservation corridors.

A large interstate highway is planned to bisect the 460 bypass corridor on the north end of town and it is not yet known what affect, if any, it will have on the Glade Road area.

Air Quality and Energy

Blacksburg has received the designation "air quality attainment area" from the Environmental Protection Agency, monitored by the State's Department of Environmental Quality. According to the Town's Comprehensive Plan, air pollutants that do exist are from the combustion of fossil fuels, primarily from motor vehicle emissions and Virginia Tech's coal-fired boilers; transportation accounts for almost 40 percent of total end use energy in town, while residential and commercial buildings comprise another main portion. The Plan recommends conserving *"energy use thus reducing fossil fuel combustion and air pollutant emissions"* to maintain and enhance air quality and resource conservation.

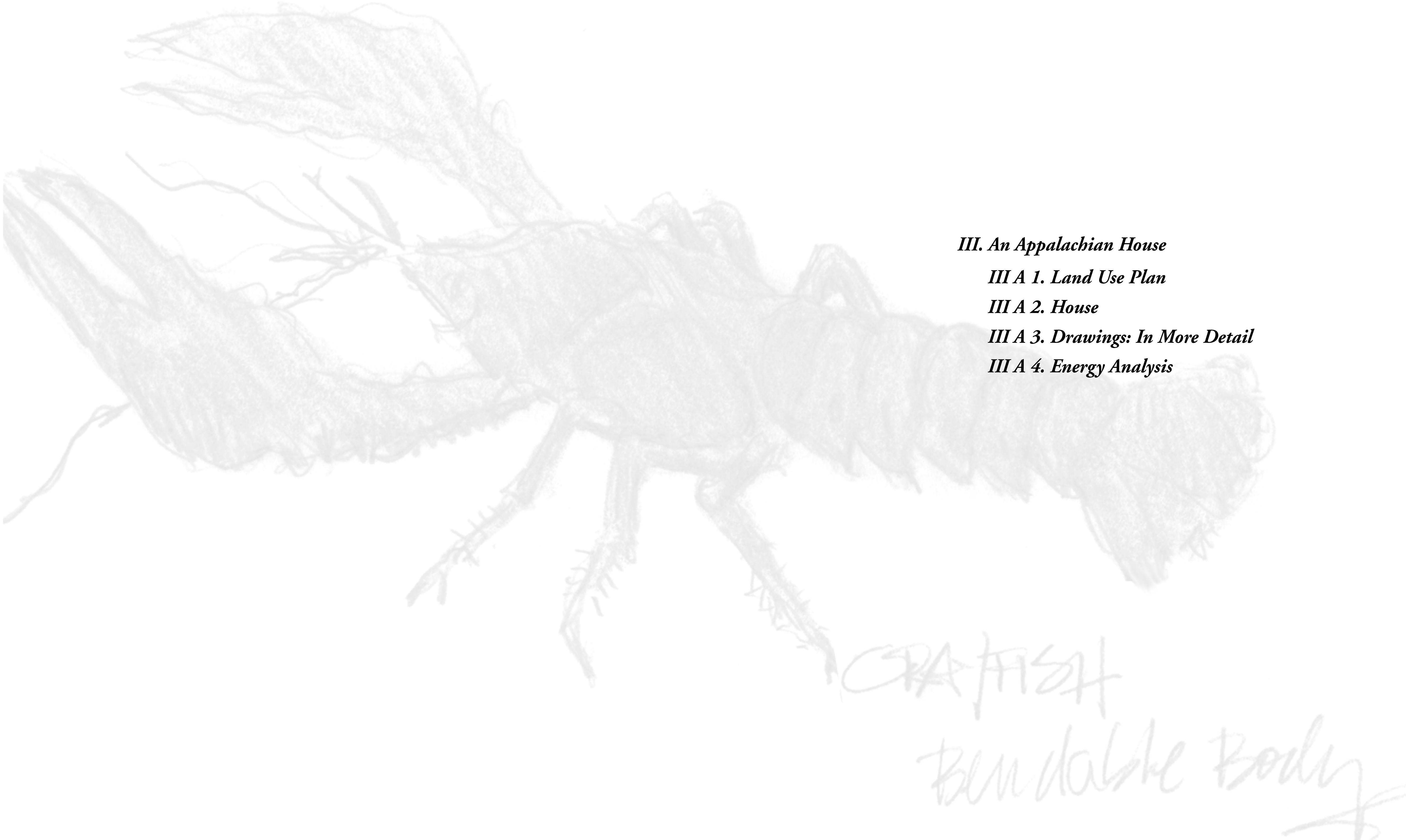
It further recommends improving the efficiency of new and existing buildings, as well as using land use patterns (such as proper orientation and mixed use development) to facilitate use of natural heating and cooling. The Plan also calls for educating the public on energy saving household practices and encouraging developers to incorporate energy efficient design in residential and commercial developments.

Extraterritorial

Along with these recommendations for the town itself are those for extraterritorial areas, or areas which are on the town's boundaries: retention of agricultural uses; preserved mountain ridges and slopes to retain natural appearance; trails and greenways that allow continuity between the town and outlying areas in national forest and other adjacent recreational areas; and retention of large tracts of agricultural land.

Summary of Plan Objectives

Among the Town's objectives as delineated in the Comprehensive Plan are the following: implement innovative regulatory and nonregulatory land use management to enhance and preserve the natural environment while accommodating future development; protect and maintain the quality of natural urban and rural streams, drainage systems, groundwater sources, and air, for people, plants and wildlife; minimize the potential for runoff problems, soil erosion, and flooding through appropriate innovative approaches to stormwater management; protect the integrity and quality of forested areas as buffers, habitat and pollutant removal systems, and ensure the retention of existing high-quality trees and woodlands and the planting of new trees during land development: conserve and protect wildlife habitat through preservation of networks and corridors of natural vegetation, forest cover, floodplains, streams and stream corridors, wetlands, and undeveloped steep slopes; promote land use patterns and building techniques that lead to efficient uses of energy; and in the future provide density bonuses to encourage designs which provide solar access and other energy saving measures.



III. An Appalachian House

III A 1. Land Use Plan

III A 2. House

III A 3. Drawings: In More Detail

III A 4. Energy Analysis

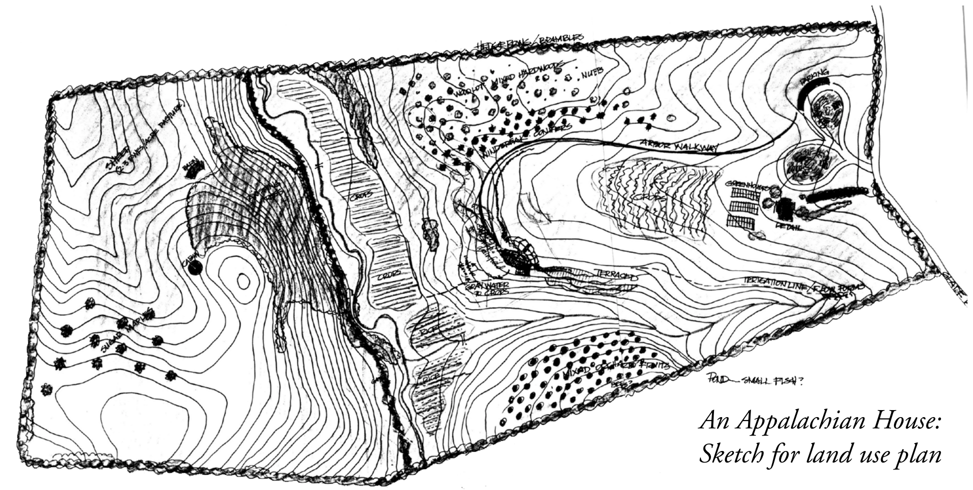
"No house should ever be on any hill or anything. It should be of the hill, belonging to it, so hill and house could live together each the happier for the other."

Frank Lloyd Wright,
An Autobiography 1932 [48]

III A 1. Land Use Plan

The site for an Appalachian House is an old farm on Glade Road inside the town limits in the western area of Blacksburg. For at least 150 years, this land has been used as a farm with an existing house that was built in 1850. My proposal for the future use of this land includes retaining its rural, agricultural character albeit with some developmental changes. The site now bears little resemblance to the forest it certainly once was, the swollen hills mostly denuded of arboreal vegetation, and swathed in a patchy meadow instead. The steepest slope of land rises abruptly on the south side of a small creek which slices through the property, flowing westward to join Tom's Creek a quarter of a mile downstream; it retains a stand of hardwoods — oaks, maples, hickories — and dotted about, here and there on the property, are other trees — Chinese chestnuts, locusts, non-native spruces, hemlock, a few very old maples, and a couple of fruit bearing varieties.

The original vision for this thesis was to establish an intentional community that could raise fruits and vegetables and wool for its own consumption, and offer for sale any excess of goods to the greater Blacksburg community. While it is still believed to be an appropriate use of the land itself, a community is seen to be more likely to develop through a natural evolution and cannot be effectively created by a single designer. James



An Appalachian House: Sketch for land use plan

Steele apparently agrees and writes in **Sustainable Architecture** [9] that "people, left to their own devices, are capable of self-regulation for the common good and instinctively seek a community if one does not exist." It is possible, however, to create a premise for such a plan, and the land use plan devised leaves open the *possibility* for the creation of a small community on this property if the residents so desire. It is also possible for a single family to develop the land as suggested, possibly creating a CSA (community supported agriculture) which typically involves many families buying "shares" and participating on a limited basis in the actual work of an agricultural enterprise.

As mentioned in the chapter on Blacksburg, the town has determined that the Tom's Creek basin, of which this site is a part, should remain rural/agricultural [11]. Subsistence farming, even with the addition of a small retail outlet for the sale of excess produce, fits well within the bounds of the Town's comprehensive plan. Little of the food currently sold in Blacksburg is locally grown and, as discussed in a previous chapter, small-scale farming is a desirable and sustainable method of agriculture for small communities.

In the Rocky Mountain Institute's primer on sustainable building, the authors point out that most of the food in the US is shipped an average of 1,300 miles and takes as much as ten times the energy to grow, ship and process as the food itself contains. They recommend edible landscaping surrounding homes using organic, permaculture methods *"that blend fruit and nut trees, grapevines, and other edible plants and shrubs with ground crops."* In their

Eco-Cities book [25], the Todds use a model of the forest to dictate the form of sustainable agriculture; they write that in a wooded landscape, the agricultural element will include annuals, perennial grains and herbs, soft fruit, livestock and trees, among others, adding that when the fruit, nut and fodder trees become mature, they will provide an economic base for the farm.

Initial plans for the Appalachian House site call for an overall scheme for the process of development, delineating certain areas of the site which are suitable for certain types of crops and not others. For example, the state's Virginia Cooperative Extension service in Publication 426-841 recommends orchard placement on the tops or sides of hills to avoid frost damage, unexposed to prevailing winds, and in soil with good fertility and drainage. On this site there is one area that meets these criteria probably better than any other, and it also is relatively close to the house site on a west-facing slope slightly above a small spring branch. There are similar requirements for small fruits (blueberries, grapes, raspberries) and VCE Publication 426-840 advises plantings that are in close proximity to the house for home gardens, making the south-facing slope an ideal location for these crops.

An Appalachian House: From site of house looking due south

Sugar maples, from which maple syrup is derived, are within their native range in this area of the Appalachians and it would be advantageous to promote their growth high on the hill at the southern extreme of the property where it would be inconvenient to grow other crops. In fact, the culture of these trees is compatible with the raising of sheep (for wool) which can graze around and beneath younger trees. A typical stocking rate in cool season permanent pastures in Virginia is two to three ewes per acre according to VCE Publication 410-366. The total area on which sheep (or other ruminants) can graze in the south pastures is about 20 acres.

The woodlot is an important aspect of this farm as it will provide an alternate heat source for the house on cloudy days, as well as the biodiversity necessary for a sustainable farm located in a forested region. (Fifty years ago J. Russell Smith emphasized trees as the foundation for restorative agriculture, say the Todds [25].) While it is unknown what the actual requirements would be, the needs of a 1500 square foot house can be estimated to be approximately 2 cords of wood per year for use as supplemental heat. Jim Clark, of the Virginia Department of Forestry, reports that for a fully stocked immature stand of hard-woods, the fuel yield is about a half a cord per acre per year; this brings the total necessary woodlot size to four to five acres. Managed correctly, in a sustainable manner, this can be achieved indefinitely, according to the forester.

Small-scale grain production is also reported by the Todds to be an essential element in a successional, sustainable farm. Backed up by the venerable Rodale Research Center and John Jeavons of bio-intensive

An Appalachian House: Site looking south/south

An Appalachian House: Site looking north

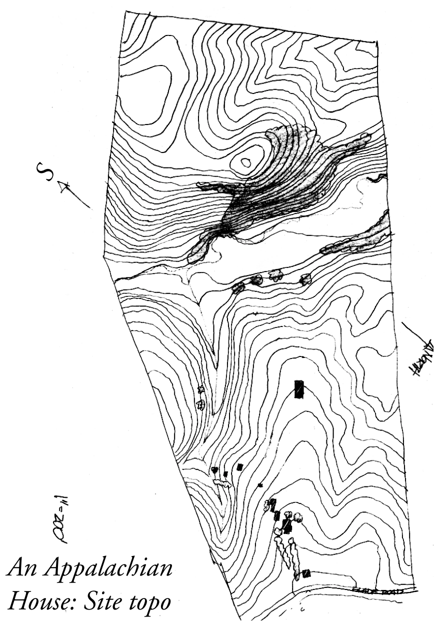
agriculture fame in California, they write that perennial grasses protect and enhance the soil while producing an annual crop of edible grains. The site has a several-acre flood plain area adjacent to the creek, which is suitable for growing grains, particularly rice, but would also accommodate wheat and rye. Jeavons has had success in his experimental gardens, obtaining the equivalent of fifty-two loaves of bread from a ten-by-ten foot plot [25].

Many of the crops mentioned require a maturation period, some for up to twenty years such as sugar maples and woodlot trees. It is expected that, in the interest of sustainability and posterity, these crops will be planted for long-term economic and ecological gain, and future generations, rather than for immediate use. Other crops, however, will have somewhat immediate returns such as small fruits and fruit trees which can bear in two to four years. In the interim, the production of grains, traditional garden vegetables, herbs and fruits, and sheep will provide some measure of support to a small family or several small families.

The cultivation of market vegetables, flowers and herbs is another possibility for income and would require building small commercial greenhouses on the property. The existing house and outbuildings, which are located close to Glade Road, and therefore accessible to the public, could house a retail center that would offer for sale whatever products came out of the farm. The proposed Appalachian House is located in the center of the property with no public access, removing it from a potential retail center.

It is intended that this plan provide some measure of economic and energy independence to the residents, but not create an island. It would become an integral part of the greater community of Blacksburg, in part by fulfilling the ideas set forth in the Comprehensive Plan [11], and then extending beyond that to offer services (such as locally grown food) to the town residents. It is a long-term plan that plants the seed *now* for sustainability in the future. Agriculture based on stewardship allows that the culture of our food will be more closely interwoven with the fabric of settlement, say the Todds.

In this design, the "settlement" would also be an attempt at sustainability through its architecture. On this site is the opportunity to create a dwelling that is compatible with the natural environment and the functions of living on a small farm in town — it is hoped without compromising the standards set forth in the development of the land itself. I believe that the essentials are comprised of a building which fits itself to its site and whose materials are consistent with maintaining the health of the local environment. In addition, the architecture should provide a certain space into which humans can easily care for themselves and their land. Kahn asked *"What are the elements of architecture that you can employ to make an environment in which it is good to learn, good to live, or good to work?"* Well, these all must be satisfied in a residential farm, and care must be taken to ensure ecological treatment of the land when housing ourselves; our buildings can achieve the quality of sustainability with which we steward our land.



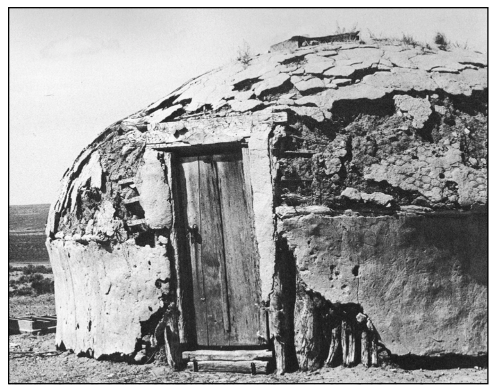
An Appalachian House: Site topo

"When you make a room out of a floor, four walls, and a ceiling, you will have besides those six things, a seventh as well: space, a thing probably more memorable than any of the physical elements that made it. Its creation, of course, is an illusion. You will not have made something out of nothing, only separated a particular part from the continuum of all space."

Moore, et al,
The Place of Houses [2]

III A 2. House

Several precepts have guided the design of this Appalachian house; one is that a building should be filled with nature; another is that nature should be substantially undisturbed or even enhanced by a building's presence; finally, a building should allow its human inhabitants to be the vehicle for a dialogue between it and nature. Marc writes that by building a house, humankind made a clear distinction between heaven and earth and between inside and outside. *"The house,"* he says, *"is the temporal nucleus where man asserts his earthly condition." [7]*

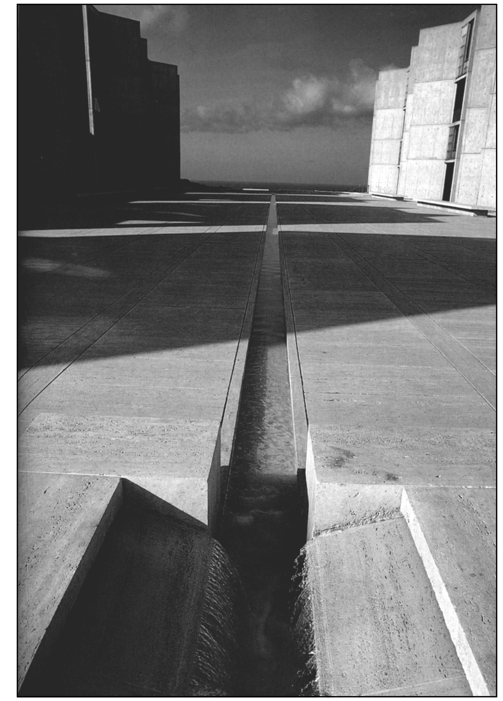


Navajo hogan [9]

While these distinctions may be present, the house also provides an assimilative structure into which humans become not just observers of the differences, but constant interpreters. Our relation to our immediate environment is most apparent and relevant and influential in our homes. Marc believed that the psyche is influenced by its natural environment and appears as a product of nature, *"a subtle form of life... Human types are thus the products of soil and climate in exactly the same way as vegetation and animal species."* [7] Human architecture arises from these same conditions, providing both a mirror to its environment and a haven from it. This design responds to the challenges of existence through the construction materials and their manufacture, the house's seating upon the land, the roof's profile against the sky, the arrangement of space delineated by the walls of the house, the compliance with the natural laws of the region.

It goes beyond these, too. It is a dwelling, as is all architecture for the living, and, as Le Corbusier observed, humans are the content of architecture [49]. Marc has accused modern architecture of providing the container *without* content. The architects writing in **The Place of Houses** [2] believe the places in which we live should nurture our dreams. They say that, through architecture, everyday life should be infused with imagination, allowing for the everyday to become exceptional and leading one's mind to multiple associations. *"The expression of dreams is accomplished by transmutation, developing the dream so that only its essence remains..."*

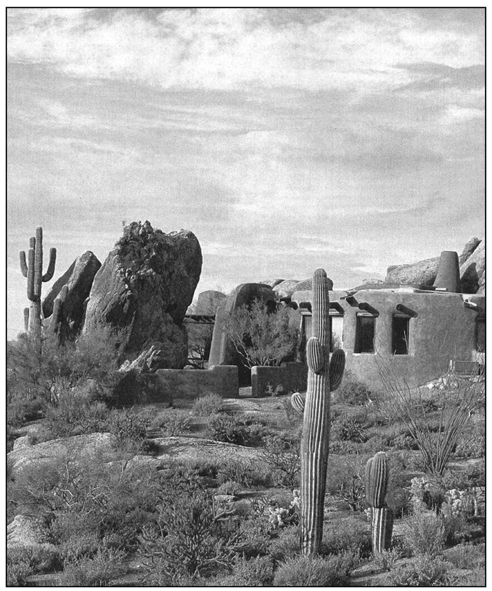
Juhani Pallasmaa has said the *"home is not an object, a building, but a diffuse and complex*



Kahn's Salk Institute [10]

condition that integrates memories and images, desires and fears, the past and the present." [50] He believes the essence of home is a mirror and support of the inhabitant's psyche that is revealed more through poetry, film, painting and writing than through architecture. He asks, *"Can a home be an architectural expression?"* In his view, no, the home and house are distinct; the house or dwelling is the container for the home — which is a collection and concretization of personal images that remind us of who we are. Joseph Campbell insists we all need a sacred place, which can be extrapolated to mean "home." *"This is an absolute necessity for anybody today,"* he said. *"This is a place where you can simply experience and bring forth what you are and what you might be. This is the place of creative incubation." [51]*

In this region of softly rolling hills and tree carpeted mountain ridges, the land begs for architecture that reflects the fluid movements of these graceful geographic features of Appalachia. It is for this reason, in part, that this design is settled into the hillside on a south-facing slope to capture the sunlight and breezes for natural winter heating and summer cooling. The materials are reflective of the locally available resources in the region. The forms are extracted from and compatible with the natural structures in Appalachia, from the tiny cone of the giant eastern hemlocks to the segmented body of crayfish.



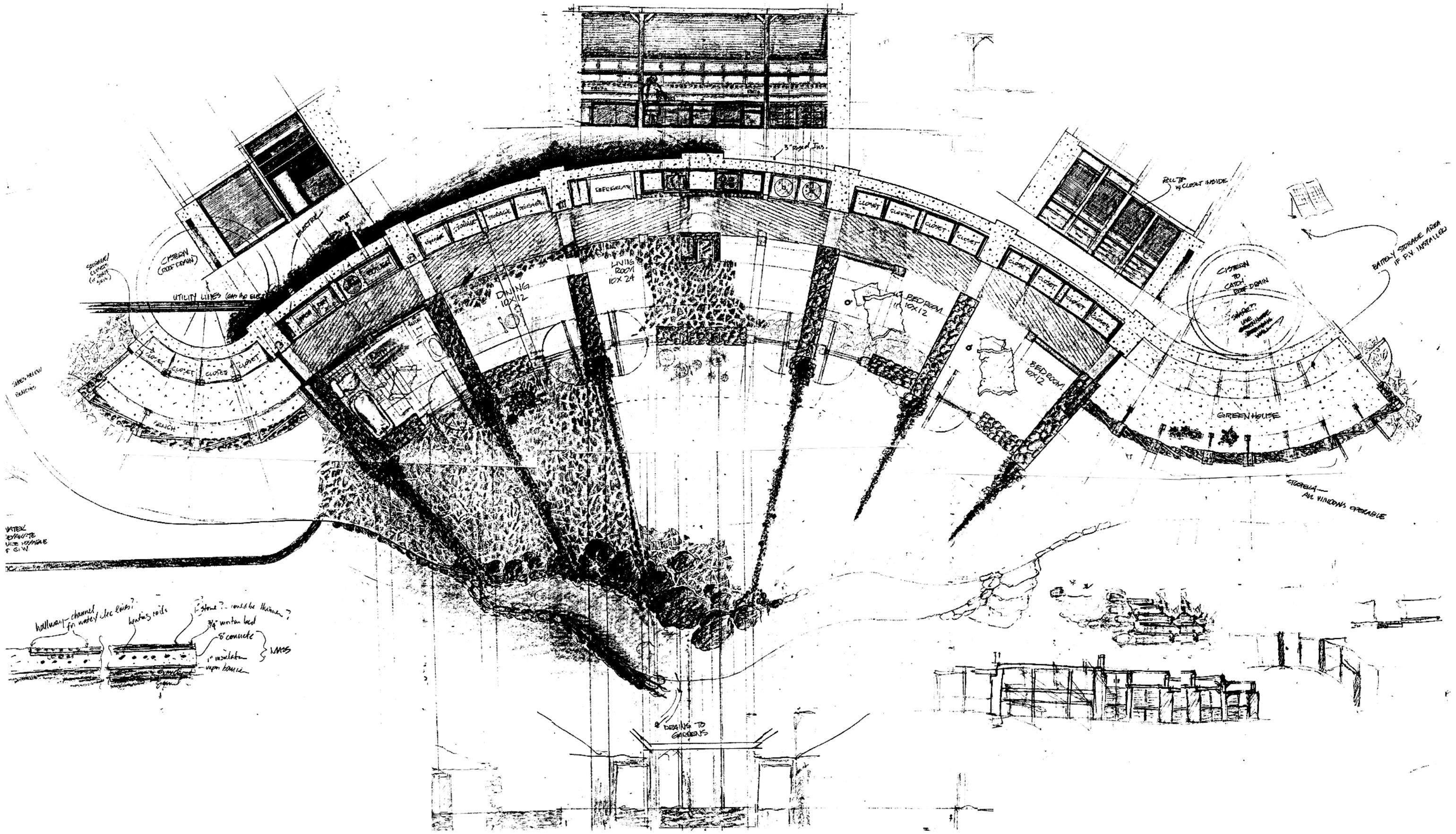
Sonoran Desert house by Charles Johnson [5]

Of primary importance in the design is the environment, which, after all, is the thing that necessitates humans living anywhere other than in the open. It also informs *how* we live "inside." In **The Place of Houses**, [2] the authors write that the place one lives *"should incorporate changing conditions of environment, of light, heat, air, sound, so that... everyday rituals can be surprised by the exceptional conditions."* There is some evidence to support the idea that how we interact with our living environment is actually crucial to our well-being. In **Shelter** [52], Rene Dubos writes in his essay "Shelters: Their Environmental Conditioning and Social Relevance" that *"perfect adjustment to environmental temperature and humidity may not provide sufficient stimulation for the full development of human potentialities. Our bodies and minds possess remarkable mechanisms for adaptation to environmental changes and are indications that adaptive responses to environmental challenges commonly have creative effects and contribute to a sense of well-being."* Further, he argues that some geographers and historians, including Arnold Toynbee, believe that civilizations arose due to adaptive responses to environmental challenges, such as pronounced climatic changes that stimulated without overpowering human adaptive mechanisms. (As an example of a successful human adaptive response, Dubos notes the reliance of pretechnological civilizations on thick-walled structures, perhaps for fuel economy, fire retardation, resistance to storms, earthquakes and floods, and desirable acoustic and thermal qualities.)

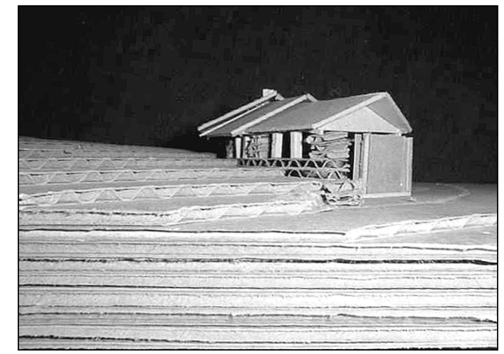
Wright's Hanna house interior [11]

The materials of the Appalachian House and their orientation are located in response to their surroundings, and also will allow an honest interaction with existing environmental conditions. The stone on the south side of the house, for example, gets warm as the sun shines on it, and holds the heat long after the sun has set. Large areas of glazing allow natural light in, and the heat of the sun to penetrate and be stored during winter months in flooring materials like stone, ceramic tile and concrete. Operable windows let breezes course through the building, while roof overhangs provide shading to keep the interior cool in summer. A timber frame roof structure utilizes an abundant renewable natural resource of the region, while providing a more fire resistant structure than the more typical light frame construction. Thick stone walls eliminate the need for additional insulation in many areas of the house. All rooms of the house are oriented with a southern exposure and direct access to the outdoors. Backup heat sources also rely primarily on local natural resources.

Some of the most successful examples in modern American architecture of environmentally responsive homes are the Usonian houses of Frank Lloyd Wright [53]. Wright believed that external changes in temperature work to "tear down the human body" in much the same way as they tear down a building. John Sargeant wrote that for Wright *"this factor was viewed as an opportunity for*



An Appalachian House: Early sketch of the plan of house



An Appalachian House: Model showing placement into hill

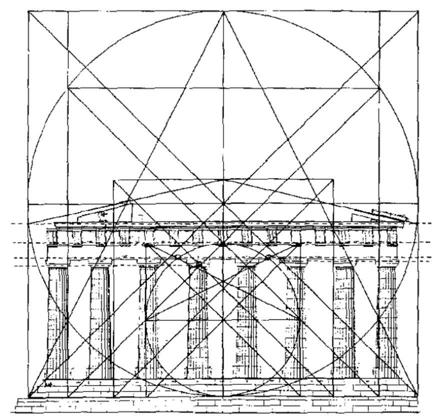
Wright's Jacobs house [12]

design to work with natural conditions, indeed to express them." In **Usonia** [54], Alvin Rosenbaum reveals that Wright's integration of site and structure were fundamental to his principles of organic design. Wright's well-known views on organic architecture began with the very basic premise: *"Architecture and acreage together (were) landscape... We seek beauty of landscape not so much to build upon — as to build with."* In his Usonian houses, Wright attempted to create homes that work with the climate to produce comfortable

Wright's Jacobs house [12]

conditions by using natural means. (He was, therefore, opposed to "air conditioning.") His Usonian houses embodied the indoor-outdoor qualities of organic architecture, glorifying nature through the least invasion of the soil; they were small, but open and spacious places with access to outdoors from most rooms. Although generic, each individual Usonian house was reflective of its locale and site. (Wright's utopian vision for America was extended from his house designs to a large, unrealized plan for Broadacre City, an integrated, cooperative, community where design commingled with nature and spiritual harmony was integrated with material prosperity across an unspoiled landscape, writes Rosenbaum.)

This Appalachian house design incorporates some of Wright's ideas, and in particular, the form has been borrowed from the arc of his solar hemicycle that arches into the hillside with a bank of solar glazing facing the south. The south-facing aspect was deemed critical in this design, as it is a primary source of warmth in winter and natural lighting year round. Where the Jacobs' house is bermed to the north, this one is



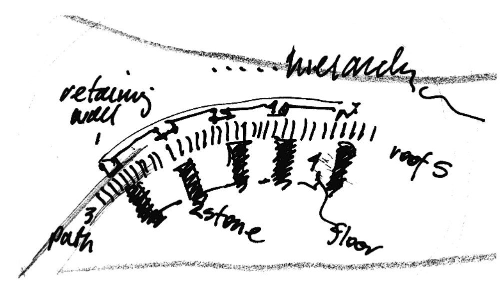
Geometric analysis of the Parthenon by Tons Brunés [13]

An Appalachian House: Model roof

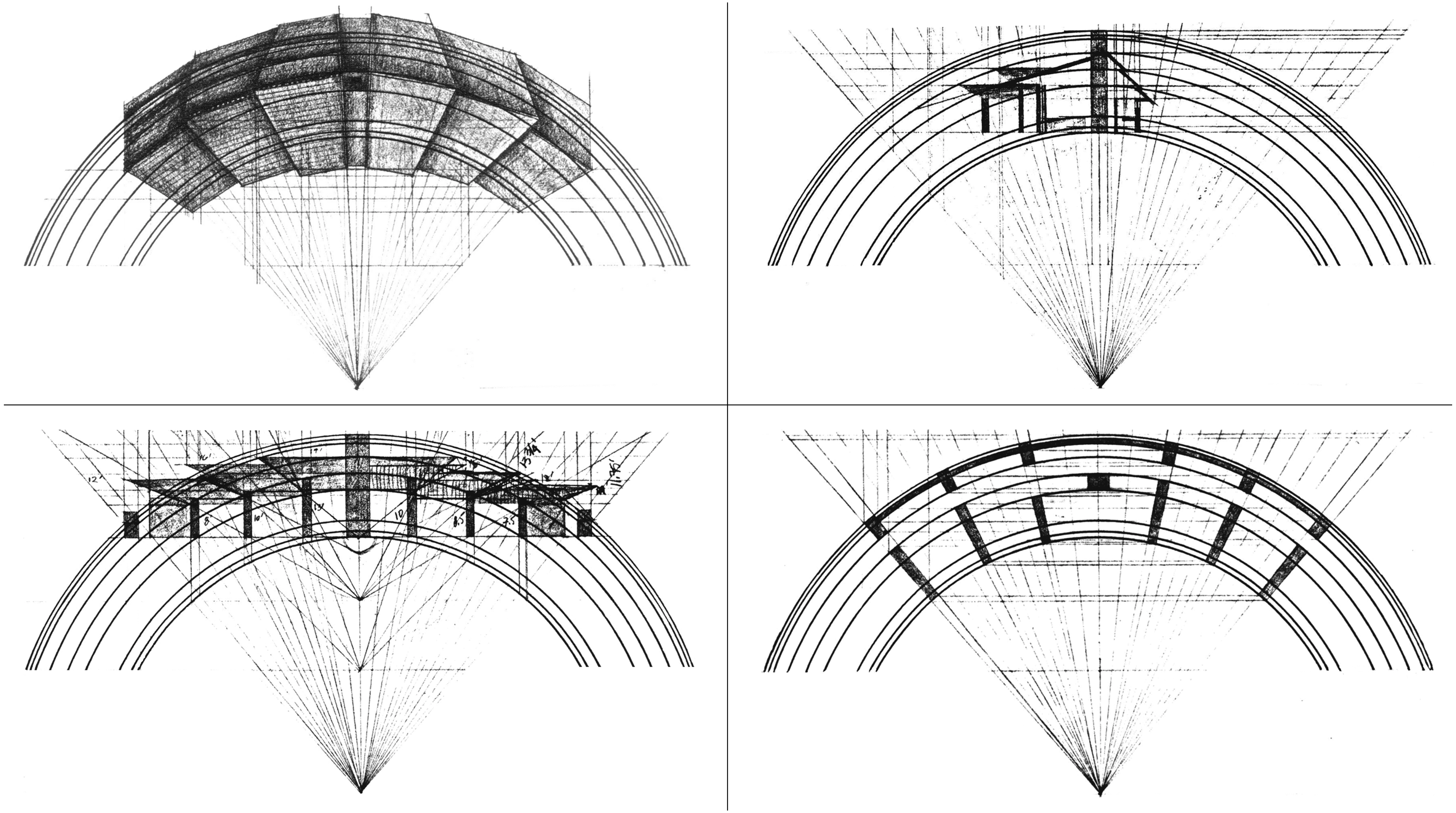
settled into the hill, merged with the land and also surrounded by it.

The shape of arc is derived from one of what Marc calls the four archetypal signs (square, circle, cross, triangle) — the primary elements of architecture [7]. (The complementary elements to architecture, he says, are the spiral, wave and dot.) The arc is swung out from a point on the land where water is collected from runoff from the house to wash the fields below it. It consciously stresses a central point, as Van Eyck has pointed out in reference to his own projects, by establishing a spatial hierarchy and subordinating all else around it. From within the house that curves around this point, it clearly allows a point of rotation to a wider landscape, offering a place of stability. Schoenauer, in **History of Housing** [55], wrote, *"The concave shape is womblike and maternal: it invites, harbors, shelters, and the concave circular plan is an 'intuitive' form, in sharp contrast to the square and rectangular forms, both of which are rationally or intellectually devised."* This house, however, is also somewhat rectangular or trapezoidal in that its expansion occurs radially about the arc segment, causing a curvilinear space within. It is this curve in fact which establishes the hierarchy of the plan.

Another example of environmentally responsive architecture is the Magney House on Bingie Point, Moruya, Australia [56]. Glen Murcutt, like Wright before him, created a home in response to the existing conditions of the site, and the desire of the clients to preserve the light-roofed sense of being under canvas (as in a tent). The house has a linear arrangement, oriented towards the sun at due north, with the roof extended above and



An Appalachian House: Plan hierarchy



An Appalachian House: Proportion studies beyond the fully glazed surface, clipped at the equinox cut-off angle. The bottom glazing has external adjustable metal blinds (the upper clerestory glass is unprotected) allowing for full-day winter sun, no penetration of summer sun, and access to dramatic views of lake and coast. Economical water collection

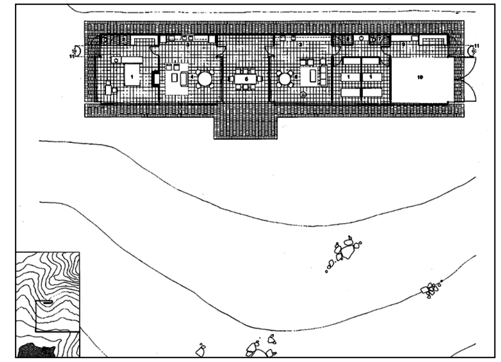
Murcutt's Magney house blinds [14]

was achieved with one main gutter forming a roof valley between the north-face living spaces and the back, south-face servant areas, ushering the runoff to two large drain pipes at the east and west ends of the house. To provide warmth on cool winter nights and protection from wind, the house sits atop an insulated slab on grade that acts as a thermal heat sink, along with the south, back wall which is constructed of brick. Finally, Murcutt produced a sculptural response to the landscape's folded forms, with the roofline arching up to gently caress the house beneath its giant wings.

While addressing the local or immediate environmental concerns here in Appalachia, it was also important to look at the materials of construction, preferably using locally available ones when possible, and ones that are produced in a sustainable way. In **Sustainable Architecture** [9], James Steele discusses some of the more prevalent materials used in modern construction and their effects on the environment. For example, concrete is a huge energy guzzler and air polluter; producing just the cement element of concrete uses approximately 6 million BTUs per ton of cement, and producing 76 million metric tons of finished concrete generates 9.8 million metric tons of carbon dioxide. Of course, concrete has many advantages (high thermal mass, fire resistance, low maintenance, etceteras), but people tend to use it as though it were environmentally cost free. Nevertheless, —benefits outweighing drawbacks — this design uses an eight-inch concrete slab beneath stone as a thermal mass. Aluminum (siding, window frames, insulation) is made from a limited natural resource (bauxite ore) which is obtained from strip mining, and its manufacture requires high energy; however, it is recyclable and many aluminum products contain up to 100% recycled content. Plywood, a mainstay of modern construction, also requires high energy consumption to manufacture, using toxic glues and resins; interior grade plywood often is made with blood adhesives, which is additionally offensive to many vegetarians. The most energy intensive of all construction materials, according to Steele, is steel; we must mine five times the material (iron ore, coal, limestone) than the ore retrieved, and it is done usually in open pit mines; most steel, however, is now made with recycled materials.

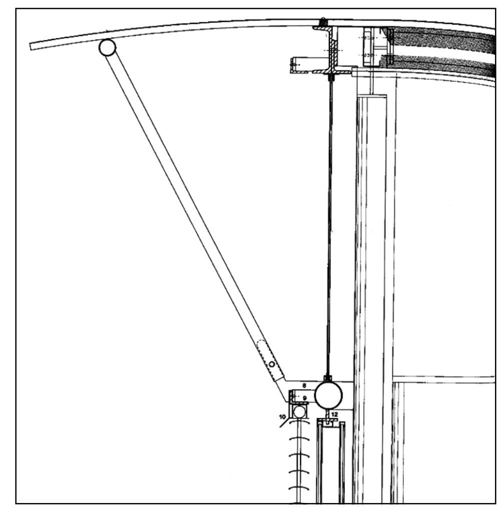
Murcutt's Magney house [14]

This Appalachian house design incorporates as little of these materials as possible, relying instead mainly on local stone, whole timbers, glass and concrete. In the **Sustainable Building Sourcebook** [57], a compilation of "green" building techniques and materials published by the City of Austin,

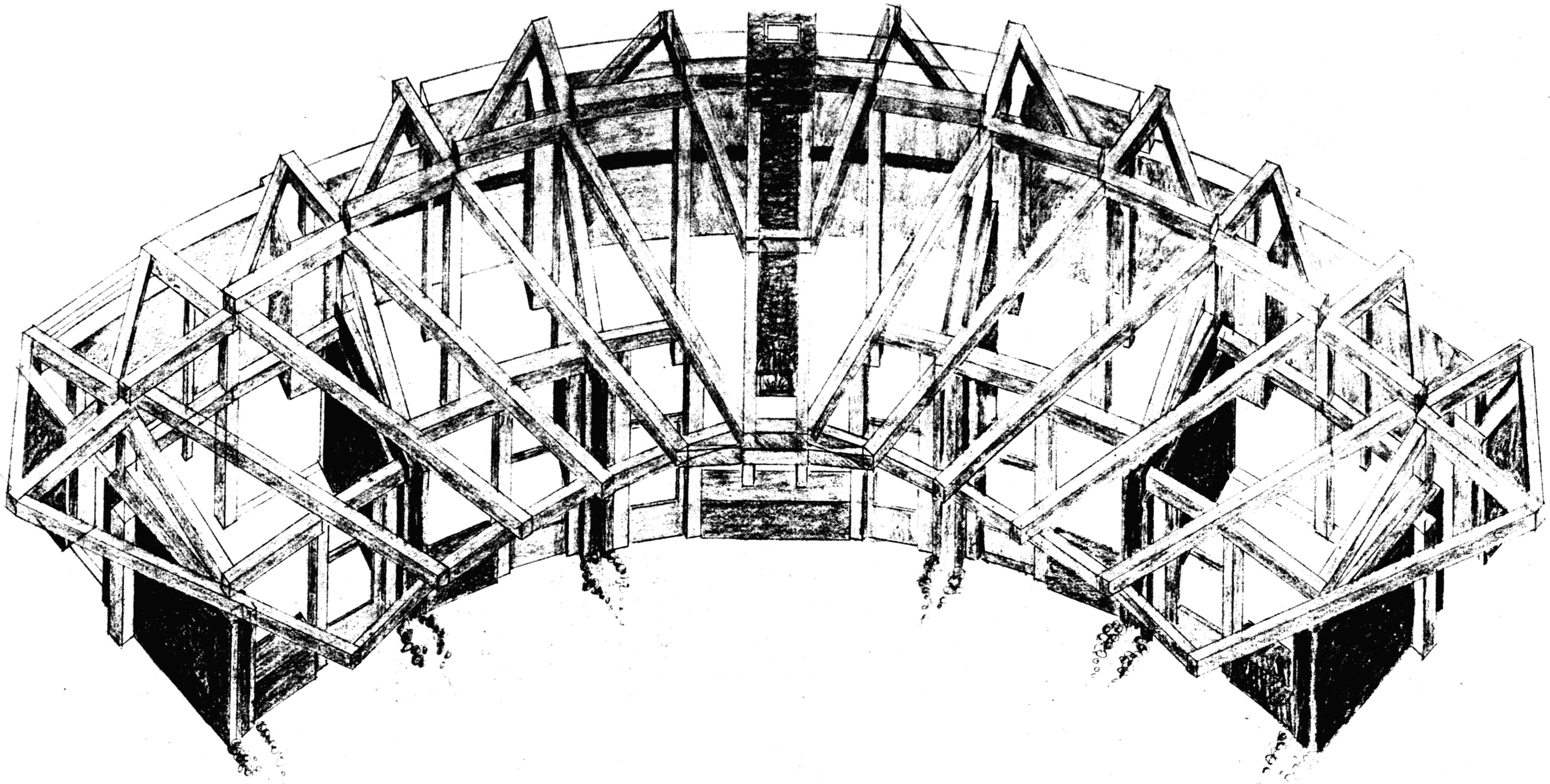


Magney house site plan [14]

Texas, these and other construction materials were reviewed such as foam insulation and roofing materials. Basically, materials were sought that have a lesser environmental cost initially in their manufacture or harvesting, and also require little or no maintenance



Magney house roof section [14]



An Appalachian House: Large timbers frame roof of house throughout their lifetimes, but also that do not require sacrificing the design. These include materials that are grown, made or manufactured within the region, thereby reducing transportation costs, and hence the emphasis on "local."

Glass, an essential element of this design, is produced from another abundant natural resource — sand or silica. Its manufacture requires high energy, but many consider its long term benefits to outweigh the cost of production. It is manufactured relatively close to Blacksburg in West Virginia, so transportation costs are minimized, and it is a recyclable material.

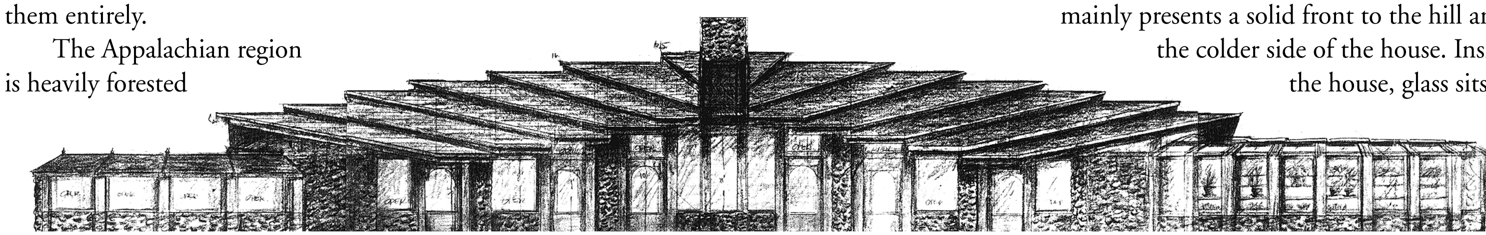
Insulation is a major concern for both sustainability reasons and energy efficiency. This design requires insulation in the roof and north wall of the house that is submerged in the soil. Perhaps one of the most benign materials would be perlite; it is non-flammable and chemically inert, and is derived from a naturally occurring volcanic mineral. It could be used as loose fill in the wall and in sheet form in the roof. Cementitious foam is also a possibility, although transportation costs would be a factor as it is derived from seawater, and therefore a fairly distant material to the Appalachian Mountains. Another choice is cotton insulation, also known as agricultural fiber insulation, made from low grade, recycled, mill waste cotton, including recycled blue jeans; it is available in batts similar to fiberglass batts, and is treated with a fire-retardant. Wool is also available as an insulation material. Additionally, work has been done using clay as an insulation infill material, usually mixed with wood chips or some other fiber.

There is probably no way around the use of plastics as vapor barriers in the north wall and roof — all the sources used on sustainable building products simply don't mention "green" vapor barriers; this could be due to the fact that there are no or few publicized alternatives now to such systems as Enkadrain and Tyvek (which might even be relatively innocuous, but no information was available). Also, the end goal is to minimize the use of non-sustainable materials – not eliminate them entirely.

The Appalachian region is heavily forested and so provides a plethora of timber, which can be harvested in a sustainable way, although under many circumstances it is not: clearcutting is unfortunately still practiced in the area. The region also provides an abundance of stone. In **This Rock Is My Home** [58], Werner Blaser writes *"Stone and timber are the materials which provide (humans) with the widest opportunities for shaping (their) environment. And this still holds true today in this age of synthetic materials, at least in a region where stone and timber are plentiful."* In our region of Appalachia there is a lot of slate and schist, both metamorphic rocks good for building, according to Ken Kern in **The Owner Builder's Guide to Stone Masonry** [59]. He says they are both good or better in water absorption resistance, insulative quality, mechanical strength, durability and possessing few impurities that would weaken the stone. Other local stones are also suitable: quartzite, another metamorphic stone, has poor insulative value but is good in other areas; sedimentary rocks include sandstone, dolomite, shale and others, and are useful in some types of construction; limestone, too, has a poor water absorption resistance rating and poor insulative qualities, but is strong and somewhat durable, says Kern. Sites near Blacksburg on Brush Mountain provide a close source of stone that can be removed from the surface of the ground (flag and fieldstone). The area also has many quarries for cut stone, although the overextraction of these materials causes unsightly blemishes on the landscape.

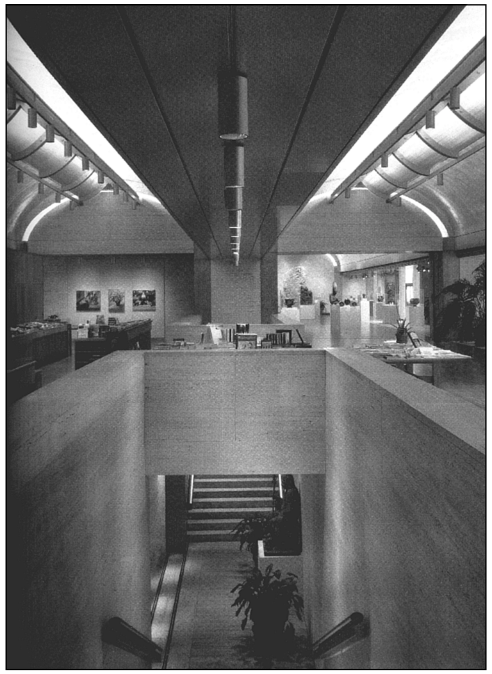
In this design for an Appalachian house, the stone is laid to become walls that radiate from a point removed from the house itself. It is also the floor, resting on top of a thick concrete slab; together the stone and concrete form a thermal mass to prevent overheating and large interior temperature fluctuations. The mass of masonry will store some of the heat gained during the day, releasing it slowly during the night.

The solar windows are almost continuous along the south wall, and smaller windows punctuate the east and west walls within the doors. Along the north wall, which is mostly immersed in earth, is a narrow band of windows which admits some north light, but mainly presents a solid front to the hill and the colder side of the house. Inside the house, glass sits



An Appalachian House: Early sketch of south face atop the walls separating each room and separating the hallway from the rooms. Small windows tucked under the eaves where the roof changes in elevation also admit diffused sunlight. These conditions all allow the light to completely infiltrate the house.

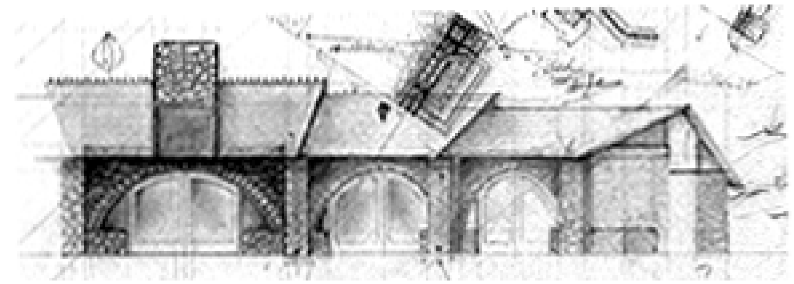
Perhaps obvious in this design is that light becomes an important element. It is not just heat, but another material as well — energy resource as well as visual aesthetic. Kahn said, *"The sun does not realize how wonderful it is until after a room is made. A (human's) creation, the making of a room, is nothing short of a miracle. Just think, that a (person) can claim a slice of the sun."* [5] He also spoke of the character of light, which alternates with the tones of space, perhaps high and narrow with graduating light to darkness, so that a vault or a dome or a column are all choices for a character of light.


Kahn's Kimbell Museum [15]

Kahn claimed a slice of sun in the long vaults of the Kimbell Art Museum and wrote of the experience: *"And the cloud that passes over gives the room a feeling of association with the person that is in it, knowing that there is life outside the room... So light, this great maker of presences, can never be... brought forth by the single moment in light which the electric bulb has. And natural light has all the moods of the time of day, the seasons of the year, (which) year for year and day for day are different from the day preceding."* [60]

On a very practical level, the windows must perform. For instance, the windows on the north side of the house can be useful — deep but shallow-in-height, and so could function as coolers for food — an alternative to electric refrigeration. Michael Reynolds points out in **Earthship III** [38] that this is an old method of food storage that uses lack of solar gain on north glazing, the cooler air infiltration through the glass, and some type of interior shutter to insulate from the warmer inside air of the house.

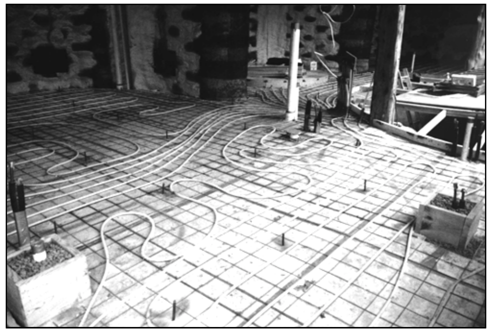
While the windows allow a certain aesthetic in the building design, they are also functional as the receptors of the sunlight on the south side. Because of this, there are some requirements that facilitate the relationship of glass to mass. In the **Passive Solar Energy Book** [36], Mazria recommends that in temperate climates the floor/glazing ratio should be .16 to .25 (square feet of window needed for each one square foot of floor area). This figure is for Dodge City, Kansas, the location also used for the *Energy Scheming* analysis, which is at the same latitude as Blacksburg (Lat 37° 46°N). The following chart illustrates the ratio for this house, which gives an average of .267. It is slightly higher than the recommended values; however, this is offset due to the larger amount of thermal mass present in the design's floors and walls, which can store large amounts of heat. It should be noted, too, that in Chapter III D. there is a discussion of the computer program *Energy Scheming*; the design was run through the program that takes into account this ratio as it analyzes the design.


An Appalachian House: Earlier sketch of south face of house

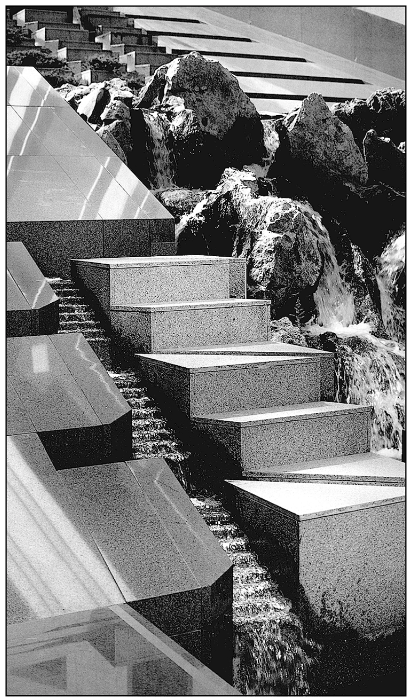
Also, in the parameters set for *Energy Scheming*, energy efficient window systems (i.e. double glazing with low-e coatings) were used which usually have the added benefits of lower sound transmission qualities, reduced UV transmission into the building, and are cooler in summer and warmer in winter.

On cloudy days and at night, supplemental heat is a practical necessity in a passively heated solar building; this house has two: a hot water radiant floor system throughout the house, and a woodstove. The success of radiant floor systems is well known, from

dimension glaze	glazing area	dimension floor	floor area	ratio glaze/floor
12 x 5	60 sq. ft.	12 x 12	249 sq. ft.	241
12 x 6	72 sq. ft.	12 x 12	249 sq. ft.	289
22 x 7.5	165 sq. ft.	22 x 16	552 sq. ft	299
12 x 6	72 sq. ft.	12 x 16	270 sq. ft.	267
12 x 5	60 sq. ft.	12 x 12	249 sq. ft.	241



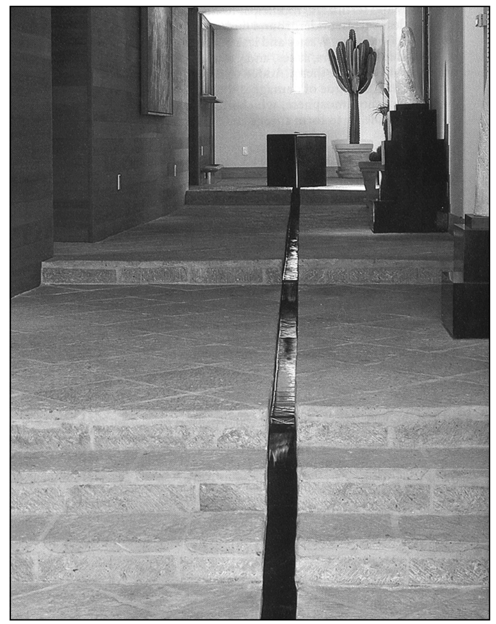
Floor coils in Batesville, Virginia, Earthpod, courtesy Fred Oesch



Urban water path [16]

Wright's pioneering use of them in the Jacobs' solar house to Mies Van der Rohe's implementation of one in the Farnsworth House. In using an airtight woodstove (with a catalytic converter to reduce pollutants) for supplemental heat, according to **Mechanical and Electrical Equipment for Buildings**, [33] the areas that "see" the stove will get most of the benefit since radiant heat is the dominant form of heat output. However, "circulating" stoves convert a larger portion of their heat to convected heat, which produces a layer of hot air at ceiling level. By providing a path between rooms at the ceiling, this hot air will slowly spread throughout a building. The more thermally massive the ceiling construction, the longer it will store and radiate heat from the warm air mass. In this design, the walls between rooms have an operating glass transom at the top that allows both air and light to pass, but minimizes the transmission of sound, although not simultaneously.

Water, an essential part of the overall design of this house, became an especially important element when designing the drainage off the roof, and also the collection was important to the conservative livelihood of the inhabitants, it's movement essential to the life out-of-doors. It is a basic ingredient of sustaining life in this house and a sustainer of otherworldly qualities that could be called dreams and magic. Water image in mythology, according to Joseph Campbell, is intimately associated with the mythological universal motif of birth, and death, representing also any threshold or passage such as that from light to darkness, from childhood to adulthood, birth to death [8]. In some myths water is a vehicle of power of the goddess or other guardian of water who personifies the mystery of the waters of birth and dissolution, also representing water's life-furthering or life-threatening aspects.



Indoor stream in desert house [5]

Moore and London say that moving water can represent life; still, it can signify death; captured in pools and reflecting light, water connects the infinite and the intimate.

Murcutt's Magney house roof drain [14]

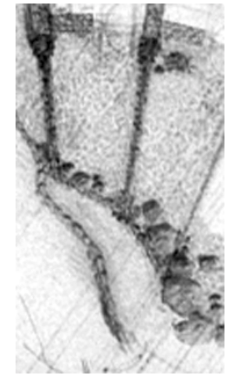
In Charles Moore's dissertation at Princeton University, **Water and Architecture** [61] he wrote, *"Architecture is an intermediary that negotiates connections or separations between people and water, communicating sensory clues through forms and materials.... Our two principles for the use of water in architectural composition, then, are first: that its movement should seem to bring it from, and then take it to, great, or even infinite distances; but that when in its cycle it comes opposite us, the contact should be intimate; and second: that its movement must be composed in our time, but should suggest a natural time beyond our own. With these principles, we should be able to create some specific designs, to use water in architectural composition."*

Moore also wrote, *"Water is a natural material with an unchanging identity, wherever it appears in architecture or nature... Its use in architecture should reflect the attitude about the natural world held by the people who design, construct, or inhabit the building.... At the end of our millennium, we are faced with the dilemma of balancing human needs with respect for nature. If water is being used neither much nor well in our own architecture, then surely some of the difficulty can be traced to our confusion over what sort of attitude toward nature we are trying to express. Yet if we can effectively incorporate water's symbolism, history, and physical nature, then our water and architecture can have potential for wonder unmatched by any other material that we can include in our environments." [62]*

Flowforms to carry and purify water (Waterforms, Inc.)

In arid Australia, Murcutt often exploits water as an animating element, using it to vitalize his buildings. He creates what Philip Drew in **Leaves of Iron** [63] called *"receptors of the sky's delicate tears."* In the Magney House water is an essential material used to generate the design for the two wings of the roof that slope to capture rainwater. Several of his farmhouses incorporate water storage tanks into the character of the houses. In the Short farmhouse, Murcutt connected a linear, horizontal water link from the house to a dam. The Kempsey Museum has enlarged cylindrical drainpipes with helical seams that swirl the water to the ground. Murcutt says about water, *"look, that is something precious and I wish to attach a certain importance to it." [56]*

In the Appalachian House, the roof accepts water and guides it on the north side to cisterns on the east and west sides; on the south side, vertical channels funnel the water from the roof down to small pools, which in turn allow it to flow through shallow horizontal channels along the patio and into a larger pool; from there the water is dispersed and directed towards terraced gardens. In this design, the Appalachian House both collects water for use and uses it as a design element. It is allowed to behave, as Donlyn Lyndon writes in **Chambers for a Memory Palace** [64], like everything else that *"seeks the center of the earth, but being slippery and mindless it shimmers across and around impervious material until it reaches its own in the ocean or in vast subterranean aquifers. ... all water systems depend on the simple proposition that water, domesticated or not, yearns for the sea.... (Water) makes such a potent and ubiquitous element of design — whether tracing through roof slope, gutter, and downspout, bubbling out of faucets and fountains, or shaping the slope of the land."*



An Appalachian House: Water paths leading to collection pond

Moore also tells us in **Water and Architecture** [61], *"every drop of water on the planet takes part in the water cycle. The cycle guarantees that all water is connected in a continuous global chain, so that water never remains an isolated incident and never exclusively belongs to any specific time or place. Even the tiniest drop of water shares a heritage with the greatest ocean."* He relates the words of architect Nicola Salvi, designer of the famous Trevi Fountain (completed in 1762) in Rome: the fountain *"shows the essential mobility of water, which never ceases in its operation and is incapable of ever remaining still, even for the briefest moment."* Moore says of the fountain, *"With a relatively small amount of water, all the world's water is called to mind, and it is water that provides the lifeblood for meaning in architecture."*

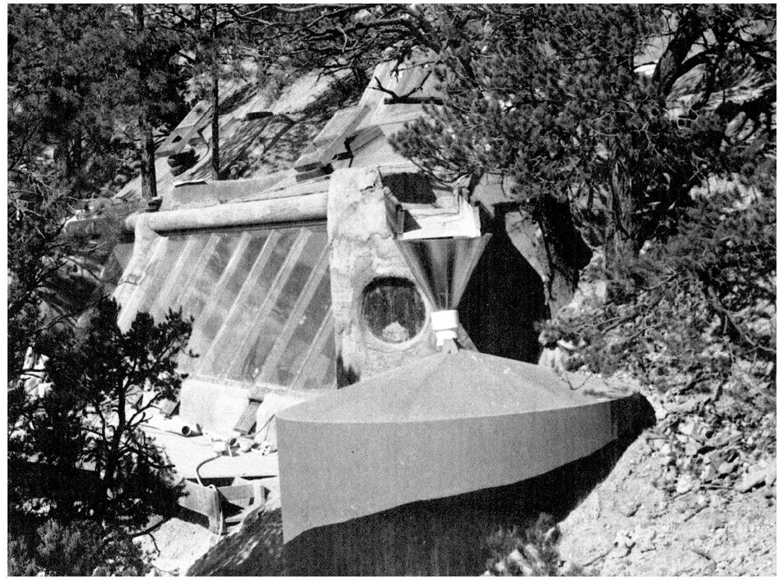
There is a practical side to water, too. For example, the collection of water for domestic use is emphasized in architect Michael Reynolds' Earthships, most of which are built in arid regions of the country [38]. Many of his homes incorporate cisterns, which have bottoms that are slightly raised above the floor of the house thereby using gravity to provide pressure and delivery of the water to the dwelling. Reynolds also recommends the construction of a reservoir above houses built on a sloped site to catch the run-off from the hill, but such a system requires additional filtering, possibly even for bacteria. The bulk of the water from the roof of this house will come off the south-facing roof and will also be collected, but for use in exterior gardens and landscape design elements.

A solar batch water heater can be incorporated into the Appalachian House design near the entry to the house; it is located adjacent to the bathroom so would require minimal piping. Reynolds suggests that installation of a tank can be perpendicular to the winter solstice sun for maximum winter performance as summer hot water can be at a lower temperature to be comfortable [38].

As a backup to the batch heater, a gas-powered demand hot water heater can be installed; these small (18x13x36") wall mounted units are placed about three feet off the floor, and vented through the roof (8" diameter hole). This small system can be combined with the batch heater so that the individual hot water sources are valved together into the same line.

Reynolds advocates the use of greywater systems for houses, separating the blackwater, or sewage/toilet water, from the apparently useful, relatively innocuous waste water from all other sources in the house (such as bath-tub, washing machine, kitchen sink, bath-room sink) [38]. In Virginia, there is no distinction made between blackwater and greywater and so it is illegal to use the greywater without first treating it, according to Clare Zaronsky, environmental health specialist for Montgomery County. The treatment is the same as that for blackwater, so most systems combine the two types of water.

Because the Appalachian House site is more than 200 feet from the town sewer lines, it is possible to have a variance from using the town sewer system and use instead a septic system on the property; there is plenty of space on the west side of the house for a drain field that is more than the minimum 50' required distance from the creek and contains no trees. As it stands, this two-bedroom house is gauged to use 300 gallons per day of waste water and requires a drain field consisting of four 75-85' lines on 9' centers. (In Reynolds' Earthships, even the septic tanks are con-structed with recycled beverage cans.) At some future time, it might be useful to actually design a greywater treatment facility on the property using an Aeration Treatment Unit (ATU) where the waste water is passed through a series of tanks and filters, and possibly using a constructed wetlands for further filtration. As an alternative to these methods of dealing with waste, there is the composting toilet, which Reynolds says, *"believe it or not, are developed to the point that they work well and do not smell." [38]*



Reynold's Earthship cistern [17]

Obviously, many elements go into the making of a house. Some, such as materials like timbers and stone, are known entities and have been used for construction for thousands of years. The effects of putting these elements together in certain ways are not always as well known. The computer program "Energy Scheming" takes the materials, orientation and design of a building and then produces a simulation of that building's energy needs, uses and results.

Chapter II A 4 discusses the use of the computer program Energy Scheming to perform an analysis of the Appalachian House, and also presents a comparison by American Electric Power of relative electricity consumption between the Appalachian House and a "typical" house in the area.

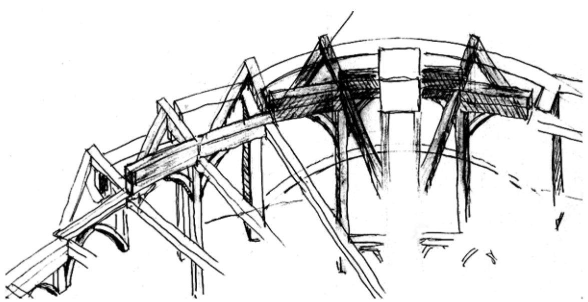
Sustainable Features

Overall, the Appalachian House incorpo-rates many features that are considered sustainable. In review, some examples include the use of local materials to save transporta-tion costs; the use of double-pane low-e glass to facilitate the efficient collection of solar radiation inside the house; the construction of a large thermal mass to store heat from the sun during the day so that it can be slowly released through the day or night to save on commercial power consumption; a green-house provides a place to grow food and possibly store batteries for active solar collectors; the installation of efficient supple-mental heat sources, particularly the woodstove that uses a renewable resource; the collection of rainwater for use in gardens and greenhouse; the efficient use of space and relative small size of the house; the durable construction materials of the house floor, walls and roof; and ultimately the use of solar and geothermal heat to make the house a comfortable place to live.

Other features could also contribute to the sustainability of the Appalachian House, such as the use of efficient lighting systems and fixtures, energy conserving appliances (refrigerator, hot water heater, washer, stove, etc.), water conserving fixtures (toilet, shower head, sinks, etc.), and non-toxic materials in the insulation or roofing materials, for example.

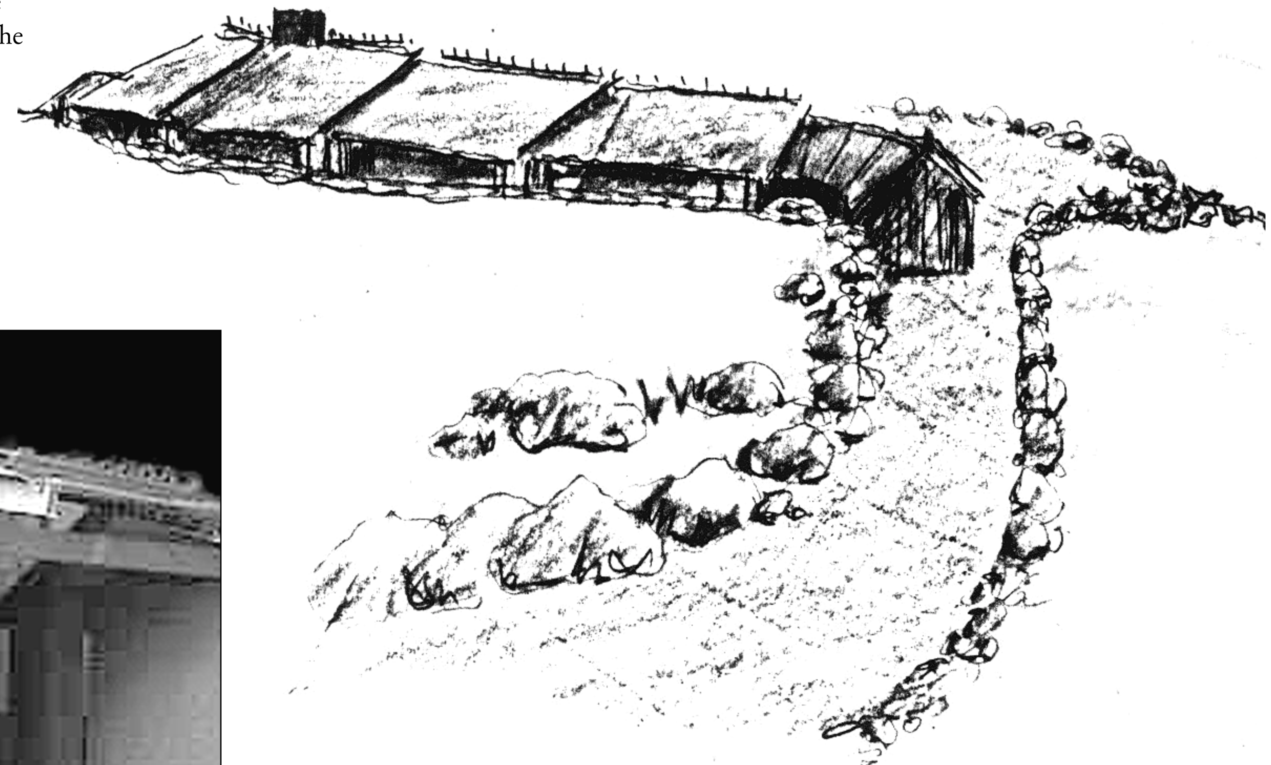
"Only after the last tree has been cut down, Only after the last river has been poisoned, Only after the last fish has been caught, Only then will you find that money cannot be eaten."

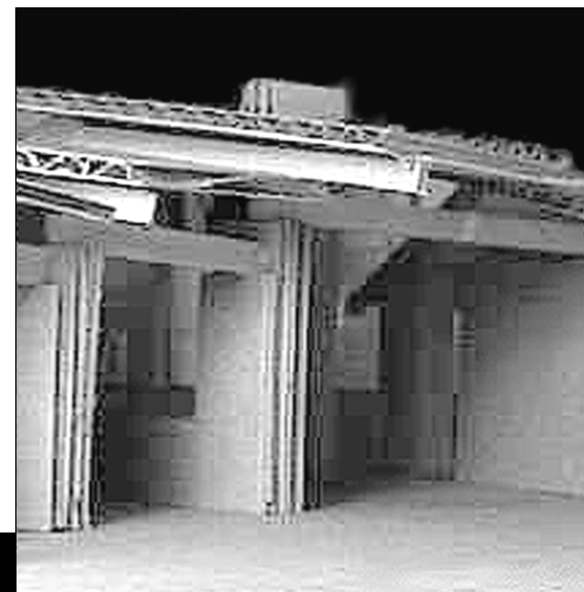
Cree Indian Prophecy



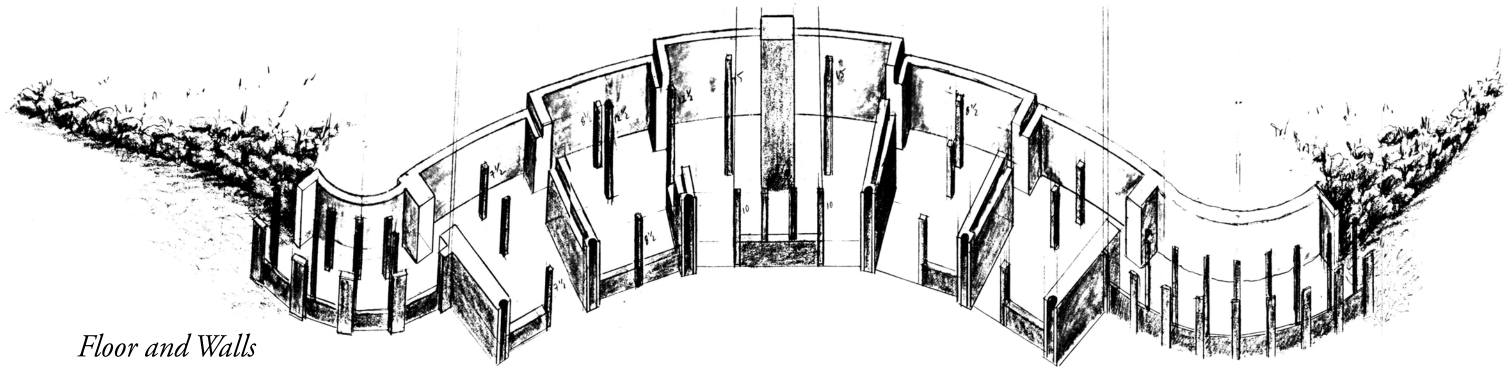
III A.3 Illustrations

This section includes several views of An Appalachian House: drawings, sketches, and models. These give an overview of the way the house is put together, its appearance, as well as the way water is shed from the roof. Line drawings show the plans and elevations of the house and were also used to scan into the computer for use with Energy Scheming.

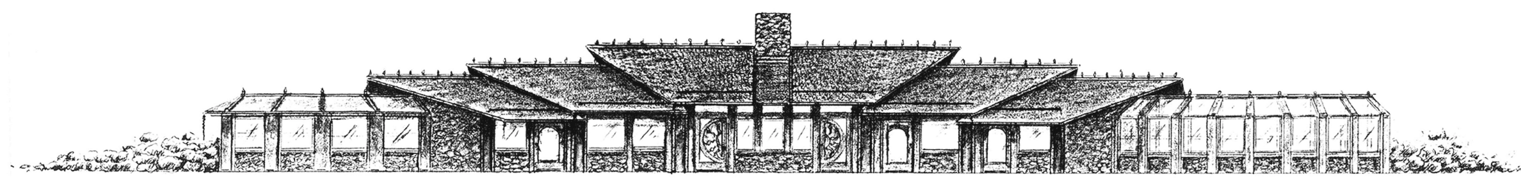




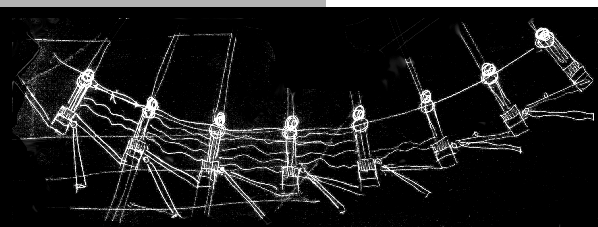
(Left) Sketches of the Appalachian House are superimposed on photos of the site. 1 is a view of the greenhouse on the east end looking towards the setting sun; 2 shows the west end of the house; 3 is looking at the house from the northwest; 4 is the approach from the northwest.
(Far right) Central chimney with woodstove.

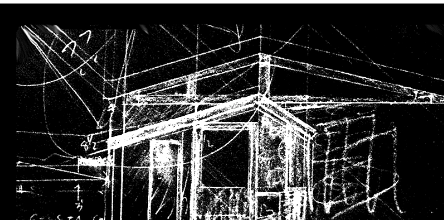


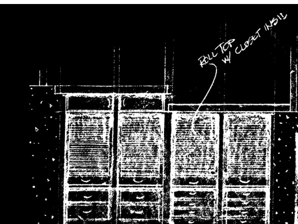
Floor and Walls

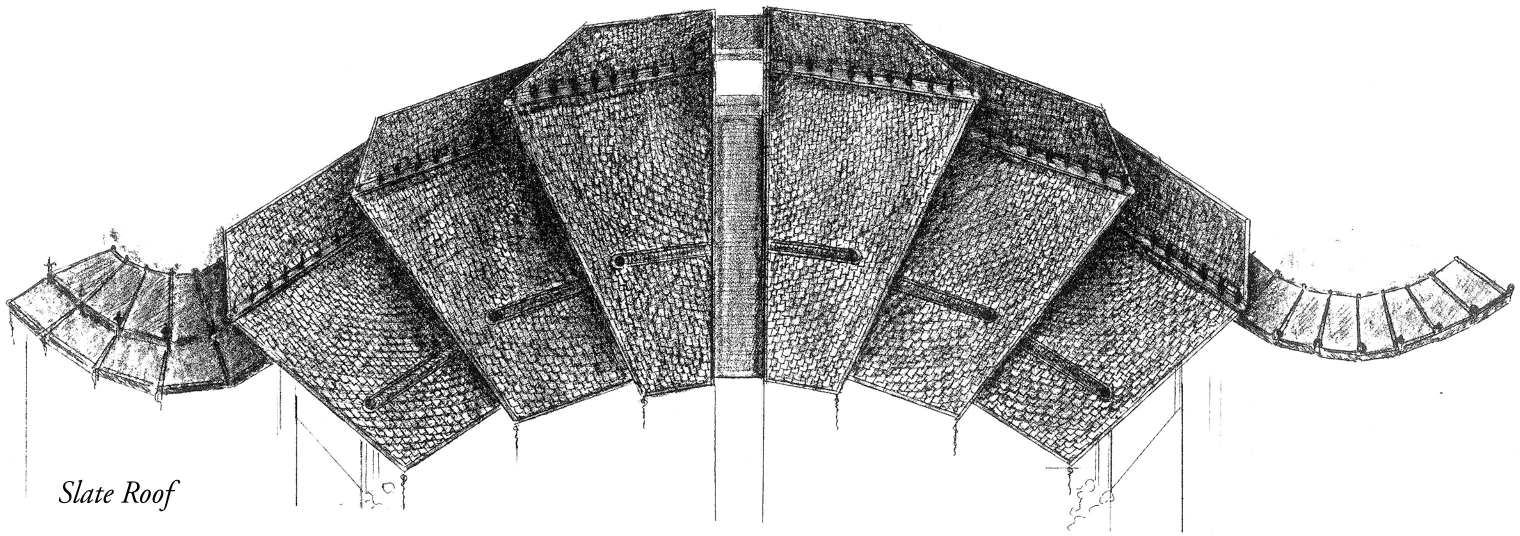


South Elevation

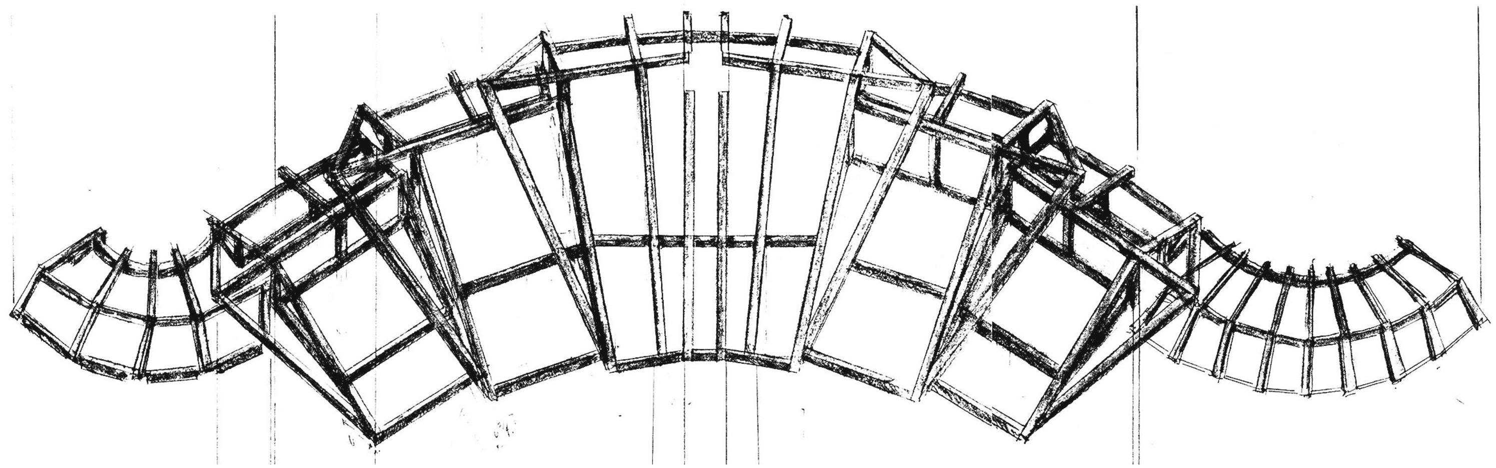




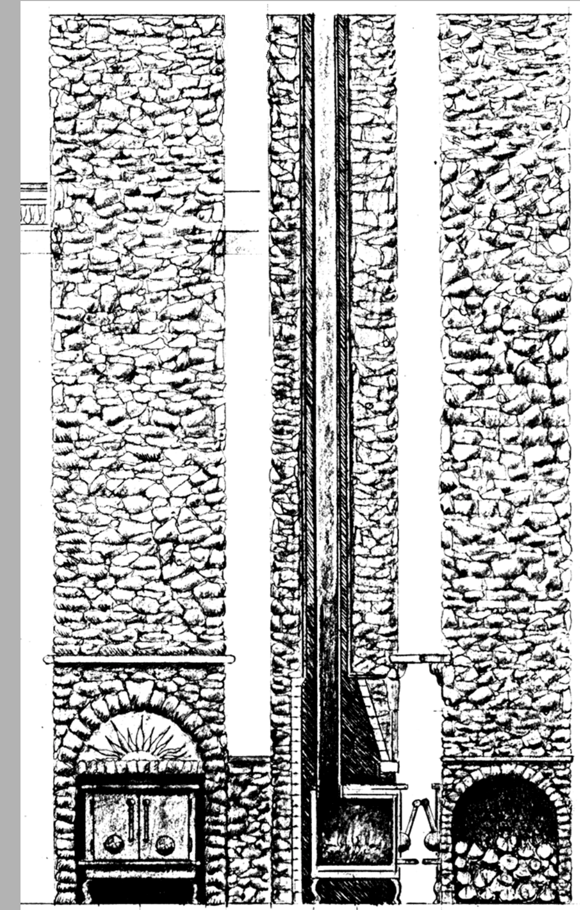




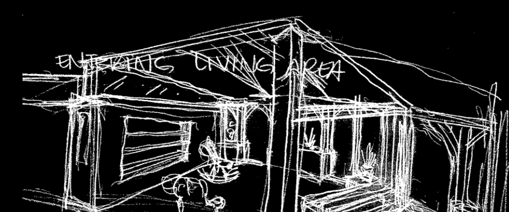
Slate Roof

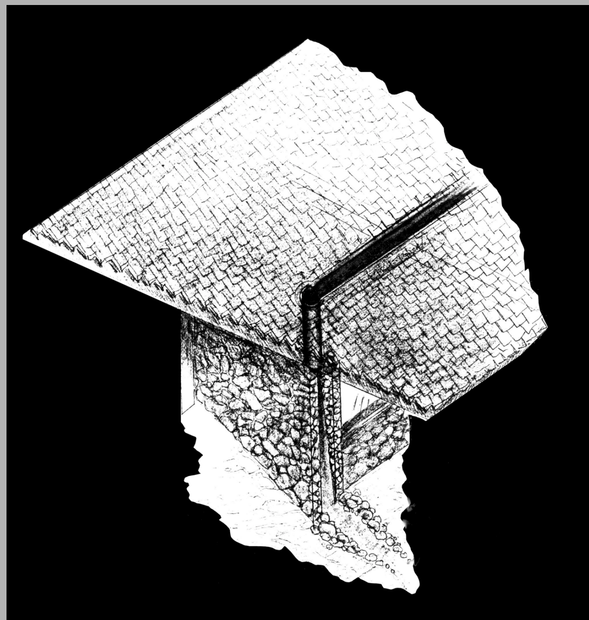


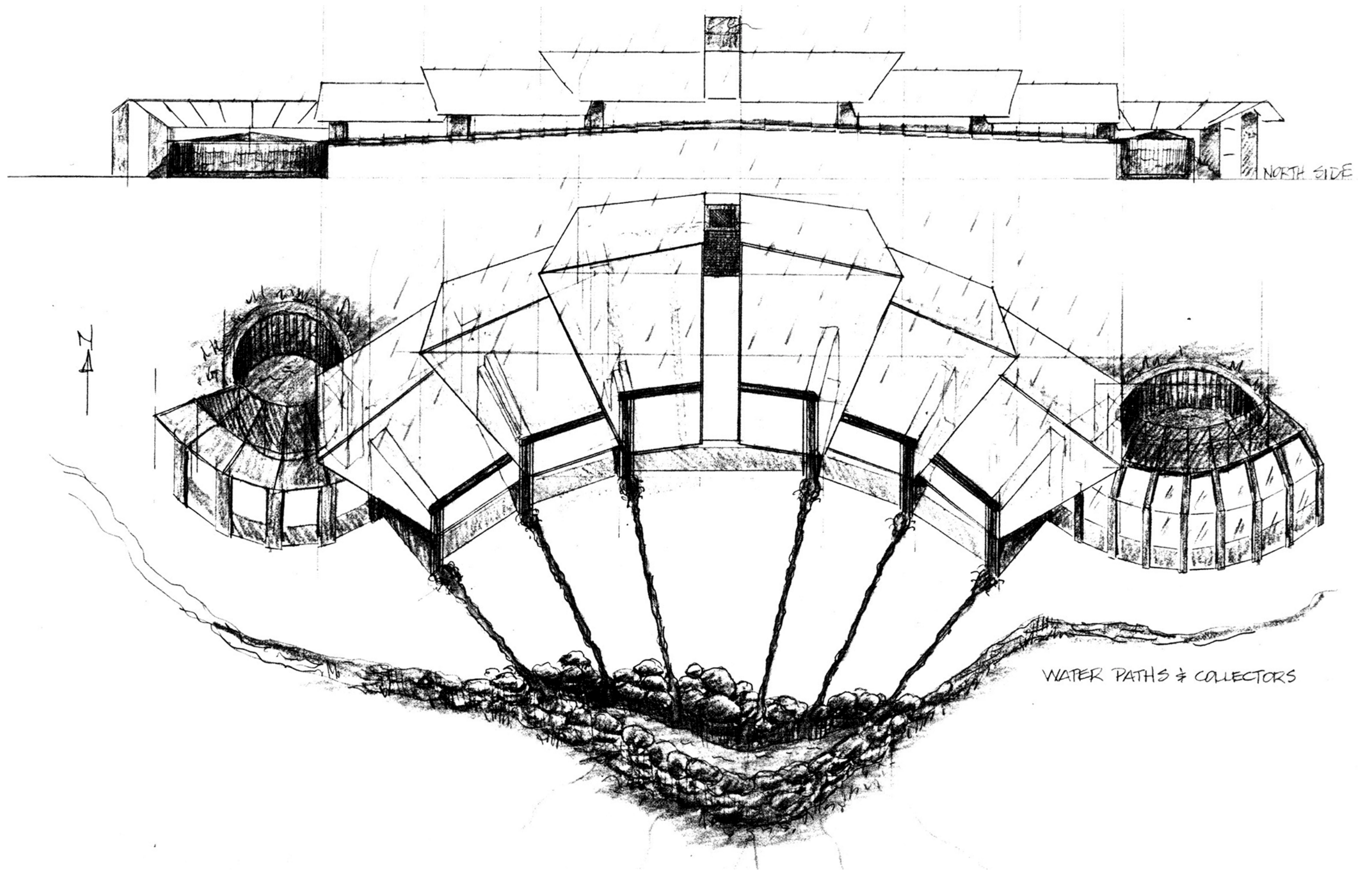
Timber Frame Structure that Supports the Roof

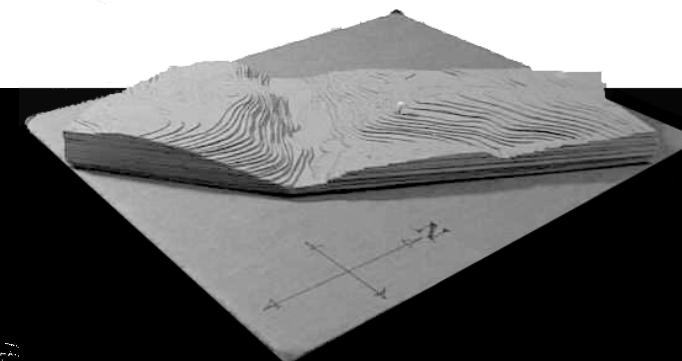


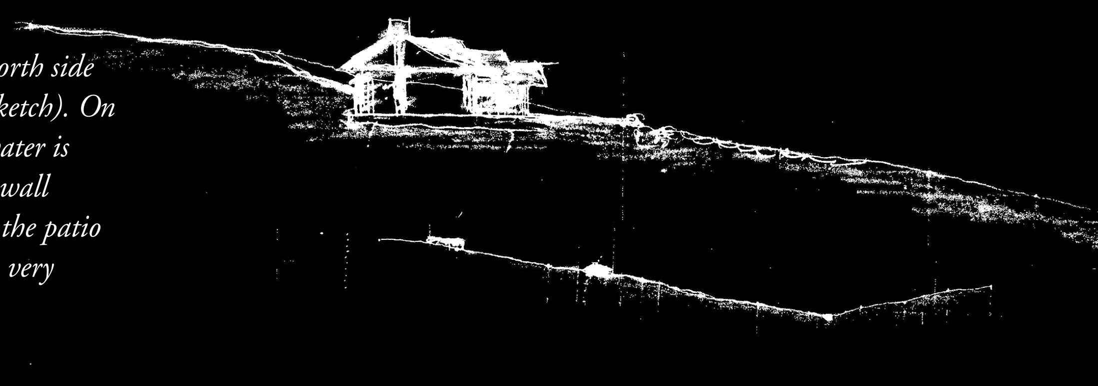
Central chimney



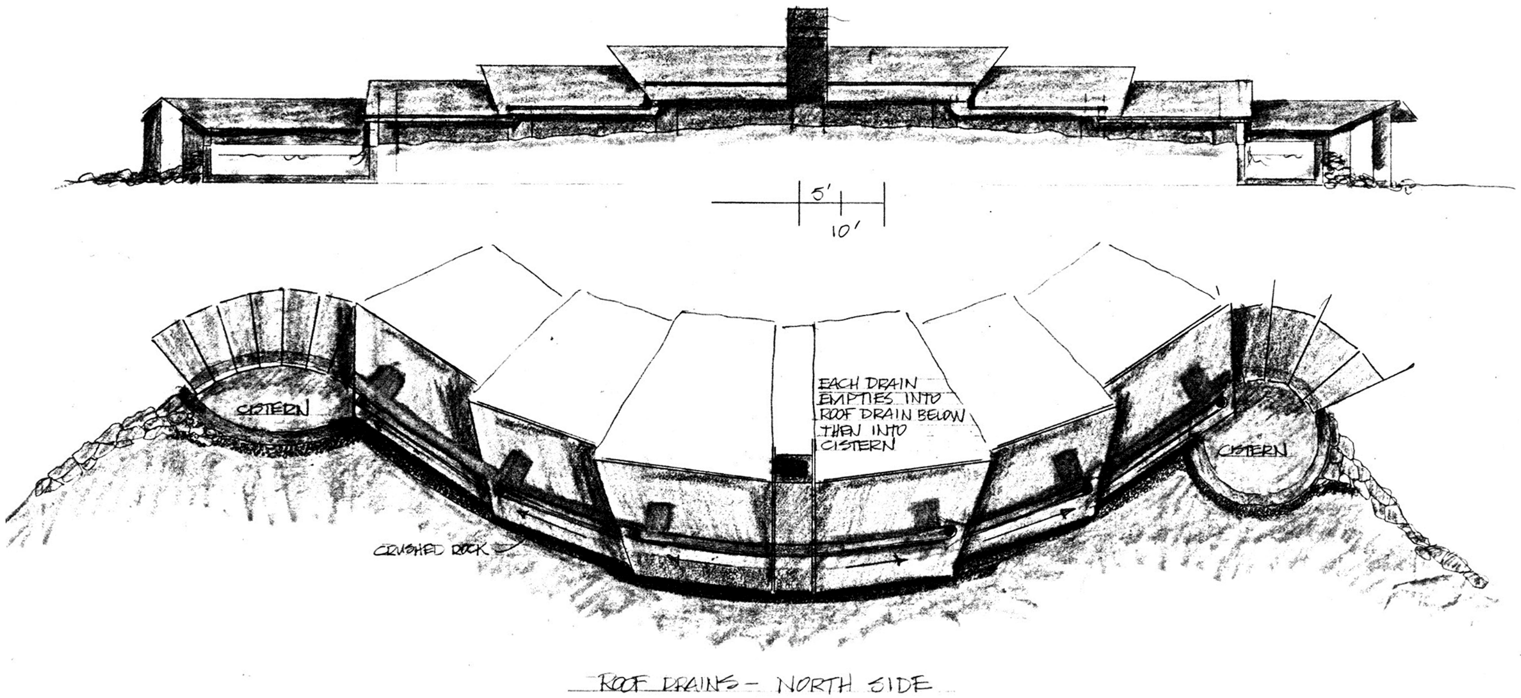


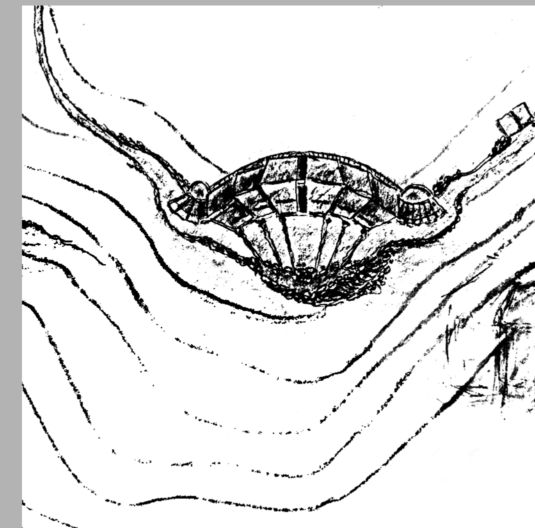




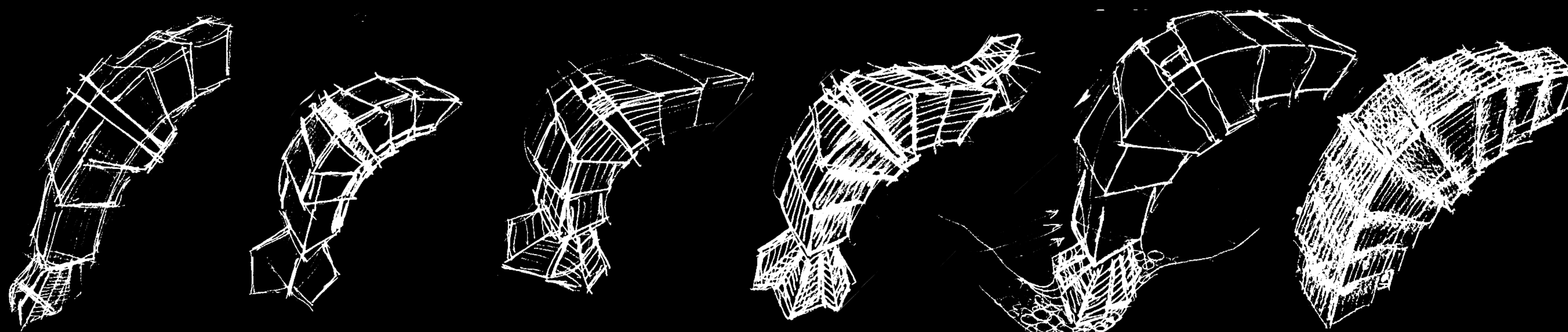


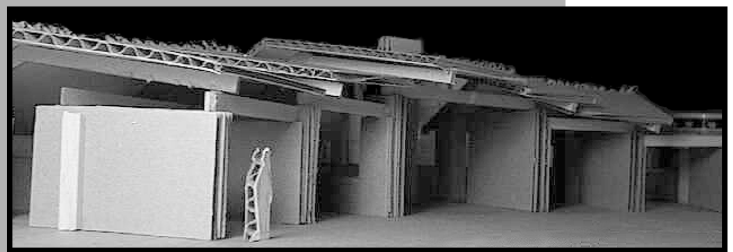
Rainwater is guided into cisterns on the north side (next page top sketches and this page top sketch). On the south side (this page bottom sketch), water is funneled from roof drains into sloped end wall channels (above) that deliver the water to the patio where it is carried away from the house in very shallow trenches in the stonework.

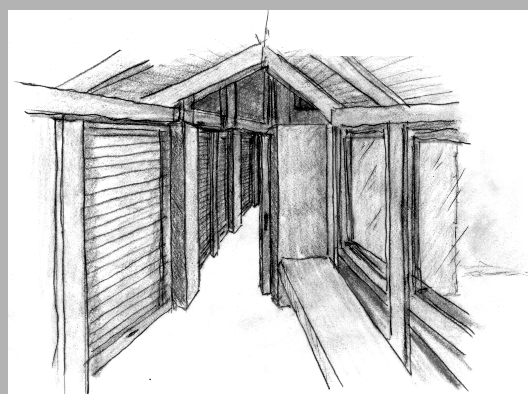




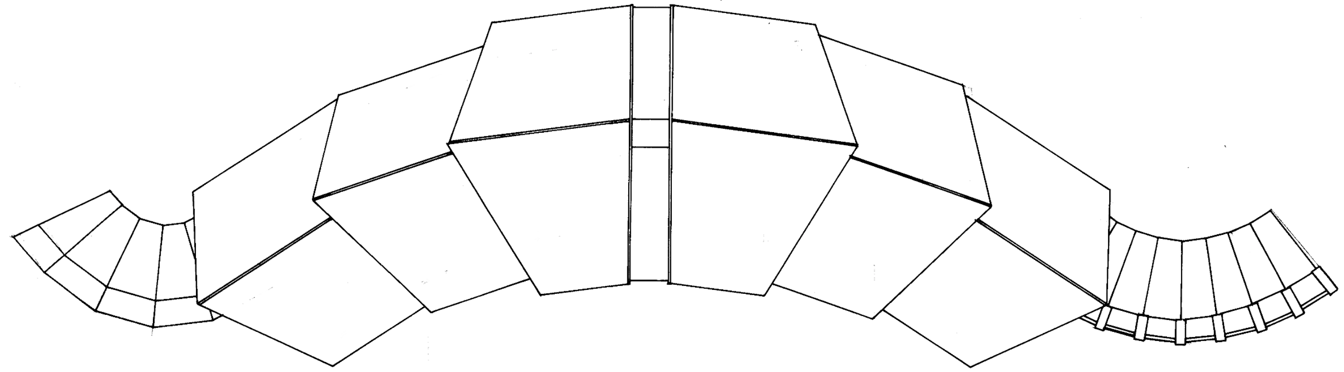
Sketch plan view



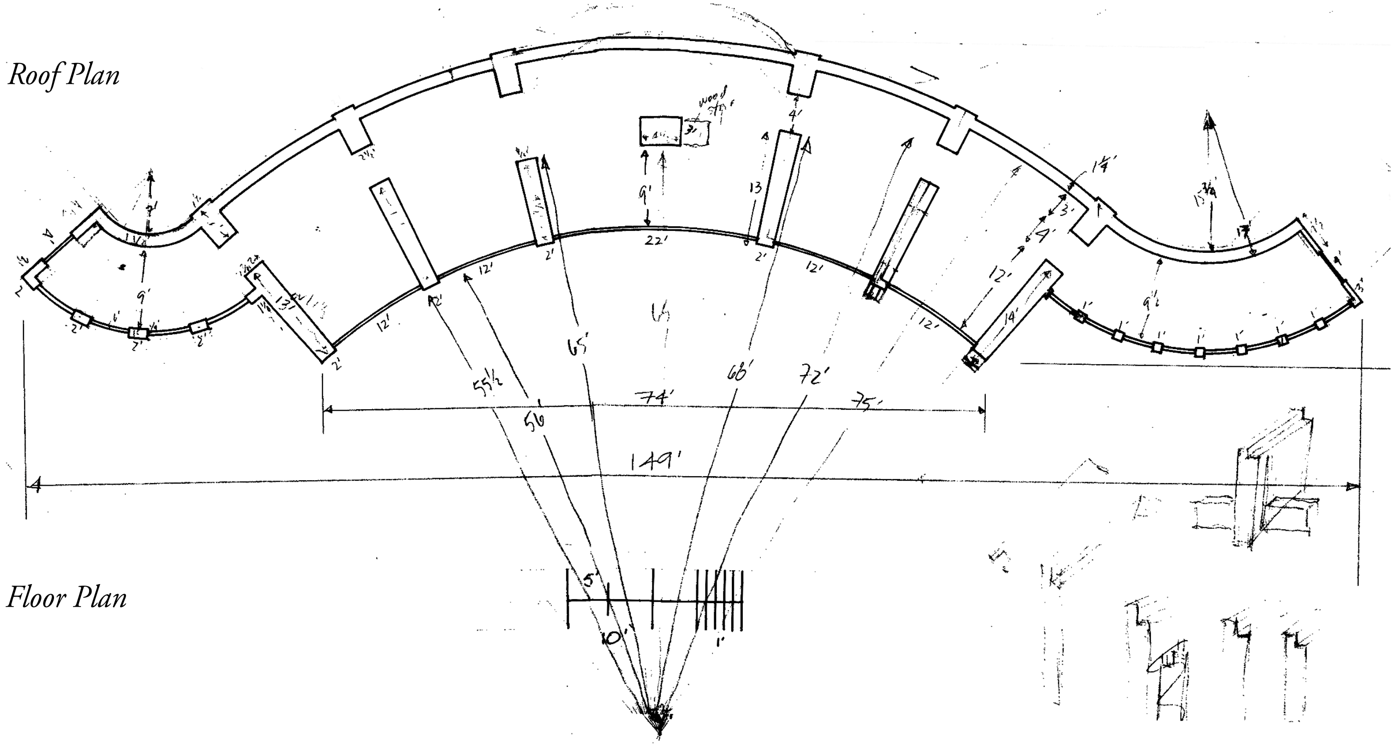




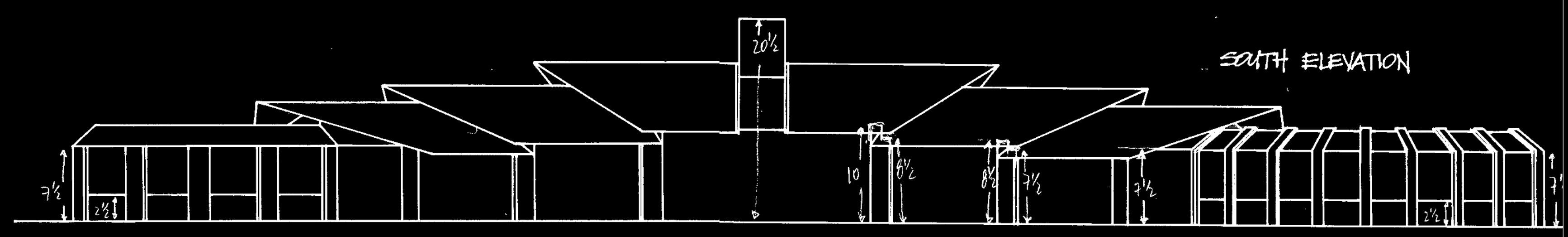
FRONT ENTRANCE HALLWAY

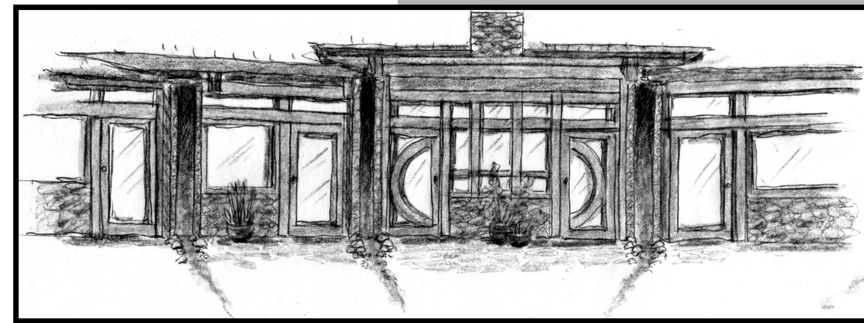


Roof Plan

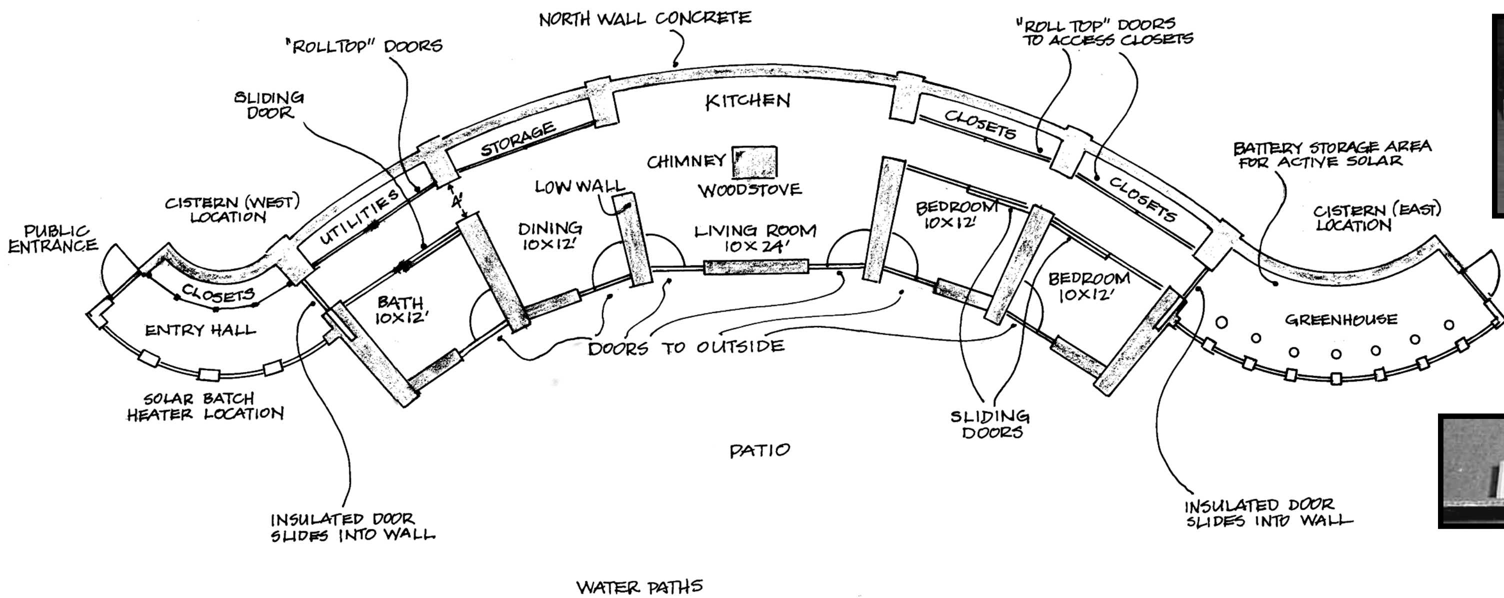


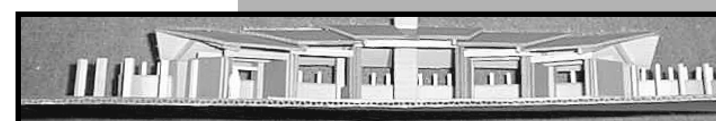
Floor Plan

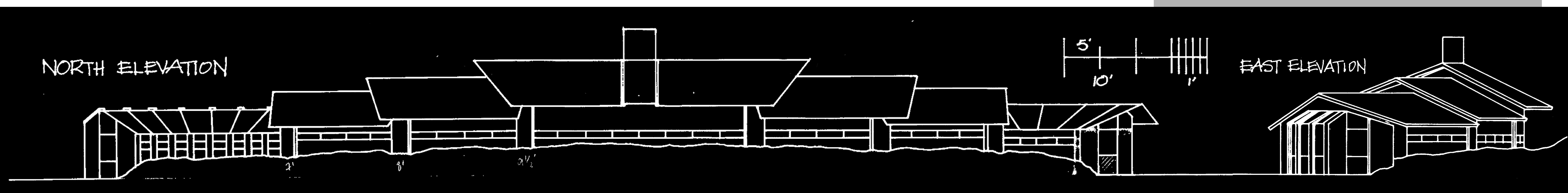




Floor Plan and Use Plan





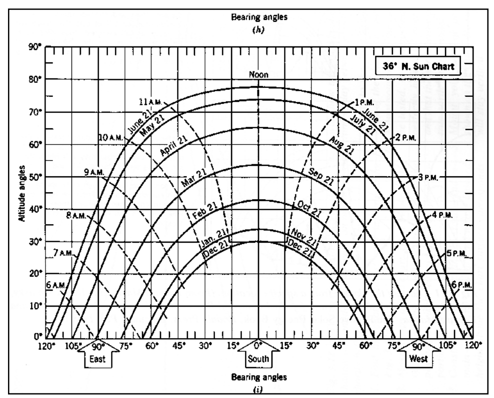


Buildings shaped without regard for the sun's impact require large amounts of energy to heat and cool. Approximately 20 percent of the energy consumed in the United States is used for space hearting and cooling of buildings."

Edward Mazria,
The Passive Solar Energy Book
[36]

III A 4. Energy Analysis

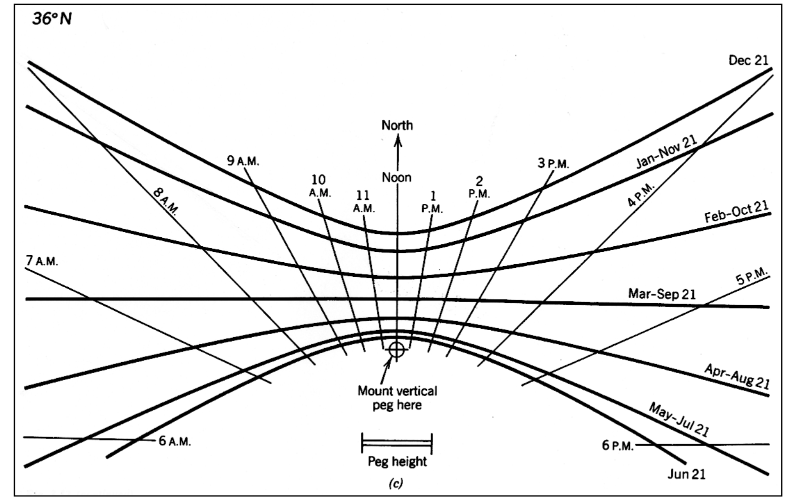
When this project was begun, it was a given that passive solar heating would be one component of the design. A south-facing slope on the property was selected to get good solar access for lighting and possible heating. As the house was designed, there was a constant reference to the sun angles and shadows; the results of these studies did not determine the design, but rather informed the design at certain stages in the development of it. After realizing a basic structure — with form, size, orientation on site, etceteras — the design was taken to the computer for a closer look at its configuration in regard to its energy requirements. A program called *Energy Scheming* provided the basis for an analysis of the building's broad energy needs. American Electric Power supplied an analysis of the Appalachian House electricity requirements



Sun angles chart MEEB [18]

for heating/cooling needs, as well as a comparison with a "typical" house in the region.

Energy Scheming is a software package developed at the University of Oregon for use with Apple Macintosh computers. It is a design tool that can be used to help create an energy efficient building by looking at broad architectural concerns rather than narrow energy issues. For example, the program calculates net heat gain and heat loss loads based on four sets of default data: building components, climate data, building geometry, and materials. After calculating the heat flows for given times of year, the program tells *where* heat loss or gain is occurring and *time of day* of gain/loss. By studying the energy reports issued from the program based on a particular set of design parameters, alterations can be initiated or integrated into the building's design.



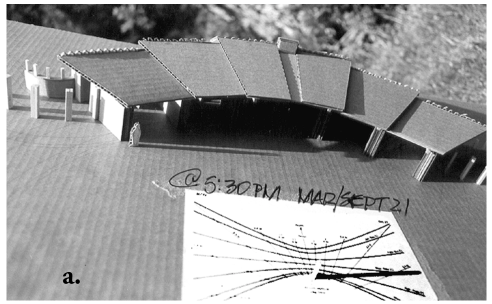
Sun angle peg chart [18]

Having already designed with energy factors in mind, *Energy Scheming* allowed a *refinement* of the design. Prior to using *ES* to evaluate the building for energy efficiency, the design for this house was originally developed using sun angle charts and calculations based on information in **The Passive Solar Energy Book** [36] and **Mechanical and Electrical Equipment for Buildings** [33]. The house/site model was also photographed with an applied sun peg shadow chart which showed that the sun would enter at brief periods of time in certain windows causing overheating at those times. The *ES* report supported this, also showing possible overheating and heat loss at other times. After extending overhangs slightly on the overheating windows, adding insulation to the roof, and constructing low walls on the south face (which were part of the original design), the *ES* report showed a more efficient and responsive building without changing the basic design.

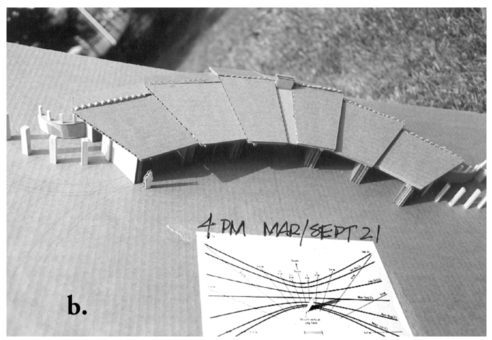
Overall, the report is positive and

Sun peg chart was applied to model, then tilted in sunlight to simulate cast shadows at different times of the year.

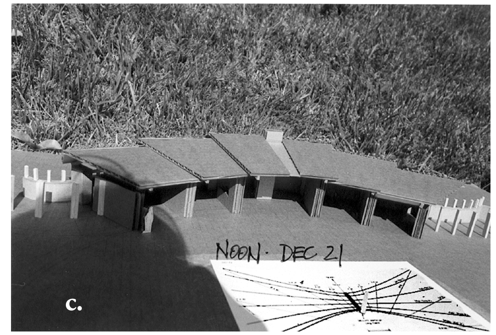
a. *Shadows cast at 5:30 p.m. on the 21st of March and September show late afternoon sun penetrating the interior on the east end of the house. This would probably cause some overheating, which was confirmed by the Energy Scheming analysis, and roof overhangs were subsequently extended.* **b.** *At 4 p.m. on the same day, the sun penetrates the interior.* **c.** *December 21st at noon shows a desirable full penetration of the sun into the house, which would result in the massive floor storing heat for later nighttime release.* **d.** *Also on December 21st, later in the day at 4 p.m., the sun continues to shine on a large percentage of the interior floor area, continuing to heat the house.* **e.** *At 5 p.m. on the 21st of April or August, the sun is mostly shaded by the roof overhang, although one small area is receiving sun inside, which could cause some overheating. Extending the roof overhangs corrected this for the most part.* **f.** *The hot noonday sun in April and August is prevented from infiltrating the house by the roof overhangs.*



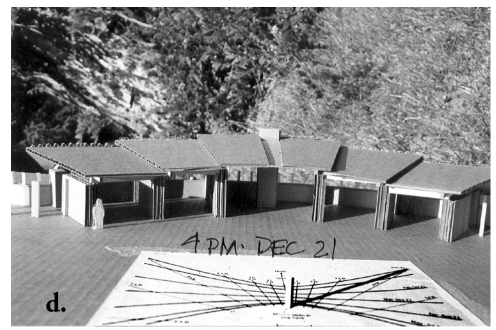
a.



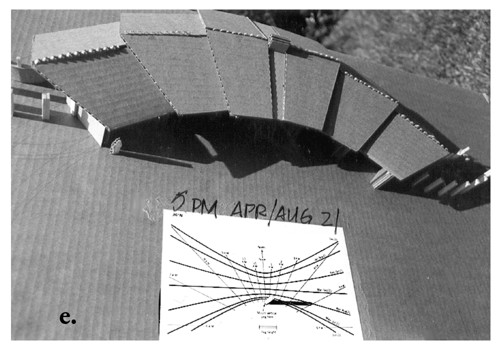
b.



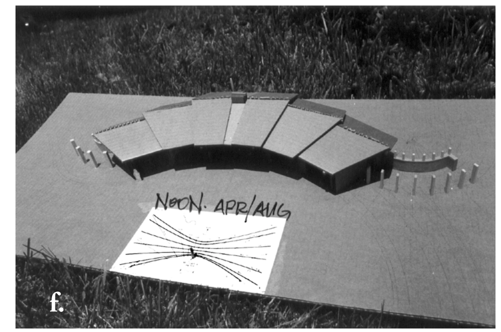
c.



d.



e.



f.

validates this building design as an energy efficient one (in a general way). Please note that the calculations for the design did not include the front entry and the greenhouse on the west and east ends respectively, as their contribution to the overall energy picture is negligible due to the massive wall that separates each from the house interior. Also, the entire floor space, including the hallway, was used for "area" in calculating the floor/glazing ratio to allow for more realistic heat circulation throughout the house. For more thorough calculations, *ES* is capable of running figures for every hour of the day for a year using even more specific design parameters. (Please see Appendix for the *ES* energy report graphs.)

Annual Energy Report Summary

In the final Annual Summary of the *ES* Energy Report, the calculations show daily heat flow for both cloudy and clear days in September, March, June and December. Overall, the figures look very reasonable and reflect a building that is responsive, mostly in a positive way, to its solar environment and able to cope with the days of obscured sunlight. In some cases, supplemental heating or cooling might be required, but in very moderate to normal amounts (say, a couple of logs on the woodstove).

In September on a clear day, there is an excess of heat (25494 Btu/h) shown during late afternoon/evening. This is due to the late summer/early autumn sun resting lower in the sky (low altitude or angle from the horizon), at an angle (azimuth or angle from true south) closer to south at those times of day that allows a lot of light into the windows at the extreme east and west ends of the house. The house could be somewhat uncomfortable in some areas at those times and might require additional cooling through the use of supplemental cooling devices such as fans or the installation of internal window shades that block the sun. It also might be completely bearable. On a cloudy day in September, there might be a need for supplemental heat as the report shows a loss of 214,793 Btu/h for the day. This figure does not take into account the mass of the building, however, as the program assumes no mass on cloudy days; it is entirely possible that the large amounts of mass in the house would retain sufficient heat or be slow enough in cooling off that the house would remain comfortable.

In June, as in September, the excess heat accumulates in afternoons to 108,699 Btu/h and could be "cooled" with fans or not allowed to penetrate the house to begin with through the use of internal shading devices. There is also a possibility of using evaporative coolers, although the moisture content of the air in Blacksburg might be so high that these units would be ineffective. Even though the external roof overhangs on the south side are deep (six feet), they are still not sufficient to block out all the summer sun along the south face of the building in the afternoons and evenings. Resolving this without the use of large air conditioning units is still desirable; using air conditioning units would require 9.06 tons of cooling (heat gain in Btu/h divided by 12,000 = tons of cooling) per day.

Perhaps the house's occupants could go outside and sit under the shade of a tree. On a cloudy day in June the report shows a complete daily balance of no heat flow. A clear day in March shows no heat gain and no heat loss, while a cloudy day has a heat loss of 164,462 Btu/h, probably requiring supplemental heat.

The greatest loss of BTUs occurs in December on cloudy days. If the mass does not have enough stored heat, supplemental heat will be necessary to replace the report's estimated loss of 346,888 Btu/h for a 24 hour period. (A good day to bake bread?) Using the airtight woodstove, this would mean adding around one hundred pounds of wood for a 24 hour period, which is a fairly typical amount. This assumes the "best" efficiency factor (0.5) for the stove and using seasoned or dry hardwood with high density (for example red oak at 36.2 lb. per cubic foot or sugar maple at 34.9 lb. per cubic foot). (Using the equation: lb. per hour = Btu per hour heat loss divided by Btu per lb. times efficiency; this translates as 14,454 BTUs per hour divided by 7000 BTUs times .5 = 4.13 lb. per hour or 99 lb. per day of wood fuel.) The conversions for other fuel sources are 3.3 gallons of heating oil per day or 101.76 kilowatts per day of electricity, both reasonable figures for heating the space required.

To increase the performance of the building, installing night insulated shades would help in areas such as the north-facing hopper windows and the south-facing casement windows, but maybe not significantly due to the large amounts of thermal mass which will release heat during the night.

Comparison of Energy Consumption

In order to assess the value of the Energy Scheming results for the passively solar heated Appalachian House, it was determined that a comparison with another energy source (electricity) and a "typical" or "average" house of similar size would be useful.

The comparison of the energy saved in this design for an Appalachian House versus a "typical" house of similar size was based on American Electric Power Company computer calculations to determine the average electricity consumption for heating/cooling for the two houses. The figures presented take into account construction materials, orientation on site, size of windows, R-values, insulation, ceiling heights, slab size, and size of rooms.

In the Appalachian House, the estimated average annual heating cost was found to be $322.49. The calculations for this residence also take into account the use of a geothermal exchange electric heat pump in conjunction with the hydronic floor coil heating system, itself a very efficient heating system. The cost is a very conservative estimate and could actually be much less due to the slightly less detailed information supplied to the computer prior to calculations.

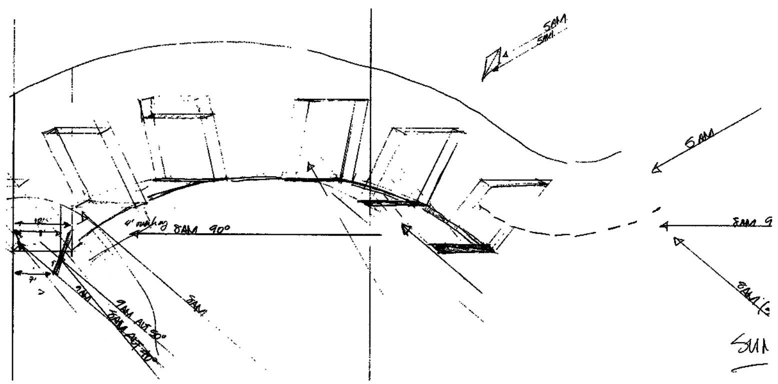
For the "typical" house in this region of Appalachia, which is ranch-style with smaller and fewer windows, the estimated average annual heating cost is $532.25.

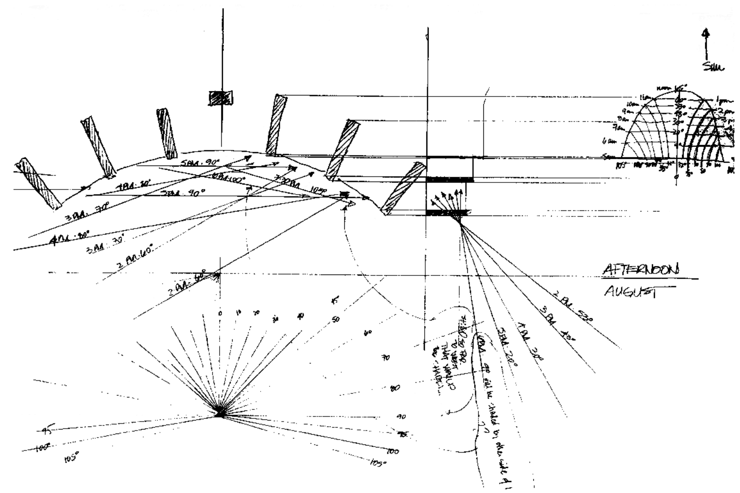
The difference of $209.76 represents a savings of 40 percent over the entire year, showing that, at least on paper, the Appalachian House is a feasible design for energy efficiency.

(Please see Appendix for the actual energy reports from American Electric Power Company.)

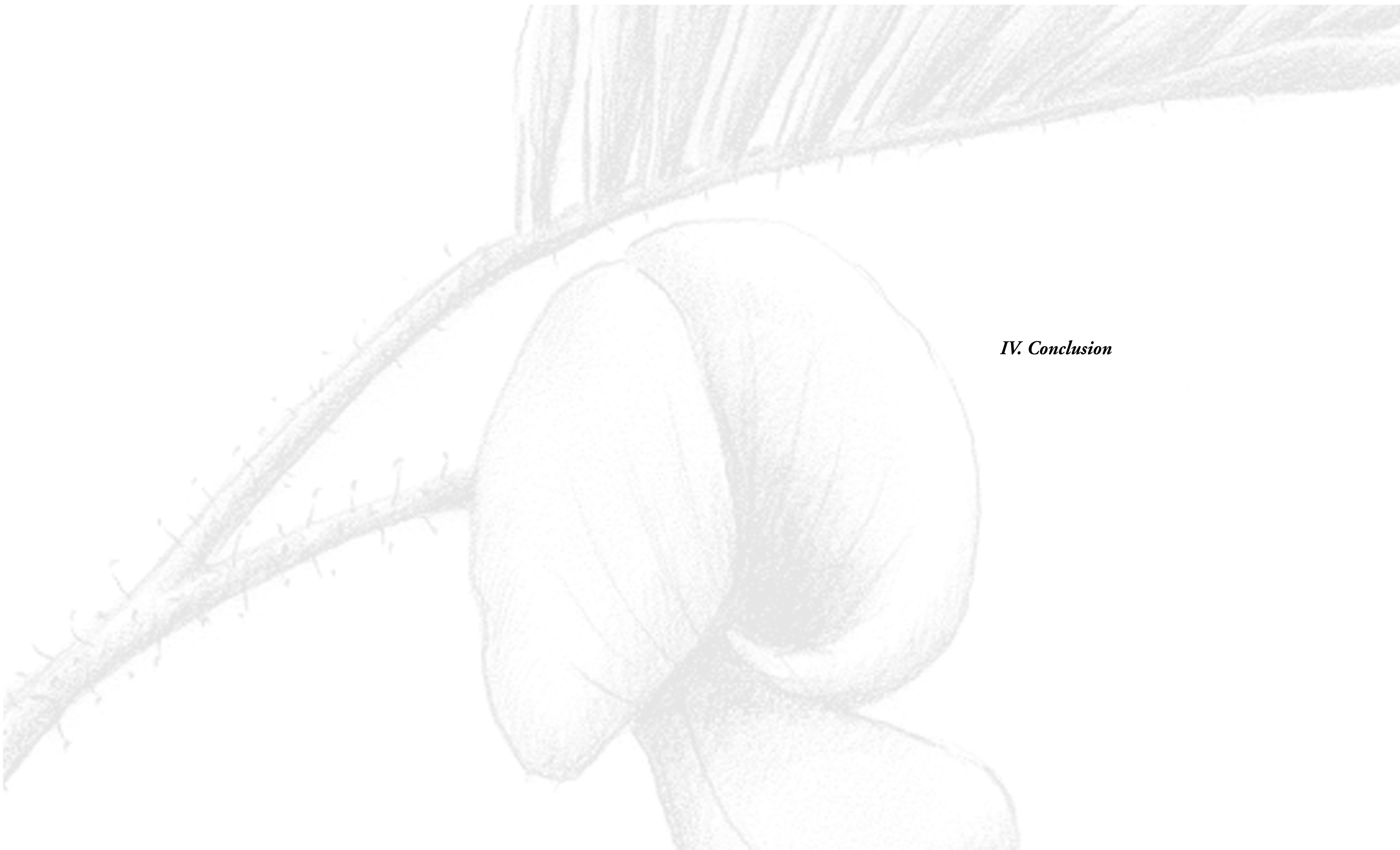
Carbon Debt Restoration

Another motivation for energy conservation is that levels of carbon dioxide can be reduced through decreased use of fossil fuels. The build-up of CO_2 helps create the negative "greenhouse effect" and, therefore, it is desirable to limit the increased carbon levels by using more efficient appliances, driving gas-powered vehicles less, and increasing the use of non-CO_2-producing energy such as solar power. It is suggested that to balance our annual greenhouse gas emissions, we can plant trees (three for every ton of CO_2 emitted) to absorb carbon dioxide, thereby making our lifestyles "carbon neutral." The average individual is responsible for generating about 10 tons of CO_2 annually. The Appalachian House design, using an electric geothermal exchange heat pump, emits an estimated four and a half tons of CO_2 for heat annually. For offsetting the heating carbon debt alone, about 15 trees could be planted to achieve carbon neutrality. The land use plan for the Appalachian House (discussed in Chapter II A 1) calls for the planting of a small five-acre forest as a woodlot with hundreds of trees, and so would more than fulfill the requirements for being a carbon neutral home.





An Appalachian House: Sun angle sketches



IV. Conclusion

The spirit of a created thing derives from a common source which goes back to the origins of the universe, of (human)kind, of civilizations, back to our birth, and is revitalized with the dawn of each new day."

Olivier Marc [7]

IV. Conclusion

The goal of this thesis project was first and foremost to create a livable house — one that is comfortable, sustainable and efficient inside and outside — by exploiting the contrasts that are inherent in any building. This was achieved in part by a deepened harmony between the house and its constructed and natural environments, while supporting its dual roles of both engaging the inhabitants with nature and protecting them from it.

The challenge was to select and assemble the many contrasting variables in the most constructive way in order to create a house appropriate to this Appalachian region. Glen Murcutt, in looking at contrasts, said, *"If both hold their integrity, each will tell about the other. One clarifies the other... I think that that difference is very important. Not for difference's sake; difference must come out of an understanding of scale, of material, of structure, of light, of shade, of wind, of smells, of sun, of the verandah, the change from outside to inside, the structure of the landscape..."*

Contrasts become evident in this house in the configuration of material versus function versus aesthetic versus sustainability versus livability, and are also manifest in certain properties of the house: light versus darkness, horizontal versus hilly, open yet protected, fluid but stable, inside versus out. This house also offers a contrasting perspective of the

historical precedents in the region related to the vernacular; in particular, while using many of the typical materials such as heavy timber and stone that were used in early log cabins and other structures, it employs a more technological approach in their assemblage to take advantage of modern materials such as low-e glazing. This last example offers one representation of how contrasts can be reconciled through the successful "clarification" of one another, thereby producing a house that is imbued with many different ideas that work together to form a common, integrated whole. This, at least, was one of the goals.

Comfort is achieved, not just with objects and their arrangement, but also through appropriate use of materials, and sustainable responses to the environment. It is an obligation to the entire environment (land, sky, water), and to the community as a whole (people, animals), to choose correctly now for the generations to come.

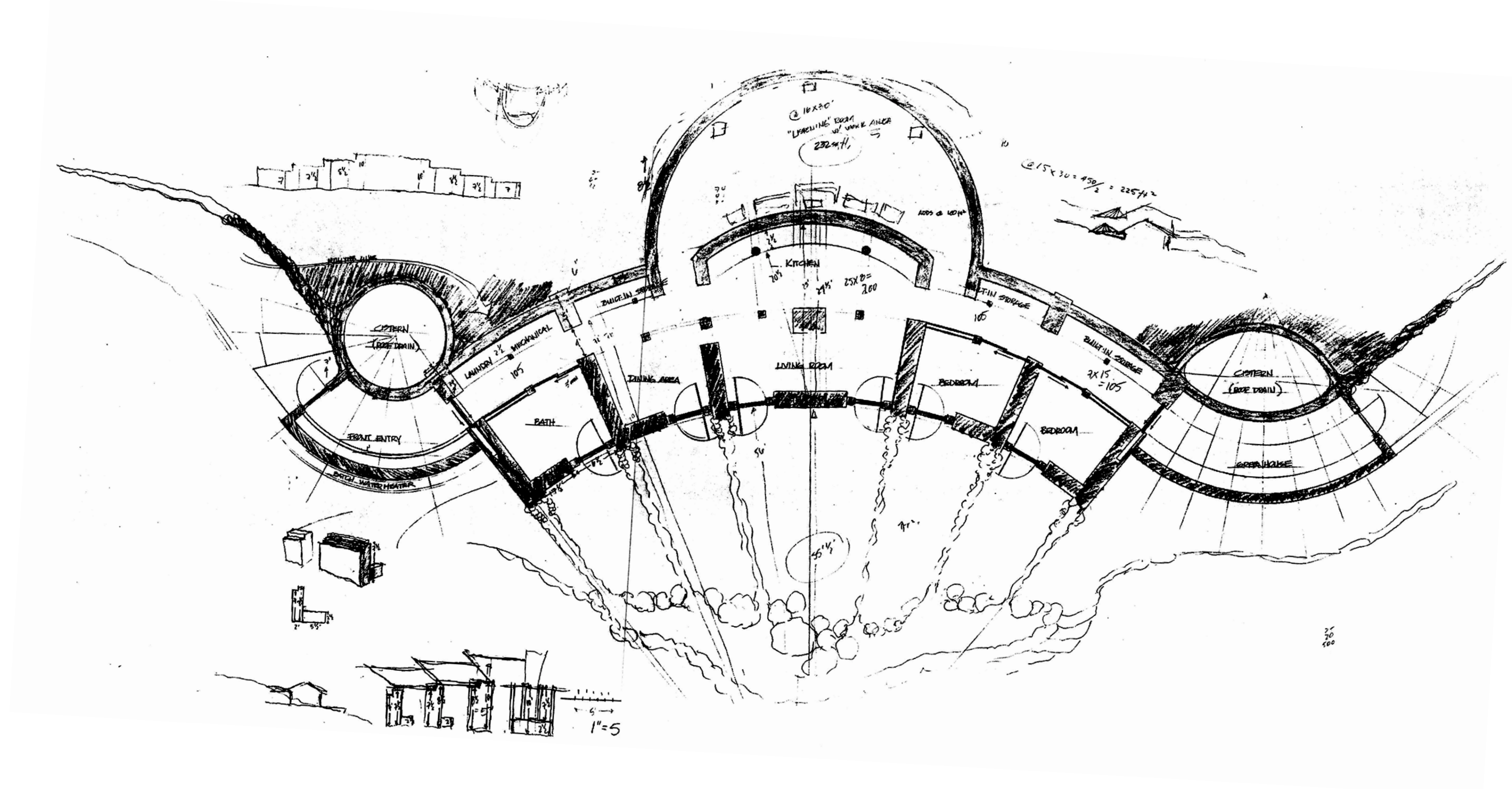
Towards this end, this Appalachian House achieves success through the attempts at energy efficiency as evidenced by the Energy Scheming reports and the American Electric Power analyses. Also, the house and land use plans are commensurate with the Town of Blacksburg's vision for itself in the future, and is therefore a suitable program for future small town development. The sustainability issues are also addressed through the house's composition of primarily local materials and their durability, and the practical land use applications. Other issues such as history and agriculture are woven into the fabric of the design as well.

Several issues were not addressed in this design for an Appalachian House, but which are nevertheless important and worthy of consideration in future projects. One is the cost of building such a structure; estimates for this house are high due to expensive materials, systems, and their implementation. Although the house is designed for long-term livability and use — which inherently carries a greater cost — it would still be desirable to discover ways of achieving sustainability while limiting the cost. It is recognized, too, that while initial costs might be high, there could be substantial savings over long periods of time (i.e. installing a geothermal heat pump now would be an investment for perhaps the next seventy-five years).

Another issue is that of expandability; a revised "future" floor plan (next page) shows an added area to the north side of the house. Basically, a new space would be carved out of the hillside, behind the kitchen, with access from either side of the kitchen. It is envisioned as an “entertainment” or “family” room and would maintain the sustainable concepts present in the main house such as the use of passive solar for heat and natural lighting, massive materials, and use of a woodstove for supplemental heat. The room would be even more able to take advantage of the geothermal qualities of the soil around it due to its three-quarters surround of earth. The house could also be expanded along the east/west axis very easily.

An additional concern is whether or not this design for an Appalachian House, or at least elements of this design, could be implemented in a more urban setting with a higher density of housing and much smaller site. This design exists in a sort of ideal world of envelopment by a large plot of land with great views and terrific solar access. Obviously, such a location cannot be found everywhere. Of course, there are limitations to using passive solar heating methods, including the necessity of southern exposure. Still, it would be useful to apply many of the lessons from this project to other, less ideal circumstances.

Finally, Juhani Pallasmaa has defined the phenomenology of architecture as being founded on actions rather than things, and this project has been one attempt to create a building that could also be described as a composite of acts — the act of warming oneself by the window or woodstove, not the hearth itself; the act of approaching the house from around the hill as opposed to the entry; the act of listening to the water cascading down the walls, not the wall itself; the act of living in the home, not the house. In this design even the so-called “passive” heating should become an active engagement of the building between the sun and the people who inhabit it.



An Appalachian House: Future expansion

V. References

Illustrations

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V. References

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VI. Committee Members

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Michael O'Brien

Associate Professor of Architecture and former Chairman of the Graduate Architecture Program at Virginia Tech; areas of expertise include affordable housing and the reuse of steel shipping containers as structural modules for prototype SRO housing for the homeless, and modular housing; designed and built the house in which he lives in Blacksburg, Virginia; with architect James Ritter designed the building that houses the Unitarian Universalist Fellowship of the New River Valley.

John Randolph

Professor and Department Head of Urban Affairs and Planning at Virginia Tech; areas of expertise include environmental planning, environmental impact assessment, energy planning and efficiency, and renewable energy; received the 1991 Virginia Energy Award for Evaluation of Virginia Weatherization Program; lived on a rural 8-acre homestead for 15 years and now lives in the town of Blacksburg; contributed to **More Other Homes and Garbage** published by Sierra ClubBooks.

Bob Schubert

Associate Professor of Architecture and Associate Dean for Research and Public Service for the College of Architecture and Urban Studies at Virginia Tech; specializes in building environmental systems and control systems for intelligent buildings; director of the Environmental Systems Laboratory for the College of Architecture.

Appendix

Energy Reports

Appendix

Energy Reports

The appendix includes the energy reports issued from Energy Scheming and American Electric Power.

Energy Scheming

This section of the appendix includes the energy analysis of the basic house design with print-outs of graphs showing the heat gains and losses and their causes for four critical times of year, June/December and September/March, for both clear and cloudy days. The analysis was performed using Energy Scheming, a computer program designed at the University of Oregon to facilitate developing energy strategies in the design phase of a building.

Four sets of default data are used as the basis for the program: building components, building materials, climate and building geometry.

The climate data is based on Dodge City, Kansas, at latitude 37° North (Blacksburg, Virginia is at 36.5 North). It incorporates temperature, relative humidity, wind speed, wind direction, solar radiation, solar altitude and solar azimuth, all of which obviously will vary depending upon time of year and whether or not it's a clear or cloudy day.

For the building data, basically the house was broken down into sections due to the curvature of the house on the site. This allowed the correct orientation of each wall and roof to give a closer representation of the building's overall orientation with respect to the sun. The front entry hall and the greenhouse were not included in the calculations due their negligible effect on the overall analysis and their separation from the main house by insulated doors.

The back retaining wall was broken into five sections facing north (277-sq. ft.), north-northeast (110-sq. ft.), northeast (91-sq. ft.), north-northwest (112-sq. ft.) and northwest (85-sq. ft.). It is comprised of solid concrete with an R-value of 17.15, with 3" of rigid insulation, and is considered to be "massive."

The walls on either end of the house and the south façade walls were also considered "massive" and concrete (even though designed as stone), with 3" rigid insulation, and the same R value. Orientations go from southeast to southwest.

The roof was broken into ten different sections, five each on the north and south sides, again, to accommodate the curvature of the house. Each section has a 4" pitch and uses metal sheathing with plywood deck, wood structure, interior wood, and 6" insulation in the cavity. The R-value is 33.28 for both gain and loss with a 9-hour lag time.

Floors constitute 1923-sq. ft. with a perimeter of 232-l. ft. The slab-on-grade concrete has a quarry tile finish and 1' rigid insulation underslab and around the perimeter. Floors are also considered "massive" with an R-value of 1.17.

All windows in the house are double-paned, low-e glass with a 90° tilt. All are operable to provide cross-venting capabilities; north sides are hopper-type, and south side is casement type windows. Due to overhangs on both sides of the house, a shading coefficient of .25 was added to each window. To accommodate the curvature of the house, windows were also broken into sections to more accurately reflect their orientation towards the sun.

Because of the passive solar nature of the house, and due to the large thermal mass, the mass was calculated separately for a better reading of its effect on the structure as a whole and its more direct impact on the energy efficiency of the house. Mass was described as an 8" thick solid, and was also broken into sections to reflect its access to solar radiation.

Using these parameters, an overall analysis was performed for one day at a time. The heat flow was calculated for each hour of the day, yielding the total BTU gains or losses for the entire day.

The first time the test was run, the results showed some overheating during late afternoon hours in April and September. Also, the report showed overheating during June and July in the afternoon. Modifications were made to the design of the roof overhang to extend it farther; that partially solved the summer overheating.

After running new tests, further modifications were made to the design by extending the roof overhangs even further so that they now are six feet beyond the walls of the house on the south side. In addition, more insulation was added to the roof to bring it up to 6".

These adjustments created a much more energy efficient house, without compromising the design. The results that are shown here reflect the third round of changes made. The following graphs are the result of *Energy Scheming's* computer calculations, and basically show a building that is very positively responsive to its environment and materials.

Annual Energy Summary Graphs: June/December

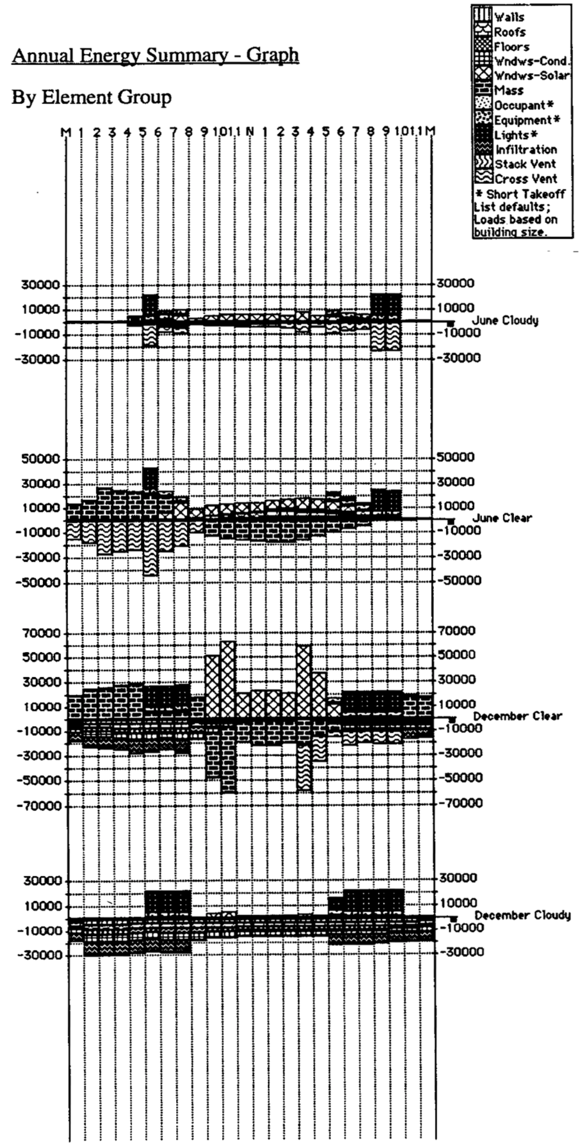
Annual Energy Summary Graphs show heat gains above a "comfort baseline" losses below.. The graph on the left shows the different element groups, such as lights, mass, solar radiation, windows, infiltration, etceteras, and their affects on the comfort level inside the house. The graph on the right shows the net heat gains or net heat losses for the same day. These graphs represent a cloudy day in December and June, and a clear day in December and June.

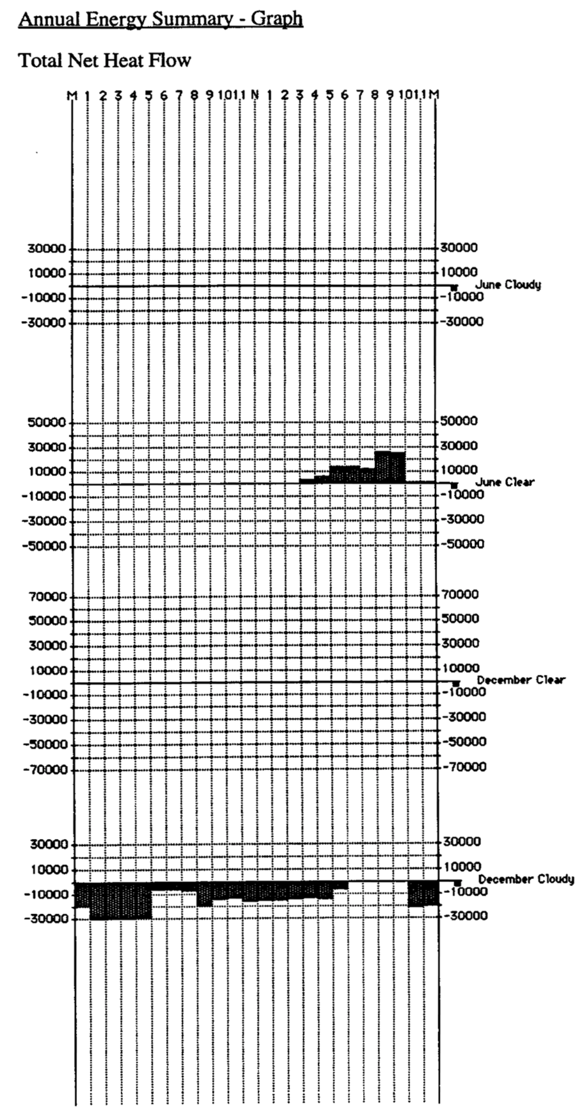
June Cloudy Element Group: Not much heat is coming in that can't be vented. Early morning and late evening heat gains are due to interior lights, but are shown to be vented. Net Gains/Losses - There are no losses or gains.

June Clear Element Group: This shows heat from the sun is warming the floor (thermal mass) during the day, but is vented away with no real heat gains. Later in the day, there is some heat gain through the windows, however, the floor's thermal mass effectively counteracts it - the floor, which has cooled off at night, cools the air coming in through the windows and absorbs heat from the sun. Again, electric interior lights cause some heat gain in the early morning and late evening. Net Gains/Losses: This shows overheating in the afternoons although mainly due to internal lights. Therefore, turning off the lights and maybe other electrical equipment, such as a television, would probably eliminate this overheating problem..

December Clear Element Group: There is some nighttime infiltration, which is mainly balanced by the thermal mass of the building releasing its stored heat and the lights radiating their heat in the early morning hours. Later, the solar gains are quite large, much of which becomes effectively stored heat for nighttime, although between three and five o'clock venting is necessary. In the evening, lights provide additional heat necessitating more venting or turning off the lights. Net Gains/Losses: No heating losses or gains shown

December Cloudy Element Group: Between one and eight o'clock in the morning, there is a lot of infiltration with little except for electric lights to provide heat. This program assumes well-caulked windows, but does not assume thermal mass on cloudy days. There is a probability that the thermal mass of the house will hold some of its heat to be released on a cloudy day. Otherwise, some solutions would be to install night insulated shades, another to build a fire in the woodstove, do aerobic activity in the house, bake bread or turn on all the lights and other electrical equipment. Net Gains/Losses: Clearly shows heat losses for much of the day with the exception of early morning as the sun is rising and late evening with the setting sun. Supplemental heat would be probably be required.





Annual Energy Summary Graphs: September/March

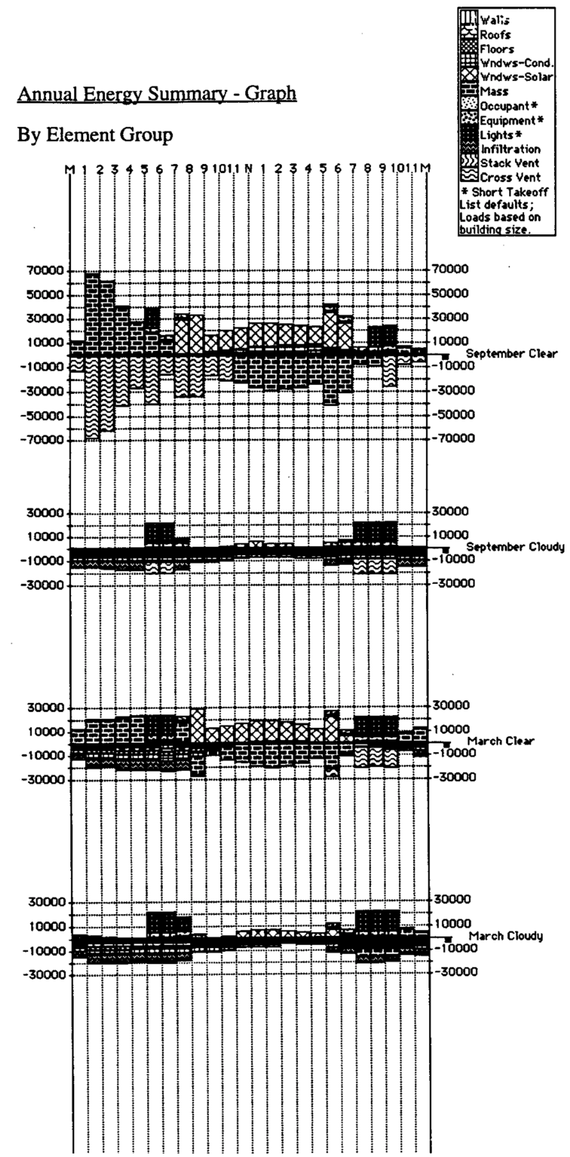
Annual Energy Summary Graphs show heat gains above a "comfort baseline" losses below.. The graph on the left shows the different element groups, such as lights, mass, solar radiation, windows, infiltration, etceteras, and their affects on the comfort level inside the house. The graph on the right shows the net heat gains or net heat losses for the same day. These graphs represent a cloudy day in March and September, and a clear day in March and September.

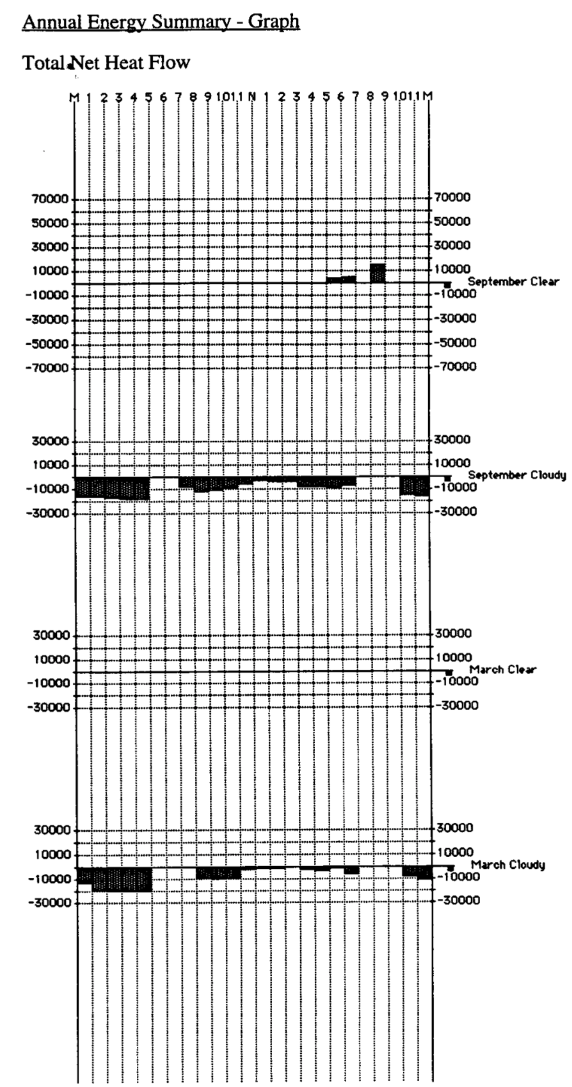
September Clear Element Group: Basically very balanced heat exchange with the stored heat of the mass being vented at night and the solar gain during the day being absorbed by the mass. Interior lights cause slight overheating, but can be mostly vented or turned off. Net Gains/Losses - Slight overheating shown in late afternoon, probably ventable.

September Cloudy Element Group: Shows some heat gain due to lights which can be vented and a little solar gain midday which appears to present no problem, and could even be an asset depending on the day. Net Gains/Losses: Might need a little supplemental heat here due to some heat losses, but maybe not.

March Clear Element Group: Infiltration at night is warmed by the thermal mass and helped by lights turned on in the early morning (who gets up at 5 anyway?). The daytime solar gain is collected by the thermal mass for nighttime release. Evenings between seven and ten o'clock have heat released into the house by electric lights that can be vented if too hot. Net Gains/Losses: No heat gains or losses reported.

March Cloudy Element Group: Nighttime infiltration would probably require some supplemental heat, although the graph shows lights providing some gain. During the day, the solar gain through the windows is warming the building a bit without much available for storage in the mass. Lights are shown to provide some heat in the evenings as well. Net Gains/Losses: Small heat losses are evident which may not be a problem. Small fires are a possible method of controlling interior temperature if necessary.





American Electric Power

American Electric Power uses a spread sheet program on manual J to generate heat gain/heat loss studies on buildings, which is a commonly used sizing method in the HVAC industry. Studies are based upon hourly calculations; for example, the heat loss is stated as 52794 BTUs per hour, meaning the house has a heat loss of 52794 BTUs every hour. AEP's cost estimates are based on a monthly cost and are calculated by using the efficiency of a particular heat pump and Bin data (weather data) from the past 20 plus years. Wall orientation and glass size are taken into account along with roof overhang.

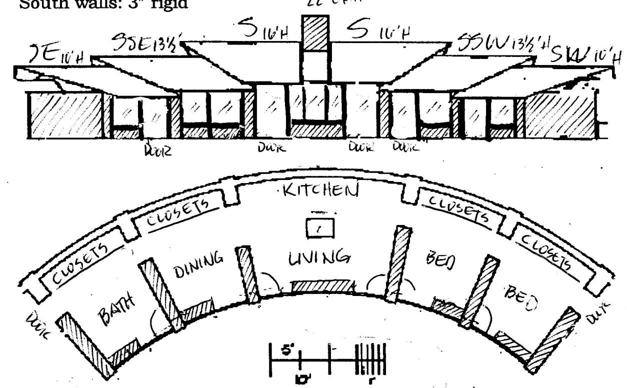
Following are energy reports that were issued by AEP. The three attached reports provide an analysis of first, the Appalachian House design, incorporating a geothermal heat pump; second, an average house of similar size to the Appalachian House for a cost comparison; last, the Appalachian House using 50% less glazing.

House, Robin Rogers, Blacksburg, Virginia

Floor Plan: approx. 1500 sq.ft.
Orientation: faces due south (but is an arc, so some windows are southeast or southwest facing)
Concrete slab with 1" edge insulation, 8" thick
Windows: all double paned, low "e" glass, partial casement, overhangs extend six feet out from windows:
Sizes, from left to right across south face, in feet:
12X4.5, 12X5.5, 22X6, 12X5.5, 12X4.5
Room sizes: left to right across south face, in feet:
12X12, 12X12, 22X12, 12X12, 12X12
Ceiling Heights: from left to right across south face; Ceiling height is given for apex of gable, in feet:
10, 12.5, 15, 12.5, 10
Hallway: 4X80 or 90 feet
North wall: approx. 100 ft., solid concrete, in ground at least 5 ft. the entire length of wall, 8" thick
South walls: solid stone, 2.5' tall, 1 ft. deep, across south face (with doorways and windows in between)... also, solid stone walls radiate into house – they are 2 ft. wide at the south face and extend in height, from left to right across south face:
7.5, 8.5, 10, 10, 8.5, 7.5

Insulation values:

Floor: Underslab 1" rigid
Roof: 6" rigid
North wall: 3" rigid
South walls: 3" rigid



AMERICAN ELECTRIC POWER
ANNUAL OPERATING COST SUMMARY

CUSTOMER NAME	1645 sq ft home	
SYSTEM TYPE	HEAT PUMP with Electric Water Heater	
BUILDING HEAT LOSS	52794	btu/hr
BUILDING HEAT GAIN	25326	btu/hr
COOLING SEER		13.00
HEATING HSPF		8.40
ELECTRIC BASE LOAD	0	kwh/month
HEAT PUMP SIZE	2.5	ton(s)
JOB NOTE:		

MONTH	BASE KWH	CLG KWH	HTG KWH	TOT KWH	COST $
January	0	0	2723	2723	$137.39
Febuary	0	0	2042	2042	$106.56
March	0	0	1383	1383	$76.69
April	0	0	512	512	$34.17
May	0	0	176	176	$16.32
June	0	184	53	237	$19.59
July	0	387	0	387	$27.55
August	0	336	0	336	$24.84
September	0	57	72	129	$13.86
October	0	0	473	473	$32.10
November	0	0	1239	1239	$70.13
December	0	0	2080	2080	$108.25
TOTALS	0	964	10752	11716	

TOTAL ANNUAL HTG. & CLG. COSTS = $583.44
TOTAL ANNUAL HEATING COST = $532.25
TOTAL ANNUAL COOLING COST = $51.19

THE THERMAL BALANCE POINT FOR THE RECOMMENDED HEAT PUMP IS 36 DEGREES F.

The results are strictly an estimate of the energy consumption and/or costs for the particular structure involved and are based on specific building parameters and operation. Any change in these building parameters and operation could cause variation in the results.

COMMENTS:

AMERICAN ELECTRIC POWER
ANNUAL OPERATING COST SUMMARY

CUSTOMER NAME	ROBIN ROGERS	
SYSTEM TYPE	GEOTHERMAL HEAT PUMP	
BUILDING HEAT LOSS	52425	btu/hr
BUILDING HEAT GAIN	35955	btu/hr
COOLING EER/SEER		17.50
HEATING COP		4.00
ELECTRIC BASE LOAD	0	kwh/month
HEATING CAPACITY:	42000	btu/hr
COOLING CAPACITY:	42000	btu/hr

JOB NOTE:

MONTH	BASE KWH	CLG KWH	HTG KWH	TOT KWH	COST $
January	0	0	1336	1336	$74.56
Febuary	0	0	1171	1171	$67.08
March	0	0	805	805	$49.76
April	0	0	388	388	$27.59
May	0	0	157	157	$15.32
June	0	194	47	241	$19.81
July	0	409	0	409	$28.72
August	0	354	0	354	$25.80
September	0	60	65	125	$13.66
October	0	0	369	369	$26.57
November	0	0	741	741	$46.33
December	0	0	1132	1132	$65.31
TOTALS	0	1017	6211	7228	

TOTAL ANNUAL HTG. & CLG. COSTS = $376.49
TOTAL ANNUAL HEATING COST = $322.49
TOTAL ANNUAL COOLING COST = $54.00

THE THERMAL BALANCE POINT FOR THE RECOMMENDED HEAT PUMP IS 18 DEGREES F.

The results are strictly an estimate of the energy consumption and/or costs for the particular structure involved and are based on specific building parameters and operation. Any change in these building parameters and operation could cause variation in the results.

COMMENTS:

AMERICAN ELECTRIC POWER
HEAT LOSS AND HEAT GAIN SUMMARY

Customer: ROBIN ROGERS
Address: 2301 GLADE RD
City: BLACKSBURG

winter design temp. difference (degrees F.) = 70
summer design temp. difference (degrees F.) = 20

ENTIRE HOUSE

Type of Exposure	Heat Loss (btuh)	Heat Gain (btuh)
Windows	9639	17595
Other	0	0
Doors	1735	584
Walls	6205	836
Ceilings	3360	2100
Floors	6917	0
Infiltration	19803	2829
Sub-total Loss	47659	
Duct Loss	4766	
Total Btuh Loss	52425	
People		0
Appliances		1200
People & Appliances		1200
Sub-total Gain		25144
Duct Gain		2514
Latent Gain		8297
Total Btuh Gain		35955

ROOM BY ROOM

Room	Zone or System #	Heat Loss (btuh)	Heat Gain (btuh)	Recommended cfm per room per zone/system	Recommended % of cfm per room per zone/system
ROGERS HM	1	50037	35955	1148	95.6%
Room #2	1	0	0	0	0.0%
Room #3	1	0	0	0	0.0%
Room #4	1	0	0	0	0.0%
Room #5	1	0	0	0	0.0%
Room #6	1	0	0	0	0.0%
Room #7	1	0	0	0	0.0%
Room #8	1	2388	0	52	4.4%
Room #9	1	0	0	0	0.0%
Room #10	1	0	0	0	0.0%
Room #11	1	0	0	0	0.0%
Room #12	1	0	0	0	0.0%
Room #13	1	0	0	0	0.0%
Room #14	1	0	0	0	0.0%
Room #15	1	0	0	0	0.0%
Room #16	1	0	0	0	0.0%
Room #17	1	0	0	0	0.0%
Room #18	1	0	0	0	0.0%
Room #19	1	0	0	0	0.0%

JOB NOTES:

This house requires a cooling system with a total minimum capacity of 35955 BTU's per hour or 3.00 TONS and should not be oversized by more than 25 percent. This calculation is based on ASHRAE guidelines, ACCA's Manual J and specified building parameters. Any change(s) in these parameters may change the results shown.

ZONE / SYSTEM

Zone or System #	Heat Loss (btuh)	Heat Gain (btuh)	A/C or HP Tonnage	Volume	CFM for 3.5 A/T per hour	CFM for 4.0 A/T per hour	CFM for 4.5 A/T per hour	CFM for Calculated Heat Gain	TOTAL CFM
1	52425	35955	3.0	15400	898	1027	1155	1199	1200
2	0	0	0.0	0	0	0	0	0	0
3	0	0	0.0	0	0	0	0	0	0
4	0	0	0.0	0	0	0	0	0	0

AMERICAN ELECTRIC POWER
ANNUAL OPERATING COST SUMMARY

CUSTOMER NAME	ROGERS 50% LESS GLASS	
SYSTEM TYPE	GEOTHERMAL HEAT PUMP	
BUILDING HEAT LOSS	47137	btu/hr
BUILDING HEAT GAIN	23497	btu/hr
COOLING EER/SEER	17.50	
HEATING COP	4.00	
ELECTRIC BASE LOAD	0	kwh/month
HEATING CAPACITY:	30000	btu/hr
COOLING CAPACITY:	30000	btu/hr

JOB NOTE:

MONTH	BASE KWH	CLG KWH	HTG KWH	TOT KWH	COST $
January	0	0	1410	1410	$77.91
Febuary	0	0	1151	1151	$66.17
March	0	0	772	772	$47.99
April	0	0	352	352	$25.70
May	0	0	141	141	$14.48
June	0	127	43	170	$16.00
July	0	267	0	267	$21.18
August	0	231	0	231	$19.27
September	0	39	59	98	$12.19
October	0	0	334	334	$24.73
November	0	0	713	713	$44.85
December	0	0	1134	1134	$65.37
TOTALS	0	664	6108	6772	

TOTAL ANNUAL HTG. & CLG. COSTS = $351.84
TOTAL ANNUAL HEATING COST = $316.58
TOTAL ANNUAL COOLING COST = $35.26

THE THERMAL BALANCE POINT FOR THE RECOMMENDED HEAT PUMP IS 27 DEGREES F.

The results are strictly an estimate of the energy consumption and/or costs for the particular structure involved and are based on specific building parameters and operation. Any change in these building parameters and operation could cause variation in the results.

COMMENTS:

AMERICAN ELECTRIC POWER
HEAT LOSS AND HEAT GAIN SUMMARY

Customer: ROBIN ROGERS
Address: 2301 GLADE RD
City: BLACKSBURG

winter design temp. difference (degrees F.) = 70
summer design temp. difference (degrees F.) = 20

ENTIRE HOUSE

Type of Exposure	Heat Loss (btuh)	Heat Gain (btuh)
Windows	4832	8883
Other	0	0
Doors	1735	584
Walls	6205	836
Ceilings	3360	2100
Floors	6917	0
Infiltration	19803	2829
Sub-total Loss	42852	
Duct Loss	4285	
Total Btuh Loss	47137	
People		0
Appliances		1200
People & Appliances		1200
Sub-total Gain		16432
Duct Gain		1643
Latent Gain		5422
Total Btuh Gain		23497

ROOM BY ROOM

Room	Zone or System #	Heat Loss (btuh)	Heat Gain (btuh)	Recommended cfm per room per zone/system	Recommended % of cfm per room per zone/system
ROGERS HM	1	44749	23497	1047	95.2%
Room #2	1	0	0	0	0.0%
Room #3	1	0	0	0	0.0%
Room #4	1	0	0	0	0.0%
Room #5	1	0	0	0	0.0%
Room #6	1	0	0	0	0.0%
Room #7	1	0	0	0	0.0%
Room #8	1	2388	0	53	4.8%
Room #9	1	0	0	0	0.0%
Room #10	1	0	0	0	0.0%
Room #11	1	0	0	0	0.0%
Room #12	1	0	0	0	0.0%
Room #13	1	0	0	0	0.0%
Room #14	1	0	0	0	0.0%
Room #15	1	0	0	0	0.0%
Room #16	1	0	0	0	0.0%
Room #17	1	0	0	0	0.0%
Room #18	1	0	0	0	0.0%
Room #19	1	0	0	0	0.0%

JOB NOTES:
W/50% LESS GLASS

This house requires a cooling system with a total minimum capacity of 23497 BTU's per hour or 1.96 TONS and should not be oversized by more than 25 percent. This calculation is based on ASHRAE guidelines, ACCA's Manual J and specified building parameters. Any change(s) in these parameters may change the results shown.

ZONE / SYSTEM

Zone or System #	Heat Loss (btuh)	Heat Gain (btuh)	A/C or HP Tonnage	Volume	CFM for 3.5 A/T per hour	CFM for 4.0 A/T per hour	CFM for 4.5 A/T per hour	CFM for Calculated Heat Gain	TOTAL CFM
1	47137	23497	2.0	15400	898	1027	1155	783	1100
2	0	0	0.0	0	0	0	0	0	0
3	0	0	0.0	0	0	0	0	0	0
4	0	0	0.0	0	0	0	0	0	0

Vitae

Robin E. Rogers

Vitae — August 1999

For the past 14 years I've been a research associate for Virginia Tech working for the electrical and computer engineering department as a public relations specialist, primarily in the Fiber & Electro-Optics Research Center. Prior to that I was co-owner and vice president of an independent bookstore in Blacksburg where I maintained the entire book and related sidelines inventory for the more than $1 million gross sales business. I have also worked as a freelance graphic designer, newspaper photographer and designer in a local design firm. I attended the Corcoran School of Art in Washington, D.C., and Arkansas State University.