Questioning the Architectural Canon in Light of Contemporary Needs:

Native American Architecture as an Example of Richness in Simplicity

lukaspetrash@gmail.com

Undergraduate Senior Thesis, University of Southern California
T. Lukas Petrash, B.Arch, USC School of Architecture, 2006

This paper was written during the author's enrollment at the University of Southern California, and was intended for an academic audience with a certain level of subject familiarity. The author wishes to thank Janek Dombrowa, AIA, under whose professorship this thesis was completed.

It is the author's desire that the information contained herein be publically available and accessible as an educational aid. Every reasonable effort has been made to conduct scholarly research and present relevant findings in a meaningful and unbiased way.

Disclaimer: This paper is presented solely for educational purposes. The author accepts no liability for the accuracy of the information or opinions contained herein, or for the actions and decisions of any individual who chooses to read it.

NOTE: Many images included in the original paper and appendices have been removed for legal (copyright) reasons. However, the image source references have been retained for the benefit of those who would care to search for them.

Abstract

The intention of this exposition is to show by example the richness, synergy, and wealth of knowledge embodied in architecture which is commonly overlooked in architectural education today. Architecture today faces many challenges—in particular, the rapid depletion of nonrenewable resources/energy and the abuse of our fragile "spaceship earth." Yet earth-consciousness is not a new phenomenon. It has been dealt with by scores of civilizations before us, though we do not always recognize them. So often we focus our architectural studies on those civilizations and movements which we deem to be the "greatest" (such as the Egyptians, Greeks, Romans, Modernity, etc.), ignoring the works of civilizations less grand. Unfortunately, many of the "great" precedents and historical monuments which students are taught in school are far from sustainable. What an architecture student is taught is what s/he will be constituted with, and what s/he will eventually emulate. If students study inefficient, environmentally unfriendly building precedents—however spectacular they may be—they will perpetuate such. On the other hand, if they study a wide variety of types and solutions from cultures with world views different than their own, their imagination will be expanded and they will be better equipped to answer today's needs with efficient, environmentally friendly solutions.

The goal of this research is not to praise a certain culture (in this case, Native Americans), or to raise one culture's architecture above another. The intention is to encourage a respect for that architecture which may appear "primitive" by showing how much richness and synergy there is beyond that which meets the eyes. My hope is to illustrate how much can be learned from studying even the simplest and most modest-appearing building types such as iglus, kivas, and pueblos. If we would study these and other such precedents of commonly ignored civilizations, we might be surprised how much knowledge and insight we would gain. So much of what those gone before us knew is applicable to architecture today. The answers are available. And yet it is all for naught unless we can learn to yield our thoughts of monumentality and grandeur, and learn to appreciate *the richness in simplicity.*

Questioning the Architectural Canon in Light of Contemporary Needs:
Native American Architecture as an Example of Richness in Simplicity

Architecture today is looking for answers to many problems. The Modern Movement failed in its effort to transform[1] the people, and many great American cities are dying[2]. (Steele, Jacobs) Overpopulation, housing shortages, and urban sprawl are all-too-common problems as people are flooding into cities throughout the world. Land prices are rising, resources are becoming more scarce, and the energy sources we have long been depending on are showing signs of failure. Even our planet, our fragile "spaceship earth" is failing, and as those responsible for "half of all greenhouse gas emissions worldwide," architects certainly share the blame[3]. (Mazria) As "-ism" after "-ism"[4] comes and goes, failing to answer society's present needs, one begins to wonder: Is there really no solution, or are we as architects doing something wrong?

The problem may lie in *where* we look for our solutions—in the precedents and models we look to for guidance. As architects and students of architecture, what are we taught to admire, and what have we been constituted with? We are taught that which is considered or deemed to be "great." Time is limited, so understandably we focus our attention on and study only the best—the "greatest" architecture. We know of Greece, of Rome, and of many great civilizations who changed the face of the earth, but gloss over or simply ignore the weak and oppressed cultures, the "primitive" buildings, and that which does not feed our eyes.

In this sense, it may be our concept of greatness which is partly to blame for our folly, for what we admire is what we will emulate. So often what we think of when we think of "great" architecture is that which is monumental, grand, or astonishing to the eye—buildings such as the

[1] It was the thought of Modern architects that architecture should transform the people, and that like a "washing machine," good (Modern) architecture should transform the people. In other words, architecture should be able to cleanse a society of its ills. (lecture, James Steele, Architecture 214)
[2] referring to Jane Jacob's research and findings published in her book, *The Death and Life of Great American Cities*, 1961.
[3] Edward Mazria, AIA. "How Architects can Reverse Global Warming."
[4] -ism, referring to the various progressions/movements in architecture and thought in response to the failure of Modernism to solve society's problems. These "isms"—Post-Modernism, Deconstructivism, Constructivism, Metabolism—to name a few, come and go with rapidity, leaving many problems unanswered.

Greek temples, the Egyptian tombs, or the Gothic cathedrals. More modern examples of "great" architecture may include Le Corbusier's Villa Savoye, or Mies' Seagram Building, or Gehry's Guggenheim in Bilbao—buildings which conquer nature and dominate the landscape. These are surely impressive feats and testimonies to man's ingenuity and architectural (or technological) genius. These are the paradigms which have been engrained into our heads as students/architects. They constitute the breadth of what we know as good architecture—the boundaries of our comprehension and imagination—and thus the pallete from which we will inevitably work.

Yet there are whole "other" worlds which exists, and one in particular—tribal architecture. This architecture represents a world view and value system far different from our own, but at the same time still addresses many of the problems[5] we face today. While the solutions appear so unsophisticated that one might not even think twice about them, one can see upon further investigation that they actually represent a wealth of knowledge and understanding about the earth, the sun, astronomy, structures, material properties, advanced construction techniques, and earth-conscious design strategies. Dwellings such as the Native American iglus, kivas, and pueblos, which appear so simple, are "simple" not because they addresses fewer issues than our buildings do today, but because they are extremely efficient and make the most of everything they employ. They are also modest, not meant to *conquer* nature but to blend in and *complement* the natural environment. More and more architects today are realizing the importance of respecting and preserving the natural environment, and of designing more efficient buildings with lower embodied energy. Nevertheless, due to the prevalence of the perception of tribal architecture as "primitive," the wisdom their solutions embody is hardly known, and their value as precedents is too often forgone.

[5] At its roots, architecture, as a design exercise is response to a series of problems (or needs), is the same today as it has been for thousands of years. Civilizations have always had to deal with problems such as climate control, shelter from the elements, withstanding natural disasters, limited resources, city design and zoning, etc. Though tribal villages may appear very different from our cities today, they nevertheless respond to a similar set of criteria.

There is much to be gained if we can but yield our thoughts of grandeur, monumentality, and complexity, and learn to appreciate the richness in simplicity. My intention is to show by example the architectural richness, synergy, and wealth of knowledge embodied in a few seemingly "simple" examples of Native American architecture, particularly the iglu, the kiva, and the pueblo. We may think we *know* these building types because we have seen them before, and because they have achieved a certain iconic status in our society today. (Nabokov 12) But there is so much more than meets the eye—so much that can be taken from tribal architecture and applied in architecture today—if we can learn to respect it enough to spend some time and dig deeper.

The Iglu:

For thousands of years, the Native American people thrived across the North American continent, developing highly advanced societies and civilizations in what is now the Eastern and Southwestern United States, Mexico, and Central America. Over time, however, as the Europeans arrived and began to conquer and occupy the new world, many native peoples were displaced from their lands of bountiful resources and forced to find refuge often in the "unlivable," leftover[6] regions. Inhospitable areas such as the interior subarctic tundras of Alaska and Canada or the deserts of the Southwest became "Indian territory." And yet here in the harshest regions we find some of the most fascinating and ingenious architectural responses (Morgan xvi). The overwhelming heat, cold, and dryness of these areas did not prevent the Native Americans from living and thriving in them. On the contrary, it prompted smarter, more sustainable, "earth-conscious" designs, which we as architects can learn from today.

[6] Time and time again, the Native American peoples were pushed from their homelands by white settlers or by the government into reservations of the least desirable land. Many Indians were forced to reservations, "leftover" lands. However, many fled to these "uninhabitable" areas and settled in them simply hoping never to be bothered or forced out by the white man again. The swamps of Florida, the sands of Oklahoma, the deserts of Arizona and New Mexico, the subarctic tundras of Alaska—these became the areas known as Indian territory. Yet no matter how "uninhabitable" the environment they found themselves forced into, the Native American people always seemed able to develop and sustain societies with incredible, imaginative architectural responses.

In order to appreciate the iglu (or any Native American shelter for that matter), one must first understand a little bit about their culture and perception of the home. Almost all Native Americans had "seasonal rounds," based on food-gathering, and thus it behooved them to develop simple but functional shelters which were either portable or which could be rebuilt many times throughout their lifespan. (Nabokov 34) Their dwellings were not conceived "as articles of permanent craftsmanship," and were viewed "less as permanent structures than as byproducts of nature constantly in the process of returning to nature." (Nabokov 17, Morgan xv) When encouraged to exchange their portable houses for European-style homes, one Indian chief replied, "Why now do men of 5 to 6 feet need houses which are 60 to 80….do we not find in our dwellings all the conveniences and advantages that you have in yours, such as reposing, drinking and sleeping, eating, and amusing ourselves with friends…" (Nabokov 12) There is certainly something to be said for architecture which not only blends in aesthetically with the landscape, but also respects the local environment and resources while satisfying man's needs. As modern concerns about global warming, high energy costs, and depletion of natural resources rise, the Native Americans' attitude toward housing and balancing man's need with the best interest of the earth seems more and more appropriate.

Although many architects and critics today are realizing the need for sustainable design, there is one critical difference in the Native American conception of earth-conscious design and our contemporary conception. Often today, when we speak of environmentally-friendly architecture, there is a "less-about-us and more-about-the-earth" mentality. In other words, there is the expectation that we as humans ought to sacrifice some of our comforts and alter our (energy-hog) lifestyles to do what is best for the earth. This may include biking to work rather than driving, taking shorter showers, keeping smaller lawns, or putting on extra layers of clothes rather than running the central heat. Or it may mean paying more for a building to make it "green," or

paying higher taxes, or penalties, etc. There is almost always some element of *sacrifice*[7] on the part of the user. However, what is critical to note in the Native American model of sustainability is that care for the environment was achieved not by sacrifice on the part of the individual, but by smart, extremely efficient design. In the same way as form follows function, so sustainability followed (i.e. incorporated itself into) the societal needs. And in order to survive, the Native Americans had to learn to design *with* nature and make the most of little by way of smart, sustainable designs. The iglu of the Inuit is a perfect example of this.

The iglu performs very well in the cold subarctic climate because it satisfies several critical thermal issues. In a cold climate, the most efficient shape for a shelter is one which encloses maximum volume with minimal surface area. (Schiler) In other words, a sphere, dome, or cylinder is much more energy efficient than a rectangular prism, such as a box. *[see figure 1]* This is because heat (energy) is transferred through the outer walls of a building, and thus the more walls there are, the more surface area there is for heat loss to the outside. Also, since heat rises, it is also ideal to have more vertically compressed spaces, so that the heat generated by humans (or fire) within the space remains in the same stratosphere in order to keep the occupants warm. (Thus a dome is more efficient than a sphere.) There should be no wasted space. At the same time, to prevent wind pressure from driving cold air or moisture through tiny cracks in the shelter's walls, an aerodynamic shape which does not block the wind is preferable. A house with flat walls will suffer, and may even be blown over by the wind. A rounded house (such as the Inuit iglu) is an excellent choice because it redirects, but does not block the wind. *[see figure 1]*

A domed house is also preferable over a prismatic (rectangular) house due to the structural and thermal properties of the available building materials. As a material, water (or in this case, ice) is an excellent thermal insulator, which means it prevents the transfer of heat through the material.

[7] As long as "being sustainable" is equated with "sacrifice"—i.e. sacrificing ones own comfort or privilege for the greater good (of the earth in this case)—one cannot blame those who do not participate, for such an expectation violates human nature and the laws of self-interest, survival of the fittest, etc. In order for sustainability to be mainstream, it must not contradict the individual's cost vs. benefit analysis.

Ten inches of un-compacted fresh snow (7% water) performs as well as 6” thick R-18 fiberglass insulation, which is 150% more insulation than the typical exterior walls of a house today. (newton.dep) Ice, being much greater in density, has a substantially higher R-value and thus performs even better. It is far superior to wood or animal skin, which may have been the only alternative materials for the Inuit. Thus ice is the wisest building material. Like stone, ice is good in compression, but cannot withstand tension. This means that it can be pressed without being crushed, but it cannot be pulled or stretched without cracking. The implication therefore is that ice cannot be used for beams or slabs to span a rectilinear roof, because such systems work in tension. It is perfectly suited, however, for use in compression structures such as arches or domes, and was thus well employed by the Inuit. *[see figure 1]*

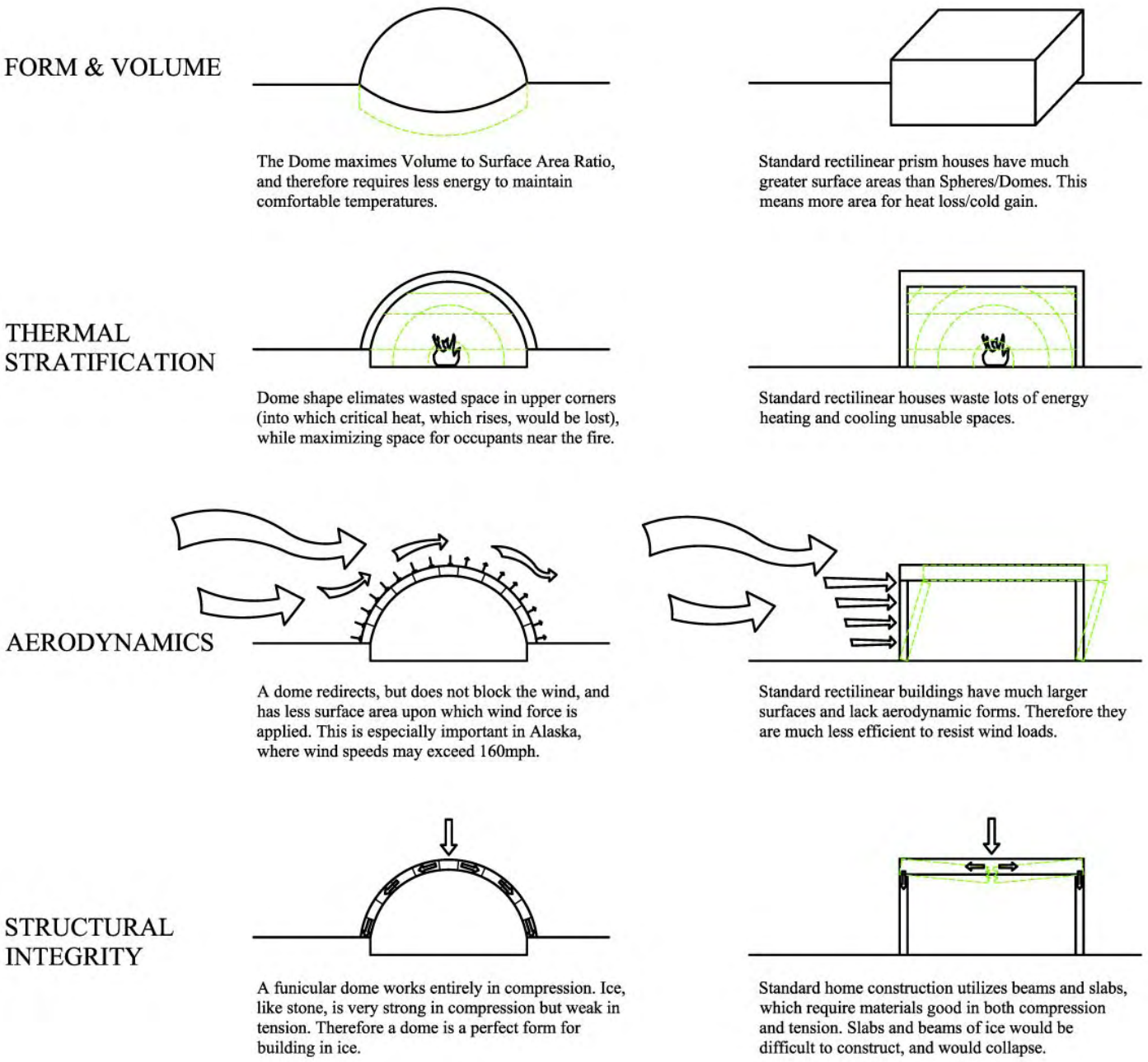


Figure 1: *Thermal, Structural, & Spatial Performance comparison of an Inuit iglu vs. a standard rectilinear home, illustrating the brilliance and synergy and involved in a seemingly simple design. (source: T. Lukas Petrash)*

The dome is in many ways an ideal solution, but building a dome is no simple task. It was not until around 100 B.C.E. that the Romans discovered that by rotating the arch they could create a dome. (answers.com) However, their method for building a dome required lots of wood for formworks to hold the individual pieces of the dome in place as the dome was being constructed, so that it did not cave in on itself. Wood has always been an essential part of building a dome, and the lack of wood has prevented many countries from utilizing domes, as well as arches. It was a major discovery[8] when in the later half of the 20th century, Hassan Fathy, an Egyptian architect, found Nubian masons who knew the secret trade of building a vaulted space without formwork. (Fathy) *[see figures 2 & 3]*

[image removed]

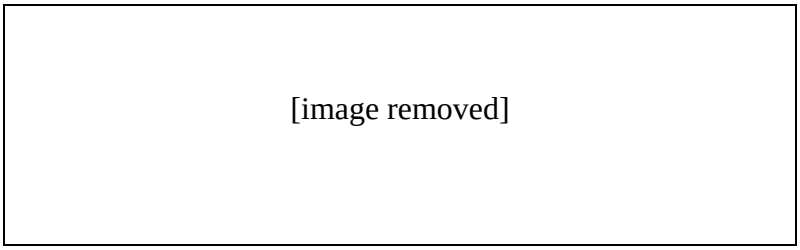
[image removed]

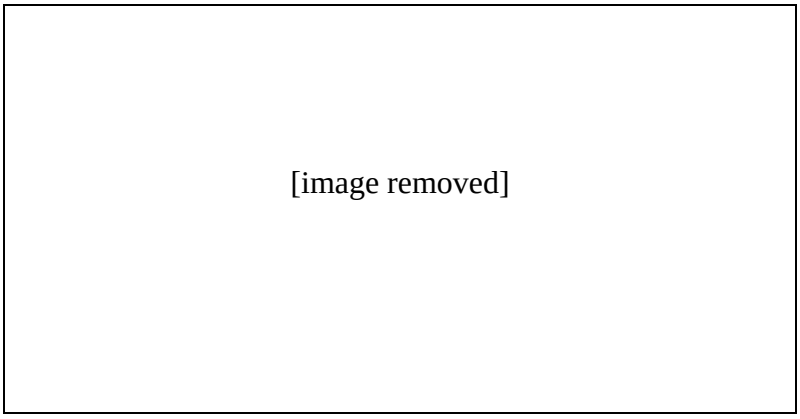
Figures 2 & 3: *Nubian masons displaying the "secret" knowledge of how to build a vault without formwork. This knowledge allowed for vaults to be constructed with little cost or waste of materials.*
(source: Fathy "Illustrations," figures 13-18)

[8] The key to making shelters (almost free of cost) for the otherwise homeless peasants was to use only the naturally available materials (earth and water), and a simple, learnable system of vault construction. As far as Hassan Fathy knew, the ancient technique of formwork-free vault construction was lost, and thus no peasant could afford to build a home for him/herself because they did not have access to wood for formwork. When Fathy's good fortune led him to a group of Nubian masons who knew the secret skill, he was beside himself. This certainly was a major discovery/advancement in architecture for the poor.

Thus it is no small achievement that the Inuit were able to develop a method for buildings domed iglus (with diameters of up to 15 feet or more) free of wood formwork. (Nabokov 195) They do this by gently slanting or spiraling the courses of ice blocks so that they lean against (and stick to) one another as they build the iglu upward. *[see figures 4 and 5]* They also built it exactly according to the catenary shape of the roof in order to prevent caving or bulging due to its optimum height-to-diameter ratio. (Nabokov 194) Once the iglu (which can be built by one many in a matter of hours) is complete, the fire inside melts the interior side of the ice blocks and forms a protective crust. (Nabokov 196) Thus the iglu is solidified structurally and sealed from the wind.

With all of this in mind, it is no wonder that when the U.S. Army hired Vilhjalmur Stefansson to write its World War II Artic survival manual, he "could not improve on what the Eskimos had taught him." (Nabokov 207) He simply "set down step-by-step instructions for building the snow block iglu." (Nabokov) However simple these ice dwellings may appear, they embody countless principles and testify strongly to the wisdom of their builders.





Figures 4 & 5: *Inuit iglu construction techniques, showing the erection of a dome without formwork. In other civilizations, domes were rarely possible without wood or other formwork to hold the dome in place during construction. (source: Nabokov 194-7)*

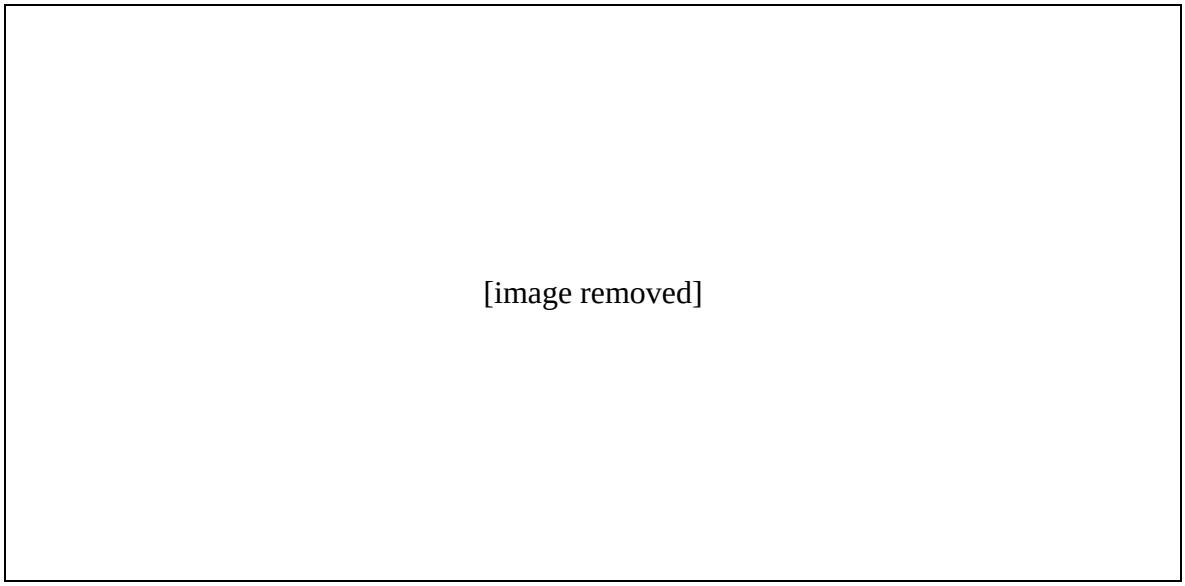
The Kiva

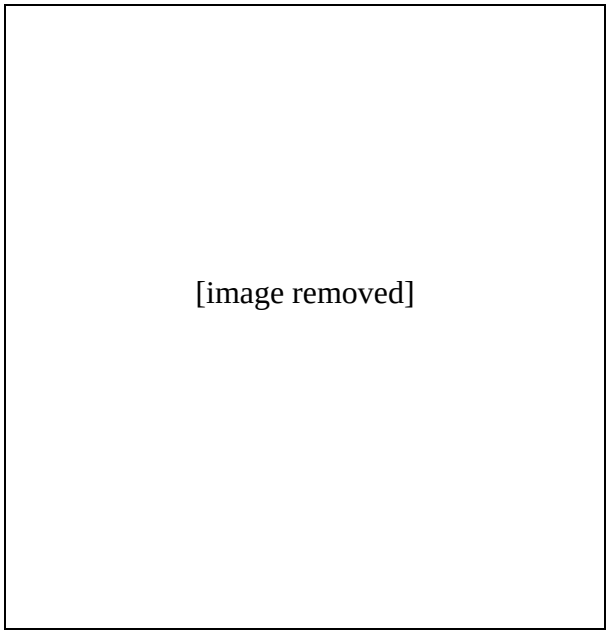
More amazing structural innovations (similar to those illustrated in the formwork-free dome of the Inuit iglu) can be seen in the kivas of the Anasazi who occupied the Southwest United States long ago. If one visits the ancient sites and views the excavated kivas today, they may appear little more than circular holes in the ground, or "pit houses." (Nabokov 356) It is easy to walk right past them without thinking twice about them, and to remain completely ignorant of the complex structural issues they solve. Many are familiar with the images of these subterranean meeting spaces, and of their social function, but who has ever stopped to consider how they looked thousands of years ago, or of how they were built? How did the Native American builders span such great diameters of sixty-three feet or more, as in the great kiva of Casa Rinconada? (Noble 33) It was a great advance for architecture when the Pantheon, which spanned 142 feet, was completed in the 2nd century A.D. Far beyond its time, the Pantheon remained the largest-spanning dome for over one thousand years, until Brunelleschi's dome was completed on the Florence Cathedral in 1436. (Schierle) From the earliest examples of corbelled[9] arches and domes, spanning large circular spaces has always been a challenge[10]. Ancient Greece and especially Rome have been acclaimed for advancing dome technology, but the Native Americans developed fascinating methods as well. They came up with a method for spanning large domed spaces free of formwork or outward thrust. This little-known method uses wood logs, and is known as cribbing. *[see figure 6]* The strength of the cribbed dome can be seen in the fact that it was covered with a thick deposit of soil in the case of the Native American kiva. *[see figure 7]* Not only did the soil roof blend the subterranean architecture with the landscape, and provide a good source of thermal insulation in the harsh desert climate—it also helped keep the kiva in "utmost secrecy." (Nabokov 356) "People want to find out…but they can't," a Taos man once remarked to an anthropologist.

[9] as seen in Mycenean architecture, such as Agamemnon's tomb built around 1500 B.C.

[10] The great temples of Greece and Egypt, for instance, were limited to spans of approximately fourteen feet maximum, due to the limited structural capacity of stone. (Schierle) It is hard to find a column-free interior space spanning a large gathering area (such as can be seen in Native American cribbed kivas) in ancient architecture.

(383) “Our ways would lose their power if they were known.” (383) Even today, few know of the cribbed dome technique, or have given the Native Americans credit for their creativity and advanced knowledge of structures.





Figures 6 & 7: *Cribbing technique used by the Anasazi to cover the kiva. The great kiva at Casa Rinconada, the largest known kiva, has a diameter or 63 feet, and utilized this method of cribbing to cover the span. (Source: Lekson 33)*

The structure of the kivas also implies that the Native Americans understood the principle of the arch. Given the time of their migration across the Bering Strait (long before the Romans “discovered” the arch), and their isolation from Europe, it is unlikely that they brought the

knowledge with them. Rather, it seems that they "discovered" the arch on their own, and may have done so even before[11] the Romans. If the knowledge which enabled Rome not only to transform the face of architecture but also to conquer and connect the known world as it did (through the use arches/bridges), was also held by the Native Americans, how can we consider Native American architecture to be simple, or primitive? If it were determined that the Indians discovered the arch before the Romans, this would surely turn heads, and raise people's respect for tribal architecture. And yet, though we are familiar with images of kivas and pueblos and tipis, where can we find an arch in Native American architecture?

It was only through my own investigation, not through any book or person that it came to me that the kiva itself is an arch—a *horizontal* arch. *[see figures 8, 9, 10]* The circular wall of the kiva, which is dug deep into the earth, must act as a retaining wall in order to counteract the immense inward thrust from soil pressure. Due to the circular, continuous arch-like form of the wall, the kiva is kept from collapsing in on itself, for the entire system acts in compression like a horizontal arch. In the same way that a vertical arch resists vertical loads in compression, so the horizontal arch as seen in the kiva resists lateral (i.e. horizontal) loads in compression as well. Though it may not resemble an arch as we are used to seeing it, it performs much the same.

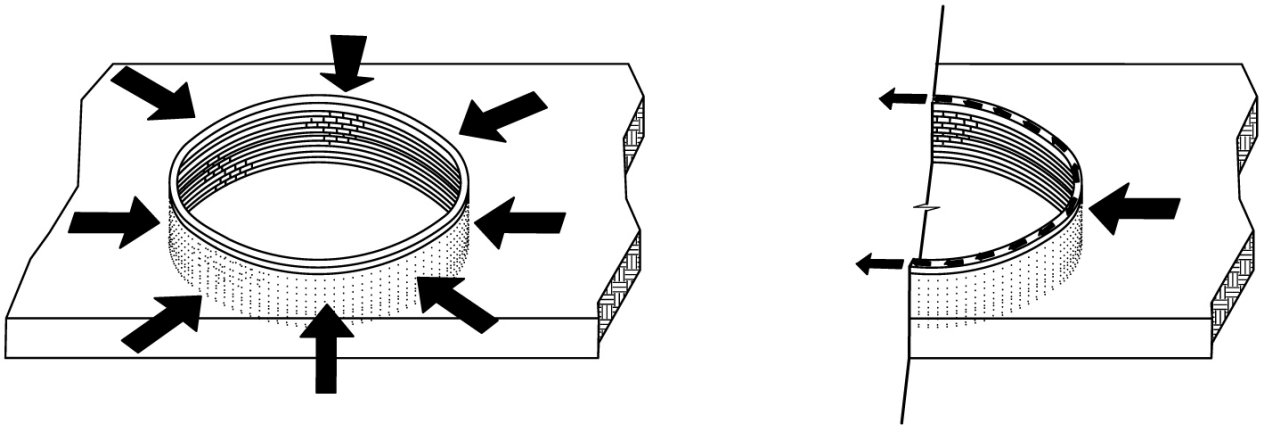
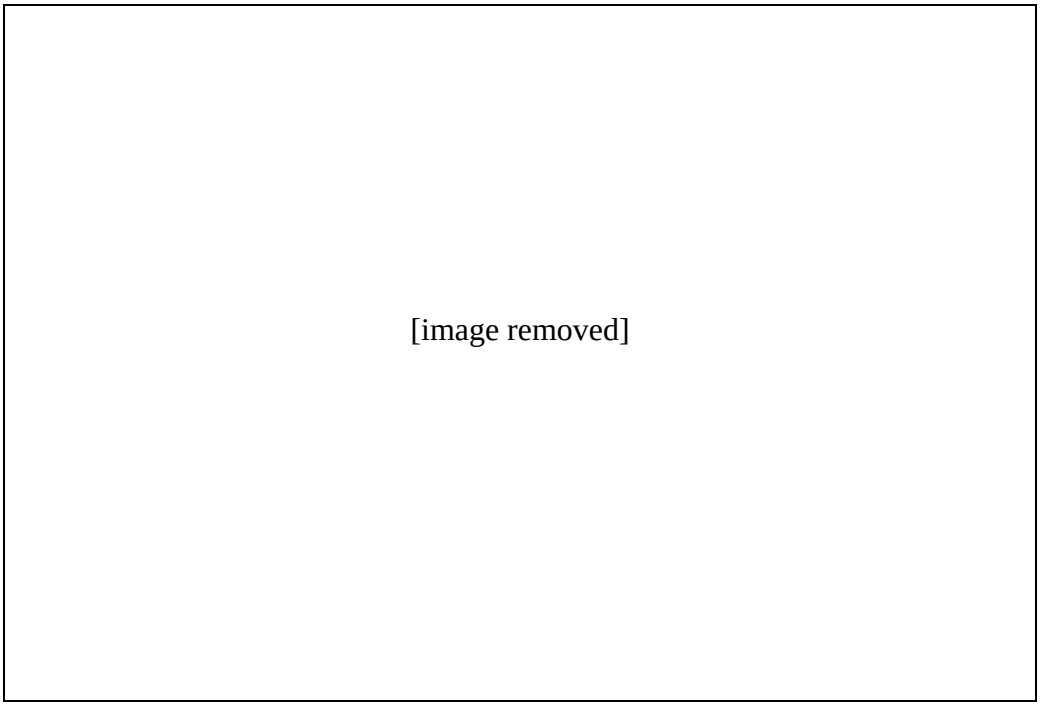
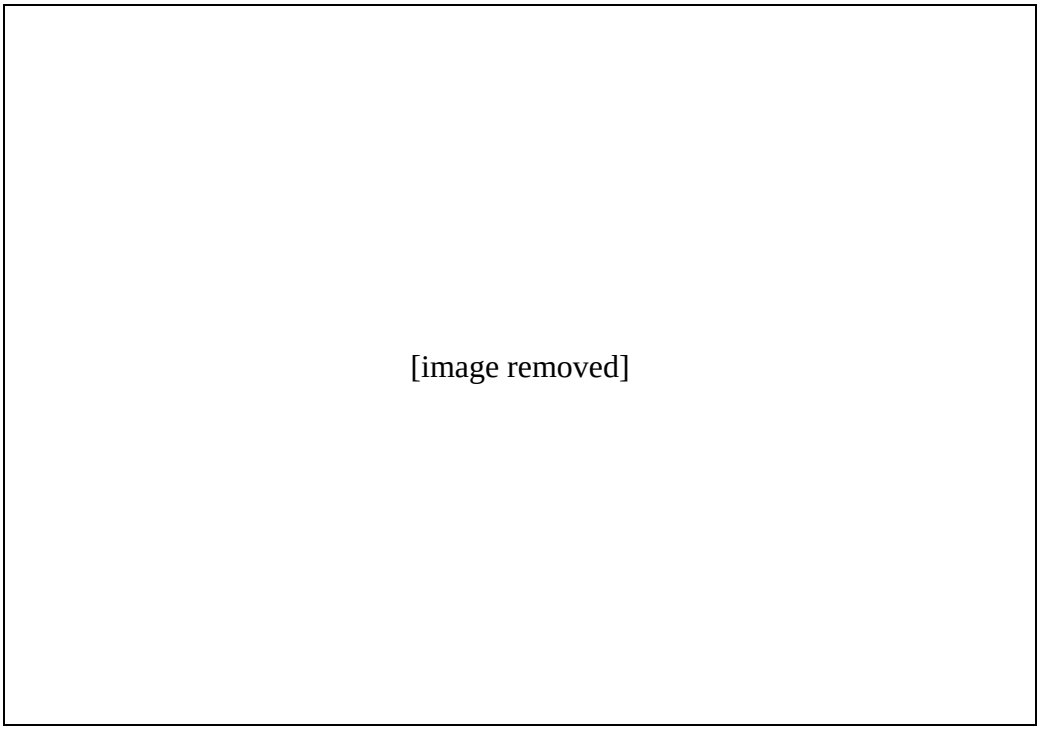


Figure 8: *The kiva as a horizontal arch, resisting lateral soil pressure loads (Source: T. Lukas Petrash)*

[11] As most (some experts have estimated as much as ninety percent) of ancient Indian sites remain un-excavated, it is hard to tell how early the Indians knew of the arch.





Figures 9 & 10: *Circular kiva wall as a horizontal arch, bearing the soil load.*
(Source above: Noble 33; source below: Noble 7)

The Pueblos of the Anasazi:

Pueblo Bonito (Chaco Canyon, N.M.), and Cliff Palace (Mesa Verde, CO.)

When Coronado saw the great pueblo cities in their glory hundreds of years ago, he was astounded and exclaimed: "I do not think they [the Indians] have the judgment and intelligence needed to be able to build those houses in the way in which they are built, for most of them are entirely naked." (Nabokov 350) Unfortunately, even from Coronado's time the "almost naked" Native Americans were already being stereotyped[12] as "primitive." Nevertheless, their buildings prove them to be otherwise. It is impossible to see and understand the knowledge with which the pueblo builders built, and not be impressed, for in many areas the pueblos surpass the energy-dependent dwellings we have today.

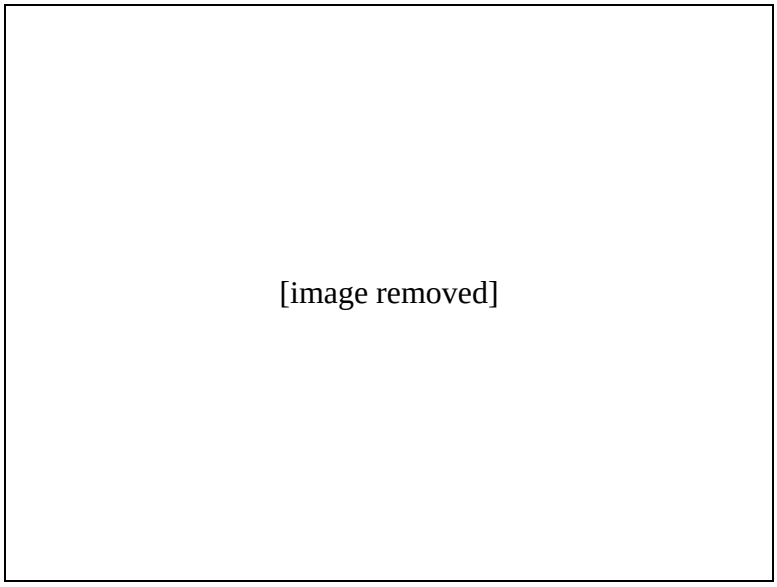
One of the first and most important aspects of the pueblos is their careful site selection and orientation. Contrary to today's developer mentality, the Native Americans understood that humans "are not distinct, separate beings from the natural environment," but that "every act and thought…affects the cosmos." (Morgan vii) Thus as they occupied the land they did so with a sensibility "that allowed nuances of the wind, sun, and ground to affect their decision making." (Morgan vii) The Anasazi believed that they had emerged onto the earth from "the depths of the Grand Canyon itself." (Scully 4) Thus they regarded themselves "as an integral part of this particular landscape, and their early buildings tended to echo its shapes and evoke its depths." (Scully 4) Rather than change the environment to fit their needs, they did the best they could to incorporate their villages into the existing site with as few changes as possible. (Morgan 265) They were also careful to use only locally[13] available materials, in this case "earth, stone, and

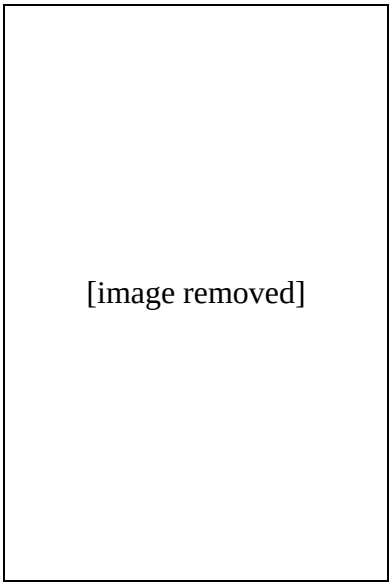
[12] Stereotyping a culture or their architecture as "primitive" may directly prevent others from appreciating it or deeming it worthy of study. Coronado was influenced by a stereotypical image of Indians, but could see the Indian cities in their glory and realize his wrong conception. Unfortunately, today we cannot see these cities in their original glory, and too often the merit which Native American architecture deserves goes unobserved.

[13] often encouraged by sustainable experts today

sunlight," so as to maintain harmony with the land. (Nabokov 356) In everything they did, they sought to maintain harmony with nature, not to conquer[14] it as we try to do today.

In choosing a site, orientation for protection from sun in the summer and full exposure in the winter was essential. The Cliff Palace at Mesa Verde is situated very precisely in the crevice of a cliff, facing south, high above the canyon below *[see figure 11]*. The Indians had many reasons for locating pueblo buildings in cliffs, including: "conserving limited available land for food production, avoiding occasional floods on the canyon floor, taking advantage of the protective overhangs of natural caves," protecting themselves from enemies, and taking advantage of stone in nearby quarries. (Morgan intro, 265) Mesa Verde in particular has an optimal solar shading situation. During the summer, the high, hot summer sun is blocked by the cliff overhang. But during the winter, when heat is desirable, the low angle of the winter sun allows for full light to be shed on the pueblos *[see figure 12]*.





Figures 11 & 12: *Cliff Palace (Mesa Verde)*
Orientation for optimal winter sun with minimal hot summer sun. (source: Nabokov 358)

[14] Conquer. So often we look to technology as a means to reverse the effects of nature and to create the artificial environments that envision in our designs. Hundreds of years ago, one had to understand the sun and the wind and materials in order to design livable buildings. Now with electricity, forced air (HVAC), artificial lighting, etc., too often architects seem to forget that it was once possible to design comfortable spaces without this, but in total reliance on the sun, the wind, and the natural environment.

Pueblo Bonito, another marvel[15] of ancient Indian architecture, is oriented in a similar manner without the cliff *[see figure 13]*. Just as at Mesa Verde, the terraced façade of Pueblo Bonito faces south, so that during the winter the adobe walls and roofs soak up solar heat all day and then radiate it into the domestic rooms at night. (Nabokov 356) This keeps the occupants warm inside of the pueblos, even though the nightly desert temperatures may drop very low. The Pueblo builders designed their apartment buildings to collect heat from the sun from dawn to dusk of each winter day. In the morning, the sun would strike the east face of the crescent, warming the work terraces almost immediately. Throughout the day, as the sun moved westward across the sky, it would provide heat and light to the various workspaces, which were zoned according to tasks to take optimum advantage of the sun. (Noble 19) The workspaces changed not only during the day, but also throughout the year to reflect the solar rhythms.

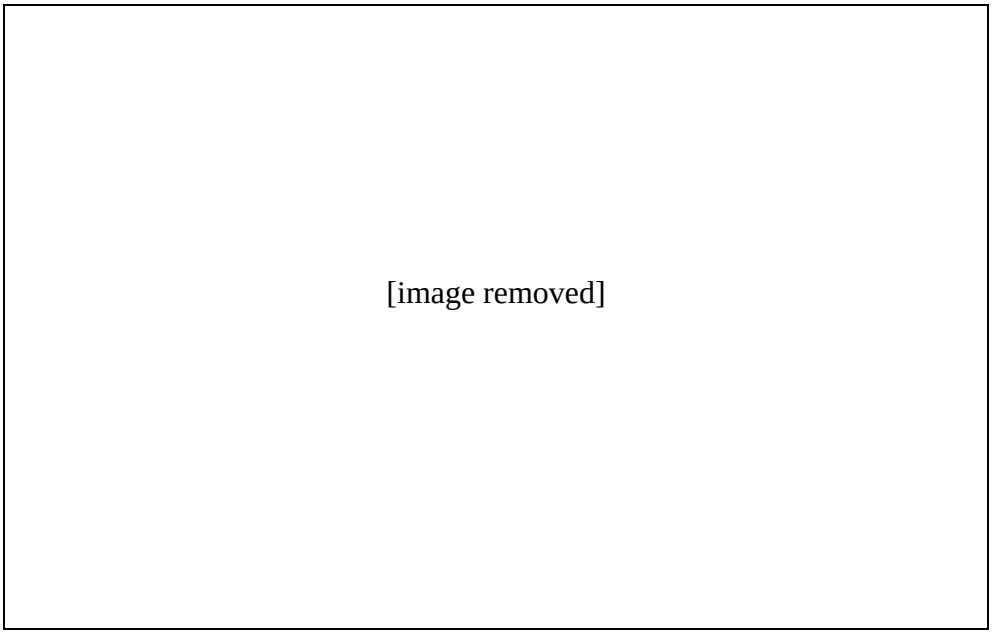


Figure 13: *Pueblo Bonito, oriented for optimum sun and shade. (Source: Noble 19)*

[15] Pueblo Bonito, the center of the Chacoan world, was the largest single structure in North America at the time of its construction. (Mays 51) Built in five stages from A.D. 860 to 1250, with an estimated 805,000 person hours, Pueblo Bonito is no small feat. (Neitzel 45) Construction of a typical room (of which there approximately 800) required 45,000 kilograms of stone, 15,000 kilograms of clay, and 4,100 liters of water. (Morgan 43, Nabokov 361) The massively timbered roof or ceiling of a typical room required 40 beams, each a separate pine or fir tree obtained from forests up to 60 kilometers from the desert canyon. (361)

For the Pueblo Indians, keeping themselves warm in the winter was only half the battle. In order to survive the summer heat, they had to develop tactics for cooling their homes naturally. In order to protect themselves from excessive summer heat, they built arbors or armadas, which they occasionally splashed with water for evaporative cooling. (Nabokov 27) Because evaporation of water molecules requires lots of heat (i.e. energy) to convert the solid into a gas, it removes heat from the air, thus lowering the temperature by ten degrees or more. (27) They also understood how to diminish heat by inducing air flow. The optimal scenario for natural ventilation is to situate air inlets low and air outlets high, so as to draw in cool air and flush hot air. (Schiler) One can see in the sections of their pueblos that the windows were placed high not only to allow light to penetrate deeply into the rooms, but also to encourage air to flow in order to cool the space *[see figure 14]*. Without electricity, they were able to maintain comfortable living conditions in the winter as well as the summer, and to provide the spaces with adequate natural light over a thousand years ago. They did this by using thermal mass, inducing air currents, and taking advantage of natural light.

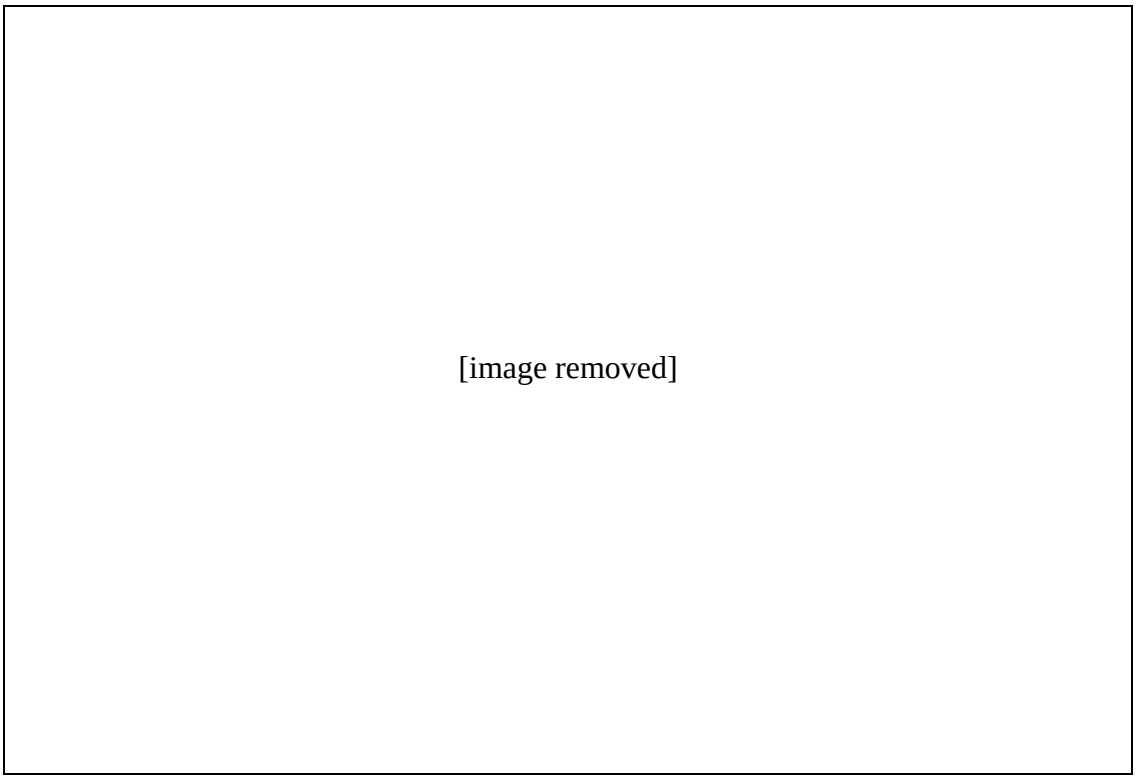


Figure 14: *Idealized Pueblo cross-section, illustrating sustainable design techniques (source: Nabokov 370-1)*

Another seldom discussed aspect of the pueblo buildings is their astronomical and cosmological[16] value. Sun worship is "strongly reflected in Anasazi architecture, landscape settings, and petroglyphy," and can be traced in modern Native American legends. (Xu 184) We know very little about the Pueblo builders in this respect, and yet there are definite indications that their architecture served an astronomical role as well. Despite the desert environment, the Anasazi were able to bring agriculture to its "prehistoric pinnacle." (Mays 51) In order to do so, they must have understood and tracked the sun's cycles and the seasons. "Ritual and religion were probably born of the need for successful crops; sun watching was crucial to fulfilling that need." (Noble 66) The dry climate of the southwest "demands observant farming, for raising crops is…a matter of life or death…" (Noble)

One architectural feature at Mesa Verde which seems to bear astronomical significance is the north wall of the Far View ruin. Ping Xu, a feng-shui consultant and architect, noted[17] that during the sunrise of the autumnal equinox[18], the north wall points straight into the rising sun. (Xu 185) All at once, the light from the sun illuminates the top of the entire wall, while the rest of the landscape remains primarily in shadow *[see figure 15]*. (185) At Pueblo Bonito, there are unexplained corner windows directly adjacent to walls, which some archeologists have hypothesized were used to track the seasons *[see figure 16]*. The windows offer a "clear view of the winter solstice sunrise," and in at least one instance, there are markings on the interior wall into which the light falls on the winter solstice. (Noble 68) However, due to the possibility of error during reconstruction, these observations remain uncertain.

[16] For brevity's sake, the cosmological and astronomical roles of Native American architecture are not discussed in length. However, entire books could be written on this aspect alone. For more information, refer to Nabokov (pps. 39-40), Xu (pps. 178-189), and Erdoes, et. al, *American Indian Myths and Legends.*
[17] while researching the feng-shui qualities of 60 prehistoric sites in the Southwest
[18] this is critical in the establishment of a calendar, and in particular, for knowing when to plant crops. To do so either too late in the season or too early would result in crop failure, and hence starvation.

[image removed]

[image removed]

[image removed]

Figures 15, 16, & 17: *Examples of possible elements and methods for tracking the seasons through architecture: wall orientation, corner windows, and sun markings. (Source above: Xu 185; source left: Noble 68; source below: Xu 186)*

Finally, a great testimony to the wisdom of the Native American builders and the true complexity of issues involved in their seemingly "simple" building solutions, is the similarity their buildings have with those designed by Chinese feng-shui masters. Feng-shui is an ancient Chinese practice used "to harmonize people with their environment" and ensure prosperity. (Xu 176) Literally, "feng-shui" means "wind-water," as it was originally intended to avoid cold wind and to receive water. (Xu 176) It has been in use for thousands of years, and surely holds architectural merit[19]. At first glance, feng-shui may appear to be superstitious, or mystical, and some of the reasoning is indeed based on myth. However, more and more, experts have been able to prove with scientific reasons why feng-shui works as it does, and why abiding by the basic principles it sets forth improves ones chances of prosperity. For instance, feng-shui may specify southern orientation for a home in order to receive "positive energy," or spirits. In Western terms, the same southern orientation is good not necessarily because of spirits, but because the sun shines from the south, providing warmth and light for the occupants in the house. Another example is that feng-shui calls pointed hills "fire hills[20]," and considers them unfavorable, whereas flat hills (called "soil hills") are preferred. (Xu 176) Again, Western preference is similar, not because one hill represents fire and another does not, but because people have learned that a steep hill is more likely to erode beneath a building, and is thus less desirable as a home site than a flatter hill.

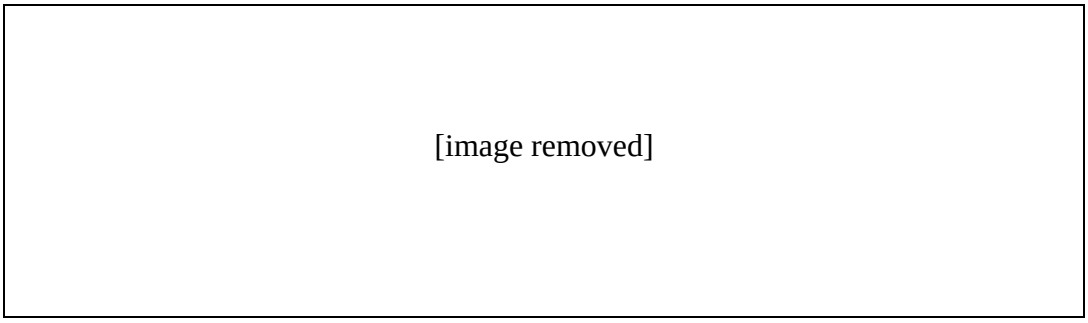


Figure 18: *Five types of hills in feng-shui (Source: Xu, 177)*

[19] Whether or not it may seem superstitious, in many parts of the world, one cannot build without adhering to its dictates, and any educated architect is expected to at least be familiar with feng-shui. It is perfectly valid reason for doing (or not doing) something in a design. In such a way, it certainly holds merit.
[20] named so because they (visually) represent the element of fire

When looking for a favorable site to build a home, a feng-shui master searches for five things: "1) a favorable mountain range[21]; 2) lucky surrounding hills; 3) nearby water; 4) a propitious location[22]; and 5) an appropriate orientation." (Xu 177) Interestingly, the canyons which the ancient Pueblo builders settled generally accommodated these five things. What Ping Xu, Ph.D, a feng-shui consultant and professor of architecture found as she compared "the feng-shui quality of 60 well known prehistoric sites in the Southwest" is somewhat surprising. *[see figure 19]* (Xu 188) While some disagreements with feng-shui do exist, there are certainly enough agreements to indicate specific trends. Many of the elements which make "great buildings" (according to feng-shui), are also found in ancient Native American architecture.

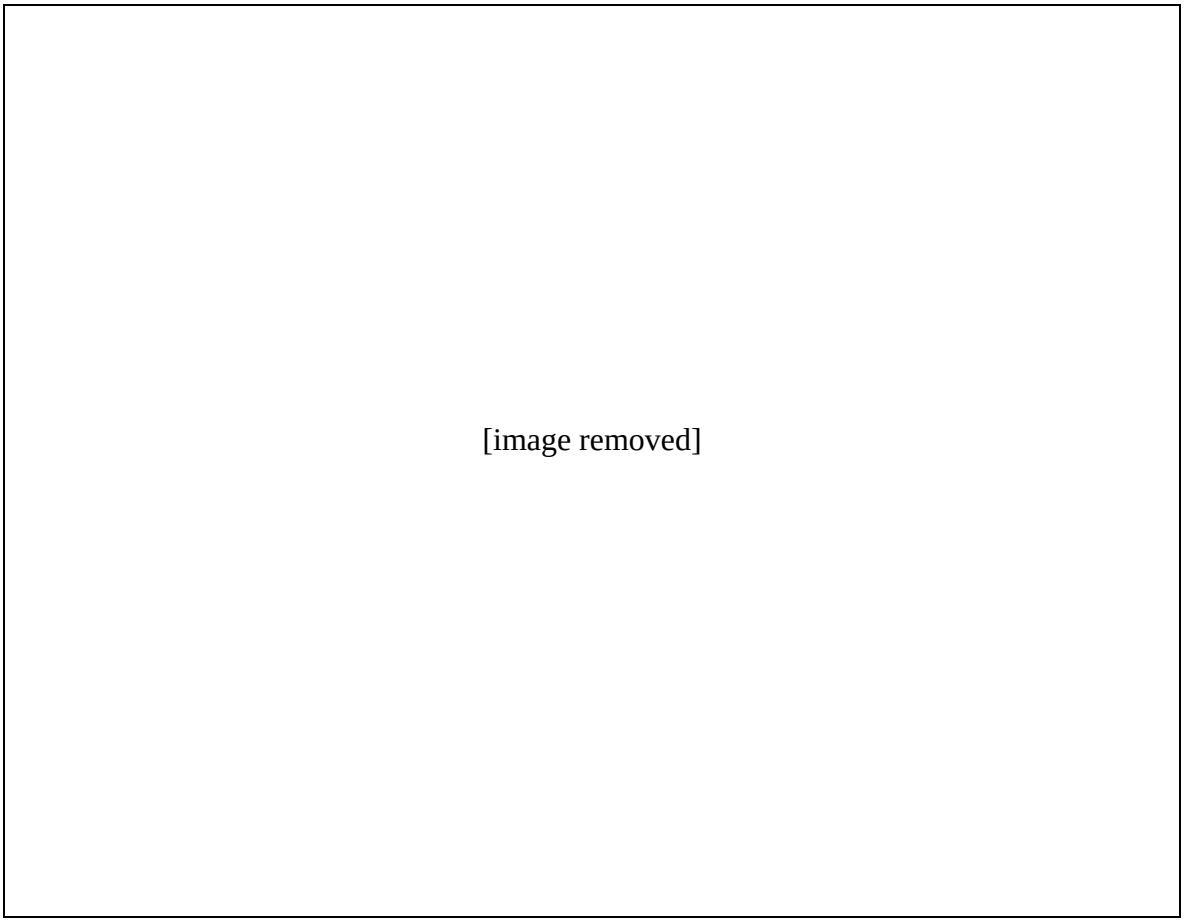


Figure 19: *Feng-shui quality of 60 well known prehistoric sites in the Southwest (Source: Xu 188)*

[21] called the 'dragon'
[22] which is referred to as the 'site' or 'spot'

Whether or not the prehistoric buildings agree with every element of feng-shui is not the issue. The critical point is to recognize the wealth of knowledge the ancient Native Americans must have commanded in order to design and build the great pueblo cities as they did. Whatever their means, their end (i.e. "product") closely aligns with the Chinese "product" based on the tried-and-true principles of feng-shui. This is certainly a testimony to the understanding of the world around them that directed the tribal architects as they built—a testimony to richness in seeming simplicity. We recognize the wisdom of the ancient Chinese builders, the merits of feng-shui, and the greatness of their architecture. Yet if the ancient Chinese were considered to be an advanced civilization, producing "great" architecture worthy of our study, how can the Native Americans not be as well? How can we praise one civilization's accomplishments and disregard another's if both civilizations accomplished the same[23] thing? Nevertheless, this is the situation today. We disregard the architectural achievements of so many cultures because we do not realize their merits, or the complexity involved in seemingly simplistic designs. Perhaps their buildings appear too different from our own—or from our perception of what is "great architecture"—that we do not understand and appreciate them. Or maybe they seem too primitive, too simple to teach us anything that we do not already know. But if we as architects are going to be able to solve the problems[24] facing us today, we are going to need to look beyond that which we have always understood and emulated—beyond traditional, "great" models of architecture. What vast storehouses of knowledge and potential precedents remain untapped because we focus only on "great" buildings by "great" civilizations throughout time. We know all too well the grand works of the Egyptians, Greeks, Romans, and Chinese, but overlook the modest domiciles of many poorer, less-dominant cultures. Yet if we want to learn how to design sustainably—how to *not* be wasteful of materials and how to design buildings low in embodied energy—is it wise to look only

[23] referring to similar end results, or products, as evaluated by feng-shui, and the idea that both civilizations provided architectural solutions which responded to a similar set of challenges, however different the solutions themselves may appear.

[24] in particular, problems referring to the abuse of our "spaceship earth," including rapid depletion of resources and wasteful employment of non-renewable energy.

at precedents from “great” civilizations with access to lavish resources and unlimited manpower (i.e. energy)? Why not study civilizations who throughout history have had little power or access to resources, but with much creativity and ingenuity have learned to make due? As the Native American examples prove, a lot can be done with very little, whether in the bleak sub-Arctic tundra or the barren southwestern deserts. “Primitive[25]” architecture is full of excellent examples of synergy of form, structure, site, societal needs, and sustainability. It addresses many of the challenges we face today. How much there is to learn from those we commonly overlook. The culmination of thousands of years of knowledge and experience lies before us. The answers are available. And yet all is for naught unless we can learn to yield our thoughts of monumentality and grandeur, and learn to appreciate *the richness in simplicity.*

[25] not referring to prehistoric architecture, but “simple,” earthy architecture

Works Cited

Erdoes, Richard and Alfonso Ortiz. *American Indian Myths and Legends.* New York: Pantheon Books, 1984.

Fathy, Hassan. *Architecture for the Poor: an experiment in rural Egypt.* Chicago: University of Chicago Press, 1973.

Jacobs, Jane. *The Death and Life of Great American Cities.* New York: Random House, Inc., 1961

Lekson, Stephen H. *Great Pueblo Architecture of Chaco Canyon, New Mexico.* Albuquerque: University of New Mexico Press, 1986. (originally published 1984 by the National Park Service, U.S. Department of the Interior, Albuquerque, New Mexico, as Publications in Archeology 18B, Chaco Canyon Studies.)

Mays, Buddy. "Guide to Indian Ruins." *Historic Preservation* 37 (1985): 50-54.

Mazria, Edward. Lecture given at the University of Southern California, 2004.

Morgan, Williams N. *Ancient Architecture of the Southwest.* Austin: University of Texas Press, 1994. pps. 39-59, 265-285

Nabokov, Peter, and Robert Easton. *Native American Architecture.* New York: Oxford University Press, 1989. pps. 7-51, 73, 97-101, 151,159-163, 195-207, 351-404

Neitzel, Jill E. ed. *Pueblo Bonito: Center of the Chacoan World.* Washington D.C.: Smithsonian Institute, 2003. pps, 1-32, 72-79

Noble, David Grant. Ed. *New Light on Chaco Canyon.* Santa Fe, N.M.: School of American Research Press, 1984.

Schierle, Goetz G. "Structural Materials in Architecture." Lecture, August 30, 2005.

Schiler, Marc. "Design for the Thermal and Atmospheric Environment." Lectures, Fall, 2003.

Scully, Vincent. Architecture: The Natural and the Manmade. New York: St. Martin's Press, 1991.

Xu, Ping. "Feng-shui as Clue: Identifying Prehistoric Landscape Setting Patterns in the American Southwest." *Landscape Journal* 16 (1997) : 174-190.

Website: http://www.answers.com/topic/100-bc, December 2005.

Website: http://www.newton.dep.anl.gov/askasci/bot00/bot00357.htm, December 2005.