Biographical Sketch

Josie Tunnell is a fifth year, honors architecture student at the University of Tennessee with a minor in Sustainability. She is also working towards completing a dual degree program to receive a Master's degree in Landscape Architecture. She carries the title of Green Thumb in the organization Students Promoting Environmental Action in Knoxville (SPEAK) where she manages the club's communal garden to provide fresh food on campus. She holds multiple awards for her design projects as well as her writing, including the Brewer Ingram Fuller Sustainable Design Award and the American Institute of Architects Middle Tennessee Student Design Award.

Originally from Middle Tennessee, she graduated from Brentwood High School where her experience with three dimensional art, science, and mathematics led her to architecture school. The rolling green hills and backyards full of forests in Tennessee sparked a passion for the environment which has only grown in strength through design school where her focus lies in environmental architecture that works to integrate itself with the landscape. Her Aydelott Award travels further dives into this topic, providing rich research to support an understanding of how to design low waste and low carbon footprint architecture and landscape design. Throughout her education, historical research into cultures has also become an integral part of her work, including her design process, in order to understand and learn from varying cultures globally. This theme continues on into her Aydelott research as well as she looks towards the perspectives of Indigenous groups to expand her knowledge of environmental design. She would like to thank the Aydelott Fund for this incredible opportunity to travel and research architecture.

Student:

Josie Tunnell

Mentor:

Gregor Kalas

Buildings:

1. Monks Mound by Mississippian architects in Collinsville, Illinois
2. Pueblo Bonito by Ancestral Puebloan architects in Nageezi, New Mexico
3. Wupatki Pueblo by Ancestral Puebloan architects in Flagstaff, Arizona
4. Athabascan Home by Athabascan architects in Anchorage, Alaska

Institution:

University of Tennessee, Knoxville, School of Architecture

Indigenous Architectural Traditions of North America

The twenty-first century provides new challenges for contemporary architects due to the environmental impact of human-caused climate change. Temperatures have started to greatly fluctuate, natural disasters are becoming more deadly, and sea levels are rising. Although it is a daunting challenge to face, there is hope found in the way humans have adapted to Earth's changing conditions for centuries. The wide diversity of the First Nations of North America are the original stewards of this continent and have fostered ways of living centered around the landscape and all of its beings. With new environmental demands, shifting perspectives towards one integrated with the Earth will foster a new world. This shift must begin with the ones who will build it: architects.

My research for the Aydelott Award centers itself around the first environmental designers of this continent in the historical buildings of Native Americans. Through the four architectural sites I visited, I gained a deep connection to the unique climate and landscapes of each place through embodying the Indigenous people's perspective. As a result, I discovered the importance of the local material usage, site selection, orientation and alignment that respond to the programmatic challenges of each community and the location of each building. Each structure generated a successful case study of traditional Indigenous techniques that display effective and sustainable construction approaches that we as architects could greatly learn from.

The four sites are:

1. Monks Mound by Mississippian architects in Collinsville, Illinois
2. Pueblo Bonito by Ancestral Puebloan architects in Nageezi, New Mexico
3. Wupatki Pueblo by Ancestral Puebloan architects in Flagstaff, Arizona
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The climatic regions each of these buildings occupy range from forests to deserts and are relevant to the architectural decisions of the Native designers. In these sustainable, Indigenous structures, low levels of environmental impact and low waste are priorities and are achieved through sourcing local materials. Adapting and orienting buildings to the elements of wind and sun are also important strategies used by Indigenous people for passive heating, cooling, and ventilation. Analyzing these ecologies is therefore an integral part of studying these bioregional and climatically adapted structures. Contemporary designers can look towards these design approaches in order to alleviate the loads on the mechanical systems of buildings that currently rely on fossil fuel consumption, which is the cause of global warming. In place of burning fossil fuels to power buildings, the design techniques of Indigenous peoples use the readily available resources of the land as the source. Through knowing their regional climate and available resources given by the land, these four sites are prime illustrations of environmental design.

Fig. 1. North American Ecological Regions map with the four Aydelott sites located, [1]

With every step of my journey traveling to these sites, the various landscapes have become my greatest mentor and have invited me to welcome a new mindset of thinking more intentionally about how to see a place and an architecture that rests perfectly within it. Learning Indigenous techniques has broadened my understanding of how to be resourceful and how to view the land as a valued resource, as

long as one has the knowledge to utilize it. While the First Nations are widely diverse and distinct in their traditions and beliefs, a common viewpoint is shared. Robin Wall Kimmerer, writer, ecologist, professor, and member of the Potawatomi Nation, explains the "core of the mechanistic view of nature, in which land is a machine and humans are the drivers… But what if we took the Indigenous worldview? The ecosystem is not a machine, but a community of sovereign beings, subjects rather than objects. What if those beings were the drivers?"[2] This balanced reciprocity between the beings of the world and us fosters resiliency and a deep interconnectedness that protects the Earth rather than exploits it. The mountains and deserts and rivers and pathways I have traveled through and the people who call these places home have deeply inspired me and provided a new lens when viewing the world and the architecture in it. With these new lessons I have been taught by Indigenous people and the landscape, I can start to visualize a new world that rises up to meet the needs of new challenges while still providing great beauty and comfort. My hope with this research is that other aspiring or already practicing architects can learn just as much as I have from the First Nations and their structures.

Endnotes

1. Commission for Environmental Cooperation, *Ecological Regions of North America: Toward a Common Perspective* (Montreal: Commission for Environmental Cooperation, 1997) 9.
2. Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teaching of Plants* (Minneapolis: Milkweed Editions, 2013), 321-322.

Monks Mound

Fig. 1. Mississippians, (photographs: Josie Tunnell) prairie looking towards eastern side of mound & Central Plaza looking towards southern side, Monks Mound, Cahokia Mounds, IL, 950-1350.

As I walk from the superimposed asphalt parking lot shaded by tall trees into the intense sunshine, my eyes squint as I take in the form of Monks Mound before me. Covered in vibrant green grass and a few scattered trees, this ancient earthen monument stretches along its north to south axis approximately 1050 and about 960 feet west to east. Taking in this sight, I felt nothing short of complete awe - a giant of architectural advancement and historical significance towering before me. As I make my way along the concrete sidewalk, already breaking a sweat due to the humidity, the grandeur of this monument hits me. This Indigenous built mound, made completely out of individual baskets of earth sourced further south on the site, has survived hundreds of years of rain, wind, soil, and human erosion while still maintaining to be the largest man-made mound in North America. This has designated Cahokia Mounds as both a State Historic

Site as well as a UNESCO World Heritage Site. As I transverse to the base, the structure and processional use of the mound becomes apparent. Wooden buildings were situated at the top of the earthwork, looming over the entirety of the Mississippian metropolis as a sign and place of power.

Fig. 2. Mississippians, (photographs: Tunnell) staircase leading up Monks Mound & reconstruction of a typical wooden Mississippian structure in the Interpretive Center, Monks Mound, Cahokia Mounds, IL, 950-1350.

The procession up the mound is structured through two terraces and a grand staircase that guides one to the top of this rectangular platform pyramid where the view gives way to the expansiveness of the empire that used to exist here. Miles and miles of Mississippian floodplain stretch out before me, although now occupied by scattered contemporary buildings, bustling highways, and orthogonal rows of industrial agricultural crops. Though this scar of modernity is ever-present, the magnitude of what this metropolis used to be hit me while standing atop Monks Mound. Although the peak was in 1050 to 1150 AD, the impression of Cahokia has remained monumental to this day. There is Indigenous knowledge and culture embedded into the Earth here. The integration with the landscape and the local natural resources utilized to create this monument is unlike any other in the

world. Through analysing the modes of construction and the site organization that tie these earthen mounds so well into the landscape, the true power of the Mississippians is revealed through the ground that the materials once came from.

Temperate Forest Climate

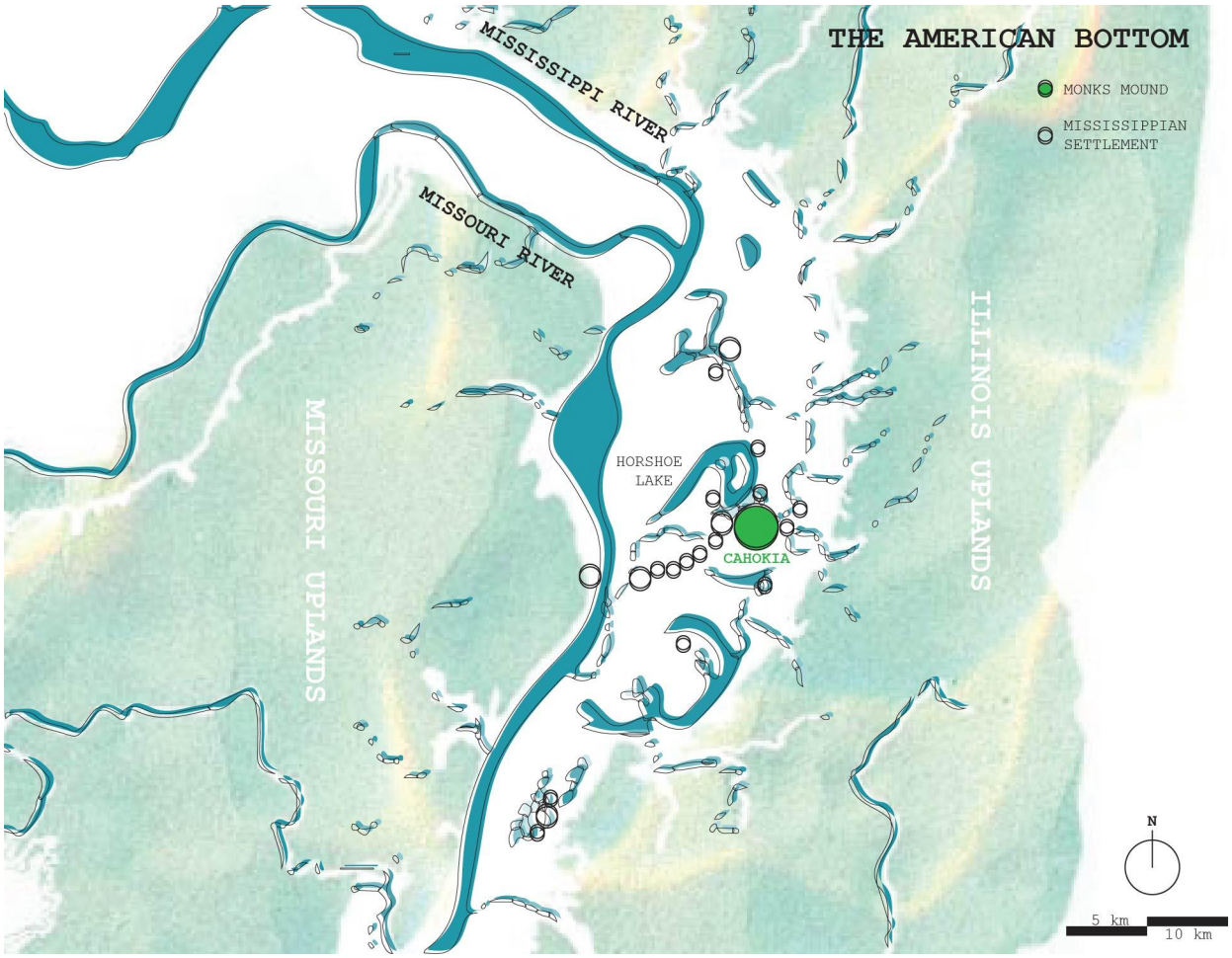

Fig. 3. (drawing: Tunnell) North American Bottom map, Monks Mound, Cahokia Mounds, IL, 950-1350.

Understanding the landscape that surrounded the Mississippians after the turn of the first millennium is necessary for deducing the historic architectural decisions. The current preservation of the various ecologies at Cahokia Mounds State Historic Site allowed me to experience the range of typologies that existed in the landscape

here. The Cahokia settlement is located in the American Bottom, the floodplain of the Mississippi River, where abundant water, rich soils, and alluvial plains allowed for habitation and the thriving of culture. This region sits in the Eastern Temperate Forest ecological region of North America distinguished by the humid climate, diverse forest cover, and high density of human activity. Abundant water feeds into the waterways that snake across the region, allowing for transportation of food, goods, and people. The Cahokia Creek and Canteen Creek were both active waterways marking distinct boundaries to the site while inviting people into this political and cultural center of the Mississippian trade network. These waterways aided in connecting an entire ancient Native trade system that spanned from the Appalachian Mountains to the Gulf of Mexico as seen in artifacts such as seashells buried in the mounds.

Fig. 4. (photographs: Tunnell) Woodland near borrow pits & prairie near Monks Mound, Monks Mound, Cahokia Mounds, IL, 950-1350.

The biodiversity of the floodplain of the larger Mississippi River area is abundant with prairie, wetland, and woodland ecosystems allowing for diversity in the building materials as well. The wooden structures as well as the earthen mounds utilized the wide range of

vegetation and resources provided by the floodplain. These three ecosystems were accessible to me during my visit at Cahokia Mounds due to maintained trails. Over by Monks Mound, a large prairie meadow is filled with lush grasses, wildflowers, and pollinators happily making their way through the field. Today, a vibrant green lawn covers the site, but Bermuda grass is not the native species of the site. The prairie meadow situated on site is much more telling of what was there earlier. These grasses would be used by the Mississippian community for roof hatching, insulation, and stucco. Further south on the site is a wetland where borrow pits, used in the past for construction materials for the mounds, have been reclaimed by the forces of water, wildlife, and vegetation. These borrow sites are situated in the woodlands surrounding the mounds, as a tall canopy of trees hides a thick understory of brush. Timber from these woodlands would be assembled to form structures. The climate of Cahokia also plays a key factor in the success of this site, as Mississippians were a largely agricultural society. Much of the area was used for bountiful crop fields and medicinal herb gardens located closer to the residential areas. The American Bottom is prone to plentiful rainfall, intense sun, abundant humidity, and regular seasonal temperature fluctuation. These abundant natural resources were utilized by the Mississippians resulting in the great success of their civilization as well as their architecture.

Clues of the Past

Fig. 5. Mississippians, (photographs: Tunnell) Twin Mounds & archeological footprint of Mississippian structures outside the Interpretive Center, Cahokia Mounds, IL, 950-1350.

The ecological reclamation of the Cahokia Mounds causes the scale and form of these structures to appear more natural than man-made. The mounds, now covered in foreign grasses that are mechanically mowed, blend into the landscape so well that they almost appear to be naturally formed hills dotting the horizon. The architectural understanding of these structures is therefore reliant on archaeological excavation and uncovering key information through piecing together clues left behind. While in southern Illinois, I was fortunate enough to visit an active dig site in order to understand the process behind how this information is revealed. The Gehring site run by Dr. Julie Zimmermann of Southern Illinois University at Edwardsville allows archaeology students to participate in excavating artifacts originating from a range of periods and displaying multiple generations who used this area only a couple of miles from the Cahokia settlement. The areas of interest visible in this site are from organic material left behind, both in storage and midden pits as

well as wooden posts.[1] The bare clay exposed through a rigorous process of shoveling, shifting, and documenting color pigmentation recounts episodes of the lives of the people occupying this space previously. Watching the students sift through the dirt to uncover broken ceramic pieces was like watching history unfold. My understanding of this ancient civilization was formed not because of what I could visibly see at the mounds, but due to the clues hidden amidst the site. Through the piecing together of these clues found at the Gehring site and others like it, a colleague of Julie Zimmerman reconstructed a typical wooden home of the Mississippians, finding that "inside the shade of the small structure, it felt warm despite the outside cold temperatures."[2] Utilizing local resources and maximizing a history of this type of construction allowed Mississippians to build comfortable, thermally regulated homes, known to us today through analyzing the ground underneath us.

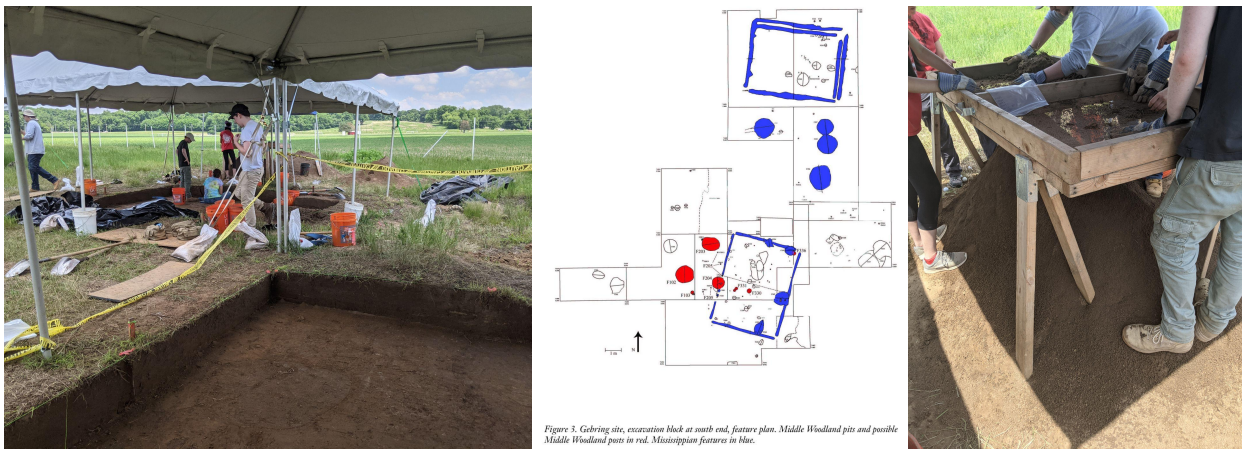

Fig. 6. Julie Zimmermann, (photographs: Tunnell) (drawing: Julie Zimmermann[1]) active archeological dig of Mississippian site, Gehring Site, Edwardsville, IL, 950-1350.

Monks Mound: Architectural Details

Monks Mound is a prime example of the resourcefulness of the Mississippian people. Through a process of digging up earth on site

and assembling it into rigid forms, on site materials can be seen as a continuous utilization of the Inidgenous community. After interviewing Bill Iseminger, anthropologist, archeologist, and former assistant manager at Cahokia, I learned the construction process of Monks Mound was recently discovered to have been built in one main core, requiring a massive communal effort and pre-planned project management. Iseminger explained the coring process of geomorphologists who extracted three inch cores from the mound in order to inspect the soil types and analyze the layering in order to understand the construction process.[3] Mound building, culminating to its greatest size at Monks Mound, set in motion the spiritual symbolism of the Mississippian people through replicating the Earth's creation of building up from the underworld in order to reach up towards the heavens. Other mounds on the site were also used for burials and funerary rituals. The construction process, although intensive in requiring the manual labor of a multitude of people, was one of religious significance as well as political power for the governing body. Mississippians excavated borrow pits using stone and wood tools, using woven baskets on their backs to haul clay, sand, and silt from the pits to the mound site. The coring of the mounds exposed the possibility that different types of soils were layered to maximize drainage in some areas through the use of sand while encouraging water retention in other areas through the use of clay.[4] Sod blocks created the edges of the mounds, which still have distinct definition today despite centuries of erosion. The mounds were most

likely bare and ceremonially covered with clay making them red monuments dancing across the landscape.

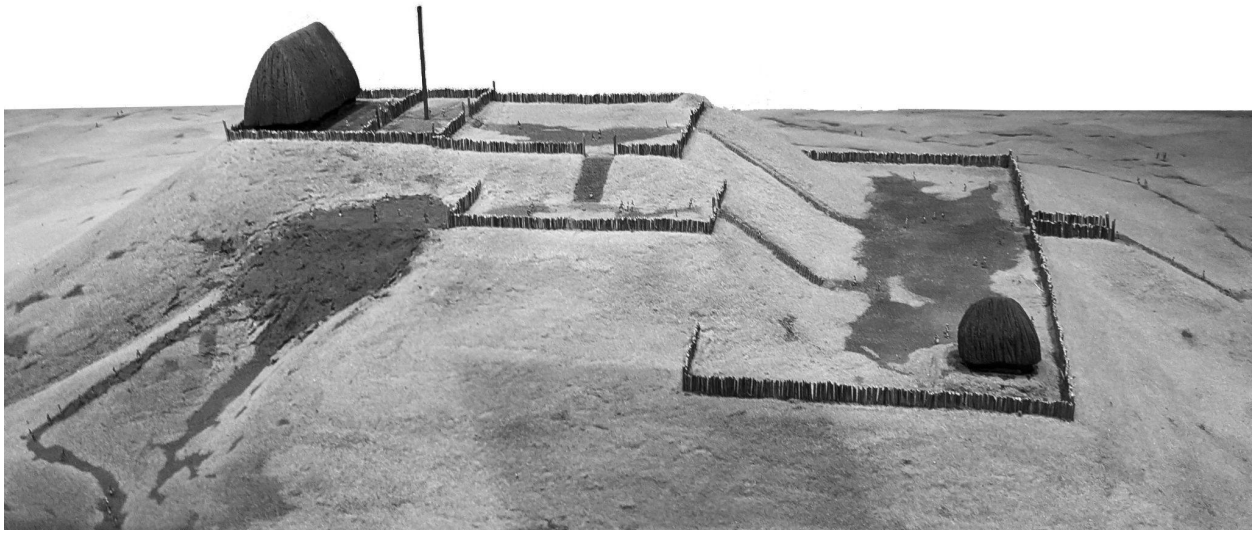

Fig. 7. Mississippians, (photograph: Tunnell) reconstruction of Monks Mound in the Interpretive Center, Monks Mound, Cahokia Mounds, IL, 950-1350.

At the top of Monk's Mound, which is where the governing body of this Mississippian culture assembled, there was a structure measuring fifty feet by one-hundred feet composed of wood covered in a prairie grass roof or waxy cattails that stood about fifty feet high. Wooden buildings were constructed by digging wall trenches, imposing light wooden poles, then fastened together through weaving saplings between poles, blanketing the structure with cattail or reed mats, and then daubing the facade with a mixture of clay and grass. This system utilized cooler ground temperatures while creating layers of insulation to regulate the internal temperature of the building, necessary for a climate with both scorching and freezing temperatures. The roof of the temple was steeply pitched and tightly thatched with grass bundles in order to prohibit the invasion of rainwater. A large post and fire also occupied the top and a wooden

barrier enclosed the area, marking off the space for important rituals only accessible to certain people. Breaking down the construction process of both the earthen mound and wooden structures allows us to understand how integral the landscape was to the design and development of these monumental mounds. The integration of local resources and their intentional usage throughout Monks Mound's building systems provides a unique example of Indigenous architecture that displays site specific regional design.

Cahokia Mounds

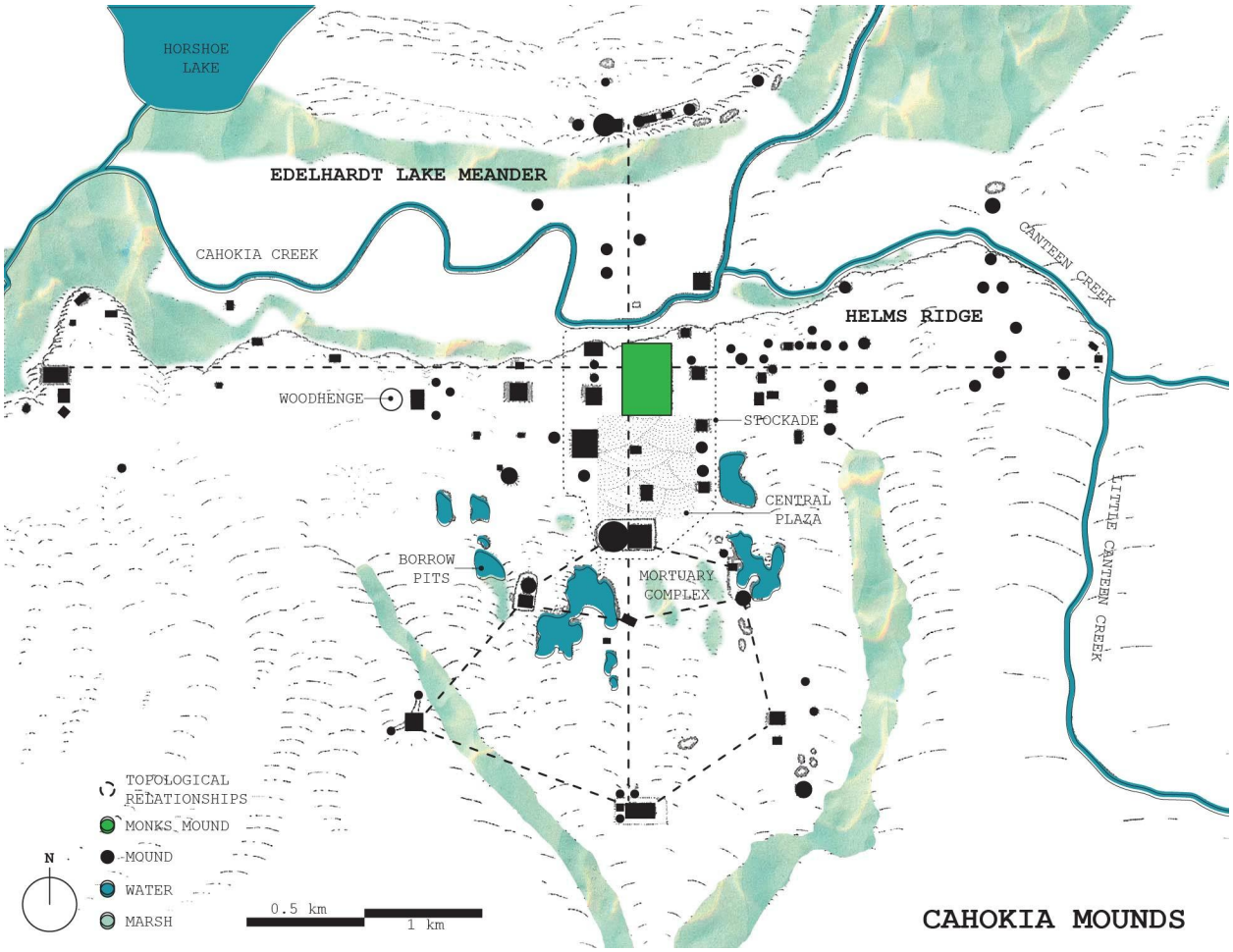

Fig. 8. Mississippians, (drawing: Tunnell) Cahokia Mounds site map, Cahokia Mounds, IL, 950-1350.

The site organization of Cahokia Mounds and its flourishing metropolis derives from the success of Monks Mound. The area was first developed in the Emergent Mississippian era of 800-1000 AD as a domestic hub atop Helms Ridge, a raised levee at the edge of the Edelhardt Lake meander where alluvial floodplain deposits collected to elevate the area ten feet above the surrounding area. This residential sector transitioned into a political and religious capital following the rise of powerful figures such as a particularly elite family. As the Mississippians transitioned into earthen mound building, the organization of the city evolved with the construction. The northern edge of the site is defined by the Cahokia Creek waterway and the top of Helms Ridge. Just south of this river is Monks Mound which was the center of the site that developed over four hundred years.[5] Most mounds and other structures, including those in communities across the river, were oriented within a radius so that they could be viewed from the top of Monks Mound. The Central Plaza situates itself directly south of Monks Mound and is a forty-acre constructed flat precinct used for several of the city's programs. This zone was flattened out to a degree necessary for drainage and covered with sand. The Central Plaza was home to the public urban center, bustling with entertainment in games such as chunkey or lacrosse, as well as homes of the prominent families and figureheads. A powerful stockade surrounded Monks Mound, Central Plaza, and the rest of the city center but was a later addition to the site. The stockade was constructed by digging holes into the ground and inserting red cedar posts which had been stripped of bark and then

charred to prevent pests and block moisture. The wall was then covered with daub similar to that of the temple. The southern boundary of the site follows a series of natural and constructed bodies of water. Borrow pits were intentionally constructed in the southern edge of the site to therefore enclose the urban conditions of this metropolis.

Monks Mound and other key features utilized cardinal directions in order to orient planning while also maximizing on the movement of the Sun. The subsequently named Woodhenge employs red cedar posts oriented in such a fashion that a sun calendar emerges. The rise and fall of the Sun in alignment with the posts indicated solstices, equinoxes, and other important dates that dictated agricultural, religious, or cultural events. This alignment with the Sun is also seen in the orientation and building of the mounds. The site overall has one hundred and twenty earthen mounds that range in structural typologies. This cardinal direction alignment is a common theme throughout my four Aydelott sites and reflects the environmental considerations that capitalize on the natural resource and power of the Sun. Monks Mound paired with the Central Plaza and the organization of Cahokia around these prominent features displays the social significance of this massive earthen mound while integrating local materials and landscape design decisions in order to organize this Mississippian metropolis.

Fig. 9. Mississippians, (photographs: Tunnell) Woodhenge, borrow pits, & stockade in front of Monks Mound, Monks Mound, Cahokia Mounds, IL, 950-1350.

Lessons of Environmental Design

Throughout the process of experiencing Monks Mound paired with the archaeological exploration of the site, the environmental considerations of the Mississippians emerged. Utilizing local materials collected from the prairie, woodland, and wetland environments surrounding the city, the Mississipians exploited these as architectural elements contributing to the monumental feat of Monks Mound. After an analysis of the soil, the full lifecycle of these materials has become apparent. Every material from the ceramics of kitchen materials to the cedar posts of Woodhenge has fully returned back to the Earth in a complete lifecycle. The materials have returned to the earth so effectively that the significance of Monks Mound and surrounding Cahokia Mounds was overlooked by the first colonizers of the area and several mounds have been lost to agricultural plowing and contemporary urban development. There is current activism by the descendents of this Mississippian culture to establish Cahokia Mounds as a National Park in order to provide more

resources to protect and restore this significant cultural landmark.[6] This idea of cradle-to-cradle directly translates to contemporary sustainable design, as we live in a world where synthetic materials have a manufactured lifespan of eons. The use of earth and wood was effective in its decomposition over time but was engineered and utilized by the ingenuity of the Mississippians to create a bustling metropolis and monumental architecture that has spanned the test of time. The borrow pits for the mounds also display ecological restoration as the excavation of building materials created an artificial environment hosting a multitude of species today. From swooping white cranes to croaking toads, the borrow pits are a prime example of humans creating a beneficial space for other species returned to them through time.

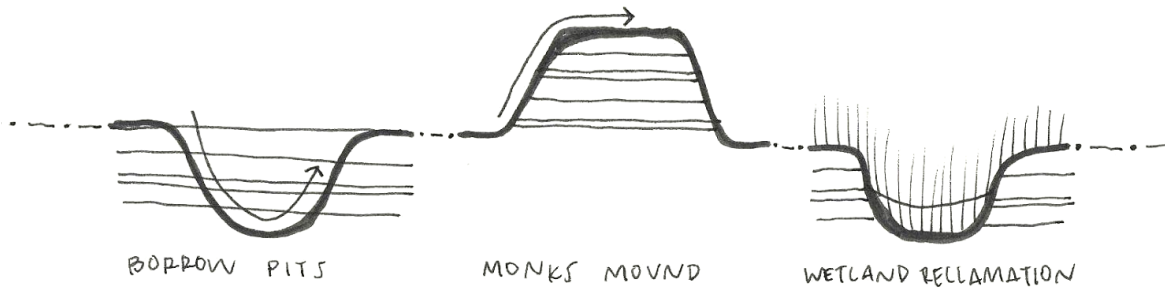

Fig. 10. Mississippians, (drawing: Tunnell) sketch of the cyclical process of borrow pits to earthen mounds to land reclamation, Monks Mound, Cahokia Mounds, IL, 950-1350.

The story of Cahokia tells us of a bountiful metropolis that eventually was abandoned due to changes in resource levels, climate conditions, and possibly social conflict. The people who lived here then dispersed to other regions with ancestral ties to eleven Native American tribes today and left the site to return back to the Earth with later occupation from other tribal groups as well as foreign communities. The material choices, power of procession, site

alignments, and sheer magnitude of size distinguishes Monks Mound above any other Mississippian structure at the time. The monument was at the center of a bustling metropolis, evolving as the people did. The clear observation and understanding of the landscape surrounding them allowed the Mississippian designers to smoothly integrate their work within the environment, resulting in a seemingly natural design. Cahokia Mounds State Historic Site is an impressive example of Mississippian earthen mound architecture that takes advantage of the multitude of natural resources of southern Illinois while displaying the political and religious power of the people at that time. The ecological reclamation of the site visible today begs the question: how will the buildings we design today return back to the Earth?

Fig. 11. Mississippians, (watercolor sketch: Josie Tunnell), Monks Mound, Cahokia Mounds, IL, 950-1350.

Endnotes

1. Julie Zimmermann, Ashley Cisneros, Luke Haun, Katie Leslie, Kaitlin Roberts, Austin Sandberg, Kelly Sopek, "Hopewellian

Occupations at the Gehring Site (11MS99) in the American Bottom," *Illinois Archaeology* 30 (2018): 86.

2. Julie Zimmermann. Interview with Josie Tunnell. Field interview. Gehring site, June 4, 2021.
3. Bill Iseminger. Interview with Josie Tunnell. Field interview. Cahokia Mounds State Historic Site, June 4, 2021.
4. Timothy Schilling, "Building Monks Mound, Cahokia, Illinois, a.d. 800-1400," *Journal of Field Archaeology* 37, no. 4 (2012): 305, https://doi.org/10.1179/0093469012Z.00000000027
5. Rinita Dalan, George Holley, William Woods, Harold Watters, Jr., John Koepke, *Envisioning Cahokia: a Landscape Perspective* (Dekalb: Northern Illinois University Press, 2003), 71.
6. Mary Delach Leonard, "Native American Tribes Support National Park Status for Cahokia Mounds," *St. Louis Public Radio*, October 1, 2019, https://news.stlpublicradio.org/arts/2019-10-01/native-american-tribes-support-national-park-status-for-cahokia-mounds

Pueblo Bonito

Fig. 1. Ancestral Puebloans, (photographs: Josie Tunnell) exterior back wall & central plaza looking towards mesa, Pueblo Bonito, Chaco Canyon, NM, 850-1150.

The canyon lay tucked away, safely secluded from suburban development and bustling highways. Within the canyon's sandstone walls in New Mexico sits the remnants of the great Chaco Canyon metropolis. Half an hour from the entrance to Chaco Canyon National Historical Park, the road transitions from paved to gravel, the wheels of my car blowing up dust behind me as I bounced along the uneven terrain. After passing the small stone masonry sign indicating my arrival, a lone form emerges out of the landscape as I ease around the bend. Fajada Butte is an isolated hill of sandstone weathered by time and is home to the Sun Dagger site, where a petroglyph on the southeastern facing cliff tracks the movement of the Sun through precisely placed stone tablets illuminating a dagger onto a carved spiral. This keylandform for the Chacoan people feels like a fitting greeting as one proceeds into the canyon, where more ancient relics

display the Indigenous ties to the landscape and the cultural significance of environmental integration.

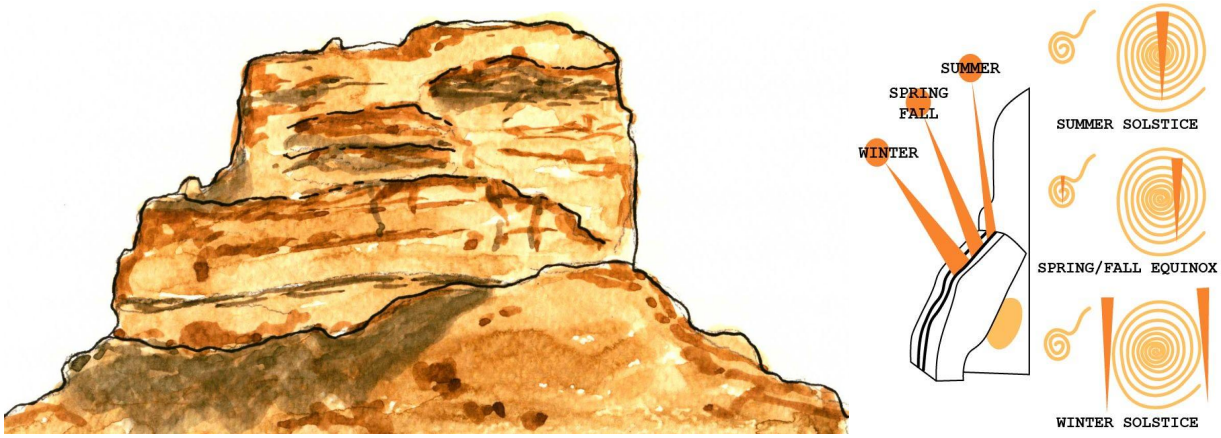

Fig. 2. Ancestral Puebloans, (drawings: Tunnell) watercolor & pen sketch of Fajada Butte & the Sun Dagger petroglyph, Chaco Canyon National Historical Park, Nageezi, NM, 850-1150.

The canyon itself consists of weathered mesas that rise straight out of the ground and flatten out at the top, effectively surrounding the buildings that sit on the canyon floor. This geological arrangement is precisely why these structures occupy this area. The alignment to the movement of the Sun and Moon to the mesa walls was significant enough for the Indigenous occupants of Chaco Canyon to align their structures with these same sitelines. As my tour group makes its way along the paved loop, we arrive at the infamous Pueblo Bonito, with its intricate stone masonry visually blending into the face of the mesa behind it. The infamous sandstone masonry of Chaco Canyon juts out as I move my hand along this ancient framework. At its peak at 850 - 1150 AD, these great Chaco palaces were once filled with travelers from all over the greater Chaco kingdom, since imported goods arrived all the way from Central America, and the structures were managed by hundreds of permanent

residents. Pueblo Bonito is a cultural landmark designated as a UNESCO World Heritage Site and icon of the Ancestral Puebloan architecture at its peak, inspiring hundreds of other Southwest desert structures. Today, as a preserved United States National Historical Park, it is still an inspiration through the lens of material innovation, sustainable architectural features, and structural integrity.

Desert Climate

Fig. 3. Ancestral Puebloans, (photographs: Tunnell) exterior wall of Pueblo Bonito & the central plaza looking towards mesas, Pueblo Bonito, Chaco Canyon, NM, 850-1150.

The New Mexico landscape in which Pueblo Bonito and the other great Chaco palaces reside is characterized by its arid climate with limited, hardy vegetation. The canyon sits in the North American Deserts ecological region with low growing shrubs and grasses dotting the landscape. These native shrubs, such as saltbush and greasewood, were utilized by the people for culinary, medicinal, recreational, and other purposes. Tree canopies are non-existent and the only shade found here is due to the geological outcrops. This desert climate has temperatures that fluctuate greatly with extremely hot summers and

freezing winters, making the freeze-and-thaw cycle a prominent concern for buildings. Britt Bankston, archeologist at Chaco Canyon and Aztec Ruins, spoke of the climatic conditions the people of Pueblo Bonito faced and how the building resiliently responded through fluid masonry usage to both the freeze and the thaw cycle of the temperature fluctuations common here. The thick, rubble filled masonry walls act as thermal insulation for the building, holding in heat from the Sun during the day to then release back into the building at night.[1] The aridity of the area also sucks out any remaining moisture and makes water an even scarcer resource. Within minutes of arriving at the site, I instantly reached for my water bottle, eventually drinking five of them throughout the course of the day to replace the moisture evaporating from my skin. The rainfall in Chaco Canyon is also distinct as it is characterized by the monsoon season from June to September, a period of daily rain showers that cause flash floods and can pop up without notice. Replenishing the plaster facade of Pueblo Bonito that covered the intricate masonry would have been a seasonal occurrence due to the erosion of the heavy rains. Dry-farming, a desert agricultural growing technique, evolved throughout the region through molding basins around the plantings to collect the scarce water and is still in use throughout Indigenous Southwest communities. This careful water resource management of the people was also carried out in Chaco Canyon through an irrigation canal system that worked its way through the canyon floor, collecting rain runoff from the surrounding mesas and redirecting it to agricultural fields. Stone dams also channeled creeks and collected

soil. Through this system utilizing the dispersed floodplain, the thousands of inhabitants of the great palaces were fed. Harnessing heat and water were necessities for the people of Chaco Canyon

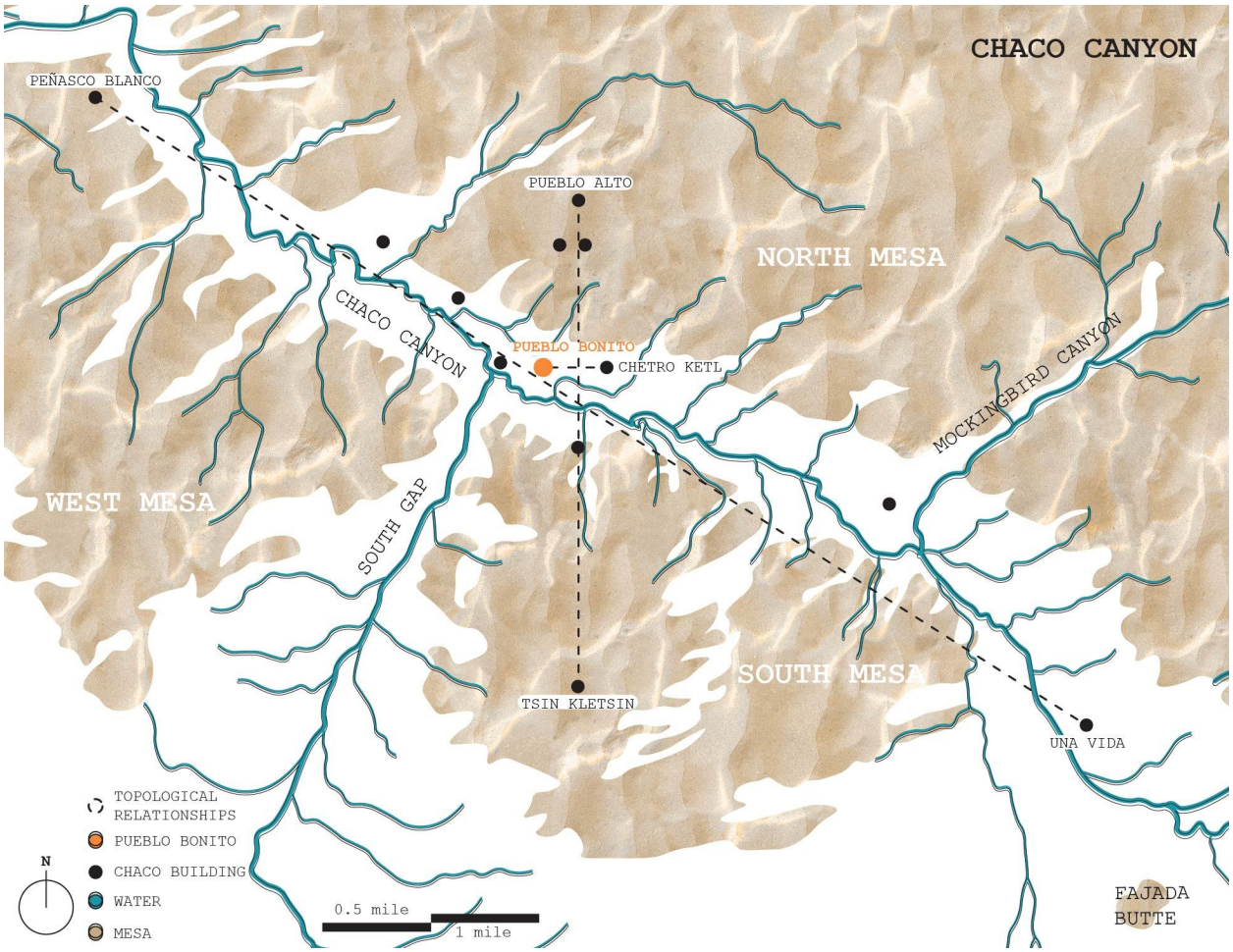

Fig. 4. (drawing: Tunnell) Chaco Canyon map showing mesas, watershed, & alignment of palaces, Chaco Canyon, NM, 850-1150.

The geography of Chaco Canyon is identifiable by tan sandstone formed millions of years ago when the region was submerged underwater, and the fossilization of marine life assembled the distinct stone mesas. The canyon was forged by the Chaco Arroyo connected from the farther north San Juan River Basin and the gradual sandstone erosion from strong water flows, breaking down sediments as it rushes along the surface. The abundant sandstone of the canyon

walls is easily broken off and is an ideal building material for its structural capacity, but also a tumultuous hazard. On the mesa wall behind Pueblo Bonito, a large boulder was carefully propped up by the ancient architects of the palace in order to prevent a massive collision between rock and structure. Following excavations by unknowing archaeologists hundreds of years later, the boulder was destabilized and crushed the back corner of Pueblo Bonito. Wandering through the floor of the canyon with the mesas towering above me, I began to understand why the Ancestral Puebloans found so much significance in this place. From the clear blue sky and the bright piercing sun to the eroded, crumbling sandstone, Pueblo Bonito is meticulously placed within a picturesque backdrop of an unequaled, extraordinary canyon. Yet this region of New Mexico with its arid desert features and distinct geological characteristics required serious resource management and landscape integration to sustain the grandeur of the Chaco culture and its monumental architecture.

Pueblo Bonito: Architectural Details

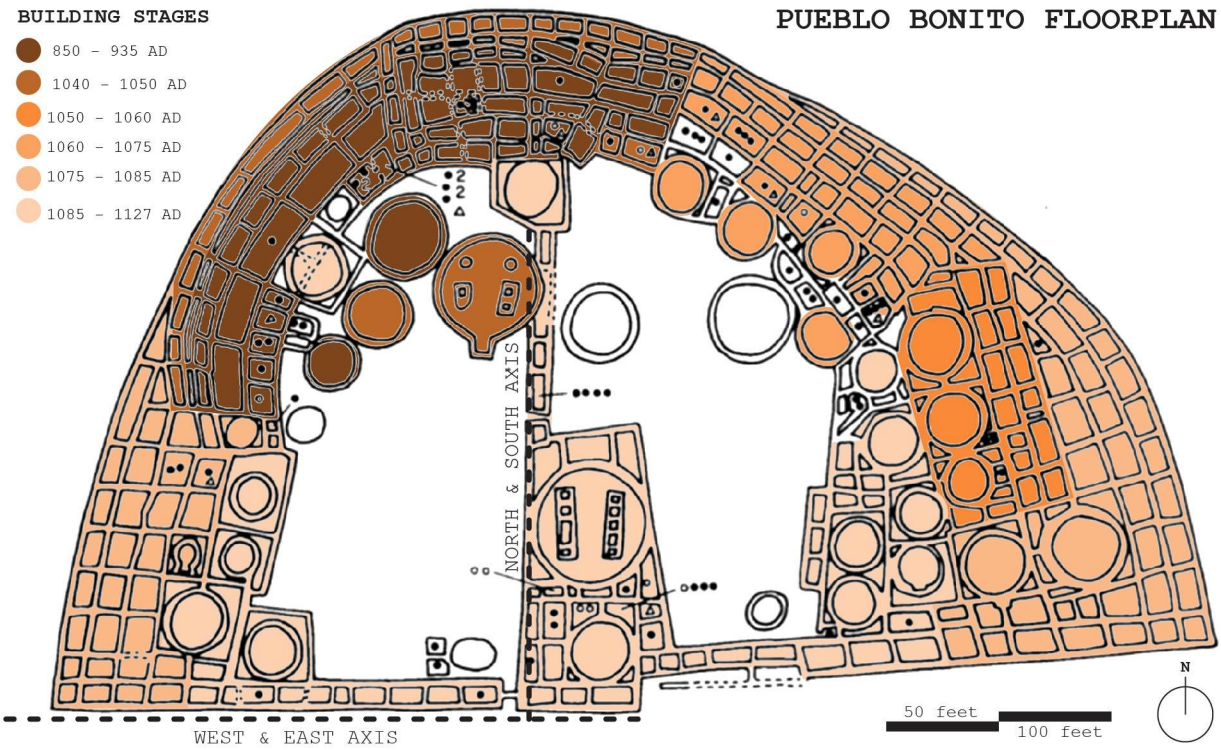

Fig. 5. Ancestral Puebloans,(drawing: Tunnell) floor plan with evolutionary construction stages & cardinal direction alignment, Pueblo Bonito, Chaco Canyon, NM, 850-1150.

Chaco Canyon is home to fifteen great palaces where travelers arrived on pilgrimage to celebrate and commune with other groups of the larger Ancestral Puebloan region stretching over one hundred and fifty miles in the Southwest. The great palaces acted as embassies with different communities building their own masonry pueblos to comfortably support their travelers migrating to the canyon for religious and social gatherings. Pueblo Bonito is the greatest of these palaces, distinct for its size and intricate masonry with over six hundred and fifty rooms. The birth of this stone giant was not achieved in a day, but rather meticulously planned over several generations as the society prospered. One key aspect to the

developmental Chacoan planning process was the orientation of celestial sitelines to the architectural features.

> "The solar and lunar cosmology encoded in the Chacoans' massive architecture - through the building's orientations, internal geometry, and geographic relationships - unified the Chacoan people with each other and with the cosmos."[2]
>
> - Anna Sofaer, archaeo-astronomer

The floorplan of Pueblo Bonito is a distinct semi-circle that covers two acres with its north and south axis approximately aligned with the magnetic cardinal directions. The central wall that separates the plaza in two marks this axis. Symmetrical forms within the floorplan are then reflected by this line. The building capitalizes on the solar heat gain of the Southern Sun in the winter time due to this orientation. This positioning is extended to the larger canyon planning with the relationship of Pueblo Bonito to Chetro Kietl delineating a west to east movement and the path from Pueblo Alto to Tsin Kletzin following a north-to-south trajectory. Four major construction phases that evolved with this orientation to the cardinal points are visibly marked within the building through the masonry types of the walls. Sandstone bricks shaped with granite tools vary in patterning as builders adapt to maintenance concerns and the availability of stone types, playing with the layering of large bricks and thin slates. The tabular sandstone is a strong material and is easily reduced into smaller fragments. The great skill, attention to detail, and intentional placement that sets Chaco Canyon masonry apart from the rest of the Ancestral Puebloan sites.

The planning process of Pueblo Bonito from the evolution of the floorplan to the masonry types represents the additive knowledge developed by the desert dwellers as they adapted to the needs of the building.

> "Chaco's built forms exhibit the sense of design and order that come from both the singular vision of the architect and the perseverance over time of the planner."[3]
>
> - Stephen Lekson, archeologist

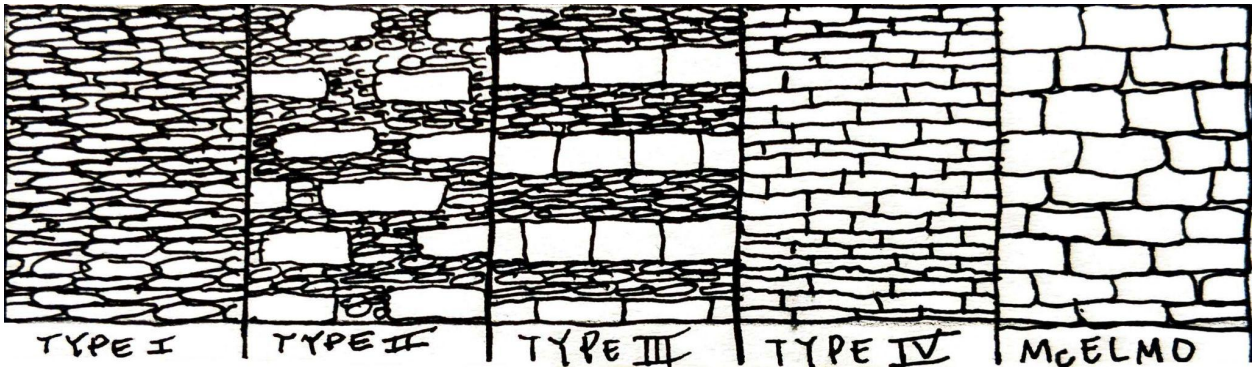

Fig. 6. Ancestral Puebloans, (drawing: Tunnell) sandstone masonry wall types, Pueblo Bonito, Chaco Canyon, NM, 850-1150.

Pueblo Bonito is also tiered with at least four stories created through a floor system supported by ponderosa pine vigas and latillas, or primary and secondary beams. This upwards stacking represents a spiritual connection to the skies and a control over the Sun as the building moves upward out of the ground to reach the heavens. This stacking also contributes to the solar heat gain of the building. The masonry wall system situated the wooden floor system into each level by reducing the stone width of the wall as it moves up, tapering upwards. Stabilization of the foundation occurs through backfilling masonry walls with sand, essentially burying the building in order to anchor it downwards.[4] Materials for the floor system, trunks of ponderosa pine, were carried in from over twenty miles away

along the established roadways in order to be stripped and shaped. The tree remnants inside Pueblo Bonito allowed scientists to date the age of the building. Inside a plastered, reconstructed room, Kialo Winters, a local, Navajo tour guide, pointed to the original latillas vigas above me. The small holes had numbers beside them, placed by scientists, which indicated the date of the wood: 1045 and 1050. Winters provided me with a historical understanding of Pueblo Bonito as well as a cultural one, as his narration of the site included oral traditions shared with him from Navajo elders, who recounted events which had taken place here.[5] This 'White City' of Chaco Canyon, titled by the adobe plastering of the palaces, was the center of an expansive civilization with great social, economic, and religious activity. Pueblo Bonito encapsulates this bustling society through its evolutionary planning, impressive masonry construction, and stacked section.

Fig. 7. Ancestral Puebloans, (photographs: Tunnell) reconstructed interior, original timber structural elements, pine doorway header , Pueblo Bonito, Chaco Canyon, NM, 850-1150.

The Chaco Way of Life

A distinctive element to Chacoan design is the great kiva visible in the floorplan of Pueblo Bonito, witnessed particularly in

the circular shapes of the central plaza. These circular masonry enclosures were the communal and ceremonial centers for Chacoan social life. With a fireplace placed off center in orientation to the southern cardinal direction, ventilation was achieved through a chimney system moving from under the ground to the sky above. At a neighboring Chacoan Cultural site, Aztec Ruins provided me with the opportunity to experience a reconstructed kiva, the blueprint having been derived from archeological evidence and extant ruins in the area. After descending down into darkness, the visitor would view a singular shaft of light falling from an opening in the ceiling and aligning with the rectangular structure below on the floor. Sitting on the stone bench lining the curved walls, I imagined the flickering of fire dancing around the room, illuminating dramatic moments of religious figures dressed in regalia entering the space to perform ceremonies. The partly submerged placement paired with the insulating stone materials and the glowing burn of a fire provided a warm, communal space for families and strangers alike to gather together. The flat roofs with a singular opening descending down into the kiva through a ladder visually blended the spaces into the great plaza of Pueblo Bonito. These important social spaces evolved first from pithouses, the first dwellings of the Southwest characterized by a similar circulation system of roof entrances with an overall curved form.[6] Kivas evolved further as well, visible in the Navajo hogan with a similar cribbed timber roofing system and octagonal shape. The significance of kivas is also still alive, as many pueblo communities still maintain the use of these circular spaces, displaying the

ancestral architectural traditions that have been passed down from the height of the Chaco Canyon days.

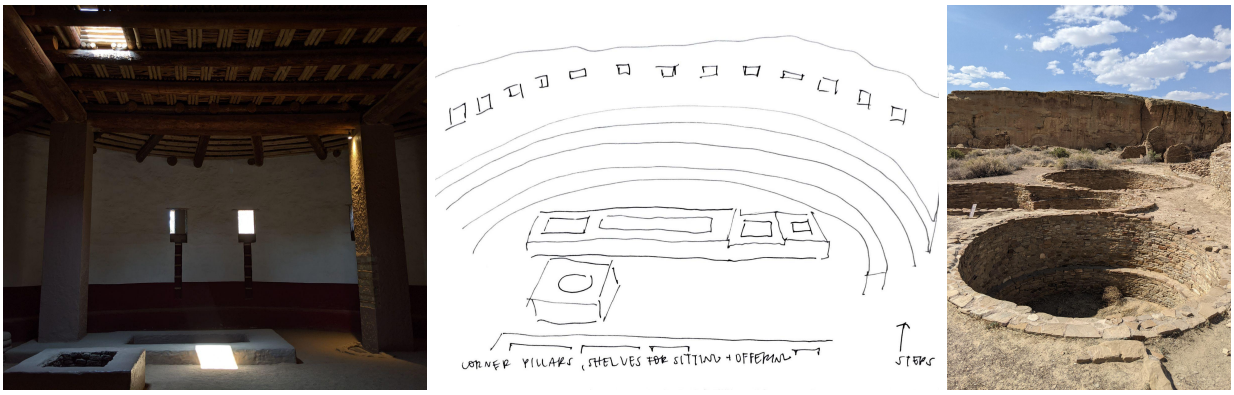

Fig. 8. Ancestral Puebloans, (photographs & drawing: Tunnell) reconstructed kiva at Aztec Ruin, sketch of a kiva in the central plaza at Pueblo Bonito, Aztec Ruins & Pueblo Bonito, NM, 850-1150.

Another tradition carried throughout the timeline of the Southwest is pottery. An imported idea from a culture further south, Ancestral Puebloans transformed clay and water into elegant vessels with intricate, geometric patterns dancing across the front, later cooked at high temperatures to strengthen the once flexible mixture.[7] The detailed construction of these found vessels displays the meticulous artistry also depicted in the masonry work of Pueblo Bonito. Distinctions among pottery types follow the different cultural groups of the Southwest, as is revealed in the archeological rediscovery of pottery shards revealing information about the people who once walked here. The traditions of clay pottery are still upheld today, specifically in the New Mexican pueblo communities. The black and white patterning carefully painted on with thin brushes sourced from yucca leaves is unique to each place and people. To see the pottery of Chaco Canyon in comparison with the pottery of the contemporary pueblo is to see the visual lineage of a cultural

history intrinsically linked to the masonry monument of Pueblo Bonito.

Fig. 9. (photograph: National History Museum of Utah) Ancestral Puebloan clay vessels, (photograph: shumakolowa.com) Myron Sarracino, Laguna Pueblo pottery

Lessons of Environmental Design

Pueblo Bonito displays the deep environmental sensitivity integrated into the design of the Ancestral Puebloans. The cardinal direction alignment reinforces sustainable design principles in multiple ways. Tiering the structure to the south provides the interior with consistent radiant energy distribution for the bitter winter months, passively heating the building. The thick core and veneer walls then hold this heat so effectively that the temperature inside the plastered rooms only fluctuates one degree within all seasons. Small doorways and packed earthen floors prevent warmth from escaping, further reiterating insulation measures. Fenestrations intentionally leveled with the Sun's movement brings in daylight for interior illumination of painted murals on the adobe walls. The geometric arrangement of the rooms not only responds to solar considerations but to wind issues as well as the surrounding walls protect the central plaza from prevailing northwestern winter wind. Natural ventilation was achieved through small openings situated high

up in the dense walls, allowing hot air to rise and make its escape. Pueblo Bonito is highly adapted to the microclimate of the canyon and its resources due to four centuries of building experience by Puebloans in the region prior to the construction of Chaco Canyon's large pueblos.

Through my conversations with Kialo Winters, I learned that the environmental integration of Pueblo Bonito was an important theme. As we moved through the walls of Pueblo Bonito and he outlined the movement of the Sun aligned to them, Winters explained that "the landscape is the highest deity here."[8] The designers of Pueblo Bonito intentionally utilized and responded to what they observed in the skies and the mesas that surrounded them. The spiritual significance of these decisions is just as important as the building's functional qualities. They built in accordance with Earth Laws, the idea that humans have a responsibility to allow ecosystems to exist, thrive, and evolve by avoiding resource exploitation and destructive practices. Just as ecosystems have cycles of birth and decay, so too does Pueblo Bonito, backfilled by the people who left it and returned to the Earth through waves of sand crashing over it. These principles of environmentalism were significant to the designers of Pueblo Bonito because of the evidence found in the heritage of modern day Indigenous communities through their ideologies, ceremonies, architecture, art, and overall way of life. These people are the original stewards of the land and the architecture they have created, and are still creating, displays this ancestral connection. It is these cultural practices that synthesize the enduring architecture of

the great Pueblo Bonito so seamlessly into the weathered, khaki-colored mesas of Chaco Canyon.

Fig. 10. (painting: Michael Kabotie, Delbridge Honanie) Hopi Visions: Journey of the Human Spirit, acrylic on canvas, kiva as symbol of birth, Museum of Northern Arizona, AZ, 2001.

Endnotes

1. Britt Bankston. Interview with Josie Tunnell. Field interview. Chaco Canyon, June 15, 2021.
2. Anna Sofaer, ”The Primary Architecture of the Chacoan Culture: A Cosmological Expression,” in *Anasazi Architecture and American Design*, ed. Baker Morrow, V.B. Price, (Albuquerque: University of New Mexico Press), 120.
3. Stephen Lekson, ed., *Great Pueblo Architecture of Chaco Canyon New Mexico* (Albuquerque: National Park Service, 1984), 35.
4. Stephen D. Dent, Barbara Coleman, ”Power and Efficiency in Eastern Anasazi Architecture: A Case of Multiple Evolutionary

Trajectories," in *Anasazi Architecture and American Design*, ed. Baker Morrow, V.B. Price (Albuquerque: University of New Mexico Press, 1997), 60.

5. Kialo Winters. Interview with Josie Tunnell. Field interview. Chaco Canyon, June 15, 2021.
6. Rose Houk, *Ancestral Puebloans* (Tucson: Western National Parks Association, 1992) 6.
7. Rose Houk, *Ancestral Puebloans* (Tucson: Western National Parks Association, 1992) 10.
8. Kialo Winters. Interview with Josie Tunnell. Field interview. Chaco Canyon, June 15, 2021.

Wupatki Pueblo

Fig. 1. Ancestral Puebloans, (photographs: Josie Tunnell) exterior including 100 room building & circular community room, Wupatki Pueblo, Flagstaff, AZ, 1106-1225.

A breeze worked its way through the rolled down windows as I drove through darkened hills in the piercing summer sunshine of the Sonora Desert. Out of the rolling volcanic landscape of the San Francisco Peaks jutted rusted sandstone boulders. With flat tops and crumbling sides, these sharp landforms were further highlighted by scattered placements of red stacked stone foundations. The dispersed pueblos, now ruins, at Wupatki National Monument are another distinctive desert architecture known in the Southwest, architecturally influenced by the high elevation and volcanic activity of the region. The high winds, bitter winters, and extreme summers have corroded the structures to rubble, yet a few of the larger buildings constructed here have survived the test of time. Despite these harsh elements, the architects of Wupatki appropriately responded by quarrying local material to capitalize on the thermal properties of the materials in order to protect and serve the community efficiently. Proceeding from the inside of the Visitor's

Center to the crimson pathway outside, a few steps later lead me to a panoramic view of one of these sandstone survivors: Wupatki Pueblo.

Mint green sagebrush and tumbling desert shrubs stand out against the thinly sliced sandstone structure nestled into the mesa. With the surrounding sloped rock forming a bowl, Wupatki rests at the higher southern side. Juxtaposed against the black covered hills, the towering burgundy structure demands attention with its visually dominating features. Through one hundred years of additions, Wupatki Pueblo intergenerationally evolved to shelter the people who lived here and the visitors who wandered through. Situated for observation of the flat plane below, the edifice stacks multiple levels with one hundred rooms which flow down into the lower elevation following the movement of the mesa. The path through the site leads one into a large circular room and further north lies an elongated ball court. Envisioning these past collective spaces paired with the elevated architecture brings the canyon to life once more. Walking down into the basin and back up again, scenes of communal ball games, familial reunions, ceremonial traditions, and the daily bustle of life suddenly fill these sandstone structures as history melds with the present.

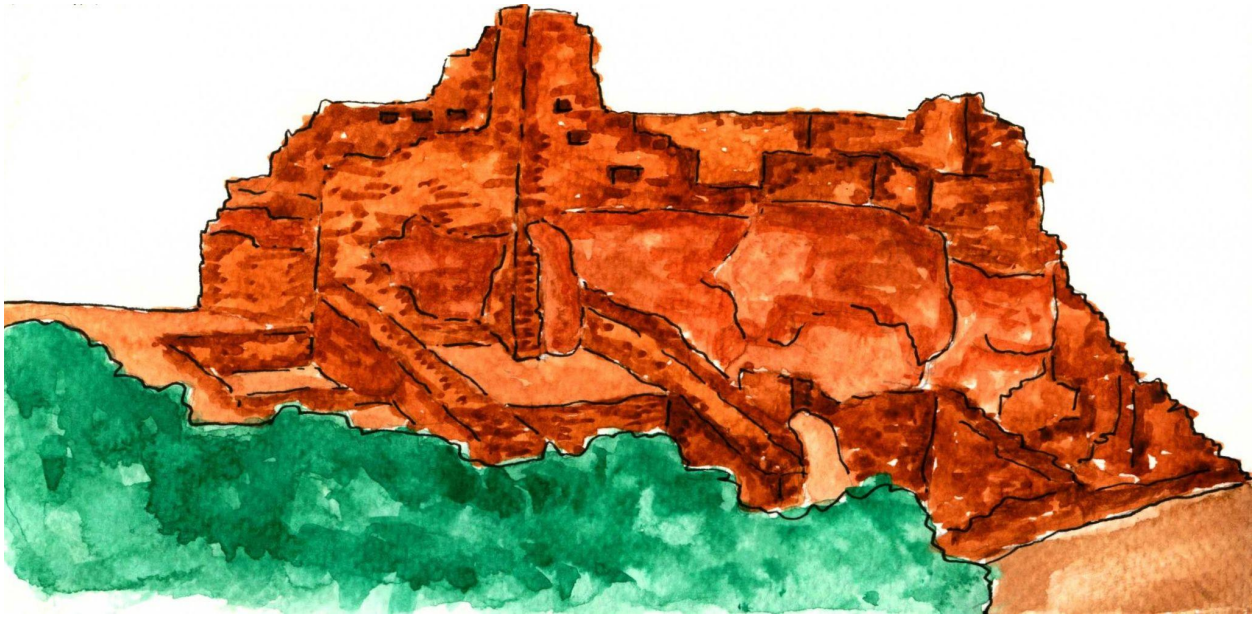

Fig. 2. Ancestral Puebloans, (watercolor & pen: Tunnell) sketch of the exterior looking north, Wupatki Pueblo, Flagstaff, AZ, 1106-1225.

Through the intentional environmental and responsive design of its ancient architects, Wupatki Pueblo resiliently stands as a precedent for collaborative communal design and sustainable desert design. Utilizing site elements from multiple cultures, harnessing the power of the Sun and the rock, and sectionally moving around geological outcroppings, effortlessly blends Wupatki Pueblo into the landscape.

Desert Climate

Wupatki Pueblo resides in the canyons of the Little Colorado River with springs that provided fresh water here. The region is a part of the North American deserts, specifically the Colorado Plateau. The shrublands and sparse canopy allow for high winds to sweep through the area, along with intense sun exposure. These windy conditions persisted during my site experience, causing me to brace myself and my hat for fear of being swept away. This desert is not always warm as temperatures drop below freezing for six months out of

the year. Experiencing the summer conditions exposed me to the unpredictable and volatile environmental shifts that are common. When hiking up the Doney Mountains nearby, the weather shifted in one moment from bright, clear skies to pelting rain and swift winds, forcing me to hastily descend the once active volcanic craters.

Fig. 3. (photographs: Tunnell) Doney Craters with a peak of the surrounding San Francisco Mountains, Wupatki Pueblo, Flagstaff, AZ, 1106-1225.

The deadly mixture of these fierce forces was visible in the wildfires raging as I made my way across the state. The neighboring Cococino National Forest had restricted access due to the spreading blazes created through a combination of lightning, dry forest material, and drought. Smoke left a dense fog in the sky, only clearing out if the winds took the soot with them. This type of landscape made me conscious that understanding local environmental conditions is essential for survival.

Another fierce force that certainly left its mark on the landscape was the powerful explosion of Sunset Crater. A part of the larger San Francisco volcanic field, Sunset Crater erupted around 1064 and lava flowed over one hundred years, spreading ash, soot, and molten lava into the sky. Following this explosion was the migration

of multiple Indigenous groups into the region, taking advantage of the plentiful water sources and benefiting from the mulch-like volcanic soil that covered the ground. The Wupatki Basin with its many canyons were utilized, as the washes channeled the mountain's snowmelt, rainfall, and organic matter from wildlife to garden plots that lie below the elevated homes. This reliable floodplain paired with water collection systems, such as pots strategically placed at the base of slick rock slopes, provided necessary resources that the people of Wupatki learned to optimize despite the generally harsh environmental conditions.

Fig. 4. (photograph: Tunnell) Sunset Crater Volcano National Monument, (painting: Mary-Russell Ferrell Colton) Sunset Crater, oil on canvas, Museum of Northern Arizona, Flagstaff, AZ, 1930.

Desert Architecture Evolution

The people of Wupatki were not the first desert dwellers but rather the peak of an accumulation of Ancestral Puebloan tradition. The Colorado Plateau covering the Four Corners, which is the junction of the current states of Colorado, New Mexico, Arizona, and Utah, has a rich history of settlement and architecture. The Museum of Northern Arizona in Flagstaff illustrates the progression of building from

pithouses to communal pueblos with kivas to finally the larger pueblos of Wupatki and Pueblo Bonito in Chaco Canyon. The museum also highlights the Indigenous cultures of the Southwest that are descendants of the people of Wupatki. The first homes of the region were dug into the ground with an entrance in the roof through which one would climb down into the structure. When communities became more sedentary and supported larger families, buildings transitioned above ground with stone, wood, and adobe rooms placed together, usually in an L-configuration aligned towards the southern sun exposure. Circular pithouses transitioned into kivas or ceremonial spaces for communal gatherings and these continue to be used today. Two other sites in the region display various features of Ancestral Puebloan design that are absent from Wupatki Pueblo due to the weathering and erosion. Through piecing together surrounding sites, a complete picture of Wupatki emerges.

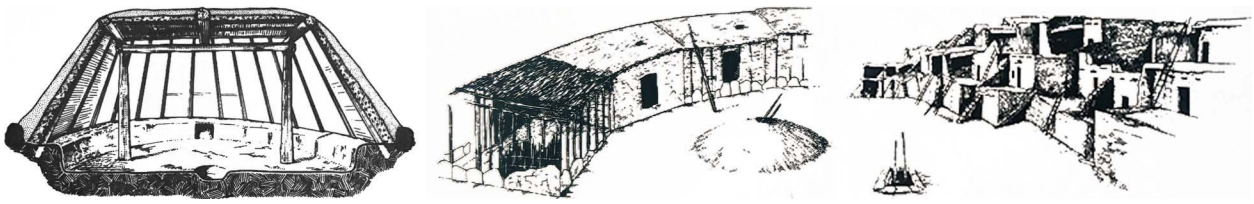

Fig. 5. (drawing: Museum of Northern Arizona) Diagram of an ancient pithouse, pueblo type I, & pueblo type IV, Museum of Northern Arizona, Flagstaff, AZ, 20-1600.

Montezuma Castle National Monument is one of the best preserved cliff dwellings in the Four Corners Region, located near Camp Verde, Arizona. Nestled into a limestone crevice, Montezuma Castle still has its original adobe plastered onto its walls. During my visit, the smoke from the wildfires clouded my view of the elevated structure, clearing out once the day and the winds had progressed. Due to the protective alcove and intentional placement of this five-story

structure, the plastering speaks to the traditions of the region. Although the stone structures of Montezuma and Wupatki are alluring in their own intricacy, the plaster is a protective covering for the facade of each structure. This mixture of sand, mud, and water was overlaid seasonally following the rainy season, which would have eroded the previous layer of plaster. This facade treatment melts the home right into the surrounding stone from which the materials originate.

Fig. 6. Southern Sinaguan,(photograph & drawing: Tunnell) limestone cliff dwelling, Montezuma Castle, Campe Verde, AZ, 1100-1300.

Just as Montezuma Castle has maintained its facade, Tuzigoot National Monument has sustained its original wooden structure. Paired with the stone walls, timber beams and smaller structural elements such as reeds were layered together and situated within the stone to provide support for the floor and roof systems. The floor system was finished with grass and mud.[1] The original architectural members supporting Tuzigoot are visible today through great preservation. Wupatki Pueblo has remnants of this system detectable in the voids of

the stone walls. With a little imagination, a similar wooden member system fits right into the patterned holes of the wall. This system not only provides superior structural support, but also supports insulation and heat retention within the building as well as providing a warm interior. Montezuma Castle, Tuzigoot, and the historical desert architect of the Four Corners region reveals elements of Wupatki Pueblo that have been lost to time as certain features of some structures have slowly returned to the Earth.

Fig. 7. Sinaguan & Ancestral Puebloans, (photographs: Tunnell) preserved wood structure of Tuzigoot & structure voids at Wupatki, Tuzigoot & Wupatki Pueblo, Clarkdale & Flagstaff, AZ,1000-1400 & 1106-1225.

Wupatki Pueblo: Architectural Details

The longevity of the stone structures at Wupatki is a testament to the integrity and ingenuity of the ancestral builders. For over eight centuries, these walls sheltered residents from wind, snow, sleet, and rain, providing a warm and shaded haven for these desert-dwellers. The unique configuration of Wupatki Pueblo begins with the foundation. Positioned on the rim of a shallow canyon carved away by flash floods and snow melt, elevated positioning allowed for

clear visibility for those who traveled here along the trade networks or those traveling here for social and religious gatherings. The flat land under Wupatki Basin paired with the clear skies allows for high visibility of the surrounding region. The canyon rim is defined by boulders and stone outcroppings which were not destroyed, but rather were seamlessly integrated into the walls of the building. The stone masonry construction employed at Wupatki is indicative of the builders at Pueblo Bonito with calculated stacking of thin stone.

Fig. 8. Ancestral Puebloans, (photographs: Tunnell) Moenkopi sandstone masonry & door frame details, Wupatki Pueblo, Flagstaff, AZ, 1106-1225.

Crimson Moenkopi sandstone, beige Kaibab limestone, and ebony volcanic basalt all abundantly populate this area and were quarried by the people of this region. Citadel Pueblo positioned on the highest mesa of the area has a quarry carved out right next to the structure, allowing one to visualize the amount of material needed to complete the three-story pueblo and its local sourcing. This vivid red sedimentary rock at Wupatki is an ideal building material as it is naturally brittle, is readily available to this region, and has strong structural integrity in a wall system. The structural system with this stone is adaptable to natural features, molding to the

preexisting boulders and moving with the settling of the building. Stacked stone with clay mortar beds created walls that were doubled up and filled with a rubble core. This system paired with the timber roof system mentioned previously allows for the distinct sectional movement of Wupatki with circulation that flowed from story to story through roof entrances with ladders descending into the enclosed rooms. The sectional expansion of Wupatki is attributed to the multiple construction phases occurring over the lifespan of the building as the population of the area grew. With stages built in 1106, 1137, 1160, and 1192, the Ancestral Puebloan designers utilized the topographic change of the canyon to expand the structure for its programmatic needs, progressing from the top of the mesa into the basin below. Sectional stacking also allowed for thermal heat retention from Southern Sun exposure. Transition was no stranger to Wupatki Pueblo, as annual seasonal change affected the social dynamic throughout the months. In the summer, permanent residents moved out to tend to agricultural fields and then migrate back to the larger pueblo once production was over; they communally shared food resources and stayed warm during the colder months. People also traveled there for celebration, entertainment, trade, and for meetings of the entire community. The cross-generational planning and expansion of Wupatki Pueblo reveals the immense fluctuation of the community surrounding the structure as well as the architect's adaptation to these challenges.

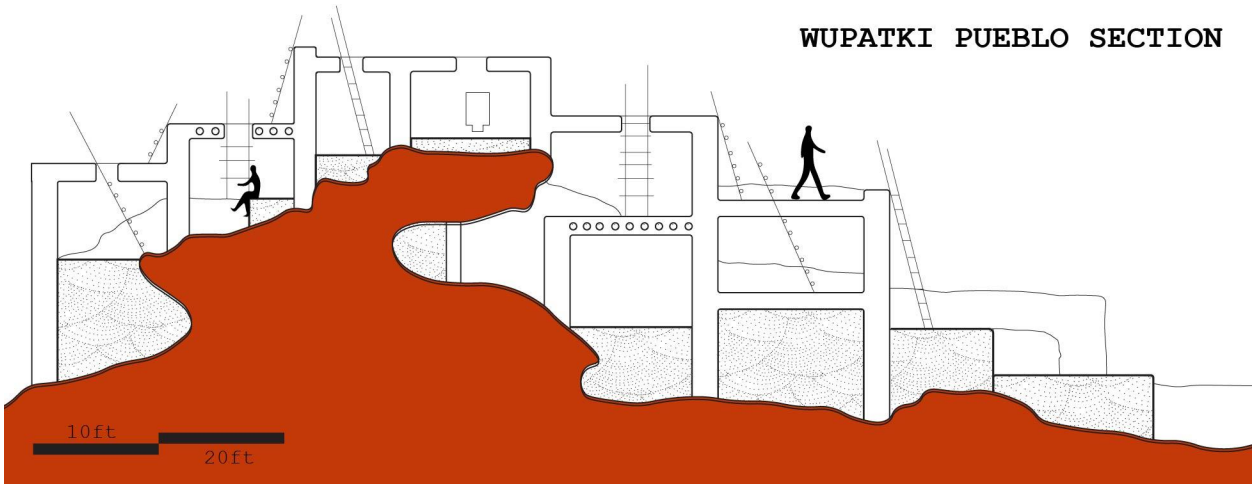

Fig. 9. Ancestral Puebloans, (drawing: Tunnell) section showing roof circulation, boulder adaptation, & thick masonry walls, Wupatki Pueblo, Flagstaff, AZ, 1106-1225.

The site layout of Wupatki Pueblo reflects the great diversity that converged in the shadows of the San Francisco peaks. Four cultures migrated there from all directions following the eruption of Sunset Crater. The Kayenta Puebloan to the north, Cohonina to the west, the Hohokam to the south, and the Sinagua, who first settled the region, all joined together as a single community and shared distinct building traditions as well. From the Kayenta Puebloan, the great masonry and T-shaped doorways visible at Pueblo Bonito drew from skills utilized at Wupatki Pueblo as well, tradesman knowledge passed from one hand to another. The elongated masonry ball court was a tradition of the Hohokam people, who had constructed a ball court in every town and trade networks moving people from one court to another. Establishing a masonry ball court here at Wupatki encourages cultural connection to the southern region while providing a communal space for ceremonies, socialization, children’s contests, and perhaps even a reservoir. The circular community room follows the customs of the Sinagua and has similarities to pithouses that evolved into

kivas.[2] The circular enclosure at Wupatki is unique in that there is no archeological evidence of a roof covering for the structure, leaving the ceremonial, communal, and religious space open to the elements and to the eyes of the surrounding basin. Though distinct cultural groups migrated and blended, they maintained distinct social traditions through their architecture of Wupatki Pueblo. There was a space for every community which chose to call Wupatki Pueblo home.

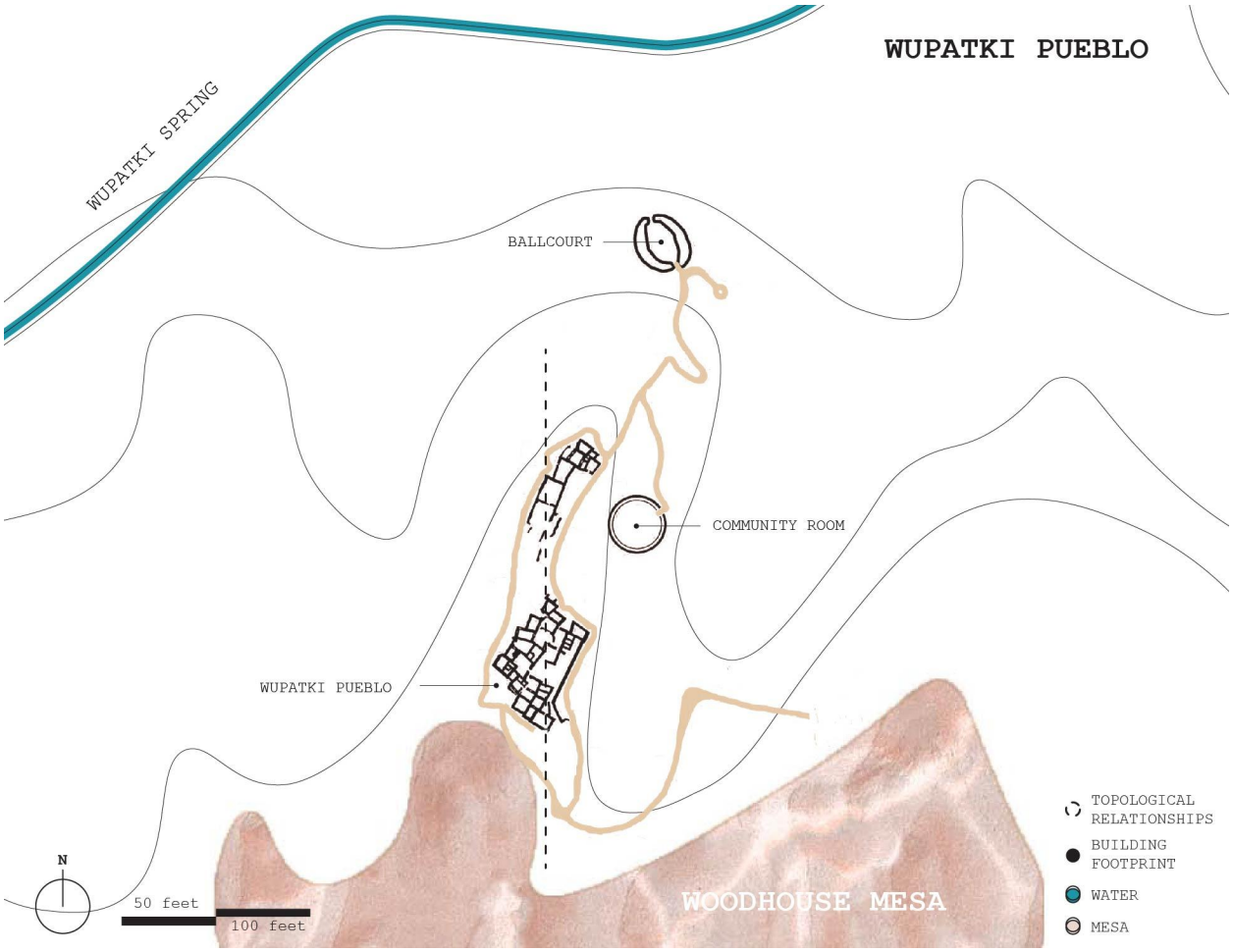

Fig. 10. Ancestral Puebloans, (drawing: Tunnell) site plan, Wupatki Pueblo, Flagstaff, AZ, 1106-1225.

Lessons of Environmental Design

The architecture of Wupatki Pueblo represents the resiliency and innovation of the Ancestral Puebloan people who built upon the

knowledge of their ancestors to create a diverse society that flourished in the desert. To achieve this level of integration with the landscape, the inhabitants responded to the elements on the site in important ways. The swift winds that will knock one to the ground were addressed through towering walls placed on the north and west sides of the structure to intercept prevailing winds. The intense sun, precious for warmth in the winter months, was collected critically yet temporarily inside the building through terraced stories on the south and east, maximizing the solar gain. The natural material of the building, specifically the stone filled masonry walls and packed earth floors, stored heat and insulated the building to retain the captured solar exposure and passively heat the people and objects inside. Ventilation shafts moved through the voids in the floors and walls, providing air circulation for indoor fires in addition to supplying fresh air back into interior conditions. Valuable water was collected through the flat roof system and channeled into storage basins kept inside the edifice. While interviewing Dennis Gilpin, an archeologist and historian specializing in the Four Corners region, we discussed this architectural relationship to the environment. There was a time when "there was a lack of waste where every resource was utilized, and they produced everything they consumed."[3] Creating a homestead was also an act of communal engagement and learned common knowledge, where everyone from the energetic children to the experienced adults could have had a hand in constructing and maintaining the shelter. The accessibility of the materials as well as the process allowed

family members, neighbors, and strangers to be united together through the construction of shared spaces.

These principles of design and environmental reverence are still in practice today by the descendants of Wupatki Pueblo. The Hopi, Zuni, Acoma, Laguna, and Rio Grande are pueblo communities throughout New Mexico and Arizona that trace oral traditions and stories of migration to Wupatki. The Havasupai, Yavapai, Hualapai, Southern Paiute, and Navajo also maintain historical connection to the events and people here. The traditional use of native materials are still in practice today with adobe construction popularized as children stomp the mud and straw which the parents then form into bricks baked by the sun. Lyle Balenquah, Hopi archeologist, explains that Hopi tradition uses "materials [that] are respectfully taken from the earth to build our homes, and in doing so, our traditional Hopi structures are literally 'born' out of the earth, and this symbolic birth reflects our connection to the environment we live upon."[4] This cyclical understanding of birth, life, and death clarifies the material choices at Wupatki Pueblo as well as the choice of the people who left this community to allow the building to return to the elements it came from. The architects of Wupatki migrated out of this desert following 1225 just as they once had migrated in. The remnants of their stay give us a glimpse of their harmony with nature and their acceptance of varied cultures who also created their homes at Wupatki Pueblo, which flourished despite the challenges of its environment. In the sweeping winds and penetrating

sunshine, we find the ruins of a great environmental architecture seamlessly flowing into the landscape.

Fig. 11. (painting: Will Shuster) The Santo Domingo - Corn Dance oil on canvas, New Mexico Museum of Art, NM, 1929
Fig. 12. (photograph: Jo Mora) traditional Hopi architecture, Oraibi Village, Northern Arizona University, AZ, 1902.

Endnotes

1. Susan Lamb, *Wupatki National Monument* (Tucson: Western National Parks Association, 2016): 5.
2. Susan Lamb, *Wupatki National Monument* (Tucson: Western National Parks Association, 2016): 13.
3. Dennis Gilpin. Interview with Josie Tunnell. Field interview. Museum of Northern Arizona, June 25, 2021.
4. Lyle Balenquah, "Beyond Stone and Mortar: A Hopi Perspective on the Preservation of Ruins (and Culture)," *Heritage Management* 1, no. 2 (2008): 150.

The Athabascan Home

Fig. 1. (photograph: Josie Tunnell) Ethereal Alaskan wildflowers frame a view looking towards the Visitors Center, Alaska Native Heritage Center, Anchorage, AK, 1999.

With my coat zipped up and my nose numb from the brisk breeze, I turned my gaze to the orange sunset blazing in the sky, despite the time on the clock being well past midnight. My first moment at the Anchorage Airport had already set Alaska apart from anywhere in the world I had ever been to before. With lush emerald forests, puffy gray clouds, and vivid wildflowers fluttering in the wind, the reflection on the glassy lake at the Alaska Native Heritage Center revealed glimpses of the five traditional Native dwellings that stand around its banks. The Heritage Center is a place of discovery and

diversity, highlighting the eleven major cultural groups that have called Alaska home for over ten thousand years. The Center is also run by Native Alaskans themselves and provides a first-hand account of these cultures and their histories. Inside the center, dancers adorned with kuspuks, a hooded shirt with a large pocket uniquely made for each dancer, motion through Yup'ik and Cup'ik moves highlighted with feather fans that sweep through the air to depict a phrase in the song in rhythm with the drum beat. Native Arctic games later occupied the stage as young athletes demonstrated the seal hop, the high kick, and the toe kick, all games developed throughout the North to create stamina, prepare for hunting, and now to bond communities. Culture bearers, young Native Alaskan interns at the Center, lead a guided tour around the traditional village homes from various regions, where the cultures were explained as thoroughly as the architecture which sheltered them. Through the dappled foliage of the forest emerged the warm, wooden lodge of the Athabascan people, supplemented by an elevated wooden food cache and a timber fish drying rack. The inland of Alaska is where this culture calls home, migrating seasonally with the movement of the wildlife, fluctuating flora, and contrasting seasons with a subsistence lifestyle. This reliance on the land and the interconnected nature of this way of life prioritizes the environment which is then reflected in the sustainable architecture.

Fig. 2. Athabascan, (photograph: Tunnell) site across the lake & exterior with food cache, Athabascan winter home, Alaska Native Heritage Center, Anchorage, AK, 700-1800.

> "The worldview of the Dena links nature and life as one, a system that maintains unity in the human, natural, and spiritual worlds. All things have spirits and everything is connected."[1]
>
> - Miranda Wright, Bernice Joseph, & Malinda Chase, Athabascan

Through experiencing a glimpse of the cultures represented at the Alaska Native Heritage Center, specifically the Athabascan people, lessons of adaptable design emerge as the precious resources of the region are utilized in distinct ways, such as thermal insulation and natural daylighting, to respond to the specific climatic needs of the Last Frontier.

The Climate of Alaska

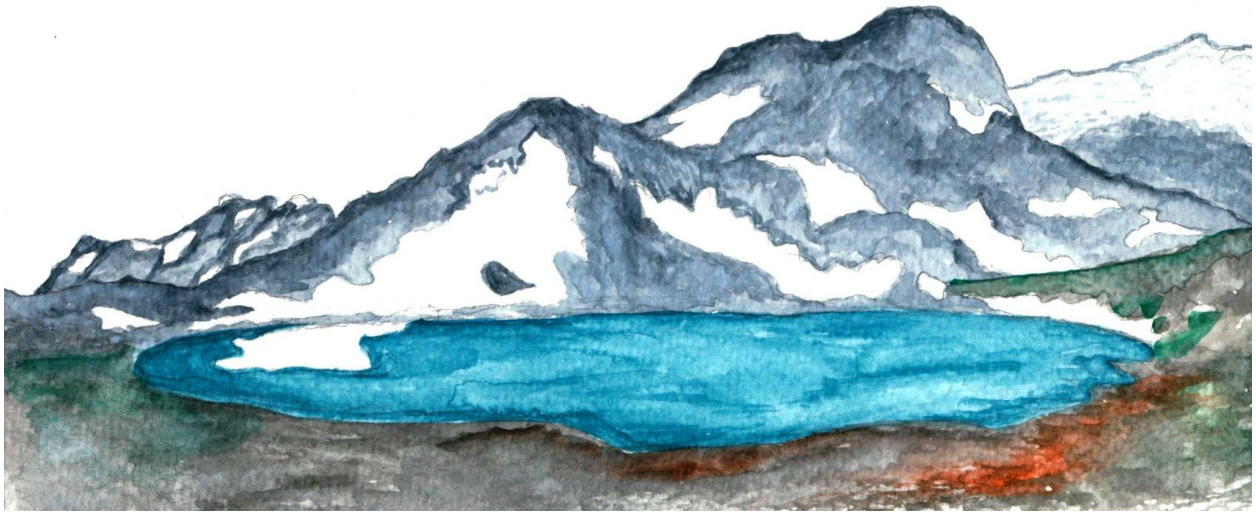

Fig. 3. (watercolor: Tunnell) sketch of Crystal Lake near Barnes Mountain, Chugach State Park, Anchorage, AK, 2021.

The northern climate of Alaska is noticeably different from the three other regions I traveled to on my Aydelott adventures. The immense landscape has multiple ecotypes and consequently a diversity of cultures have adapted to the varying conditions. The Athabascan people, a broad term that encompasses many of the names of the people within it, occupy a wide range of inland Alaska, spreading across the Northwestern Forested Mountains, Marine West Coast Forests, and the Taiga ecological regions in the land between the mountains of the Alaska Range and the Brooks Range. From mountaintops to rolling plains, Athabascan people travel along regional bands of land with territories that are respected by other familial communities. These lands are filled with coniferous and hardwood forests, full of teeming wildlife, edible gatherings, and life-giving water sources. From large mammals such as moose, bears, caribou, and sheep to

spawning fish and migratory fowl, the land provides sources of food as well as materials for clothing and shelter.

This subarctic region is characterized by its mild, short summers and freezing, long winters. For several months of the year, snow covers the ground, while permafrost is a permanent condition in the landscape. Paired with blustering winds, the freezing temperatures and frequent snowfall creates a landscape void of color or growth in the harsh winter months. Due to the northern latitude and the shift in the Earth's rotation, the summer Sun never sets on the summer solstice, while the winter Sun never rises on the winter solstice. This midnight sun versus polar night relationship is translated into the lifestyles of the people here as active hunting seasons revolve around sunlight while communal, indoor activities occur by the firelight in the winter. Despite the challenges of waning sunlight and harsh winters, the Alaskan environment provides everything the people need, if one only knows how to harness these resources.

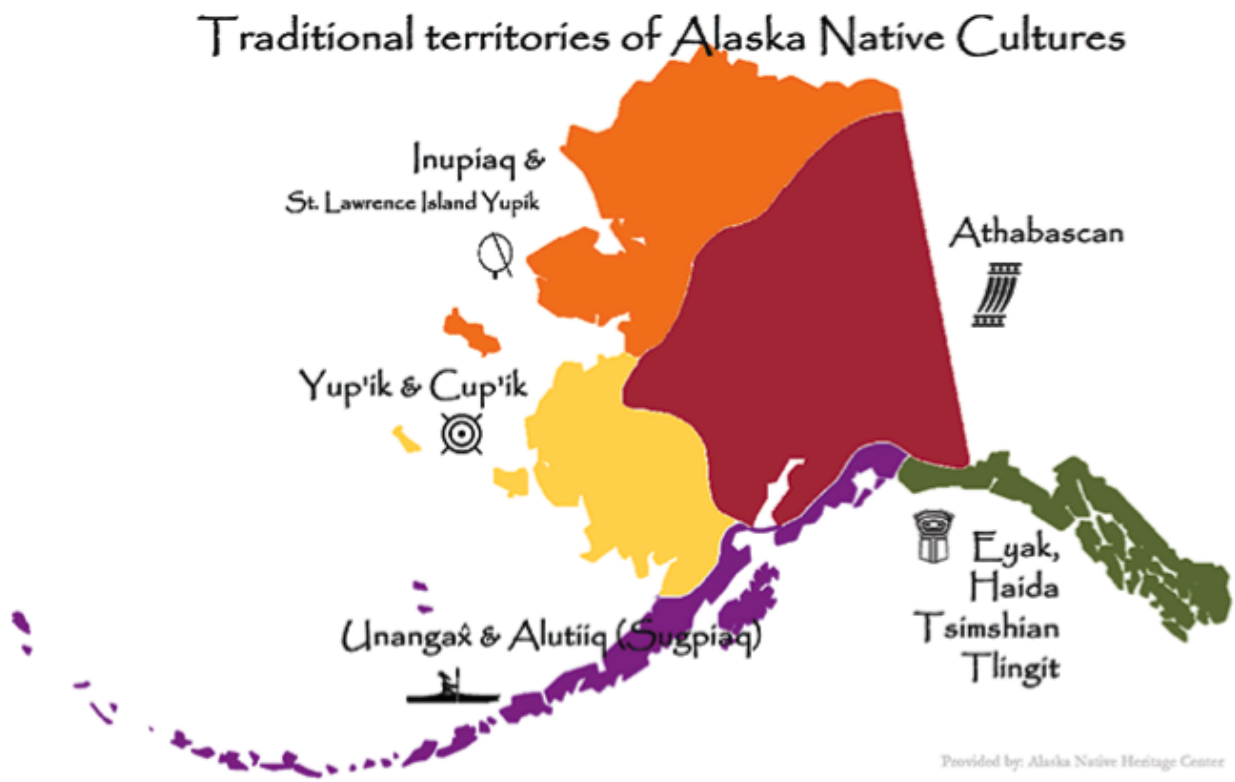

Fig. 4. (drawing: Alaska Native Heritage Center) map of the traditional territories of Alaskan Indigenous groups, Alaska, AK, 2021.

The Athabascan Way of Life

The start of the Athabascan way of life can be traced back to 480 BC. With its deep history, regional ecological diversity, and small family group dynamics, the Athabascan peoples encompasses a large and diverse group of around 40 cultures with similar lifestyles yet differing traditions. The nomadic lifestyle the Athabascans shared requires traveling ten to fifteen miles per day, moving with the seasons. Migratory shifts are marked by the passing moons, named for events of the changing conditions throughout the season. In the summer time during the greatest period of movement, portable tents of caribou hide protect against sun and rain, flexible and light enough to be packed up and carried to the next location. In the winter, two to five households converge in timber lodges with communal

celebrations such as potlatches, where successful hunts and gathered goods are shared during feasts to honor loved ones and celebrate their time together. My research focuses on these timber structures which were winter homes.

Fig. 5. Athabascan, (photographs: Tunnell) timber structure, moss filling, & fire ventilation, Athabascan winter home, Alaska Native Heritage Center, Anchorage, AK, 700-1800.

Stripped poles from the dominant white spruce and birch of the forest comprise the structure of the home. Trees are just one cherished component of the forest, as explained at the Museum of the North, as the "Koyukan Athabascans have 45 words for different tree species, parts of the plant, and kinds of trees."[2] This heavy timber structure requires precise fabrication and placement as no nails or fasteners are used, but rather the interlocking elements provide the full structural support. Moss acts as an insulation between the timber poles, a unique filling to block incoming wind, while utilizing local lichen to retain heat. The roof is also comprised of stripped poles covered in moss, sod, caribou skin, or birch and spruce bark. These organic materials block snow from entering the home while the pitched slope slides the snow off the roof and onto the ground. The floorplan for these homes is quite simple: one entrance, a room in the front, and a room in the back. The separation

of rooms physically reflects the separation of activities that occur. The front of the house contains a firepit paired with a void in the roof acting as a vent for the smoke where cooking and drying food separates the rest of the home in case bears come through the front door. The back of the home is reserved for sleeping, sewing, carving, and other winter activities that do not involve food. Light enters the space through eastern windows covered with translucent, dried animal intestines positioned to catch the fleeting sunshine.

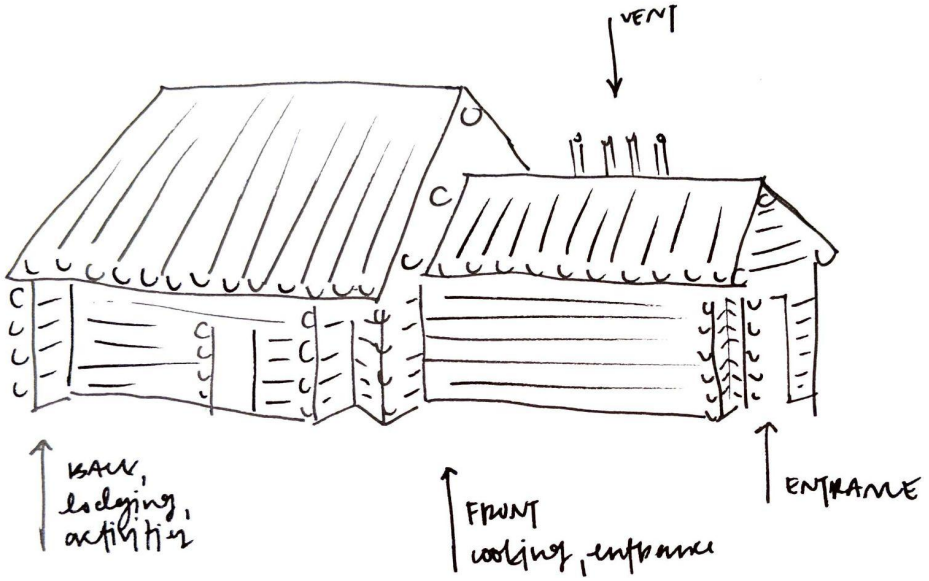

Fig. 6. Athabascan, (drawing: Tunnell) site sketch of home layout, Athabascan winter home, Alaska Native Heritage Center, Anchorage, AK, 700-1800.

Two other structures accompany the home to provide food resources for the family. Having these two structures on display alongside the winter building successfully illustrated the way of life of these people. Several elevated food caches composed of timber elements are built at a distance from the home in the woods with ladders leading up to the small door, protecting the precious food supply from intruders. These storage units were accessible by ladder and distributed throughout the forested territory of the family in

order to provide multiple places for food, specifically in the spring following the harsh winter when resources were low. An airy, tectonic framework next to the bank of the lake at the Heritage Center represents the fish drying rack used by the Athabascans to preserve their fish supply. Exposure to the Sun and the wind allowed the catch of the day to stay digestible far into the harsh winter. This variety of timber uses displays the resourcefulness of the Athabascans with mindful uses for every part of a tree that had been cut down. The intentional placement and material sourcing reflects the landscape of the region, as well as the adapted design to the nomadic lifestyle of the Athabascan people in an ever-changing climate.

Fig. 7. Athabascan, (photographs: Tunnell) fish drying rack & elevated timber food cache, Athabascan winter home, Alaska Native Heritage Center, Anchorage, AK, 700-1800.

Other Native Alaskan Architecture

The other Native dwellings constructed at the Alaska Native Heritage Center also deserve recognition for the ingenuity and resiliency of the Indigenous people. The eleven cultural groups reflected here include the Inupiaq & St. Lawrence Island Yupik, the Yup’ik & Cup’ik, the Unangax & Alutiiq, and the Eyak, Haida, Tsimshian, and Tlingit.

> ”Living in Alaska means adapting to what the land provides. The different resources available are a part of the distinct cultures in each region”[3]
>
> - *The Land Shapes the People*

The Native Alaskan groups have a wide variety of ways of living that are isolated to the specific region they live in, which then creates a variety of architectural traditions. The cedar plank home of the Eyak, Haida, Tsimshian, and the Tlingit groups sticks out with its red timber, large footprint, and interior totem poles acting as columns. The Marine West Coast Forests provide these large cedar trees which are then intentionally crafted by these Indigenous groups. After ducking through an oval-shaped entrance, a warm interior opens up with a central lowered floor plate where a blazing fire usually flickers. The intricately carved and meticulously colored totem poles hold symbolic values for the carver, representing the respect for culture, family, self, and the environment that is a shared value within the four cultures. Totem poles are also symbolic representations of these cultures, marking family territories and displaying the history of the clan. This clan home holds up to one hundred people in that communal and family gatherings are prioritized and reflected on the interior. The crimson cedar naturally repels rot and is abundantly sourced in large forests along the coasts of Alaska’s panhandle. The beautiful articulation of wood carving paired with an architecture created around social interaction elegantly displays the value of these cultures.

Fig. 8. Eyak, Haida, Tsimshian, & Tlingit, (photographs: Tunnell) cedar plank house with carved columns & heavy timber structure , Alaska Native Heritage Center, Anchorage, AK, 700-1800.

The cultures of the Inupiaq and the St. Lawrence Yupik occupy one of the harshest environments on the planet: the tundra. With no local timber, freezing temperatures, and hungry polar bears, materials are in scarce supply and retaining warmth is essential. Whaling is an important tradition for these groups who have access to the Arctic Sea and baby whale jaw bones also happen to be great for structural support. As the building is dug underground for warmer ground temperatures and less exposure to the elements, the jaw bones are placed as an archway for the tunnel leading down into the home. A pair is also placed outside the home, acting as a signpost for the underground home. The entrance into this unit is incredibly small; even at the Heritage Center it took quite an effort to scuttle in and this entrance is larger than usual. The reason for this small size is to restrict the threat of enormous polar bears crawling into the home. With limited resources and freezing conditions, the cultures of the Arctic Circle designed warm, well-adapted architecture embedded into the Earth. Although I mentioned just a few of these Native Village sites, the diversity of building types, material choices, and

structural systems is abundant and was refreshing and inspirational. All of the homes displayed here give visitors a sneak peek into the lives of Native Alaskans.

Fig. 9. Inupiaq, St. Lawrence Yupik, (photographs: Tunnell) semi-subterranean structure covered with wildflowers & ovular wooden entrance , Alaska Native Heritage Center, Anchorage, AK, 700-1800.

Lessons of Environmental Design

My time in Alaska gave me the opportunity to hike towering mountains, slide around on glaciers, witness flying bald eagles, munch on fresh salmon, and start to see the land the way the Indigenous people do. I came to appreciate the beauty of this land the Athabascans call home. The nomadic lifestyle they live allows them to experience all the grandeur of summertime in Alaska while bundling up and settling in when the world freezes up and sunlight ceases. The wooden winter homes are adapted to hold onto wanted elements while repelling undesirable ones. Choosing wood as a structural choice not only uses local, accessible materials but also happens to be an incredibly insulating material that holds warmth from the Sun and the hearth. Layering the pole structure with moss,

sod, hide, or bark protects the structure while holding the essential warmth inside. In colder climates, homes are dug into the ground a few feet deep in order to tap into the stable, warmer temperature of the ground. Placing the fire inside the home also spreads heat throughout while fulfilling another need like sustenance. Orienting the building and positioning the windows to face east provides necessary daylighting when the sun is still around. Holding onto the heat during the winter months while repelling snow and invasive cold air could be the difference between life and death.

Adapting to living in these subarctic conditions includes living without waste by finding uses for as many parts of the plants and animals that provided resources. Wildlife hunted or trapped by the Athabascans was not just used as a food supply, but also for window and roof coverings. Trees stripped for structures created an abundance of bark for roof coverings. Migrating with the wildlife, the ripening of berries, or the spawning of fish provides a variety of unique resources throughout the seasons that are attainable only through the flexibility of this lifestyle. The Athabascans are a prime example of what it means to live off the land and to adapt with it. A substantial moral and ethical component of this way of living is the sanctity and spirituality of nature, where wasting living beings is not even an option. In contrast to the Athabascan people, university-trained architects throughout North America are typically embedded in industrial production using fossil fuels for energy. We have a lot of room for change in terms of conserving and reducing this unsustainable, overuse of finite resources. Cultures like the

Athabacans provide a model of resilience and resourcefulness that the western world can learn from. The Indigenous people of Alaska are a testament to the evolutionary adaptation to a place possible through passing down communal knowledge, observing the surrounding conditions, and working in conjunction with local resources in a way that respects and appreciates nature. It is here where we must look as architects to understand what it means to adapt and fluctuate with new and changing conditions.

> "Our people had log houses without nails and all lived the same. We lived the subsistence way of life, and loved it that way"[4]
>
> - Alberta Stephen, Eklutna

Fig. 10. (wood carving: Ron Senungetuk) Whaling Whales, Whaling Celebration, maplewood, oil stain, aluminum, Anchorage Museum, Anchorage, AK, 1991.

Conclusion

Ending my Aydelott journey in Alaska provided me with the opportunity to experience three different ecological regions, ranging from the Mississippian floodplains to the arid deserts of the Southwest to the subarctic of the North. The Native American people that adapted to these distinct conditions designed an architecture that utilized local materials in a way that provided comfortable,

livable, and sustaining architecture that remains monumental to this day. As contemporary architects head into a world altered by anthropogenic climate change, we must similarly adapt to new environmental conditions. Through my research, I hope to express the full breadth of Indigenous builders - the environmental challenges they faced, the architectural ways they responded through material selection and cardinal alignments, and the beauty that was created through this process. I wish to voice my utter gratitude for all of the Indigenous communities I was able to experience and research. Without Native American people, including the entire wide and diverse range of these cultures, North America would not be the gorgeous landscape nor the social giant without the deeply intertwined impact. Through the analysis of Indigenous North American architecture, contemporary designers are better equipped to understand local environmental conditions, evaluate sourcing of local materials, and create building systems that provide a safe, comfortable space for its occupants without a dependency on finite resources such as fossil fuels. Even though technology and industry has evolved and catapulted architecture into a new age, there are still valuable lessons hidden amongst the structures of the past. Through this analysis, we do not have to reinvent the wheel but rather harness the knowledge of past generations. Indigenous people were here first on this continent, building monumental and communal architecture, and every designer can learn from a perspective centered around people and the planet, rather than people over the planet.

Endnotes

1. Miranda Wright, Bernice Joseph, & Malinda Chase, wall text, *Smithsonian Arctic Studies Center: Athabascan/Eyak*, Anchorage Museum, Anchorage, AK.
2. Wall text, *Athapaskans: Annual Cycle,* Museum of the North, Fairbanks, AK.
3. Wall text, *Alaska Exhibit: The Land Shapes the People,* Anchorage Museum, Anchorage, AK.
4. Alberta Stephen, site plaque, *Athabascan Village Site,* Alaska Native Heritage Center, Anchorage, AK.

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