

# **Internalizing the Sun**

An Exploration in Light-Driven Architecture

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Committee:

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**Abstract**

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Christopher Meek

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Can architecture utilize light to evoke a feeling of the sublime? This thesis is an exploration of daylight-driven architecture, architecture that is designed to utilize direct sunlight and ambient skylight for specifically prescribed effects. The foundation of this project draws on the thinking of architectural masters, the perspective of lighting experts, and the lessons of precedent studies to direct a process of designing architecture that allows occupants to approach a sense of divinity.

I believe that architecture is at its best when shelter, space, symbolism, and function are balanced with a desire to delight. Architecture's ability to elicit emotion from individuals, to incite wonder and awe, largely through occupation, is special. In order to exceed programmatic requirements and provoke an emotional response, the endeavor is to create architecture that is akin to art.

The proposal explored is an architecture which utilizes natural light to evoke the sublime through its cosmic connection with the sun, sky, and horizon.

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### **Dedication**

This thesis is dedicated to my parents, Kosarupa and Bada Haridas, to my brother Charles, to my dearest friends, you know who you are, and to my community of well-wishers.

You are my foundation.

### **Thank You**

To my committee, Chris and Ann Marie.

You have my deepest gratitude.

### **A Note to Myself**

Vision, passion, and commitment are worth any hardship.

Remember who you are, and the love of those who support you.

Life is more vivid when present.

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# **CHAPTER 1: INTRODUCTION**

## **ELICITING EMOTION THROUGH DAYLIGHT-DRIVEN ARCHITECTURE**

Colloquially, people acknowledge the grandeur of inspiring situations and moments by describing this impact as occurring on a deeper level. An intrinsic feeling of pleasure occurs when the conscience is excited in ways unexpected, such as when we sense a connection to something greater than ourselves. Kant's famous example of this is the sunset.<sup>1</sup> What I seek from this thesis is an architecture of the sublime; defined as follows: "It moves to wonder and surprise, and always wins against what is merely delightful or persuasive."; "not to persuade but to entrance."<sup>2</sup> I believe that architecture is at its best when shelter, space, symbolism, and function are balanced with a desire to delight. Architecture's ability to elicit emotion from individuals, to incite wonder and awe, largely through occupation, is special. This thesis seeks a better understanding of how to evoke emotion through architecture. It endeavors to create experiences that people internalize and make personal; spaces that are memorable, yet open to interpretation and varied forms of appreciation. This exploration focuses on daylight, perception, and space with a goal of eliciting feeling through architectural experience. I hypothesize that a conscientious manipulation of natural light in architecture is the key to eliciting meaningful and memorable experiences for occupants.

Compiled research and precedents led to a proposed design of a new visitor and interpretive center at the Kitt Peak National Observatory; providing a testable case for my hypothesis. It is an exploration of daylight-driven architecture; architecture that is designed to utilize direct sunlight and ambient skylight for specifically prescribed effects.

The foundation of this study is inspired by the work and perspectives of Peter Zumthor, Steven Holl, Richard Kelly, and James Turrell, who are all heavily invested in the effects and use of natural light. The thinking of Zumthor and Holl, whose works focus on light and mass, provides the central groundwork. Their thinking is then concentrated through the work of Kelly and Turrell, and their differing approaches towards perception and lighting. Visual perception and precedent studies elaborate on the emotion this thesis's architecture proposes, examining evocative gestures which elevate architecture into the realm of art, approaching the sublime.

### **THE COSMOS AND THE SUBLIME**

As human beings, our urge to look upwards can be attributed to our sense of a higher power, whether that be divinity, extraterrestrial life, or uncontrollable natural events. The sky as a representation of the divine and the horizon has long held an interpolated value as the coming together of the earth and heavens; "long before the invention of writing or the construction of observing instruments, the sky was a cultural resource among peoples throughout the world."<sup>3</sup> We have inherited the same reverence for the cosmos that civilizations across history, from ancient India and China to the Greeks, Egyptians, Mayan, Incan, and tribes of Persia, Africa, and the Americans held as central to their worship, culture, and understanding of the world.<sup>4</sup> It is innate to being human. Ancient observatories<sup>5</sup> from Stonehenge and Angkor Wat (*Figures 01-02*) to Chaco Canyon, the Sundagger, and the Aztec Sun Stone have given way to modern iterations, filled with scientific instruments. I believe this can be understood as the contemporary evolution of our human desire for a cosmic relationship: "It appears that even a secular world needs



some spiritual experience.”<sup>6</sup> However, there is a perceived disconnect; the scientist’s approach to the universe is cold and uninviting. People looking to experience the cosmos do not have the same cultural support that was once inherent to civilized societies. My desire is to realize architecture that connects us to something greater through the lens it provides, to reawaken our connection with the sky and cosmos.



*Figure 01: Stonehenge | Figure 02: Angkor Wat*

First introduced as a philosophical concept by the Greek philosopher Longinus, the sublime was used in relation to rhetoric and the art of persuasion; it expressed the power of an orator’s language to “pierce everything like a flash of lightning.”<sup>7</sup> It was later given its definition in the realm of architecture by C. N. Ledoux and E. L. Boullée, (referred to by Joseph Rykwert as the “first moderns”). In the most general of senses, the “sublime refers to immense ideas like space, time, death, and the divine.” Its significance in architecture lies in its conceptual reach and spiritual dimension. In the contemporary context, it is interpreted as a feeling of being overcome, tremendous to the point of being immeasurable. To entrance, like a flash of lightning.

The experience of the sublime is equated with the experience of the divine, but it does not require divinity. Evoking the sublime requires a certain sense of majesty along with that of fear, brought about not by beauty we wish to possess, but by the beauty that surrounds us and utterly changes us: "One fears deprivation of life, company, light, or freedom. The pleasure comes in the suspension of the threat of deprivation, with the recognition that death is not imminent."<sup>8</sup>

The sublime is the experience felt when standing in the shadow of a tidal wave, or dwelling at the edge of the horizon, or in walking towards the approaching light at the end of an underground voyage. Every example to consider has some direct or symbolic connection to light. For this reason, the focus is to understand light alongside architecture; light and matter as a pair of co-modifying elements.

## **CHAPTER 2: ARCHITECTURE AND FEELING**

### **FOUNDATIONAL ARCHITECTURAL THINKING**

A clearer sense of what forms sublime architecture begins with a review of phenomenology. In the broad and contemporary sense, phenomenology (as it is applied to architecture) rests on the belief that both sensation and rationality are necessary to create meaningful space. As elaborated by Kate Nesbitt in *The Sublime and Modern Architecture: Unmasking (An Aesthetic of) Abstraction*:

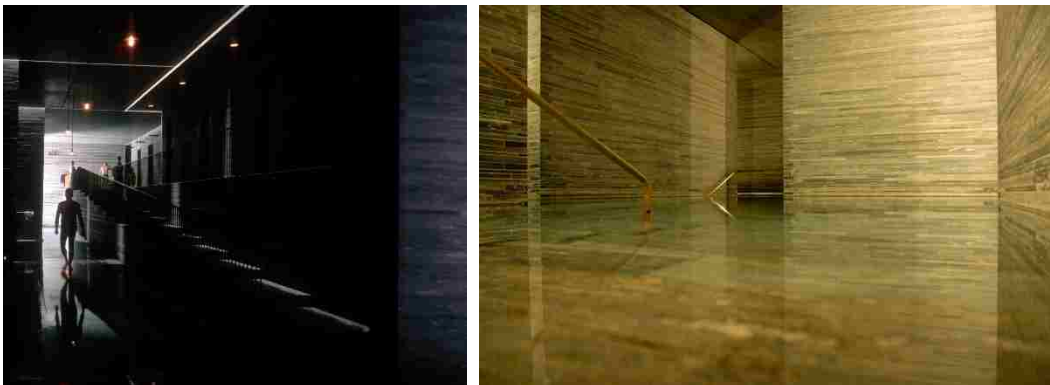
Contemporary theory is heavily influenced by two different philosophical domains: phenomenology and aesthetics. The prominence of the former in this century, especially the work of Martin Heidegger and Gaston Bachelard, laid the groundwork for today's emerging aesthetic of the contemporary sublime.<sup>9</sup>

The sudden rebirth of interest in the sublime is explicable on a number of levels. First is the emphasis on the knowledge of architecture through phenomenology. This approach foregrounds a fundamental issue in aesthetics: the effect on the viewer of a work of architecture. In the instance of the sublime, the experience is visceral. Second is the fact that through its realignment with the realm of aesthetic philosophy, architectural theory is situated to engage the metaphysical. The sublime is the path through which architecture achieves metaphysical import.<sup>10</sup>

Based in the science of observing consciousness through subjective responses to experiential phenomena, phenomenology's transition into architecture is largely a result of the work of Martin Heidegger. The term, whose roots date back to the time of Plato, or arguably back to that of Hindu philosophy, was coined by Lambert and subsequently used by Kant, Fichte, and Hegel.<sup>11</sup> Husserl expanded upon Hegel, and Heidegger upon Husserl.<sup>12</sup> In his text: *Being and Time*, Heidegger elaborated the definition of phenomenology to include unconscious and semiconscious activities such as speaking, dwelling, and the subtle response to sunlight on an appendage.<sup>13</sup> In connecting the concept of phenomenology with architecture, Heidegger paved the way for a generation

of architects and theorist to push the concept of architecture as an experience defined by all senses.

Turning to contemporary practice, two inspirational architects cited for their phenomenological perspectives are Peter Zumthor and Steven Holl. When Zumthor speaks of architecture, he not only describes the qualities it possesses but addresses how it is perceived and the emotions it elicits. He makes it personal: as a speaker, as an architect, and as an occupant; “I don’t understand light. It gives me the feeling there’s something beyond me, something beyond all understanding. And I am very glad, very grateful that there is such a thing.”<sup>14</sup> *Beyond all understanding* is precisely the emotional response of the sublime, and Zumthor’s feeling for light carries through in his architecture. For example, Therme Vals (1996) is a spa in Switzerland which depends on gravity-defying gestures to provide continuous slivers of light from above (*Figures 03-04*). The effect is articulated through steel tension cables carrying the weight of each roof-segment into and down its connected wall. This enormous endeavor is an expression of the feats Zumthor chooses to undertake to realize his vision of architectural experience.



*Figure 03: Entry Expanses of Spa | Figure 04: Grazing Light and Central Pool*

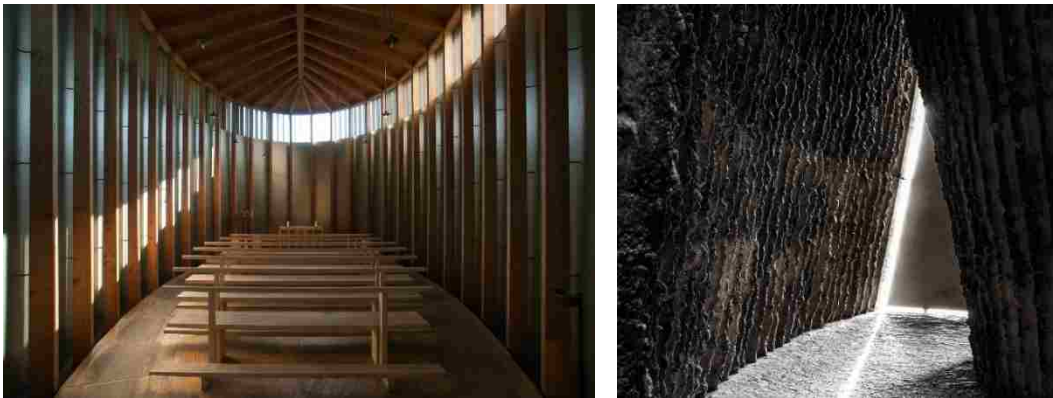
Zumthor's approach to architecture is annotated in his book *Atmosphere*, where he elaborates the twelve elements that are necessary to form a building that "manages to move" him. Unsurprisingly one such category is light, and his focus lingers around daylight, describing at differing instances as a muse, a belief, and an approach to design. This approach is sculpturally driven by light: "to plan the building as a pure mass of shadow then, afterwards, to put in the light as if you were hollowing out the darkness, as if the light were a new mass sleeping in." Zumthor refers to daylight as, "so moving [...] that I feel it almost as a spiritual quality," which he uses alongside material as the primary elements for his goal of creating architecture with *atmosphere*. Zumthor "appreciates places and building[s] that offer people a haven,"<sup>15</sup> and is outspokenly against architecture that "leaves no space for the occupant."<sup>16</sup> His belief is that architecture should not only provide physical but also mental shelter. Zumthor's interest in atmosphere is twofold; it originates with the question, "what do we mean when we speak of architectural quality?"<sup>17</sup> and lies in how he feels<sup>18</sup> when perceiving the whole; it speaks to how the sum of architectural elements is heightened in their joinery. Zumthor believes that architecture starts with material and space and utilizes light to give it life.<sup>19</sup>

Two chapels, Saint Benedict (1988) in Switzerland and Bruder Klaus (2007) in Germany, both embody Zumthor's concept of light as the life of architecture. Each is constructed of drastically different material palettes, but their dependence on natural light for texture and emotion is clear even in a passing glance. Each portrays a story of time through their overhead apertures, turning these small spaces into emotional cores, creating places that provide a deeply-felt impact whether experienced for a minute or an hour. Their texture, material, and airiness are axially opposed: Saint Benedict is lightly colored, textured by

wood and board-form concrete, and uses light to provide a sense of open space for thought; meanwhile Bruder Klaus encompasses, grounds, and concentrates the mind of occupants in a dark, dense, and charred mass, textured by burned-away formwork, providing a space with a deep sense of introspection. While drastically different, each chapel is striking, emotional, and memorable (*Figures 05-12*).



*Figure 05: Saint Benedict Chapel Entry | Figure 06: Bruder Klaus Chapel Entry*



*Figure 07: Saint Benedict Chapel Interior | Figure 08: Bruder Klaus Chapel Interior*



*Figure 09: Saint Benedict Chapel Overhead | Figure 10: Bruder Klaus Chapel Overhead*



*Figure 11: Saint Benedict Chapel Approach | Figure 12: Bruder Klaus Chapel Approach*

These three examples each use highly textured materials and narrow slats to draw in light without images of the surrounding vista, evoking the light of divinity shining from the heavens.

Steven Holl is known for his use of form, light, and color; form playing an especially pivotal role. Many of Zumthor's buildings have striking forms, but it is usually a result of other intentions. Holl on the other hand carves and sculpts his architectural forms as a means for serving light. In addition to his work as an architect, Holl is an influential writer, theorist, and researcher. His intentions and thinking about his work and practice are well documented and are the subject of much architectural debate. His understanding of perception is a primary source of his architectural success and is likely a driving reason for his stewardship of form: "Perception and cognition balance the volumetrics of architectural space with the understanding of time itself. An ecstatic architecture of the immeasurable emerges. It is precisely at the level of spatial perception that the most powerful architectural meanings come to the fore."<sup>20</sup>

Holl's position is that perception is not additive; "we cannot readily break perception into a simple collection of geometries."<sup>21</sup> Jordi Safont-Tria, a Barcelona Architect, describes Holl's architectural theory as "the interweaving of thought and the experience of the senses."<sup>22</sup> Holl's University of Iowa Visual Arts Building (2006) is centered by an atrium that fully embodies this idea. It is not simply the building's open expanse or wrapping pathways that give the space its power, rather it stems from how the ideas of the space all coalesce and function together (*Figure 13*). The excitement of arrival is maintained through movement within the atrium and up the stairways. The overall experience is largely dependent on movement and subsequently, the idea of movement is what drives the wrapping elements that harmonize to form the space.





*Figure 13: Visual Arts Building Atrium at the University of Iowa*

In his book *Parallax*, Holl goes into great depth on the matter of changing perspectives in architecture. His notion of light is intrinsically tied to time; both by the arc of the sun and the movement of the human body. The Knut Hamsun Center (2009) in Norway is a beautiful example of this description. It is full of striking moments that provide a radiant intensity (*Figures 14-18*). In addition to light, Holl places a great emphasis on drawing upon and responding to the landscape. This center exemplifies this concept by bridging internalizing moments of light and providing awe-inspiring connections with the greater landscape. By constraining occupants in a tower-like structure, each external reveal is magnified in beauty.



*Figure 14: Interior View of Openings | Figure 14: Interior Stairwell | Figure 16: Interior View Out  
Wooden Balcony | Figure 17: Exterior View of Façade and Landscape*



*Figure 18: Knut Hamsun Center Balcony View of Surrounding Landscape*

The New York University Department of Philosophy (2007) is quite different from the landscape-driven Knut Hamsun Center. It is a historic renovation of a 1980 building, in which a six-story stairwell was installed that uses perforated material and a play of colored light to create small, shifting moments of awe (*Figures 19-21*).



*Figure 19: Top of Stairway | Figure 20: Stairway Interior Series | Figure 21: Diagram of Stairway*

Holl's buildings rarely have physically applied color, but his use of light and colored glazing produces an array of tones that leave lasting impressions. One such example of this is St. Ignatius Chapel (1997) in Seattle, Washington (*Figure 24*). His design exploration began with watercolor paintings expressing the ideas of light he sought to infuse within the chapel. He conceived a building with seven *bottles* of light, pairing colored lenses with complimentary-colored baffles (*Figures 22-23*). These color the incoming light and then invert this color through reflection. As light changes in position and intensity throughout the day, slips of color strike varied surfaces. Safont-Tria remarks that Holl, "achieves an arresting harmony in the carefully proportioned equilibrium of each of the colors."<sup>23</sup> The chapel itself is a light space with textured walls and a polished, concrete floor, further reflecting the filtered and colored light of the space, which provides a play of brilliants and increased drama.

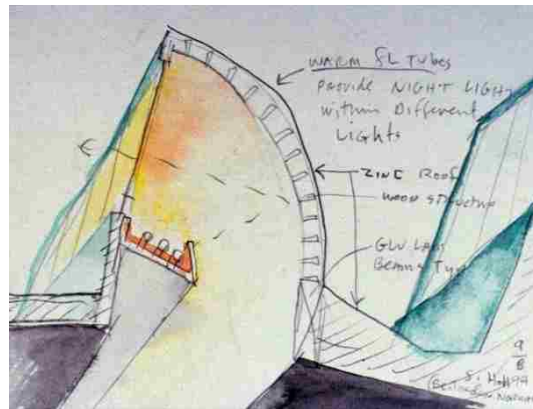
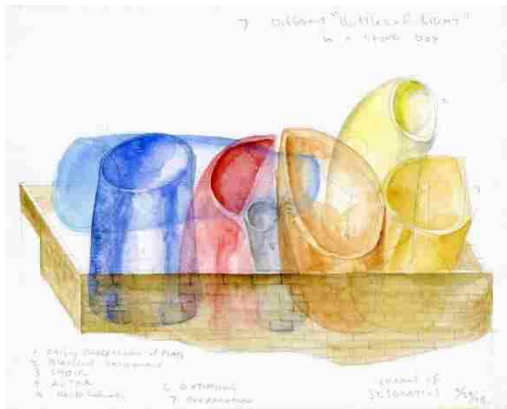


Figure 22: Diagrammed Bottles of Light | Figure 23: Lens and Baffle Detail



Figure 24: St. Ignatius Chapel Interior

The focus on daylight has narrowed my approach towards examining each of these architects. There is substantial overlap in their methodologies since they each rely heavily on material to capture light's presence. However, their approaches to this are based on differing impetus. Zumthor is a craftsman who cares mostly about material and little about form. Holl is a painter who bends his spaces regardless of material. Both understand the power of light and matter and give great care to the detailing of their

buildings. Zumthor's and Holl's respective architectural experiences depend greatly on how light is let into the space and the play of light upon surfaces. Clearly the qualities and haptic sense of materials—from texture to color, to temperature, and the articulation of forms (cast and assembled)—occupies just as much of their attention as light.

Neither Zumthor nor Holl is expressly concerned with evoking the sublime, but each creates moments in his work which achieve this. However, the closest moments seem to be the result of capturing a landscape's majesty or an instance of intense lighting. The experience of the sublime within architecture might have as much to do with the specificity in which architecture is opened to its surrounding sky or landscape as it does with its use of light and material.

### **LIGHTING AS A PROFESSION**

Pushing deeper into the common themes between Zumthor and Holl, next is to focus on the articulation of lighting intended to evoke emotion. This section will explore the work of Richard Kelly and James Turrell, encompassing their contributions to the fields of architectural lighting design and light artistry respectively.

Richard Kelly is a pioneer in the field of lighting design, establishing the power and intelligence of the profession through his work with Louis Kahn, Philip Johnson, and Mies van der Rohe, among many others. His most notable collaborations include the David H. Koch Theater, Glass House, and Seagram Tower. Kelly begins his text: *Lighting as an Integral Part of Architecture* with, “[a] feeling for light and lighting starts with visual

imagination, just as a painter's talent does."<sup>24</sup> He uses the example of a painter because of the way paint must be applied, layer by layer, to elicit an image. This layering of paint is how he interprets the layering of light within space. Furthermore, Kelly classifies three elements, or types, of light: "(1) Focal glow or highlight;" the light of applying a visual center, of contrasting a single point or series of foci with its surroundings. "(2) Ambient luminescence or graded washes;" atmospheric light, the light that diffuses into and uplifts space. "(3) Play of brilliants or sharp detail;" light that dazzles and engages in a manner like that of a starry sky or rippling reflections across water (*Figures 25-27*).



*Figure 25: House in a Garden | Figure 26: Kimbell Art Museum | Figure 27: Mirror Tower*

When Kelly's lecture on lighting as an integral part of architecture was first spoken and consequently printed in the *College Art Journal* in 1952, he was at the forefront of new thinking in architectural lighting. This was the first time in the modernity of architecture that light was given a widely-adopted taxonomy. Lighting could now be seen, spoken of, and understood as an integral part of design.

Louis Kahn's Kimbell Art Museum (1972) in Fort Worth, Texas is known for its use of natural light through its light baffles (devised by Kelly). The most notable aspect of this system, and where Kelly evolved Kahn's idea, was the innovation to perforate the inner-reflector so the baffle itself was illuminated in addition the diffused highlight of space (*Figure 26*). Without this, there would be a great contrast between the light washing the

ceiling and the baffle itself, which was originally going to be opaque. Kelly saw this as an issue, citing that a dark line of baffles would erode the vision Kahn was endeavoring. At the Yale Center for British Art (1974) in New Haven, Connecticut, Kahn and Kelly collaborated again to create a similarly luminous environment. Doing this in a museum or gallery setting through daylight is inherently difficult because of the consistency of light required. When executed successfully, the layer of articulation elevates the feeling of the space for the occupant. The genius of Kelly's work with Kahn lies in their deliberate use of skylight. For both the Kimbell Art Museum and the Yale Center for British Art, the light is diffused by a film or baffle, which evens out the light to allow a softer gradient to wash the textured surfaces adjacent to the openings (*Figures 28-29*).



*Figure 28: Yale Center for British Art Gallery | Figure 29: Yale Center for British Art Gallery*

What Kelly teaches us is that the best kind of light is not light that is seen, but rather light that is felt,<sup>25</sup> that architecture elicits feeling through its intentional use of light.

In contrast to Kelly, the work of James Turrell is firmly art. He is a light artist, meaning that his medium is light itself and the installations he creates play off of the primal relationship people have with light. He refers to his work as “non-vicarious art”<sup>26</sup> because it can only truly be experienced firsthand. Much of Turrell's work reflects a type of quiet,

contemplative, and collective meditation that is embodied in buildings of Quaker religious gathering, attributed by experts to him being raised as a Quaker. As opposed to most traditional types of art such as painting, his work uses light as the direct representation and articulation of light. He describes this incredibly forward approach as having an “American view of depiction”<sup>27</sup> meaning he represents his subject directly. His methodology is incredibly effective at tapping into the primal relationship people have with light and he is fully aware of this: “Like a deer in the headlights, humans have this relationship with staring into camp fires or the like. His contemplative emotion is stirred. A kind of wordless thought.” As one of the first artists of what would later be known as the Light and Space movement, Turrell stands out because his work is charged with eliciting such emotion and feeling and does so with expert care. The origins of this movement trace back to Southern California in the mid-60s and were partially inspired by the unchanging sky of Los Angeles. While several notable pioneers of the movement, including Robert Irwin, De Wain Valentine, and Eric Orr helped change the contemporary relationship between art and light, Turrell stands apart as special. It is not simply that light is his medium, but that he uses it in connection with space and time to distort perspective. He is focused not only on light but on human perception and changing perspectives. In this way, his art shares a commonality with Holl’s thinking and research. Both of their work has a certain spatial quality that demands to be occupied, whether physically or intellectually. In an interview, Turrell speaks to the idea that people are heliotropic. That is, we are oriented towards the sky. He then goes on to make the point that because of this orientation, he can “change the color of the sky.” Humans tend to assume that light, and its color, is something “bestowed” upon us. This assumption provides Turrell with the means to change the color of the sky by targeting the changing context of vision. “It’s all



about getting people to value light. To feel its physical presence.” The average person spends fifteen seconds looking at a painting before they move on<sup>28</sup> whereas Turrell’s work is often occupied for upwards of an hour. Being physically within art is a different experience altogether.

A few prime examples of Turrell’s installations include *Aural* (2018) at the Jewish Museum Berlin, *Space that Sees* (1992) at the Israel Museum, *Virga* (1974) in the Guggenheim Museum, and *Sloan Red* (1968) at the Pasadena Art Museum (*Figures 30-33*).



Figure 30: *Aural* | Figure 31: *Space that Sees*

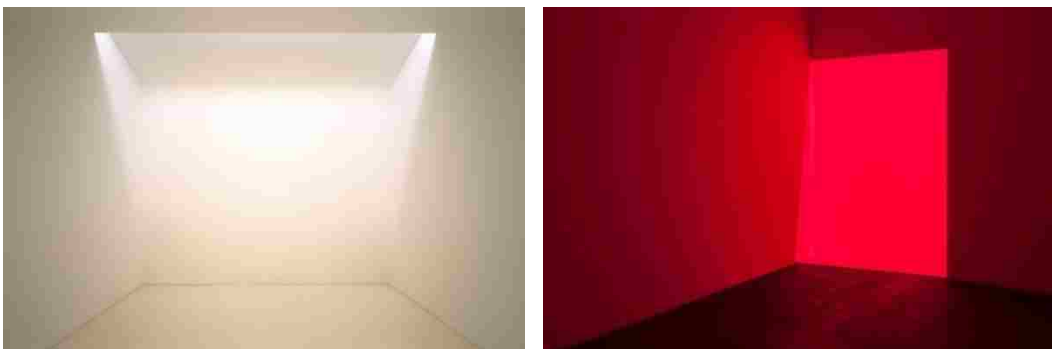


Figure 32: *Virga* | Figure 33: *Sloan Red*

Turrell is so expert in his understanding of light that he often utilizes human expectation of natural light to direct his installations. *Virga* is a perfect example of this. The project was a box-shaped room in which he simply modified the ceiling to hide the source of the projected white light. The effect is that it draws people into the center of the space with a desire to look at the source of projected light, assuming it will be a view of the sky. Even if there is full knowledge that the light is a projection, the mind and body are still drawn towards the room's center. *Sloan Red* uses projected light to create a peeling away of a corner. It feels jarring to look at until the effect is registered, as if it were a visual itch, and can continue to irritate even once known. These art installations are heavily reliant on persuading the eye and display that vision and perceived notions are so powerful they can create an inclination to override understood fact. That being said, it also displays the magnetism people feel towards daylight and the letdown of discovering it to be artificial. His skyspaces, of which *Space that Sees* is just one of many, are world famous and in high demand. With a move as simple as framing of the sky he captivates and persuades people to linger. Providing a space to view the sky alone offers the same type of quiet contemplation present in Quaker gatherings and felt in the proximity of a flickering fire. The sky and its light and color are beautiful but taken for granted.



Figure 34: Crater Aerial View | Figure 35: Crater Horizon View | Figure 36: Crater Bowl

In 1977 Turrell purchased an inactive volcano outside of Flagstaff, Arizona, appropriately named Roden Crater (Figures 34-45). Over the past 51 years, it has been a hub of

expanding personal installations. This project is interesting as a study because it is a personally funded project and because it shares many aspects with his commissioned installations. His attraction to the property is in large part because of the Arizona sky, which is of notable interest to Turrell because of its striking hue, the extreme angle of the sun, and its minimal clouds; it reminds him of the skies in Southern California and connects him to his roots. It is cited that his initial intrigue of Roden Crater was because he was “interested in working with the visual phenomenon of celestial vaulting.”<sup>29</sup> An idea Turrell, while citing Marcel Minnaert, describes as, “the phenomenon [...] related to the distance-size perceptual relationships that cause the moon to look larger when it is close to the horizon than it does when it is high in the sky, although in either position the actual size of the image projected onto the retinas is exactly the same.”<sup>30</sup> As written about in *James Turrell: The Roden Crater Project: an Exhibition Organized by the University of Arizona Museum of Art, Tucson*, Turrell’s exploration with Roden Crater intends to “put the visitor in to a direct relationship with our universe that can be obtained in no other way and in no other place.”<sup>31</sup> This architecture is composed as a series of gallery rooms; each an installation with some astronomical response and positioning incorporated. It is embedded in the ground, seeking the sublime through its interactions with the landscape, sky, and cosmic associations.

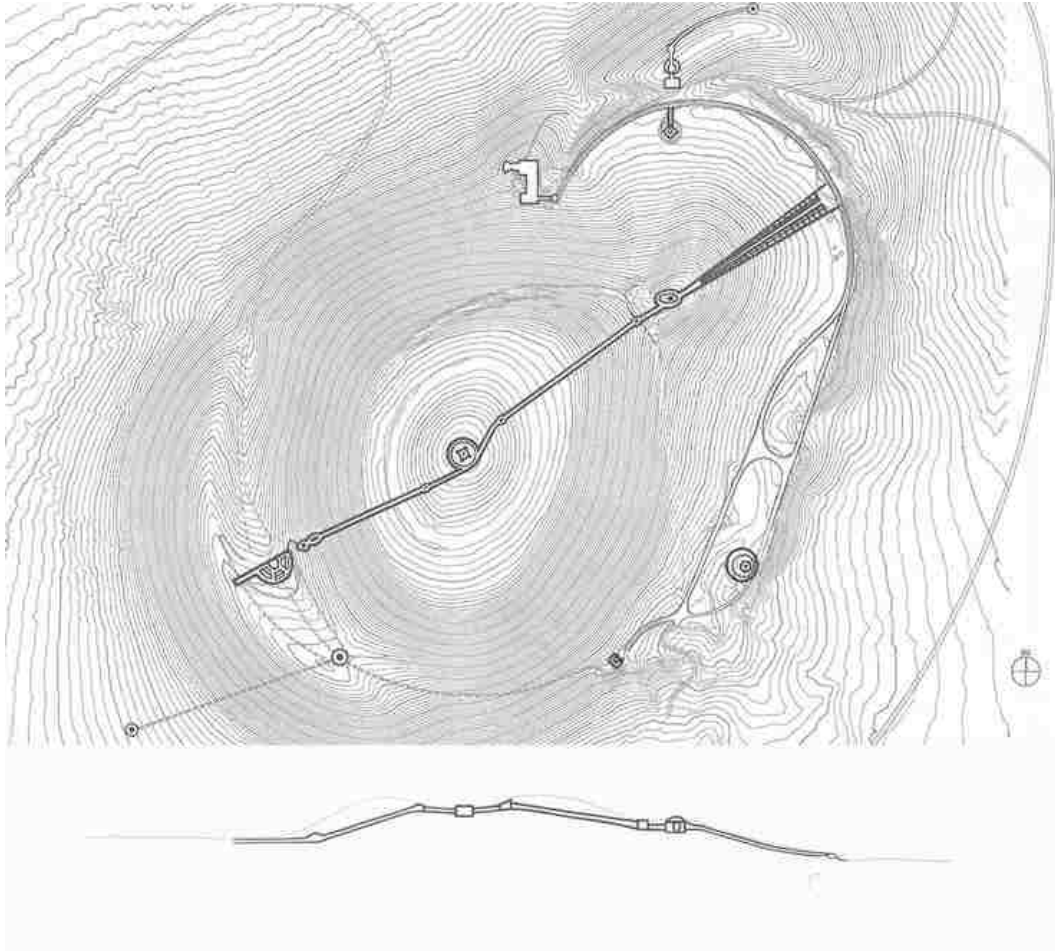
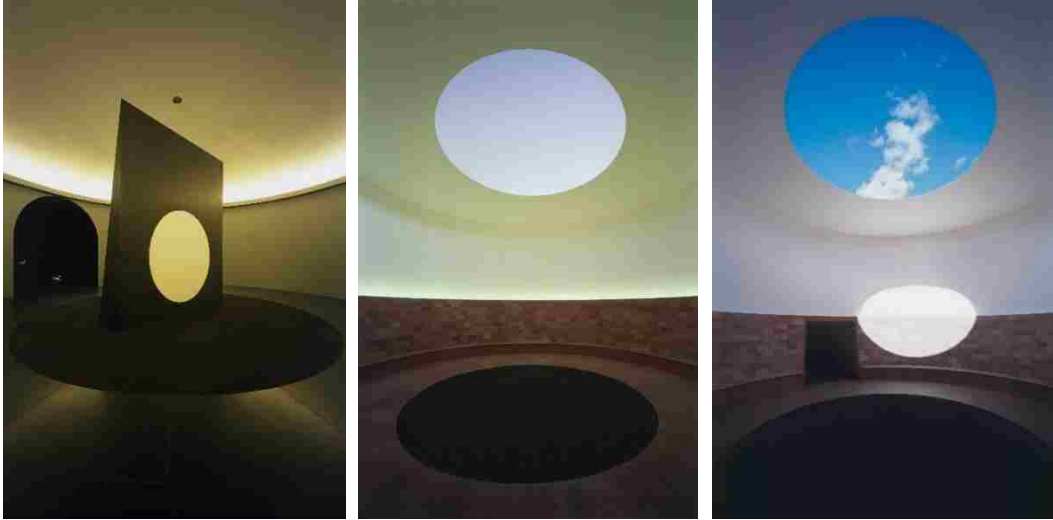


Figure 37: Roden Crater Plan and Section



Figure 38: East Portal | Figure 39: East Stairway | Figure 40: Back of Stair | Figure 41: East Tunnel  
Out | Figure 42: East Tunnel Inward



*Figure 43: Sun and Moon Chamber | Figure 44: Crater's Eye | Figure 45: Crater's Eye*

Turrell wishes for the sensual aspects of his work to be remembered and discussed as opposed to the details of how he designs. Chuck Close, an internationally regarded American artist, photographer, and painter known for his large-scale photorealist portraits, commented that Turrell is “an orchestrator of experience, not a creator of cheap effects. And every artist knows how cheap an effect is, and how revolutionary an experience.”<sup>32</sup> It is the experience that drives Turrell’s work. His insistent need to share the “joy of sensing”<sup>33</sup> makes his art special. His approach is holistic in its intention of evoking emotion; carefully crafting each scene to show exactly what he envisions. By directing and framing light in a way that invokes the human conception of life as a gift from outside of ourselves, Turrell facilitates the whole range of emotions of the sublime: quiet contemplation, longing, the sense of belonging within a grand universe, and a connection with our primal selves turning towards the sky.

## THE ART OF ARCHITECTURE

Art and lighting design remind architects of the emotional aspects of their work. Architecture has the same ability as Turrell's installations to be driven by the role of perception and the acute feelings people have with their visual and metaphysical surroundings. It was interesting to notice, despite their disparate intentions with light, that Turrell and Kelly both paint and layer with light while contemplating occupant perception. This realization that art and function can both draw from the same approach serves as an inspiration for this thesis.



Figure 46: Sistine Chapel Interior | Figure 47: Taj Mahal Approach

In addition to being functional, architecture ought to delight its occupants. The ultimate manifestation of this is in evoking a sense of the sublime. Art, as seen through romantic and political movements across the ages, showcases the influence of image and feeling with people. Art and architecture have a long and interwoven history of mutual inspiration, and in notable examples like the Sistine Chapel or the Taj Mahal, being indistinguishable from one another (*Figures 46-47*). While fine art can exist for its own sake, architecture must address its functional attributes. However, architecture can and should aspire beyond its prescribed necessity to also provide an emotional component. For architects to be content with function alone is to be unsympathetic to the influence

buildings can contribute to public and private experience. In this sense, it is irresponsible to not consider the emotional and experiential effects of architecture; just as it would be blasphemous to proclaim art as powerless. Once constructed, buildings no longer belong to the architect. They are no longer schematic designs, they are real, and their effects are real, and even more so, their occupants too, are real. Since architecture connects with people on a fundamental level, architects should feel an obligation to address the emotional needs of occupants.

## **CHAPTER 3: DAYLIGHT DRIVING ARCHITECTURE**

### **HUMAN PERCEPTION**

Perception is a shared, cultural aspect of human life. Furthermore, perception is rather malleable as shown by the work of artists, architects, and designers throughout the centuries; from the Parthenon designed by Iktinos and Callicrates to Palladio's Teatro Olimpico, to the work of Salvador Dali, and more recently the work of Turrell. This is in part because human sensory perception is predominantly visual.<sup>34</sup> Perception affects hormones and emotions as reactions to stimuli, but it is also affected by those same hormones and emotions.<sup>35</sup> How people feel about a space directly effects the experience they have within it. The experience occupants have in architecture is dependent on the encompassing environment; from materials to openings, to views, and contrasting tones, as well as their own emotions and responses. One of the elements showcased in the work of Turrell is the ability to direct a perspective with absolute clarity. Part of the power of his skyspaces is the constrained surroundings, providing a relaxed environment with minimal stimuli while showcasing the sky in a perspective rarely enjoyed. Constraint and atmosphere are necessary to orchestrate an experience. However, unbinding forced-perspectives and providing an array of material surroundings provides occupants with a greater opportunity to perceive and internalize a shared experience in different ways.



## PHOTOPIC AND SCOTOPIC VISION

Light is formed as a picture in the mind through two types of photoreceptors in the eye, rods and cones. Cones are widely known for their ability to interpolate color, but they are also the primary means for perceiving sight in bright environments. This is your *photopic* vision. In dim or dark environments, rods are the primary photoreceptors being used because their specialty is tonal contrast (rather than color). This is your *scotopic* vision. These different types of vision come with different characteristics and uses, and as a result, the human eye can see up to fifteen orders of magnitude, from skylight ( $0.000001 \text{ cd/m}^2$ ) to sunlight ( $100,000,000 \text{ cd/m}^2$ ). However, the eye can only see between three and four magnitudes at a time.<sup>36</sup> Going from dark to light places—switching from scotopic to photopic vision—happens near-instantly. An example of this is emerging midday from a theater. In contrast, adjusting to lower levels of light, switching from scotopic vision to photopic vision, takes anywhere from one to ten minutes depending on age and genetics. This process can take up to two hours to fully adjust to the night sky. When sight is dependent on rods, on scotopic vision, it is only once this range is maintained for some time that color in a dim environment is perceived in color. Seeing the sky from inside a dark space such as a cave provides a completely different sensation and perceptions of color than from one of Turrell's skyspaces.

## PRECEDENT STUDIES

The projects studied here provide direct examples of daylight driving architecture, from intended effects to materials, form, scale, and details. The same lighting intention can be enacted through multiple approaches. Likewise, adjusted aspects such as scale, color, and texture change the way an intention is perceived. Evoking the sublime is not inherent to one approach, but rather can be codified as a gesture grand enough to strike people on a deeply internal level. It is a sense of feeling both individual—small—and a part of something much larger or holistic. This encompasses the grandeur of standing at the foot of the Pyramids of Giza (*Figure 48*), or sitting in the pews of La Sagrada Familia, to the claustrophobia of the Italian catacombs, or the compression of dwelling amongst the concrete slabs in the Memorial to Murdered Jews of Europe in Berlin.



*Figure 48: Pyramids of Giza*

The first precedent study is a historical example of the sublime. Defined by its mass and its astronomical alignment, El Castillo at Chichen Itza in Mexico is dated as being built between 800 and 900 AD. Constructed by the Mayan, this pyramid topped with a temple served both the Mayan and Toltec civilizations as a gathering place for worship.



*Figure 49: Spring Equinox Gathering at El Castillo*

It continues to attract people every year to view it during the summer and winter solstices. The structure is twisted from due South, aligning itself with astronomical events. On the summer solstice during sunrise and on the winter solstice during sunset, sunlight narrowly passes by the tiered corner, forming a line of light that illuminates a wall from a carved serpent head up to the temple (*Figures 49-50, 52*). Furthermore, the equinoxes are marked with a zig-zag shadow that, as it moves throughout the day, describes if the serpent is either on its journey of rising into the sky or sinking into the ground.

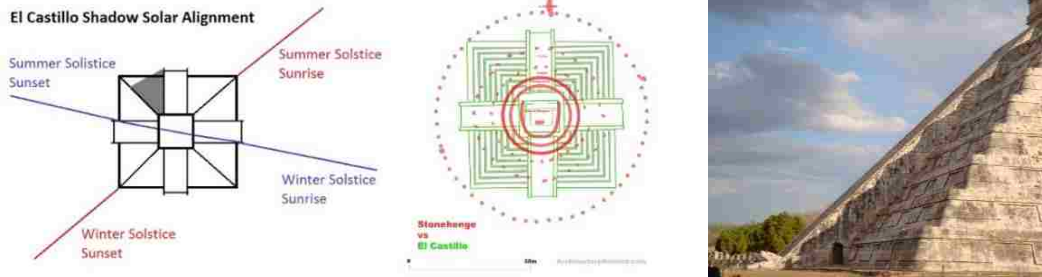


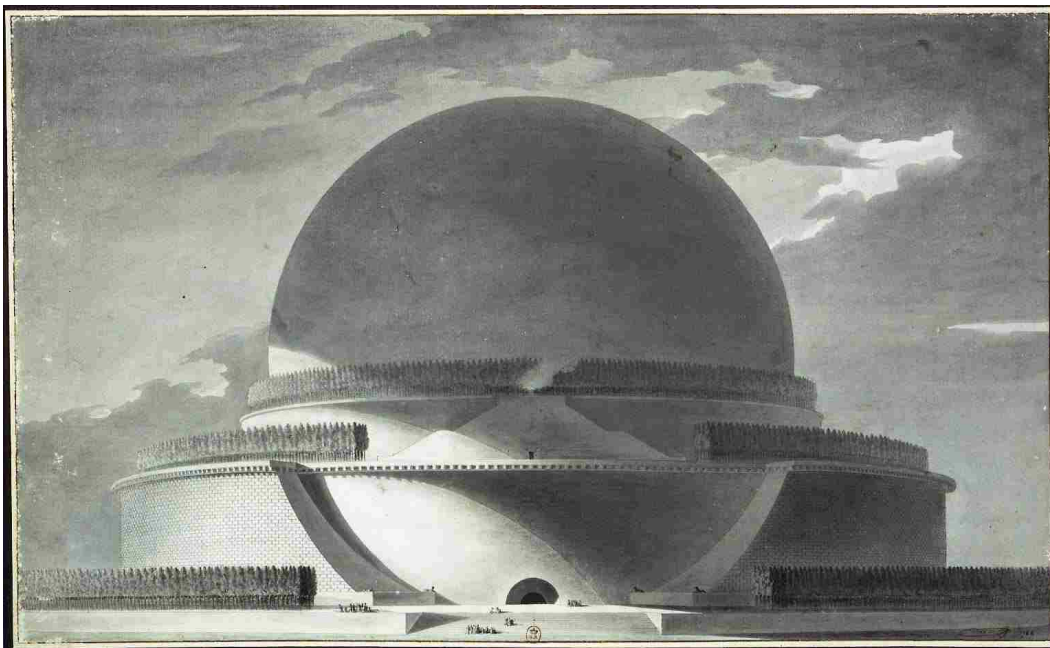
Figure 50: Solar Alignment | Figure 51: Comparison with Stonehenge | Figure 52: Serpent of Light

The site of Chichen Itza is an exquisite and early example of aligning buildings to the sun and astrological events, and El Castillo is often compared by astrological historians to Stonehenge in terms of cosmic precision and ancient sophistication (Figure 51). The simple, stepped mass of El Castillo builds upon the landscape, anchoring itself to the site while creating an outlook to draw in the wider sense of place (Figure 53).



Figure 53: Chichen Itza Aerial

Another such precedent which evokes the sublime is the Cenotaph for Isaac Newton by Boullée. Conceived at a scale and with unornamented form so provocative that the drawings alone provide the excitement and sense of fear necessary for this effect. This conceptual project was designed in 1784 as an example for his architecture students. It was used to bolster his belief, a point that he regularly made to his students, that architects ought to provide a greater vision; that their work should provide ideas that expand the human understanding for what is believed to be possible. The project itself holds layers of symbolism, from the processioning rows of trees, to the number of steps, the division of masses, and its interior openings (*Figures 54-55*).



*Figure 54: Cenotaph for Isaac Newton Exterior*

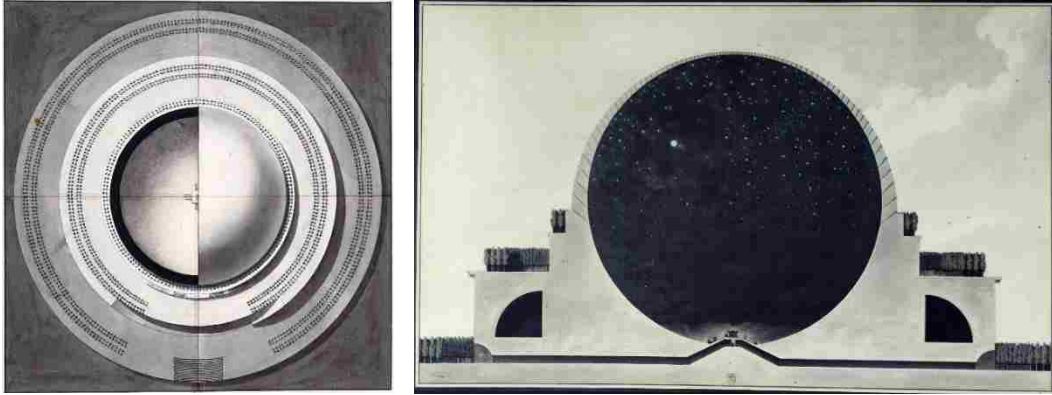


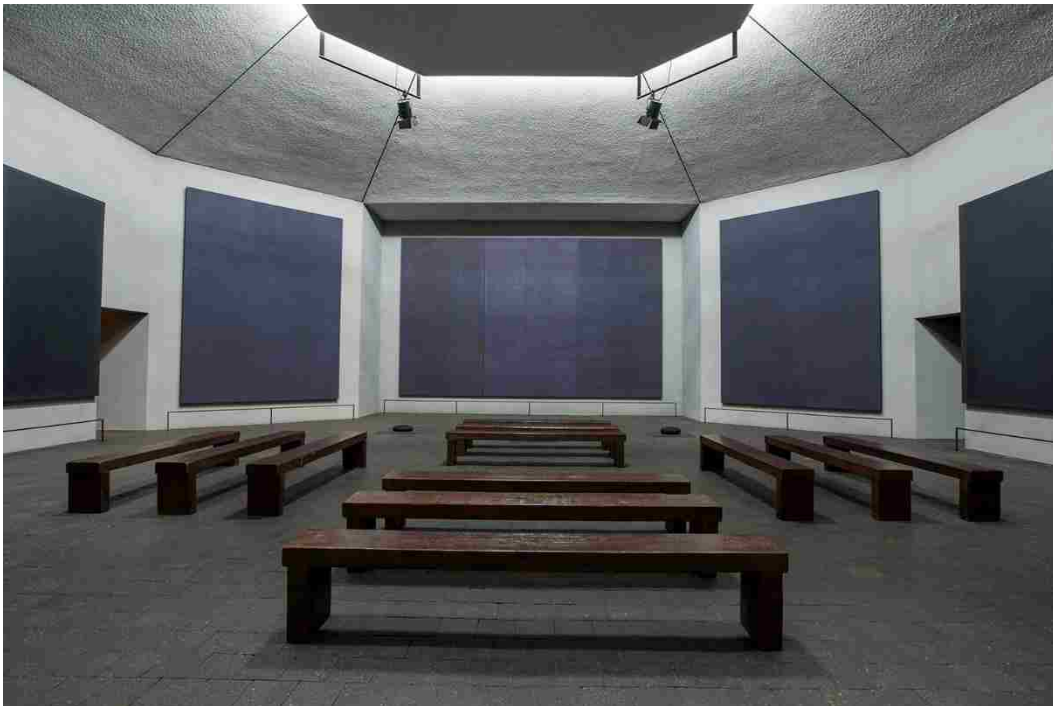
Figure 55: Plan-Elevation | Figure 56: Section

The interior becomes a view of the stars lit by skylight, paying homage to Newton in recreating the astronomic position present at his birth. The architecture evokes the sublime in at least three scenes. Arriving at its base is a dwarfing experience. The compressed entry is its own journey into darkness and up into a daylight 'night sky,' which is its own equally overcoming experience (Figures 56-57). The play with mass, scale, cosmic-alignment, and the reverence inherent in a memorial converge as a surreal vision which exercises the imagination. Boullée's cenotaph may be on the edge of absurd, but his devotion to a vision is a valuable lesson to be learned.

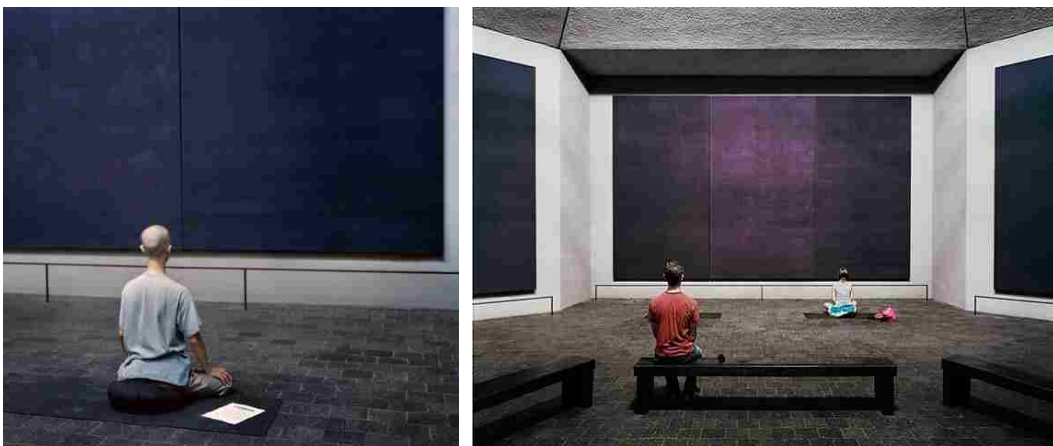


Figure 57: Daylit Starry Night

The Rothko Chapel (1971) in Houston, Texas by Philip Johnson, Howard Barnstone, and Eugene Aubry is the next project to examine. As a nondenominational chapel, this building invokes a specifically intrinsic form of the sublime through a subtle, meditative environment.

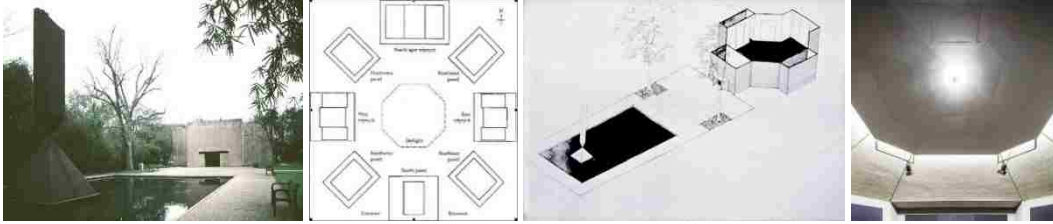


*Figure 58: Rothko Chapel*



*Figure 59: Dwelling in the Chapel | Figure 60: Depth of Color Starting to Reveal Itself*





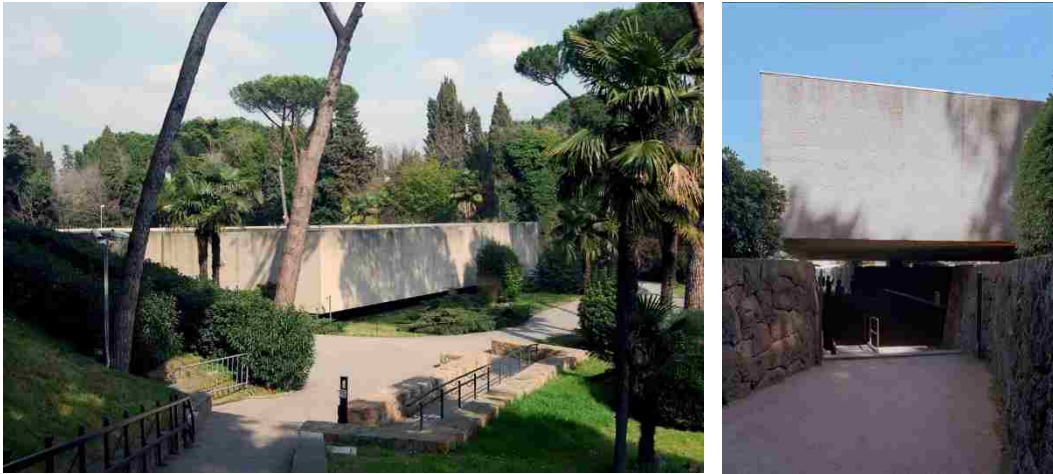
*Figure 61: Approach | Figure 62: Wall-Art Layout | Figure 63: Cut Axonometric | Figure 64: Skylight*

This space draws on the shift in types of vision explained in the previous section. The works of Mark Rothko are richly layered but require time for eyesight to adjust to the dim setting before the hues and nuances of the room can be registered and appreciated. The intrigue here is that such a simple design when paired with evocative art, and a purpose of introspection, gives way to a grand experience. The intelligence and simplicity of the architecture reflect that of Rothko's work.



*Figure 65: Depth of Color Fully Revealed*

The final precedent is the Mausoleo delle Fosse Ardeatine (1950) on the edge of Rome, Italy by Giuseppe Perugini.



*Figure 66: Mausoleum Approach | Figure 67: Mausoleum Entry*

The compressive weight this mausoleum imposes on occupants is surreal, and it utilizes a sliver of light along its perimeter to enforce the shear massivity of the overhead condition. Its scale further exacerbates this pressure, almost as if the space itself is trying to bury you alongside the deceased (*Figures 66-70*).



*Figure 68: Compressed by Mass*



Figure 69: Lighting Effect | Figure 70: Pressure of the Deceased

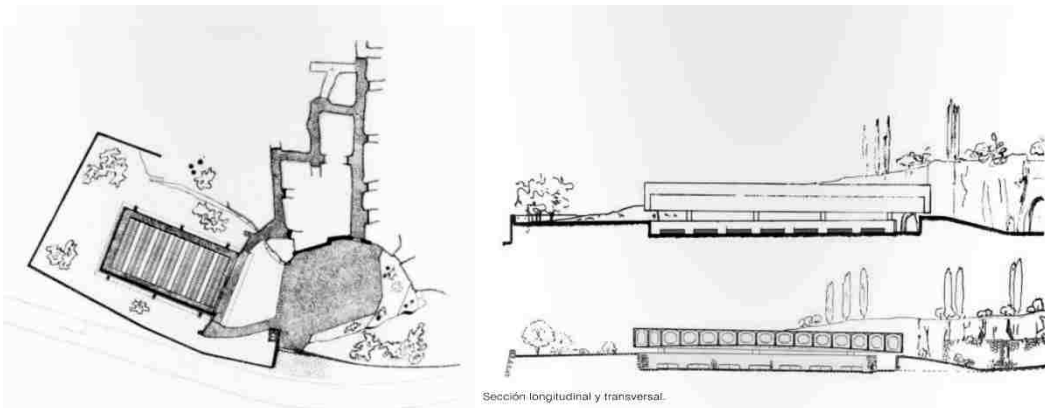


Figure 71: Mausoleum Plan | Figure 72: Mausoleum Sections

The contrasting element of this project is a small museum which grants a reprieve, alleviating some of the mausoleum's immense pressure. The ground above this portion of the building opens to the sky as the path forward shows an exit and the exterior landscape beyond. There is a certain airiness and relief of pressure, presenting a way through rather than simply implying it from above. This provides a literal and figurative breath of fresh air, along with a sense of hope. The mausoleum is depressive, and the reality this architecture commemorates is saddening, but this moment of sky, landscape, and intensified perspective communicates an experience of the sublime through longing, appreciation, and evoked optimism (Figures 73-74).



*Figure 73: A Breath of Fresh Air*



*Figure 74: Skylight through the Ground*

## **CHAPTER 4: PROPOSAL**

### **PROJECT**

This thesis centers around the design of a new visitor center for the Kitt Peak National Observatory in Arizona. Modern observatories are designed to give scientists access to the night sky, while ancient observatories were made to ‘capture light’ for specified reasons. Thousands gather annually on the solstice to see the serpent at Chichen Itza and make a pilgrimage to see the Sun Dagger at Chaco Canyon. This project seeks to bring some aspects of these historic constructs into the modern era, proposing a monumental architecture that honors the cosmos with a contemporary building centered around traditionally-scientific learning.

I am positing an interpretive center as an experiential analog to the scientific research and structures of the KPNO. The project edits the experience of light and space to form a unique connection with the horizon. It is a visitor and interpretive center that is focused, in a Turrell-like manner, on a narrative of space and light which reconnects visitors with the sun, sky, horizon, and our unique cosmic relationship. The project, therefore, becomes a complete experiential journey; heightening this focus on light and movement through accompanying haptic interactions with concrete, stone, sand, brass, wood, wind, sound, temperature, and the landscape.

## CONTEXT

An hour's drive southwest of Tucson, Arizona, sits a rugged, rural, and arid site of sparsely forested mountains surrounded by desert (*Figure 75-76*).



*Figure 75: Drive Up to Kitt Peak National Observatory*

This land is the home of the KPNO; “Located [...] on the Tohono O’odham Reservation in the Sonoran Desert, over 500 visiting astronomers from throughout the United States and many foreign countries use these facilities to carry out their research in a typical year.”<sup>37</sup> Managed by the National Solar Observatory (NSO), the KPNO is home to one of the largest

assortments of optical and radio telescopes on earth. The organization conducts world-class research, hosts informational classes, and provides the public with daily tours and scheduled night sky viewings.<sup>38</sup>



*Figure 76: Landscape and KPNO*



*Figure 77: McMath-Pierce Solar Telescope | Figure 78: Mayall 4-Meter Telescope*

The mission of the National Solar Observatory is to advance knowledge of the Sun, both as an astronomical object and as the dominant external influence on Earth, by providing forefront observational opportunities to the research community. The mission includes the operation of cutting edge facilities, the continued development of advanced instrumentation both in-house and through partnerships, conducting solar research, and educational and public outreach.<sup>39</sup>

– NSO Mission Statement





*Figure 79: KPNO Aerial*

The KPNO is a campus of research structures from simple office buildings to massive telescopes composed of space-age materials. It is a loosely-arranged campus of white, functionally-driven buildings within an astonishing landscape (*Figure 79-81*). There are twenty-five telescope buildings, two of which rise roughly a hundred feet into the sky (*Figure 77-78*).

The current KPNO visitor center offers information and imagery but does not put occupants in physical contact with the phenomena of the sun and sky, the landscape, or the surrounding horizon. The proposed visitor center and interpretive center instead focuses on providing a unique and direct experience with the sun's "influence on Earth."<sup>40</sup> The idea is to use the context of monotonous, functional buildings as a foil for an architecture that instills visitors with an appreciation for the sun and cosmos through earthly effects, the sky, and the horizon. This coupling of a proposal focused on poetics

and approaching the sublime with a campus of outward-reaching, scientific structures, highlights the value of direct and experiential education.



*Figure 80: Panorama from Mayall 4-Meter Telescope*



*Figure 81: Looking Down from Kitt Peak*

## ARCHITECTURE

The expression of this work manifests as a choreographed journey: The approach to Kitt Peak is up a winding mountain road that terminates in a parking lot within the scientific campus (*Figures 82-83*). Stepping out into the dry mountain air, the strong, crisp wind along the landscape is the first thing to be felt.



*Figure 82: Road Up to KPNO | Figure 83: Walking from Visitor Parking Lot Towards Visitor Center*

The visitor center draws a visual focus as the path directs pedestrians towards its entry. Inspired by the surrounding context, the building’s wood cladding and sandstone court set the building apart from the surrounding structures. The materials help provide occupants with a greater sense of place, but the building is otherwise a largely functional structure (*Figure 84*). It provides space for gathering, educational exhibition, a café, a gift shop, and two funicular lobbies—to and from the interpretive center (*Figure 85-87*).



Figure 84: Visitor Center Approach



Figure 85: Visitor Entry | Figure 86: Visitor Lobby



Figure 87: Funicular Lobby

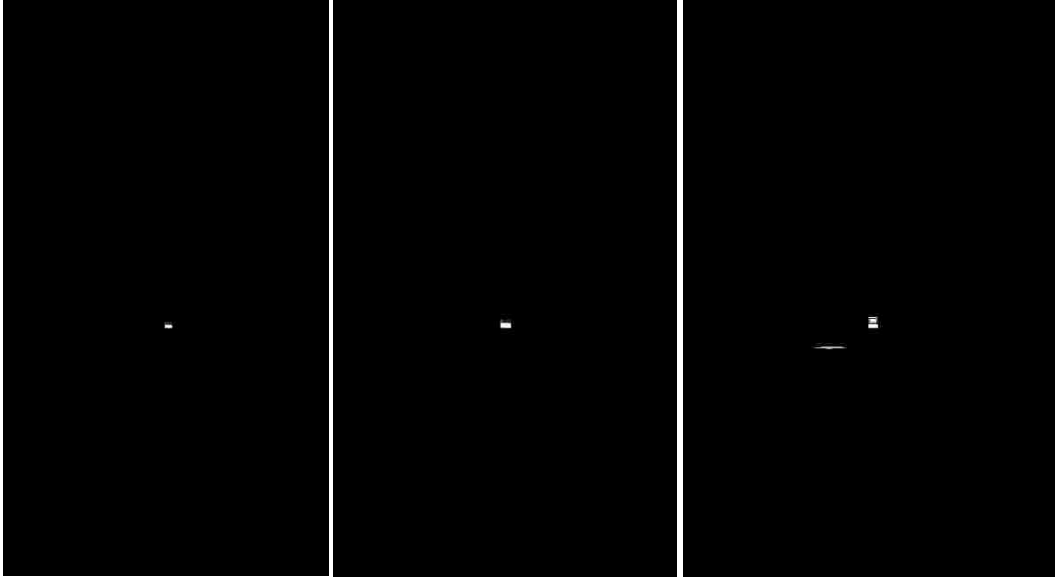
The funicular from the visitor center arrives in a vestibule located underground and distantly to the north. Fully-formed in concrete, this vertically-expansive room is stark, cold, and drafty. Diffused skylight enters the space from high above, infusing a deep contrast between the vestibule and the darkness of the passage forward. It is desolate,

as the initial anticipation has been fully replaced by unease. The sky is far away, there is a sense of feeling buried, and the only path forward is through darkness (*Figure 88*).

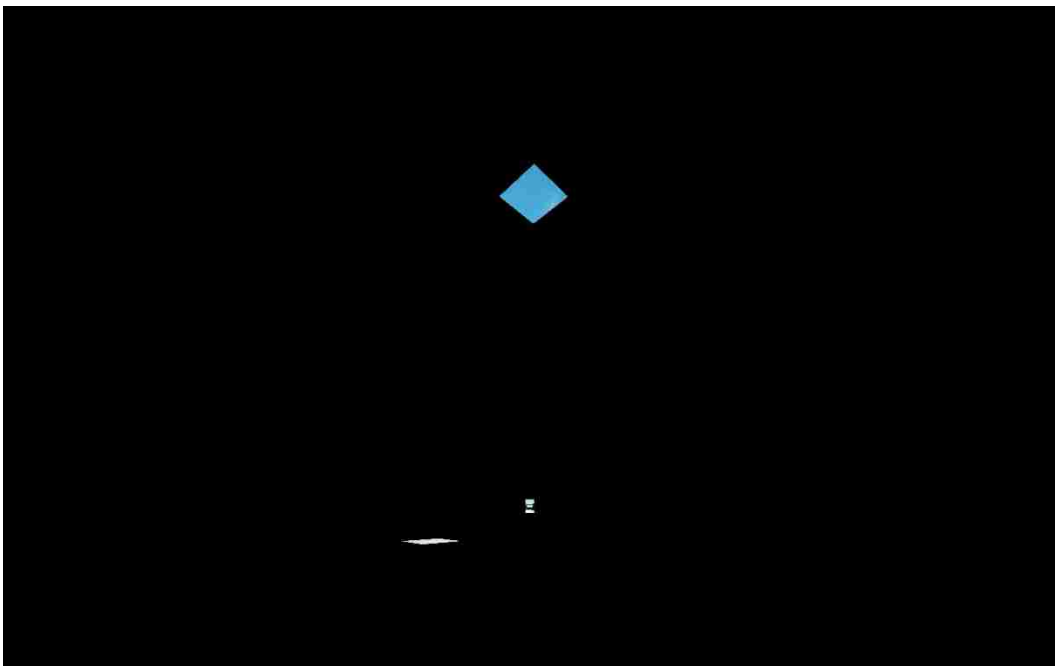


*Figure 88: Funicular Vestibule*

As occupants move down the passage the walls and ceiling compress in and the space further darkens. There is a desire to use the wall as a guide and its cold, textured surface accompany the deafening silence into darkness, now with a small light appearing in the distance. The passage ends as the space expands open in the form of a pyramid, with a skylight at its zenith (*Figures 89-90*).

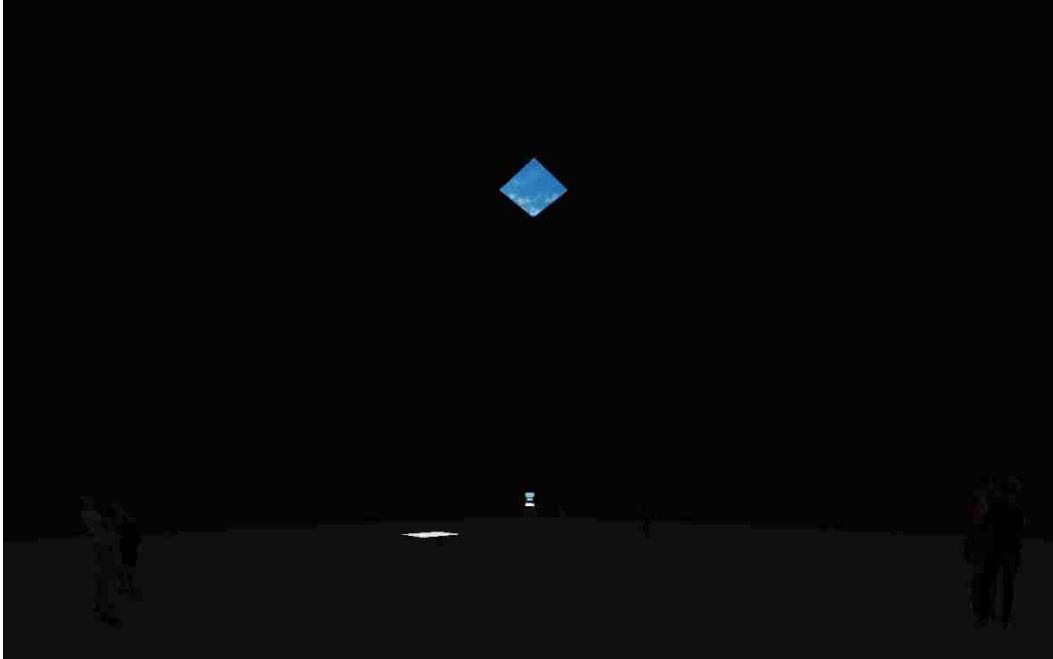


*Figure 89: Passage Series into Pyramid Skyroom*



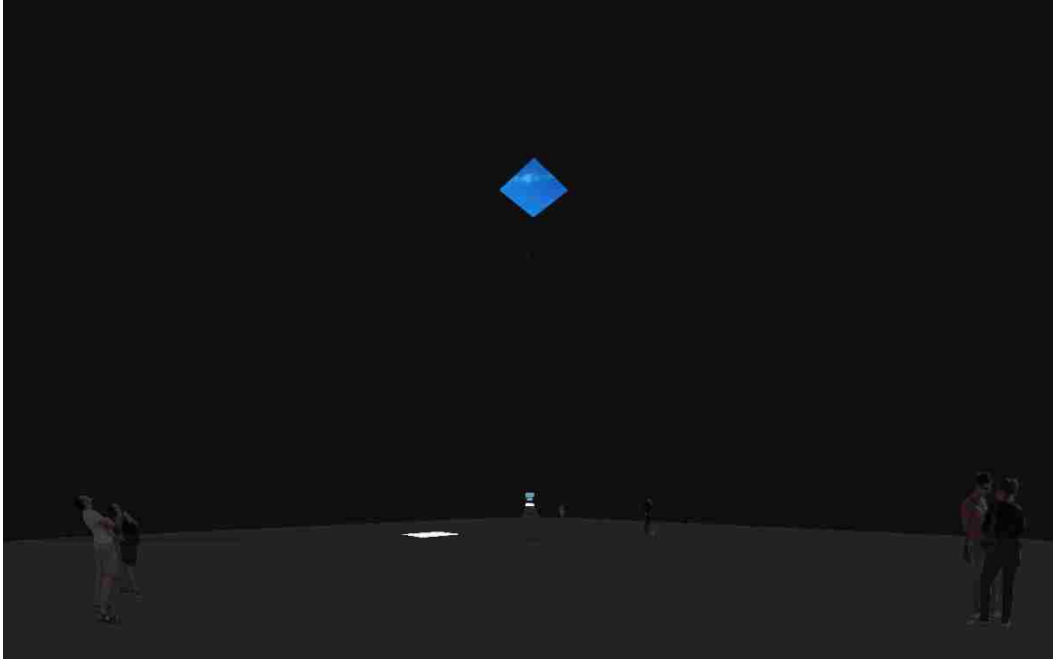
*Figure 90: Pyramid Skyroom Using Photopic Vision*

While still surrounded in darkness, this expansive room is warm, with heat radiating from the floor. There are no walls to touch, but the focal glow from above moving slowly along the floor alludes to the expanse of space (*Figures 90-91*).



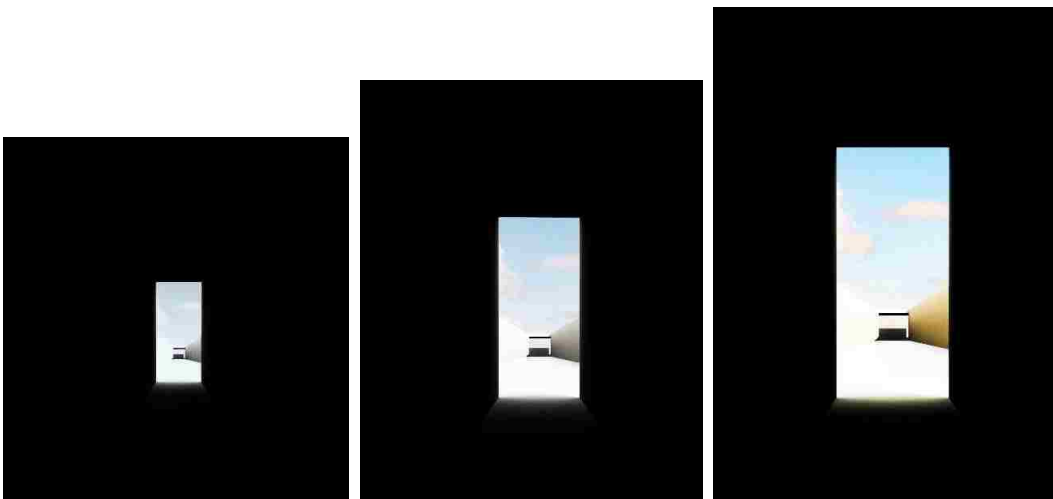
*Figure 91: Pyramid Skyroom as Vision Adapts*

Unlike the passage, there is an ease in this room; it is unrestricted in volume, with a clear sight of the passage into the light ahead. By now the occupant's vision will have adapted to the darkness, and the view of the sky (visible during this shift from scotopic to photopic vision) has shifted from a pale, overexposed light to enriched hues of blue. By taking away the sun and any clear association with space, the experience becomes fixed on the sky with a sense of relaxed meditation washing over. It is understood within this moment that the space is a chapel to the sky, and the passage of darkness prepared the occupants for reverence by first creating longing; a sense of loss culminating in a greater sense of appreciation (*Figure 92*).



*Figure 92: Pyramid Skyroom Using Scotopic Vision*

When occupants feel ready, the journey forward has already revealed itself. This passage out is inclined, but only slightly, as if walking out of a cave. The warmth of the skyroom is still felt as the light from outside grows in clarity. The passage maintains its width, but the overhead gradually expands upwards (*Figure 93*).



*Figure 93: Passage Series into the Sun*



Emerging from this passage opens occupants up to the sky with sandstone walls at either side eclipsing any view of context. The sun is felt from behind, and a play of brilliants on the stone accompanies the ambient luminescence. The sky appears brighter than it is, and the walls protect occupants from the wind as the surrounding world emerges auditorily (*Figure 94*).



*Figure 94: Emergence*

The true color of the sky comes into focus as the sounds of the surrounding environment begin to register. During the gradual climb of the procession forward, the walls slowly lose their severity in height. The path leads to an opening that frames a view of the distant horizon. Approaching this view, the frame is understood as a threshold (*Figure 95*).



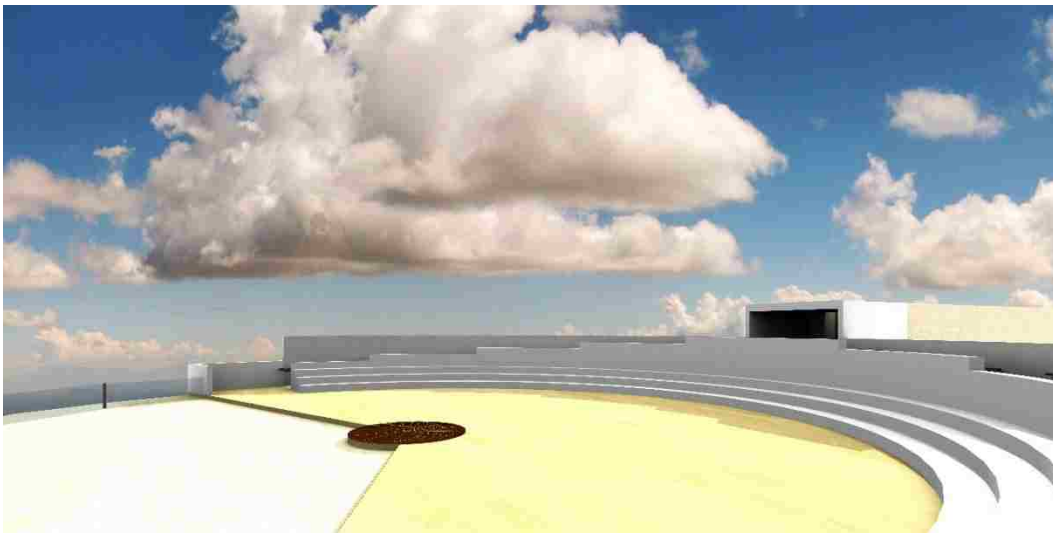
*Figure 95: Frame and Portal*



*Figure 96: Approaching the Horizon*

“As the horizon of our globe contracts, the horizon of our thought expands. In the face of the immeasurable transformations in thought, our values at every scale stand to be redefined.”<sup>41</sup> In moving through the threshold, occupants face the true vastness of the horizon (Figures 96-98).

A large sandstone disk forms a platform for dwelling. Occupants travel along the walled edges of the disk, with handrails of wood and brass accompanying the slope down to the disk's surface. At the center rests a brass plate inscribed with location-specific sun paths. Glass and sand provide a hot and open expanse to the north to sit and meditate. This point of culmination reflects a journey engaging the earth, sky, and sun with a space for contemplation lifted into the horizon. The focus is directed towards the sun's play of light on the distant landscape to the North. The amphitheater and its walls, in representation of the earth, provide shade, a place to sit, and a cooled surface to lean against.



*Figure 97: Occupying the Disk*



*Figure 98: Turning Back*

The journey back begins by turning towards the sun and the pyramid (*Figures 98-99*). The focus until now has been fully directed towards the sky and horizon. In this moment of feeling blinded, there is an acknowledgment of the sun's divinity.



*Figure 99: Returning through the Portal*

In moving back through the disk's threshold, the lapped stone walls are now understood to be offset, providing a splintered view of the landscape and allowing thin lines of light to divide shadow (*Figures 99-100*).



*Figure 100: Walking Back to Earth*

The dark passage from the pyramid is flanked by wide pathways to a picnic area and nature trail. The pyramid, which had felt like an underground sea devoid of light, can now be understood as a lightly-pigmented, concrete chapel, loosely reminiscent of the surrounding landscape. The pathway up to the picnic area has glass siding allowing the surrounding flora to creep in. The picnic area is positioned on the North side of the pyramid. Arriving here feels like stepping back to earth. There are benches, a restroom, and space for dwelling (*Figure 101*). The view of the landscape near and far is intoxicating. A trail of decomposed granite leads around the West side of the pyramid, dappled by light carving through leaves.

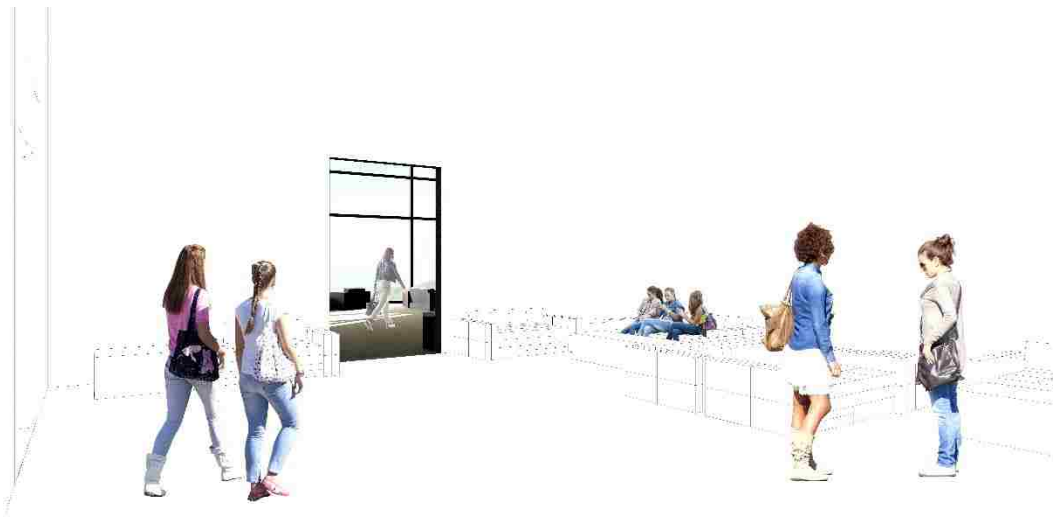


*Figure 101: Arriving Back on Earth*

The trail terminates outside the skylight which lit the arriving vestibule (*Figure 102*). There are a set of doors into the return funicular. It is here that visitors can understand their own role of perception, and that the experience of feeling buried in the ground was exaggerated.



*Figure 102: Walking Around the Pyramid to the Return Funicular*



*Figure 103: Funicular Return Lobby*

Arriving back in the visitor center, there is a sense of surrealism (*Figure 103*). There is a longing for the sky, a newfound urgency to feel the air, and a softness in the gaze. Whether through rising and falling action or only in isolated moments, the sublime was felt. What lingers is a deepened appreciation for the earth and humanity's unique position in the cosmos.



Figure 104: Site Plan | Figure 105: Plan, Section, and Site Drawing

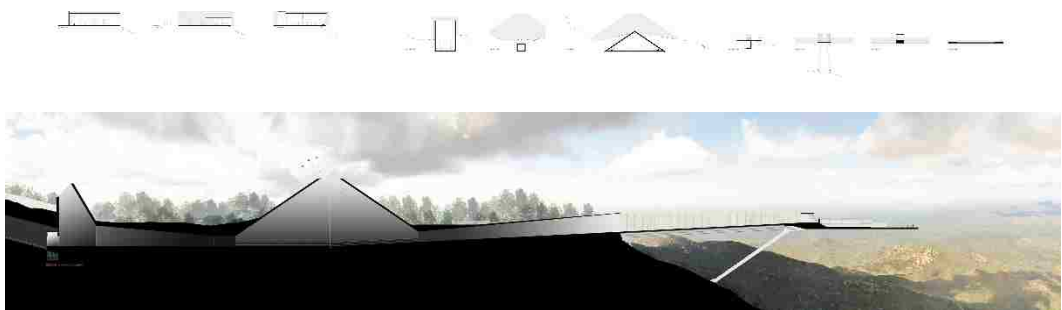


Figure 106: Section Series | Figure 107: Section of Experience

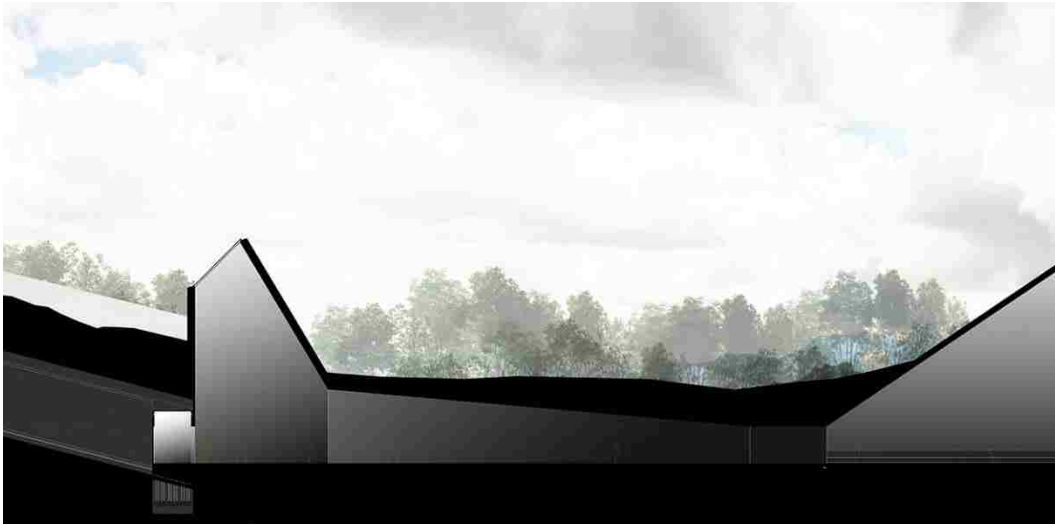






Figure 107: Section of Experience (Expanded)

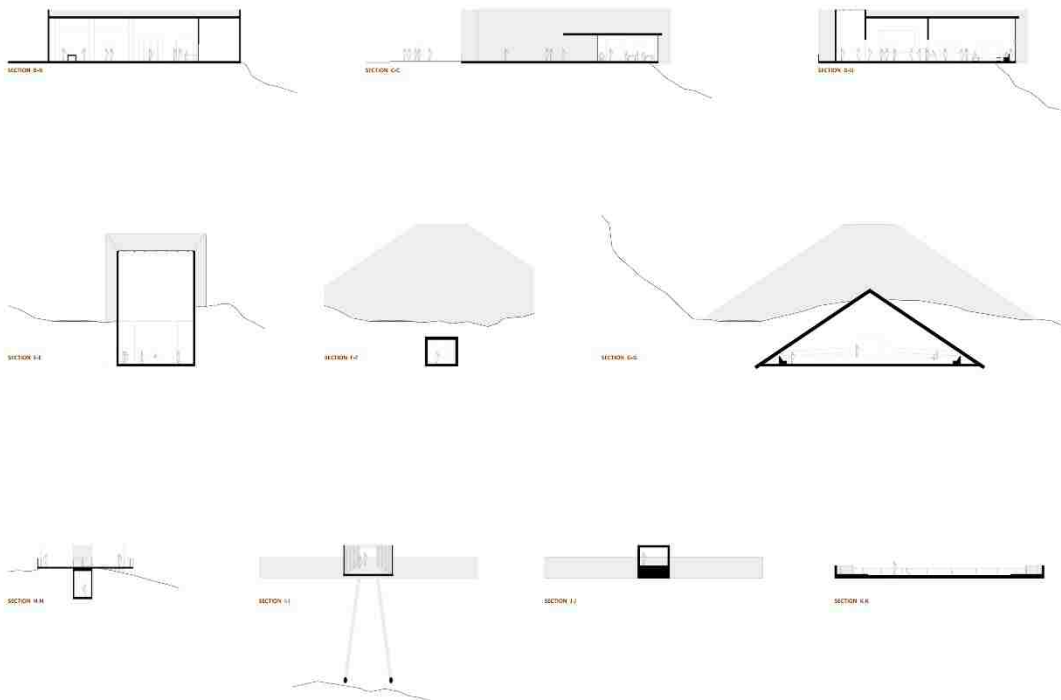


Figure 106: Section Series (Expanded)

## **CHAPTER 5: CONCLUSION**

Appreciation comes to mind when reflecting on this experience. In examining the topics discussed, what stands out is the depth of thought architects and artist have dwelled upon for centuries. It is exciting to join this lineage of thinking and search for a personal space within it. What began as a bold declaration to design sublime architecture has led to a softened view of the profession. Creating architecture of such a magnitude is an emotional endeavor which requires a great depth of thinking in terms light, form, materiality, and related tangible elements which can be spoken of in simple terms, but also involves a type of introspection which words do not properly equate. Not because it is beyond description, but rather, because it is interpretive and prone to subjectivity. Thinking back to Longinus, as annotated by Tate, the sublime is: “Not to persuade, but to entrance, like a flash of lightning.”<sup>42</sup> This level of emotion calls for an element that is not simply explained, something beyond a sense of grandeur interwoven with fear, or the perfect formation of atmosphere. I believe it to be something uniquely human.

The sublime can be evoked as a happenstantial observer of sharp lines of sunlight in a dusty room, or in the warmth of a loving and longing embrace, or in peering into the universe that is a newborn’s eyes. Emotion itself is the source of the sublime, no matter if it stems from fear, awe, love, longing, appreciation, connectivity, a cosmic, natural, or spiritual divinity, or your own humanity. Endeavoring to create evocative architecture that stimulates such emotion is a journey only beginning, and I am excited to see where it takes me.



## FIGURE CREDITS

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Figure 02: Angkor Wat, Creative Commons – Christopher Rose; Source: Flickr: <https://www.flickr.com/photos/khowaga/16249986007/in/photolist-qKXqGx-8BqWEY-4jGrDB-8BnPuk-RviFCj-99JYB8-8BnVWg-7Gp5SM-enuTJ-8v3vVN-8BqX7C-2BSyu-zvkin-5MFE3G-8BqYJC-8BqZiu-q3xAyh-chW5ju-Lf3PYc-j8NJ9f-dDNn2w-FnyKxs-3KJfPG-8wxKXU-exHfS-4kk3PW-8BnQpx-4n8BVC-Uf62qq-aecqYU-2BU6N-4CZE99-aiyLC5-7Gt2Sw-7HVdA2-SPSKxx-2BTf1-UByZa3-9eacQx-7HaxJ-8HoTBg-8BqTmq-5MFDPh-7Gp3T2-4BToVU-67CeUX-8yjDVT-UC3KA2-7oJMnb-zvkik> ..... 3

Figure 03: Entry Expanse of Spa, Creative Commons – Jpmm; Source: Flickr: <https://www.flickr.com/photos/jpmm/4178079681/in/photolist-7ncJmk-7ncKwz-4zt6W2-aHJbuT-4zxmka-4zxnfw-4zt7pi-aHJaWr-4u1Fgf-aHJ99V-8hEhzy-7ngEbl-7ncJEF-4tWCdZ-4tWCkn-4u1EKq-7gzD14-HA9eR-HAavM-HA9XP-HA57L-HA9yR-5pSGGa-HAaoX-6gHgi-7ncKkT-H6FVh-H6PAX-a6FbFo-H6MNo-bEySEU-bv5EK3-7ncLgv-7ncHyV-4cNqw2-bv5ykw-53UCca-53YS3m-ik7fvq-53YRFS-bEySHu-H6TKp-4z8kxm-4z42ZX-guDuxe-4z8tUh-H6N2w-24PVkRY-H6Hwc-H6MWy/> ..... 6

Figure 04: Grazing Light and Central Pool, Creative Commons – Tiago Oliveira; Source: Flickr: <https://www.flickr.com/photos/olotini/465106728/> ..... 6

Figure 05: Saint Benedict Chapel Entry, Copyright Felipe Camus; Source: Archdaily: <https://www.archdaily.com/418996/ad-classics-saint-benedict-chapel-peter-zumthor> ..... 8

Figure 06: Bruder Klaus Chapel Entry, Copyright Samuel Ludwig; Source: Archdaily: <https://www.archdaily.com/106352/bruder-klaus-field-chapel-peter-zumthor> ..... 8

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Figure 09: Saint Benedict Chapel Overhead, Copyright Felipe Camus; Source: Archdaily: <https://www.archdaily.com/418996/ad-classics-saint-benedict-chapel-peter-zumthor> ..... 9

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- <sup>8</sup> Nesbitt, K. (1995), 101.
- <sup>9</sup> Ibid, 96-97.
- <sup>10</sup> Ibid, 100.
- <sup>11</sup> Heidegger, M., & Hofstadter, A. (2013), 145-229.
- <sup>12</sup> Lawlor, L. (2007), 389-390.
- <sup>13</sup> Heidegger, M., Macquarrie, J., & Robinson, E. S. (1962).
- <sup>14</sup> Zumthor, P. (2006), 7-61.
- <sup>15</sup> Zumthor, P. (2010), 1-22.
- <sup>16</sup> Ibid.
- <sup>17</sup> Zumthor, P. (2006), 11.
- <sup>18</sup> Ibid, 13.
- <sup>19</sup> Zumthor, P. (2010).
- <sup>20</sup> Holl, S. (2000), 13.
- <sup>21</sup> Ibid, 62.
- <sup>22</sup> Safont-Tria, J., K., Sanford, & Holl, S. (2012), 51.
- <sup>23</sup> Ibid, 44.
- <sup>24</sup> Kelly, R. (1952), 24-30.
- <sup>25</sup> Ibid.
- <sup>26</sup> Turrell, J.
- <sup>27</sup> Ibid.
- <sup>28</sup> Turrell, J.
- <sup>29</sup> Adcock, (1990), 57.
- <sup>30</sup> Turrell, J., 247.
- <sup>31</sup> Adcock, C. (1990), 10.
- <sup>32</sup> Hylton, W.
- <sup>33</sup> Turrell, J.
- <sup>34</sup> Kelly, R. (1952), 26.
- <sup>35</sup> Perception is affected by hormones on the basis that feeling is shown to adjust perception.
- <sup>36</sup> IES Handbook of Fundamentals.
- <sup>37</sup> National Optical Astronomy Observatory. <https://www.noao.edu/outreach/kptour/>
- <sup>38</sup> Ibid.
- <sup>39</sup> National Solar Observatory. <https://www.nso.edu/about/mission/>
- <sup>40</sup> Ibid.
- <sup>41</sup> Holl, S. (2000), 20.
- <sup>42</sup> Tate, A. (1948), 347.