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Abstract: This thesis sets out to create a design concept based on the slow changes in the geometry of sunlight. The basis of the research examines humans' perception of their visual surroundings, specifically in relation to experiencing natural changes in light. The research section culminates with the question: **How can a design concept accentuate a changing moment of sunlight, thereby connecting people to their place on Earth?** This question guides the analysis section which examines the conditions that best emphasise sunlight's movement. Synthesizing all the research, the design highlights the geometry of sunlight in order to accentuate daily and seasonal changes on Earth. It is constructed in relation to the sunlight at its particular location on Earth. The design creates a moment of alignment at solar midday, accentuating an earthly transition that would otherwise go unnoticed. The design frames the sunlight as it changes throughout the year. This brings attention to the dynamics of the sunlight throughout space and over time. The design exposes earthly cycles which build a connection to the environmental changes that constantly occur in our surroundings.

Solar Midday

A design proposal to experience changes in sunlight and build a connection to our place on Earth.

ABSTRACT

This thesis sets out to create a design concept based on the slow changes in the geometry of sunlight. The basis of the research examines humans' perception of their visual surroundings, specifically in relation to experiencing natural changes in light. The research section culminates with the question: **How can a design concept accentuate a changing moment of sunlight, thereby connecting people to their place on Earth?** This question guides the analysis section which examines the conditions that best emphasise sunlight's movement. Synthesizing all the research, the design highlights the geometry of sunlight in order to accentuate daily and seasonal changes on Earth. It is constructed in relation to the sunlight at its particular location on Earth. The design creates a moment of alignment at solar midday, accentuating an earthly transition that would otherwise go unnoticed. The design frames the sunlight as it changes throughout the year. This brings attention to the dynamics of the sunlight throughout space and over time. The design exposes earthly cycles which build a connection to the environmental changes that constantly occur in our surroundings.

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TABLE OF CONTENTS

INTRODUCTION

Background

The background to this thesis arose from observations living in different places around the world. Every place I moved to, provided a new rhythm to the day and year as the light cycle changed. Each environment had a profound emotional effect on my experience in the place. I grew up in San Francisco, USA, living in a sunny neighborhood of the foggy city. To contextualize my norm (living in San Francisco), San Francisco has mild seasons both in weather and amount of daylight (see Table 1). The winter is full of clear skies scattered with an occasional rain, and the summer is the foggy season. As the fog is low to the ground, it moves fast above head and often burns off by the afternoon. While there are changes in the length of the day based on season, seasons rarely affect the amount of time spent outside.

I spent a year in Abu Dhabi, UAE, a desert city with consistent sun. The heat in Abu Dhabi made it necessary to spend most daylight hours indoors and the constantly sunny weather felt like time passed monotonously. Every day became a steady repetition of itself. With no daylight differentiations from one day or season to the next, it felt like time repeated itself on a daily cycle.

After Abu Dhabi, I moved to Seydisfjördur, Iceland where, for the first time, I experienced the true highs of summer and lows of winter. However, because of the cold weather, the winter is covered in snow which brightens the ground and reflects much of the light. When I moved to Copenhagen, Denmark, I experienced the dark gray, rainy winters with the many layers of clouds that insulated the city from the sun. In both Seydisfjördur and Copenhagen, the seasonal cycles of light changes the entire experience of life. In the spring, seasonal depression lifts and activities change: flowers bloom, postures straighten and people frolick while basking in the sun.

City:	Difference in daylight hours between winter and summer solstice:
Abu Dhabi	3h9min
San Francisco	5h14min
Seydisfjördur	17hr1min
Copenhagen	10h31min

Table 1: A comparison of cities and the difference between daylight hours at winter and summer solstice.

As I moved from one place to the next, I began to understand my connection to daylight in a new way. I observed that the daylight in each place had a direct effect not only on my emotional wellbeing, but on the entire culture. In places where there are great shifts between seasons I noticed profound changes in people. Depending on where on Earth I lived, my experience was dictated by the way light changed.

I became interested in the different timescales in which daylight changes. There are three main timescales I observed:

1. Momentary (noticeable) timescale -- a cloud moving in front of the sun
2. Daily timescale -- sunrise or sunset
3. Yearly timescale (which becomes more prominent the farther one is from the equator) -- days getting longer or shorter based on season

Each one of these timescales informed my experience living in the US, UAE, Iceland and Denmark. My experience of time was informed by the changes in daylight.

I set out to research the connection humans have with daylight, and create a design from which to become more familiar with light cycles. I look to answer the initial question: why are humans so interconnected with the changeability of daylight and how might one be able to accentuate this in every-day life? How might one become more familiar with their place on Earth through a connection to daylight?

Vision

This thesis unpacks the connection humans have with sunlight. I combine an intellectual argument with a qualitative design experiment to grasp the importance of understanding the human connection to change. The thesis focuses on the ways in which we perceive changes in daylight. The circadian rhythm evolved from our earliest ancestors to adapt to earthly changes in light. Human vision is at the center of the circadian rhythm and is the means through which we experience our lit surroundings. Vision is one sense that has allowed us to create a strong connection to our evolving natural environment. An emphasis is placed on building a connection to the outdoor ecosystem which changes in relation to natural light. The circadian rhythm is the vital indicator of these natural changes. People currently exist mainly within architectural spaces, detached from their natural surroundings. During times of rapid growth and globalization, it has never been so important to reconnect to our natural environment. This thesis sets out to create a lighting design which is able to ground people in their natural surroundings by calling attention to the changes in light in space over time.

Method

The thesis begins with a theoretical literature search to understand time on a fundamental level and research the biological connection to visual change. The literature study reveals the research question which focuses on accentuating changes in sunlight, thereby connecting to one's place on Earth. The research question guides the reader through the analysis section. The analysis mixes the theoretical findings from the literature search with qualitative observations to arrive at underlying principles to be taken into the design: namely working with the geometric aspect of sunlight in order to accentuate changes in light on Earth. The state of the art examines ways contemporary and historical artists and architects integrate daylight (and particularly sunlight) into their work, showing the long history and importance of incorporating daylight into everyday life. The success criteria synthesises the accumulated knowledge in order to guide the development of the design. These sections pave the way to the design that allows viewers to experience changes in sunlight, thereby building a deeper connection to one's place on Earth. The perspectivation section outlines ways of taking the design further beyond the thesis. The success criteria is ultimately used in the conclusion to evaluate the success of the design and understand it in a larger context.

THEORETICAL LITERATURE SEARCH

Connection to Change

Place on Earth

In attempting to understand change, it is important to unpack the idea of time. Scientists unravel the linearity of time in leading quantum physics discoveries. They show that only change, not time, lies at the core of the laws of physics (Rovelli, 2018). In the context of this section, I will focus on deconstructing time as it pertains to light. Specifically, this section unpacks time as it defines the calendar day and year. When the calendar year is broken down, it is actually made of physical movements that we perceive through changes in light.

The earth is rotating at a speed of one rotation around its axis every day and one rotation around the sun every year. At the root of it, these rotations are physical relations between one another. The day, month and year cycles are not tied to “time,” but are tied to gravity and laws of motion. It is believed that the earth rotates around its axis as a bi-product of an asteroid hitting Earth 4 billion years ago. The impact ultimately created our moon and set the earth to spin around an axis of 23.5 degrees (Deaton, 2019) (see Figure 1). The earth (and its moon) rotate around the sun because of the sun’s gravitational pull.

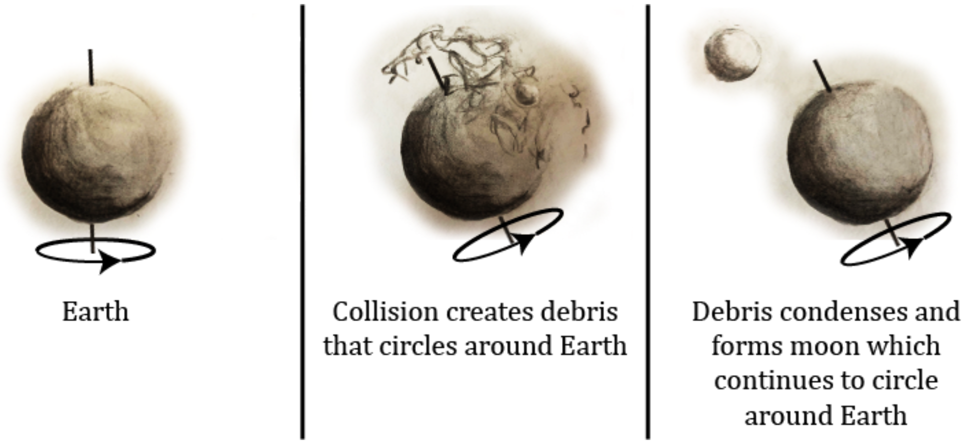

Figure 1: Demonstrates how the earth's axis was created and how the moon formed. Information derived from "Summer Is about Here. For That You Can Thank a 4-Billion-Year-Old Rock" (Deaton, 2019). Figure created by Emma Strebel.

These cycles exist purely due to the relationship between one mass and another. We experience these physical relationships as a change in state. For example, when the earth rotates a certain amount, sunlight hits Earth where we are; the sun becomes visible to us and "rises". Or when our location on Earth is tilted away from the sun, we notice that there is more darkness throughout the 24hr day; it is winter. Those changes we call "time". However, they are merely physical changes. In order to understand our existence within our surroundings it is more accurate to speak of change. Our surroundings are constantly changing. And they are changing in many ways at once. The Earth rotates to expose us to daylight, the water evaporates to create a cloud, the wind picks up, moving leaves and their shadows, we enter indoors and turn on a desk lamp. Changes in us and our surroundings are happening all at once. As Rovelli says in his book The Order of Time, "there is no common time and no privileged direction in which change occurs" (Rovelli, 2018). Cause and effect exists multi-directionally within a web of connectivity. Humans have developed ways to perceive these changes.

Sensitivity to Change

Understanding the non-linearity of time is vital in beginning to understand our biological connection to change. Time is made of infinite changes occuring at every moment and living organisms respond to each one of these changes. External changes affect the individual and in turn the individual affects their surroundings. It is a feedback loop that is constantly active. As Rovelli states:

> "For millennia before clocks, our only regular way of measuring time had been the alternation of day and night. The rhythm of day followed by night also regulates the lives of plants and animals. Diurnal rhythms are ubiquitous in the natural world. They are essential to life [...]. Living organisms are full of clocks of various kinds--molecular, neuronal, chemical, hormonal--each of them more or less in tune with the others." (Rovelli, 2018)

In order to survive on Earth, all life, including humans, evolved to adapt to external changes. As day follows night, our hormones adapt, influencing our neurons, triggering a release of chemicals, resulting in behavior, etc. That behavior then interacts with and changes its surroundings. As Weinstock explains in Nature And The Cultural Evolution Of Architectural Forms, "Nature has no normal state, but is a continuing series of changing landscapes and climates, and [...] living organisms change and develop accordingly" (Weinstock, 2008). We exist in a constant feedback loop within our surroundings.

Circadian Rhythm

The first source of life on Earth created a mutation which was able to detect changes in its lit surroundings. This was the Last Universal Common Ancestor (LUCA) (Bhadra, 2017). This form of life developed an ability to sense daylight and hide from UV rays. It was more successful at living on Earth and thus its offspring had more potential to survive. These organisms continued to form mutations that led to more variations. Some mutations made the organisms more successful at living on Earth. Those organisms succeeded in successfully reproducing and adapting. 3.5 billion years later, LUCA evolved into every living being we know today: bacteria, plants, and animals (including humans). Every variation that stems from this primitive life form evolved an advanced sensitivity to light. This sensitivity to the diurnal cycles is known as the circadian rhythm. The major driver for the circadian rhythm are changes in light (Bhadra, 2017). In plants this rhythm tells the organism when to take in light for photosynthesis and when to process the light into sugars. In animals (including humans) this rhythm dictates when we get tired, regenerate cells, store memories, get hungry, digest food, etc. It dictates a tremendous amount of our mental and emotional state. Therefore, changes in our lit environment have an enormous impact on our mental, emotional and physical state. The circadian rhythm is one way we adapt to our surroundings.

> "It's of absolutely no adaptive value to anticipate predictable events within the environment unless it's capable of being set to the external world and most of the time it's light that provides this essential signal or zeitkeeper[...]to set the internal world to the external world." (Bragg, 2015)

This is a reciprocal evolution between all forms of life. As Weinstock says, "The forms of Nature [...] interact with each other and with their local environment, and in doing so they modify that environment, which in turn may change sufficiently to induce further reciprocal modifications. Natural forms have the capacity to change significantly and to generate new forms, structures and properties from existing ones" (Weinstock, 2008).

Perceiving Change (Visually)

Sensing Visual Changes

The circadian rhythm exemplifies that the ability to perceive change is at the core of what makes an organism successful at living on Earth. We have developed ways to detect changes that occur in our surroundings. These include hearing, seeing, touching, tasting and smelling. The sense which evolved most with the diurnal cycle of change is the eye's ability to see light. "Sight like hearing requires a modulated and crafted form of light for meaning. Stabilize images perfectly on the retina and they disappear. This is a fact of sense psychology. We see only change, movement, life" (Zajonc, 1995). In speaking about vision, it is important to understand the physiological importance of seeing change. The circadian rhythm is one way we process changes in light, however, this research explores a greater spectrum of perceiving visual changes. These range from visibly noticeable to unnoticeable. The major difference is the time-scale at which these changes occur (see Figure 2). It should be noted that slow change on a human timescale is remarkably fast change on the earth's timescale. In this thesis, I refer to the speed of change in relation to the human time-scale because I focus on humans' ability to notice these earthly changes. Humans constantly read their lit environment in order to acclimate to a space. Lam writes about lighting for humans' biological needs and argues that "changes in the perceived status of these important aspects of the environment trigger warning signals in the brain, demanding attention" (Lam, 1992). These changes happen at different speeds. The research investigates the differences between noticeable and unnoticeable changes and how "the perception of temporal duration is crucially bound up with memory" (Le Poidevin, 2019).

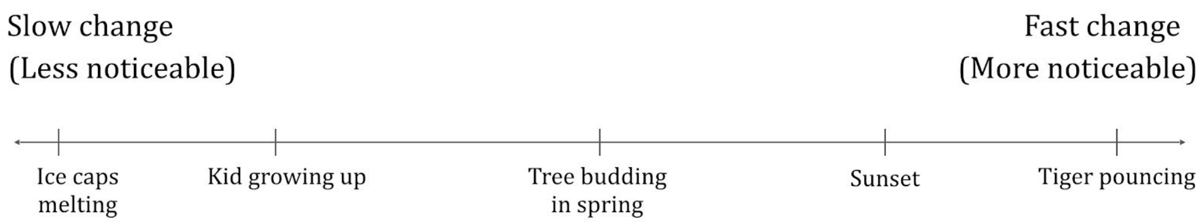

Figure 2: Timescale of visual change based on human perception. There is no clear threshold from one way of perceiving change to the next. Figure created by Emma Strebel.

Noticeable Changes

Humans have evolved to have a keen sense for visual movement. Examples include a light switch being turned on, a ball flying towards you or water flowing out of a faucet. This aspect of vision occurs primarily in peripheral vision. It originates in evolutionary advantages, and is fine tuned to capture attention. If a predator lurks beside you, it is advantageous to respond to the visual cue. To act on that observation could mean life or death. Often fast movements require a response, however sometimes these movements are deemed unimportant and get filtered out of our consciousness. Regardless of whether they are registered as conscious or not, noticeable changes occur at a speed which is visibly changing from one moment to the next. Noticeable change engages memory in an immediate and precise way. Le Poidevin says that perception of visual movement occurs because of our acute short-term memory. For example, "As I see the second hand in one position, I have in my short-term memory an image (or information in some form) of its immediately previous position, and this image affects my current perception. The result is a perception of movement" (Le Poidevin, 2019). The brain stores a precise visual image of the previous moment and compares it with the current moment. For example, when a ball flies toward a person, the brain calculates the speed depending on the change in position and size of the ball on the retina from one moment to the next. The precise calculation of speed based on light hitting the retina is a vital skill for perceiving change in people's surroundings. Its precise detail allows humans to perceive their surroundings while accounting for the orientation and position of the body. Since fast movements are noticeable, they are easily recognisable and understandable.

Unnoticeable Changes

Unlike fast movements, changes that happen at a slower time-scale, are visually unnoticeable while they are happening. For example, with bare eyes, it is impossible to see the moon move in the middle of the sky, watch a plant grow or see a glacier melt. In each of these examples, there is no perceivable moment to watch while the change occurs. The speed of change in these examples is so slow that the eyes cannot track the changes as they can in the perception of fast movements. Thus, slow changes easily go unnoticed.

There are certain ways to make these unnoticeable changes noticeable. The moon's movement becomes observable when it is rising and is seen in relation to the static horizon; plant growth becomes noticeable if one marks the growth every week; a glacier melting becomes visible if one is given a photo of what it once looked like. When perceiving unnoticeable changes, one does not realize the change is occurring until it has already occurred. At that time, one is able to look back and compare its current state to a previous state. When making this comparison, the past is defined and can be seen in relation to another point in time. As Le Poidevin explains:

> "We first perceive the hour hand in one position, say pointing to 3 o'clock, and later we perceive it in a different position, pointing to half-past 3. So I

> have two perceptions, one later than the other. I may also be aware of the temporal relationship of the two positions of the hand. Nevertheless, I do not perceive that relationship, in that I do not see the hand moving. In contrast, I do see the second hand move from one position to another: I see the successive positions as successive." (Le Poidevin, 2019)

The brain is good at placing marked changes in an imaginary timeline. This timeline exists purely in our memory. Carlo Rovelli explains the difference between the past and future. As he says:

> "The past leaves traces of itself in the present. [...] The craters of the moon testify to impacts in the past. Fossils show the forms of living creatures from long ago. Telescopes show how far off galaxies were in the past. Books contain our history; our brains swarm with memories." (Rovelli, 2018)

Our brain is full of memories which are traces from the past and inform our present experience of our surroundings. However, over long periods of time these traces in our memories become less precise. At slow timescales, the brain registers atmospheric changes rather than precise changes. As William Lam describes, "Our evaluation of any environment is colored by the memory of prior experience in analogous situations" (Lam, 1992). While this is true for instantaneous movements, it is particularly important in understanding the experience of an atmosphere that changes over a longer duration of time. Additionally, our circadian rhythm expects atmospheric changes and adjusts our experience of life accordingly. We base our life off of daily and yearly light cycles: It gets bright out, wake up: it gets dark out, go to bed: days get shorter, hunker down: days get longer, frolic with the flowers. Moments throughout the day and year evoke different atmospheres. Our bodies are so used to these rhythms that we subconsciously begin to expect the change.

The expectation that change will occur evokes a feeling of anticipation. As Le Poidevin says, "...causes always precede their effects; perception is a causal process, in that to perceive something is to be causally affected by it" (Le Poidevin, 2019). Once those earlier events are perceived, it triggers the anticipation of future events occurring. For example, comparing the size of a plant a week ago with its current size allows one to anticipate how much it might grow in the next week. Rovelli argues that the interaction with change is at the core of what we call time and that “brains are made up essentially of memory and foresight” (Rovelli, 2018). It is vital to be able to anticipate cause and effect. Whereas fast movements trigger automatic calculation of speed of change relative to the human, slow change, requires people to conceptualize the change over long intervals of time. Being able to conceive of the change in plant growth allows one to predict when the plant might be ready for harvest. This ability is innate within human beings.

While the body consciously and subconsciously makes these calculations about its surroundings all the time, the circadian rhythm is particularly entwined in this phenomena. By calculating one's lit surroundings, it allows humans to prepare the body for the changes to come. Based on the previous hour and 12 hours it prepares for the upcoming hour and 12 hours. The circadian rhythm is attuned to the 24 hour light cycle. The predictability of the sun rising and setting (whether visible or behind clouds), keeps the body in check. It’s the slow changes in the Earth’s rotation that keeps the body clock running.

Awareness of Changes

Consciously perceiving change on slow time-scales is hard because of humans’ “egocentric” experience of space and time (Grush, 2005). This means that spatial and temporal perception is relative to the body. Being that vision is purely caused by light hitting the retina, visual changes are perceived in relation to the eye. Grush argues that our perception of space and time is subjective and based on point of view; “Egocentric temporal representation uses my current time, now, as a temporal reference point, much like egocentric spatial representation uses my current location, here, as a spatial reference point” (Grush, 2005). Hoerl furthers this idea when he says, “perception is from a point of view which stands in the way of […] how things are objectively” (Hoerl, 1998). This is important to understand when speaking of change because perception of change is subjective. Therefore, it is hard to conceive of space and time in a much larger or much smaller way than what is relevant for human experience. As Grush says,

> "In the case of behavioral space and time, large and small magnitudes can be represented, although because the units derive their content from perception and behavior, discriminatory abilities are best within a certain perceptually and behaviorally relevant range and degrade as we exceed the limits of what typically becomes behaviorally manifested, both with very large spatial and temporal magnitudes, as well as very small spatial and temporal magnitudes" (Grush, 2005).

This begins to happen within the slow daily light cycles from sunrise to sunset. Given our innately human way of perceiving the environment, "[...] the history of the happening of the world itself can only be an effect of perspective[...] an effect of our peculiar point of view in the world[...]. Inexorably, then, the study of time does nothing but return us to ourselves" (Rovelli, 2018).

The egocentric way humans perceive their surroundings makes it hard to conceptualize of changes occuring on a plant's timescale or the earth's timescale. Thus, although equally impactful, these slower changes in our visual surroundings become more subconscious and neglected.

There are evolutionary advantages to developing a sensitivity to noticeable and unnoticeable changes. However, since slow changes in our lit surroundings trigger a generally subconscious response and fast changes are easily observed, there are vast differences in our awareness of slow changes. It is easy to overlook circadian and atmospheric changes if they generally affect us subconsciously and do not require direct responses.

Importance of Slow Changes

For the majority of human evolution, we existed within the natural cycles of light. "The transition to agriculture began around 9500-8500BC" and by 3500BC most everything had been domesticated (Harari, 2015). Within the past approximate 10,000 years, most human communities have moved from a nomadic existence to living primarily only indoors. The National Human Activity Pattern Survey (NHAPS) conducted throughout the United States from 1992-1994 shows that the participants spent on average 87% of time indoors, 6% of time in vehicles (Klepeis et al., 2001). Along with this switch, technology has progressed particularly fast within the past 100 years with the industrial revolution, and of course since the turn of the millennium as interactive and LED technology is on the rise.

Throughout these progressions, instant gratification seduces peoples' focus, in turn causing us to disregard the experience of earthly changes. A focus on slower environmental changes is being overlooked. With this mass cultural switch, people have become more detached from their place on Earth. As Carl Sagan says, "We are very devoted to the short-term and hardly ever think about the long-term" (Sagan, 1997). This becomes particularly crucial when conceptualizing the environmental change humans have on Earth. It is easy to not recognise the impact we have on the slow (on human timescale) changes in the environment. By connecting to a slower human timescale of change, we connect with the profound effect natural changes have on us humans. Through this connection we are better able to understand our coexistence with our natural surroundings. It is this element which guides the research question and analysis with the goal to enhance peoples' awareness of earthly changes in daylight in order to ground people in their surroundings.

RESEARCH QUESTION

How can a design concept accentuate a changing moment of sunlight, thereby connecting people to their place on Earth?

ANALYSIS

Introduction

In order to answer the research question, analysis investigates ways of making slow changes in daylight more noticeable. This includes a study of daylight and its different qualities in relation to earthly change. The analysis also investigates what kind of space allows people to observe these changes best. Lastly, this section unpacks what kind of tools can bring awareness to these changes and the importance in connecting to one's surroundings. Each piece of analysis is used in developing the success criteria to be used to later evaluate the designs.

Changeability of Sunlight

A daylight analysis is conducted exploring different types of daylight. Various kinds of daylight are analysed based on their changeability. In this section, the "changeability of daylight" is also referred to as the "dynamics of daylight". Daylight takes two main forms: sunlight and skylight. There is a strong difference between the two. Sunlight is a direct light source from the sun and skylight is an indirect light source where sunlight bounces off the atmosphere and is redirected to the earth's surface. Hansen and Mathiasen explore these qualities in detail in "Double Dynamic Lighting Balancing Diffuse and Direct Light" (Hansen, Mathiasen, 2019). They examine four types of sky conditions taken from the CIE Standard, which allow for different dynamic qualities. Within these four sky conditions, there are four types of shadows. The first two conditions are variations of overcast skies which offer diffuse and hardly any noticeable dynamics. The last two conditions are partly cloudy and clear sky, where there are stronger dynamics and the changes in daylight are more noticeable (Hansen, Mathiasen, 2019). Their analysis shows that when there is any amount of direct light, dynamics are more noticeable. Analysis continues by examining the differences between shadows in a clear sky and overcast sky. Visual differences between shadows are examined, followed by an analysis of the dynamic differences of the shadows.

Visual Differences between Shadows

Humans' ability to detect a shadow's form is vital in noticing it. Sharper edges are more easily noticed because they have a quick transition between one color and another. As Zajonc says, "We see only change" (Zajonc, 1995). Change is not only on a timescale (the difference from one moment to the next), but it is on a spatial scale too. A slow (gradual) transition from light to dark is harder to detect than a quick (sharp) transition (see Figure 3).

Figure 3: This figure shows the difference between sharp and gradual change in color. Figure created by Emma Strebel.

If one is able to detect the edges of an object it is easier to define its placement. Figure 4 shows the difference between sunlight shadows and overcast shadows. The camera's position stays the same as the sky conditions change from clear sky (including sunlight) to cloudy. Figure 4 exposes the stark difference in being able to detect form in shadows between sunlight and overcast conditions. This is mostly due to our ability to easily notice sharp edges. If the light has sharp edges, we are able to notice changes easier than if it has soft edges. Additionally, during clear sky conditions, sunlight is directional with straight rays of sunlight. It therefore creates a sharp shadow with high color contrast. With an overcast sky, the sunlight bounces off clouds and becomes multi-directional, thereby making the shadows fuzzy with less color contrast (see Figure 4).

Clear Sky:

Overcast sky:

Figure 4: Figure exemplifies the ability to see edges in sunlight better than with an overcast sky. This is because of the color contrast and sharp edge of the shadows. The camera's position is still as the sky conditions change from clear sky to overcast. On the right, a color swatch shows the color contrast between light and shadow in each picture. Photos are taken by Emma Srebel.

Dynamics of Shadow

The visual differences between shadows allow people to notice changes in them differently. Sunlight and semi-cloudy conditions allow for easily detectable changes because their form is easily detected. During overcast conditions, light is dispersed more evenly and there are less noticeable changes over time. If there is form, we are able to track the shape and position of the shadow from one moment to the next. If the form is lost (like with soft shadows), it is hard to detect changes. Again, Zajonc's statement, "We see only change" holds true (Zajonc, 1995).

The form that is produced by sunlight occurs because sunlight is a direct light source. The light comes from one source: the sun. As the light rays move to Earth, they hit anything in their path. If that object (or particle) is opaque, the ray is stopped and a shadow is formed in the remaining path to the ground. Skylight is so expansive and multidirectional that the form is lost. Sunlight, therefore, has a uniquely geometrical quality. Due to its geometry, its movement and position is predictable. While clouds come and go at random, the earth keeps rotating at the same speed. The predictability of the movement of sunlight informs the routine of light in a space. Thus, by observing changes in sunlight and the shadows it casts, we are able to see the earth rotate. Since the geometry of sunlight changes depending on one's location on Earth, spatially perceiving changes in sunlight connects people to their place on Earth. It is this aspect of the dynamics of sunlight that I am interested in accentuating in the design.

Accentuate a Fleeting Moment

Sundials

The geometric nature of sunlight and its connection to exposing time of day and year is not a new discovery. Infact, the measurement of sunlight dates back to prehistoric times (Lennox-Boyd, 2006). Sundials are historic ways of marking changes in light in order to keep track of the day and season. A surface is marked relative to a shadow cast from sunlight. This way, the position of the shadow is contextualized in the cycle of the day and year. The mark exists in relation to moments past (days and seasons gone by) and future (days and seasons to come). The diurnal light cycle occurs because of the rotation of the earth on its axis and the yearly light cycle occurs because the earth moves around the sun. While the invention of sundials was the beginning of linear time as we know it (clock hrs and calendar days and years), they mainly mark a routine of change.

Marking Moments of Light

Traditional sundials mark a path of the sunlight/shadow throughout the year. However, the same effect occurs when only one moment of light/shadow is marked. It offers a comparison to understand other moments (see Figure 5). By creating a mark, of a previous moment of light, every following moment of light is seen in comparison to the mark.

Figure 5: Figure shows black tape marking the edge of sunlight at a particular moment. After some time, the patch of light moves. The change is seen clearly because the black tape is left as a remanence of a past moment of light. Images taken by Emma Strebel.

By marking the position of light at a certain moment, it makes reference to the past and future cycles of light. It calls attention to the earth's routine of light. By marking the past the viewer is invited to anticipate the future. Thus, by creating a reference point, the viewer more easily notices change.

Context to Enhance Change

Architecture

The dynamics of sunlight often change at a speed that is visually imperceivable. Thus, it is helpful to track them in contrast to a static environment. We perceive change relative to its surroundings, specifically when it contrasts “context or expectation” (Lam, 1992). Thus, when one's surroundings are static (like in most architecture), humans are able to see the changes and movement more easily. Static environments such as architectural spaces enhance the ability to notice change. The stillness offers contrast to the movement.

Additionally, in most social structures today, people spend the majority of their time indoors where the slow changes that occur to a great extent outdoors are minimal. Architecture is a generally static framework where most humans spend the majority of their sleeping and waking hours (Klepeis et al., 2001). Due to this reality, there is an enormous disconnection to the element of natural change in people’s surroundings.

Windows

While existing within architecture, windows offer a visual connection to the outdoors. They are the central element to connect us to our natural surroundings (not to mention doors which offer a physical connection). The changes that occur through the window (in the external environment) are more easily noticed because they are seen against a static framework. Windows offer a view of the outdoors which is a connection point to important biological needs that William Lam defines: time, weather and “the presence of other living things” (Lam, 1992). Whereas the view exists because light reflects off objects into our eyes to create an image of the outdoors, it does not only reflect into our eyes, but all throughout the space. The most noteworthy of this light is reflected off the sky. As light enters indoors reflecting off walls and furniture, it alters the perception and experience of the interior. As the light from the outdoors (daylight) changes, it alters the inside spaces visually and atmospherically. These changes also offer a connection to time, weather and living things (Lam, 1992).

Incorporating the daylight analysis, particularly of sunlight, I examine sunlight as it enters through a window into an indoor space. The geometry of sunlight and its shadows are dependent on the position of the sun relative to the viewer's position on Earth, the window and the surfaces the light hits in the room. While sunlight is not always visible because of weather conditions, the earth's rotation allows for the sun's movement and position to be predictable throughout a space. This way, the dynamics of sunlight offer a visual and spatial connection and orientation to the time of day and year.

Connecting to Place on Earth

There are many different lit environments that one space can have depending on time of day and year. As a space slowly changes with the daylight, people's emotional and physical states change accordingly. Occasionally people notice a poignant moment of light, such as at sunset. Since most architecture is not built around creating poignant moments of light, they usually exist at random: for example, noticing the alignment of sunlight through a window and onto a painting during a summer sunset. Encounters like these remind us of the unique beauty of a particular moment. One realizes the chance encounter as light pierces through a space. Witnessing a precise moment of light draws attention to the change inherent in daylight. The moment one steps away, the light will be different. This brings awareness to the environment changing before our eyes. However, understanding that sunlight will return in a similar way the next day and year offers comfort to letting the moment go. Because of the geometry of sunlight, the routine of sunlight throughout a space is predictable on a daily and yearly cycle. Experiencing these rhythms of light connects people to rhythms of life. Becoming conscious of these unique moments of light ground us in our ever-changing physical and visual surroundings. While creating a design, the goal is to use sunlight as a tool for noticing the fleeting nature of a moment on Earth.

STATE OF THE ART

The state of the art section consists of inspiration from contemporary and historic art and architecture. Each piece of work accentuates the earth's changes by incorporating daylight, and usually sunlight. These themes of using daylight in architecture and art date back to man's earliest civilizations and are integral to the foundations of religion and science. The state of the art section brings in other approaches to exploring light, listening to Zajonc when he says:

> "[Light] has been treated scientifically by physicists, symbolically by religious thinkers, and practically by artists and technicians. Each gives voice to a part of our experience of light. When heard together, all speak of one thing whose nature and meaning has been the object of human attention and veneration for millennia. During the last three centuries, the artistic and religious dimensions of light have been kept severely apart from its scientific study. I feel the time has come to welcome them back, and to craft a fuller image of light than any one discipline can offer" (Zajonc, 1995).

Historical integration of daylight into architecture

The practice of working with the geometric nature of sunlight has been used for many centuries as a way of connecting people to seasonal cycles. Many integrate sundials to mark the precise time of day and year. In other contexts, monuments are centered around sunlight aligning with particular aspects of the architecture only once a year; those include Stonehenge, Newgrange and Gnomon of Saint-Sulpice. These spaces integrate sunlight poetically and reference the preciousness of a particular moment of light. This preciousness is at the core of the design.

Contemporary Artists

James Turrell is known for his iconic *Skyspaces*. These spaces have a circle, oval or rectangle cut out of the ceiling where viewers are able to see a section of the sky. Often the interior is lit to contrast the sky, creating double dynamic lighting (dynamic electric light and dynamic daylight) which plays with the viewers perception. The dynamics often create optical illusions where the color of the sky is perceived to be a color that is different when the viewer exits the space.

Charles Sowers is fascinated by natural phenomena such as the sun, wind, vibrations and reflections. He creates public artwork in order to encourage "careful noticing" "into normally invisible or unnoticed phenomena" (Sowers, 2020). His piece, *Solar Totems,* uses a lens to condense the sun's intensity enough to burn a mark into a large wooden post. The lens moves to a new place every day, leaving behind a burn that marks the movement and intensity of the sun on the previous day. The piece catalogues the daily dynamics of sunlight.

Chris McCaw is a photographer. He creates long exposure photographs called *Sunburn* where the sun's movement over the course of a day is burned into a film negative as the image is captured. The burn leaves a mark and often a hole through the image.

Daniel Rybakken creates light fixtures that incorporate aspects of daylight. His work such as *Daylight Comes Sideways*, *Daylight Entrance, Stockholm* and *Subconscious Effect of Daylight* are imitations of daylight in which the viewer thinks they are observing sunlight coming into a space. However, each of them uses electric light in order to simulate daylight. While *Daylight Comes Sideways* incorporates the dynamics of trees moving in daylight, *Daylight Entrance, Stockholm* and *Subconscious Effect of Daylight* are static projections of a patch of light as if sunlight were coming in through a phantom window. The fixtures simulate a moment of daylight coming into a room and make the viewer think the patch of light will move over time.

Contemporary Architects

Hiroshi Sambuichi creates structures that accentuate moving materials such as wind, sunlight and water. His work connects visitors to their natural surroundings. He mixes moving materials with still spaces and argues that: “Instead of seeing moving things while you move, you see the moving things much better when you stop moving” (Sambuichi, 2017). He creates moments where people are able to experience and appreciate their subtly moving surroundings.

James Carpenter Design Associates is known for their use of natural light in the built environment. The team often works with glass to create reflections and refractions with the daily changes in sun and sky conditions.

Jan Utzon’s house in Mallorca is an example of a house built to accentuate moments of daylight. Specifically, there is a west facing window where, when the sun sets, the sunlight enters into the room and shines across a wall. Depending on the season, the sunlight enters at a different angle.

Gordon Matta Clark was an installation artist who created architectural interventions. He is known for creating large-scale cut outs from one floor to another, allowing viewers to see through one room to the next. He creates windows from one space to another for viewers to re-develop their relationship to their place on Earth.

These bodies of work explore daylight in different ways. They are used as inspiration to create a design that emphasizes the geometric dynamics of sunlight, grounding viewers and inhabitants in their ever changing environment.

SUCCESS CRITERIA

In making a design, the goal is to create visual encounters that make viewers conscious of experiencing natural changes around them. When natural changes occur at a visually unnoticeable time-scale, people often forget that the changes are occuring. The design is meant to bring these subconscious changes into viewers' consciousness. The background, literature review, analysis and state of the art are synthesised into success criteria from which to evaluate the success of the designs to fulfill the research question. The criteria are as follows:

- The design works with the geometry of sunlight throughout a space to accentuate the viewer’s place on Earth.
- The design marks a moment of sunlight to accentuate a change that would otherwise go unnoticed.
- The design uses sunlight to accentuate daily and seasonal changes in order to connect viewers to their experience on Earth.

DESIGN

Concept

Embarking on the design I am interested in creating an awareness of the way sunlight moves through a space in order to accentuate the viewers experience on Earth. I work with the aspects particular to sunlight, specifically the parallel lines of its rays, and the routine of its motion. I am interested in detaching changes in sunlight from clock time as we know it. By connecting to changes in sunlight, we build a connection to our changing surroundings. Becoming aware of changes in sunlight allows viewers to conceptualize the earth's rotation as Cosmic time. I explore ways to accentuate the earthly changes that occur around us at all times. In doing this, the design is meant to build viewers' connection to the earth at large.

Experiments

I mainly look into the way sunlight comes into a space. I explore the alignment of sunlight with the structure of a building (see Figure 6). I envision an opening in a room where sunlight comes in through a window. At certain times of day and season, the sunlight pierces through the opening into the next room. This creates a feeling of anticipation as the light moves through the space.

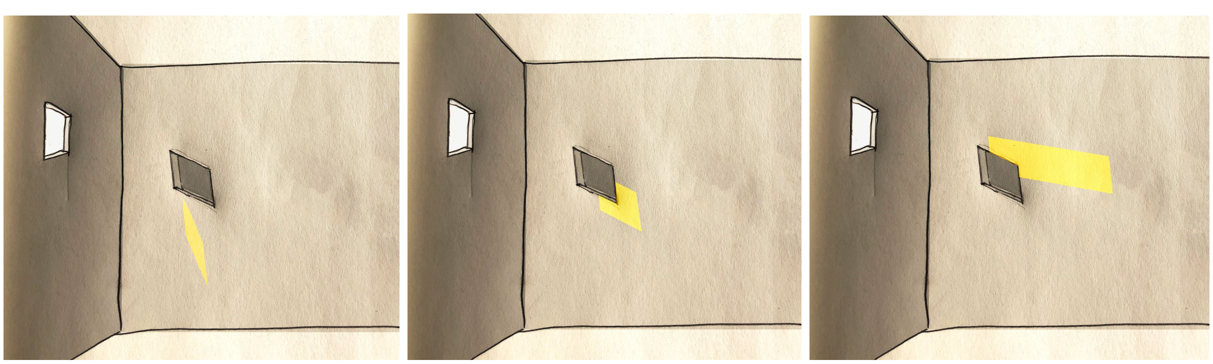

Figure 6: Demonstration of preliminary sketches for the initial design concept. Sunlight comes in through the window and hits the adjacent wall. An opening is created in the adjacent wall marking one moment of sunlight. As the seasons and time of day changes,

the sunlight aligns with the opening and pierces through to the next room. At other times of day and year, the sunlight does not align with the opening, and it creates a comparison to a previous lit environment. Figure created by Emma Strebel.

Bringing this design into Cinema 4D, I realize there is rarely a chance to experience this piece in a powerful way (see more of this concept in Appendix 1-6). I use the success criteria to evaluate the design:

- While the design works with the geometry of sunlight throughout a space, it does not accentuate the viewer's place on Earth. With this knowledge, I realize the design should be integrated in its location on Earth: distinct to the sun at its particular location. Thus, the design should change according to its location (latitude or longitude) on Earth.
- It successfully marks a moment of sunlight in order to accentuate a change that would otherwise go unnoticed, however, this moment occurs very rarely, and there is no rhyme or reason for when it occurs. Instead, I want to accentuate a particular moment that occurs daily (instead of yearly). Additionally, this moment should be a moment of transition that often goes unnoticed and has particular meaning.
- Finally, the design uses sunlight to accentuate daily and seasonal changes, however, the sunlight often does not shine on the wall with the opening. In these moments the opening is only a representation of another moment, but does not offer direct comparison. In addition, in order to connect viewers to their place on Earth, the design should be grounded in the sunlight particular to its location. I look further to find a design that offers daily and seasonal comparisons particular to its location on Earth, in order to connect viewers to their experience on Earth.

Since many decisions on this design are arbitrary (i.e. the position and size of the window, the moment chosen for the opening, the depth of the walls and the orientation of the building), I look deeper to create a stronger design.

Final Design

Structure

I decide to work with a design that changes depending on where it is located on Earth. I work with the difference in geometry of sunlight depending on where the design is located on Earth. I also choose to emphasize one moment of the day which often goes unnoticed and which occurs on a daily basis: solar midday. The final design is a structure that exemplifies direct sunlight as it enters into a structure. Sunlight enters into a long rectangular opening on the top of the space and casts a stripe of sunlight down the side and bottom of the design (see Figure 8). This shape moves through the room over the course of the day. In the Northern Hemisphere, the opening is on the south side of the structure and is oriented at precisely 180° South. In the Southern Hemisphere, the opposite is true. Regardless of where the design is placed on Earth, as the sun rises, sunlight creeps down the westward wall. At midday, the stripe of sunlight aligns perfectly with the floor and no sunlight hits the walls. After midday, the sunlight moves up the East wall until it disappears when the sun sets. The sunlight is the palpable focus of the piece.

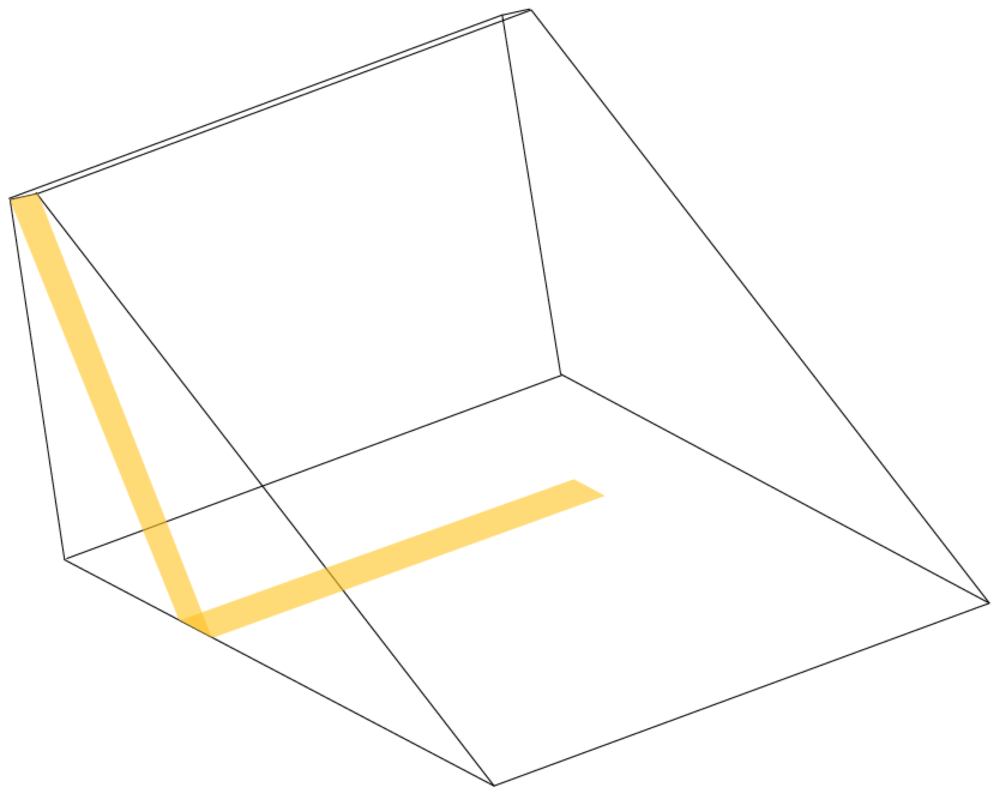

Figure 8: Figure shows the design proposal at one moment in time. Figure created by Emma Strebel.

The specific shape of the design originates at the equator and depends on the Latitude of its location. The design is integrated within the geometry of sunlight. The angles of the June and December Solstices[1] derive the shapes of the structure (see Figure 9). The North and South walls of the room align with the angle of the sun at midday on the Solstices (see Figures 9 and 10).

[1] I refer to the solstices not as Summer or Winter Solstice because the seasons are opposite depending on whether one is in the Northern or Southern hemisphere.

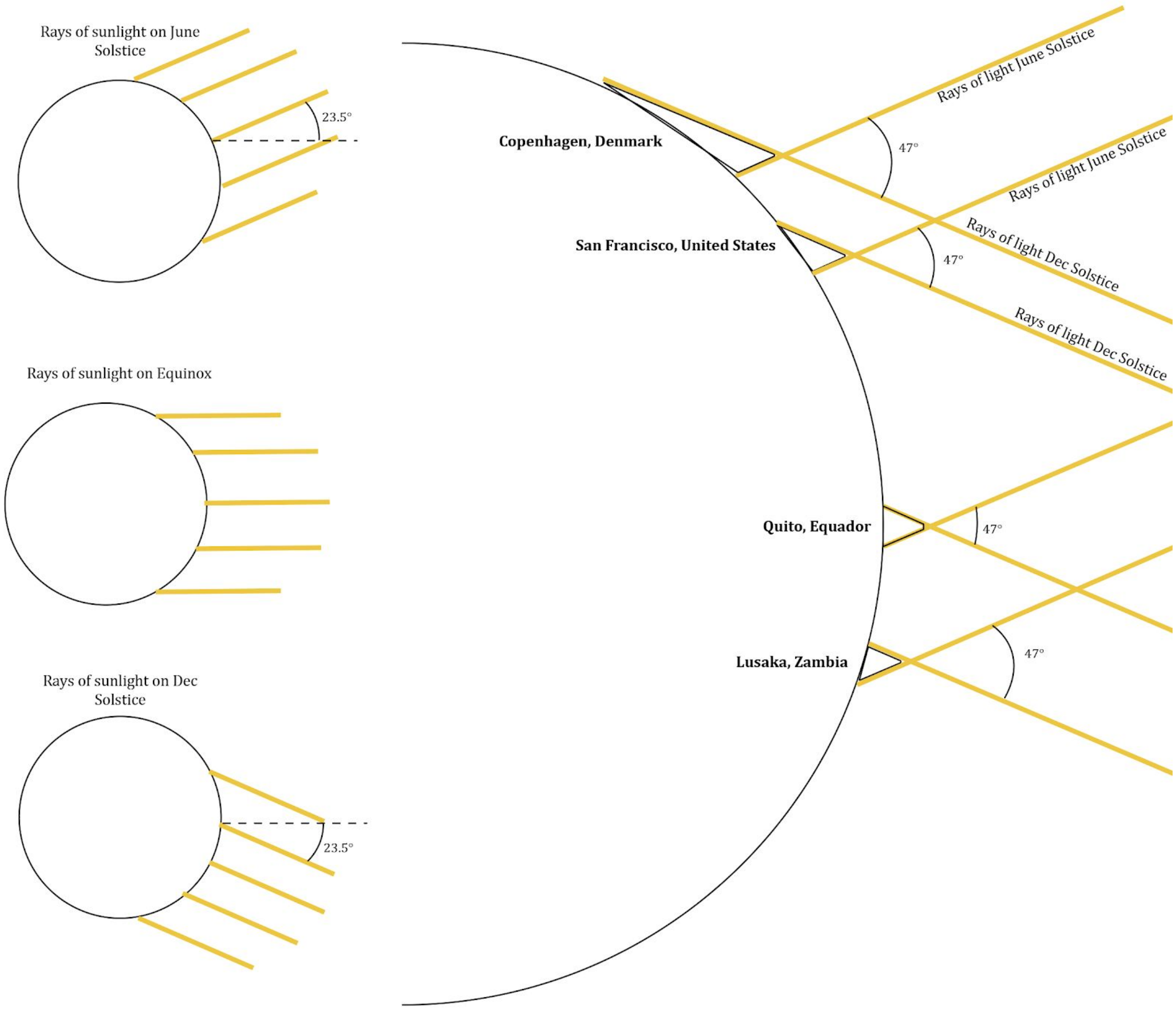

Figure 9: Figure shows the change in angle of sunlight depending on season. The rays of light on the solstices create the angles of the North and South walls of the structure. Since sunlight hits the earth in parallel lines, the difference in the angle of sunlight hitting the earth between the solstices is always 47 degrees. Figure created by Emma Strebel.

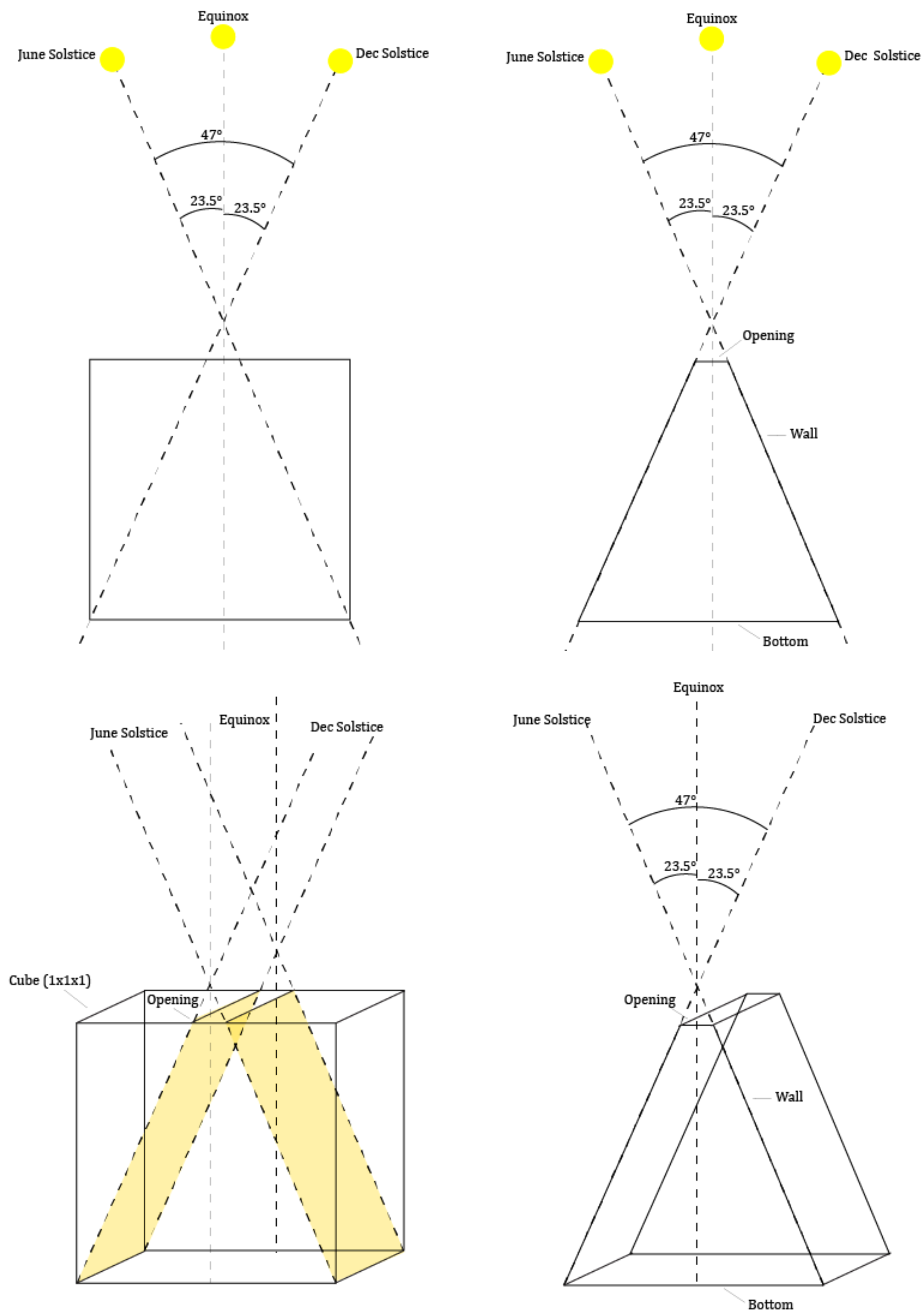

Figure 10: Figure shows the design as it is located at the equator. The rays of sunlight on the solstices create the North and South walls. I use a cube to derive the dimensions at the equator such that the width, height and length are the same. An opening is created on the top of the structure to make the height of the structure the same size as the width and length and to let sunlight into the space. Figure created by Emma Strebel.

Depending on the latitude of where the piece is installed, the angles of the North and South walls are different. While the size of the opening and the difference between the angles of the North and South walls stay the same (with a consistent 47 degree difference), the shape of the entire structure changes relative to the ground (see Figure 11). At the equator, the sun moves from North to South equally and the opening is perfectly centered. North of the Equador, the opening faces South. South of the Equator, the opening faces North and the seasons switch (see Figures 11-13).

Additionally, the length, width and height of the design at the equator are all equal (see Figure 10). The further the design is from the equator, the shallower the angles are relative to the ground and the longer the bottom of the structure gets (see Figure 12).

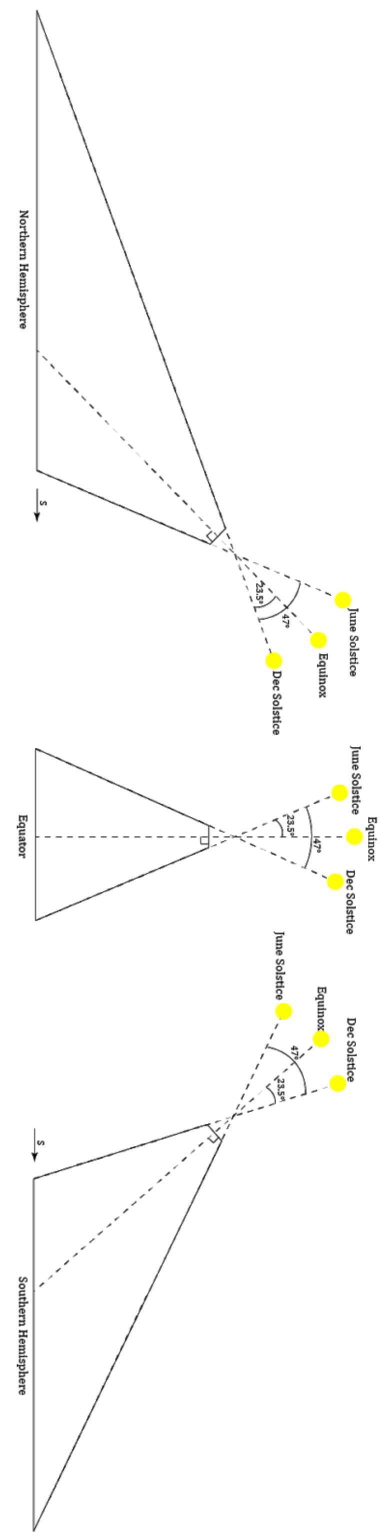

Figure 11: Figure shows the general shape of the structure depending on whether the design is located north, south or on the equator. Depending on where the structure is located, the opening faces a different direction. The opening is always perpendicular to the angle of sunlight at midday on the equinox. Figure also shows that each design has an opening of 47 degrees. Figure created by Emma Strebel.

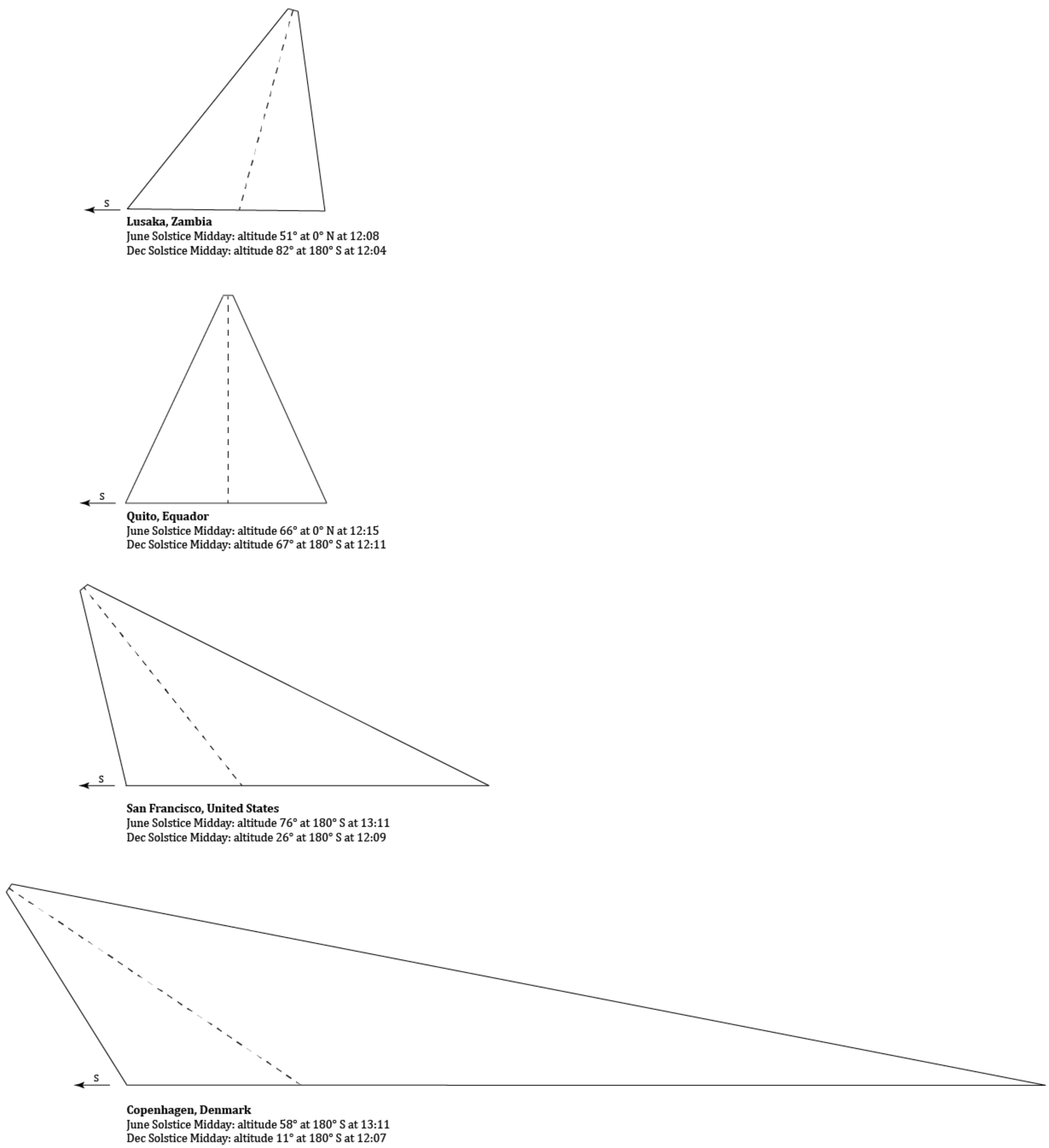

Figure 12: Figure shows the shape of the design in four locations on Earth. The angles of the walls are equivalent to the altitude of the sun at midday on the June and December Solstices. The dotted line shows a ray of sunlight on the equinox. The opening on the top of each structure is perpendicular to this line. Figure created by Emma Strebel.

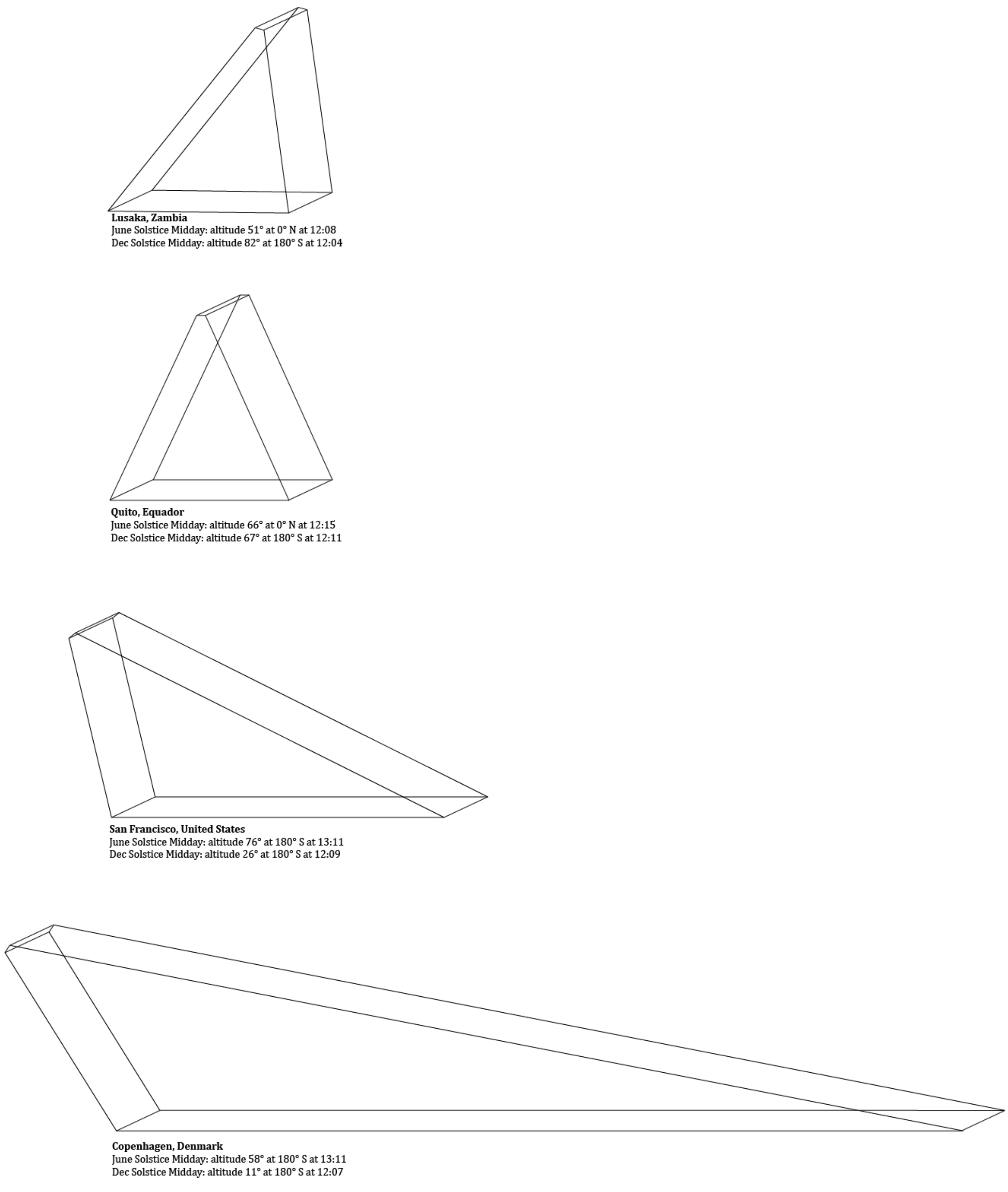

Figure 13: Figure shows the design three dimensionally. At the Equator the bottom of the structure is a square. Farther from the equator, the bottom elongates. The height of every piece and the size of the opening remains the same. Figure created by Emma Strebel.

The stripe of sunlight that enters through the opening aligns with the floor precisely at midday. Since the rays of sunlight are parallel, midday is the only time when light does not hit the walls. Precisely at midday the sunlight shoots down the East side of the wall to create a strip that goes from the East to West side of the bottom of the structure. Just after midday, sunlight shoots up the Eastern wall (see Figures 14 and 15).

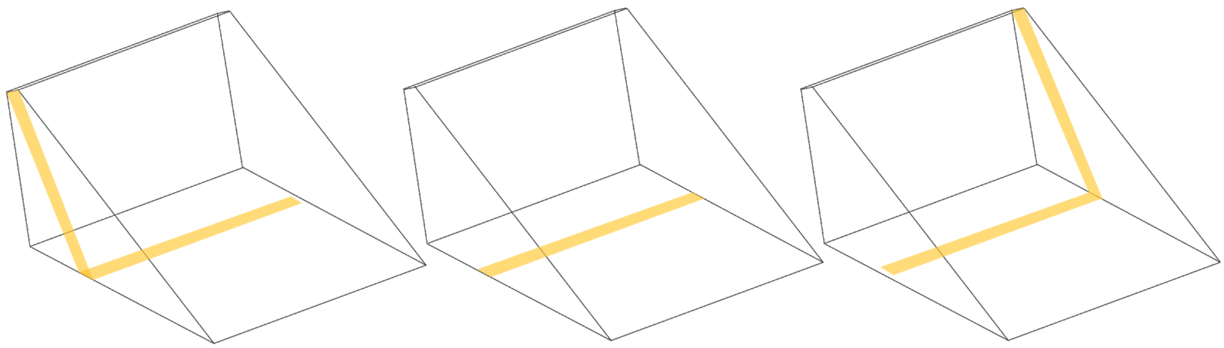

Figure 14: Figure shows the sunlight as it moves through the space just before midday to just after midday. Figure created by Emma Strebel.

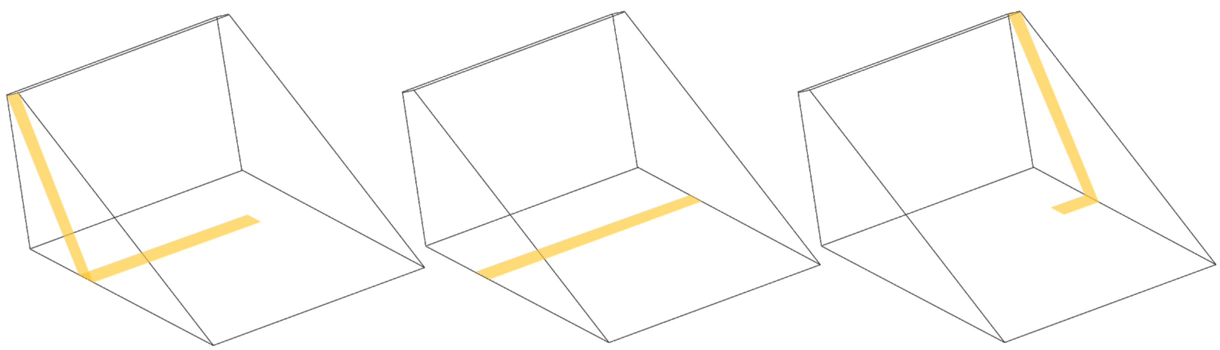

Figure 15: Shows the sunlight as it moves throughout the space in the hours surrounding midday. Figure created by Emma Strebel.

Over the course of six months, the midday sunlight moves from the southernmost point to the northernmost point of the floor. Every year, the sunlight moves throughout the space and back again (see Figure 16). The farther one gets from the Equator, the longer the angle is, thus the thicker the line of sunlight becomes (see Figure 17).

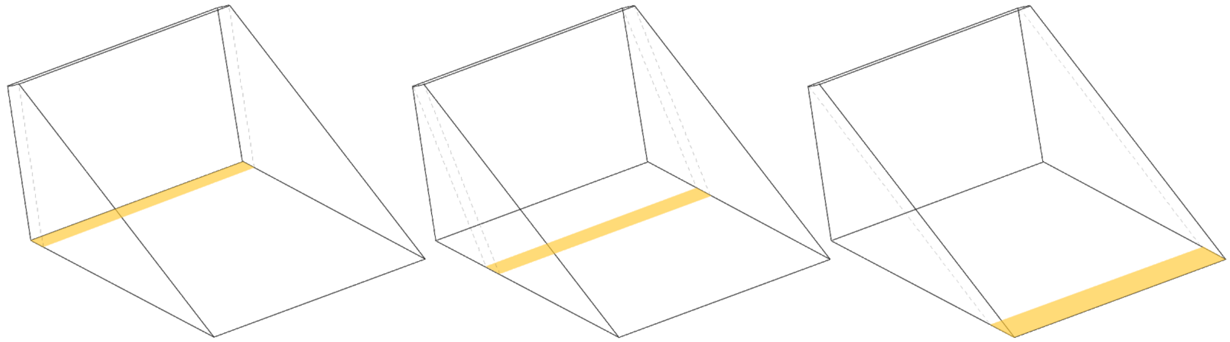

Figure 16: Figure shows the sunlight as it moves through the space at midday over the course of 6 months from June Solstice to December Solstice. Figure created by Emma Strebel.

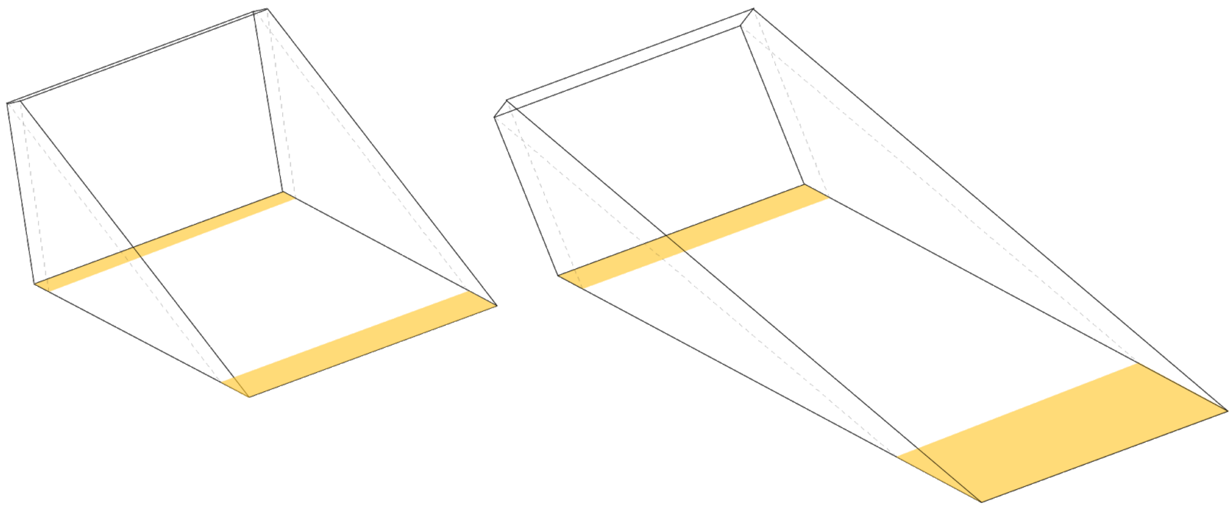

Figure 17: Figure shows that the further the design is from the equator, the thicker the stripe of light is on the floor. Pictured is sunlight at midday on December and June Solstices. Figure created by Emma Strebel.

I speak of midday separately from noon because true midday is when the sun is at its highest elevation and is located at 180 degrees South in the Northern Hemisphere and 0 degrees North in the Southern Hemisphere. The moment of midday changes with the seasons and location. 12:00 noon is a moment picked to become uniform in each time zone and does not change depending on the rotation of the earth. The design engages with cosmic midday thereby detaching it from clock time.

This design integrates the geometry of sunlight, particularly the parallel rays unique to sunlight. Due to this aspect of the design, it is scalable as long as the ratios and angles are consistent. Thus, the piece can range from a small structure in a garden to the size of a room viewers enter into. As long as the piece has access to sunlight for the majority of the day (particularly at midday), the design is successful.

When there is an overcast day, the design captures skylight and ambient light that reflects off the walls, offering a dim illumination of the entire space. However, even then, the particular angles of the structure are a visual reminder of the movement of sunlight at a particular location on Earth. Regardless of the amount of sunlight on any given day, the shape of the design compares the daily and yearly movement of sunlight, grounding viewers in their place on Earth.

Why Midday

During the morning and evening, the sun is low, near the horizon. Generally, during these hours, shadows change drastically as the sun's altitude changes quickly. Additionally, during this time, the hue and intensity of the light changes at a fast pace. However, in the hours leading up to and away from midday, the sunlight is generally quite similar. The sun's altitude and intensity stays relatively similar around midday, however, its position moves from being located in the East to the West. At midday is this turning point. But in every-day life, this moment of transition is never noticed.

However, the movement of sunlight through the design is the opposite. During the hours following sunrise and leading up to sunset, the sunlight entering into the design does not change much. Leading up to midday, the sunlight moves faster throughout the space. At midday is when the sunlight changes most dramatically and its changes become most noticeable. The design is built to frame the movement of the sunlight and accentuate midday. By marking midday, the structure contextualizes the movement of light throughout the space.

The Experience

The design creates a meditative space to experience the midday transition. It accentuates slow movements in sunlight. Just as people enjoy watching the transition that takes place at sunrise and sunset, this design creates a space to observe midday: the moment when a particular place on Earth transitions from rotating toward the sun to rotating away from the sun. It disconnects viewers from time as an objective truth, and rather connects people to the inherent changes that are always occurring. The design highlights a moment at one particular place on Earth. It alludes to the multitude of other changes that occur at every moment. The design separates itself from clock time by building a connection to one's place on Earth.

Prototype

In order to further my understanding of the design, I decide to create a mockup. I make it out of diffuse plexiglass at a size of 30cm wide and 30cm tall. Examining different diffuse plexi materials, I test P95 clear, which has a surface diffusion. I realize that the ability to see sunlight hitting the plexiglass depends on the viewing angle (see Figure 18). The more light that is transmitted, the less one is able to see the light on the surface of the plexiglass. I therefore arrive at Lighting White 60% which has some white pigment in the acrylic, rendering it not transparent but is still very translucent (see Figure 18). This is the best plexiglass for the project because the plexi captures the light in the material, creating a sharp form of sunlight from any viewing angle. It also has a higher contrast between areas that are in sunlight and in shadow. The diffused material catches the direct sunlight, creating a sharp line of light, while maintaining translucency to be seen from the outside. The sunlight, ambient light and skylight enter into the space and bounce off the walls creating a soft glow of diffused light.The plexi exemplifies the sharp form of sunlight allowing for its changeability to be more noticeable (as described in the "Changeability of Sunlight" analysis).

Lighting White 60%: P95 Clear:

Left View:

Straight on View:

Right View:

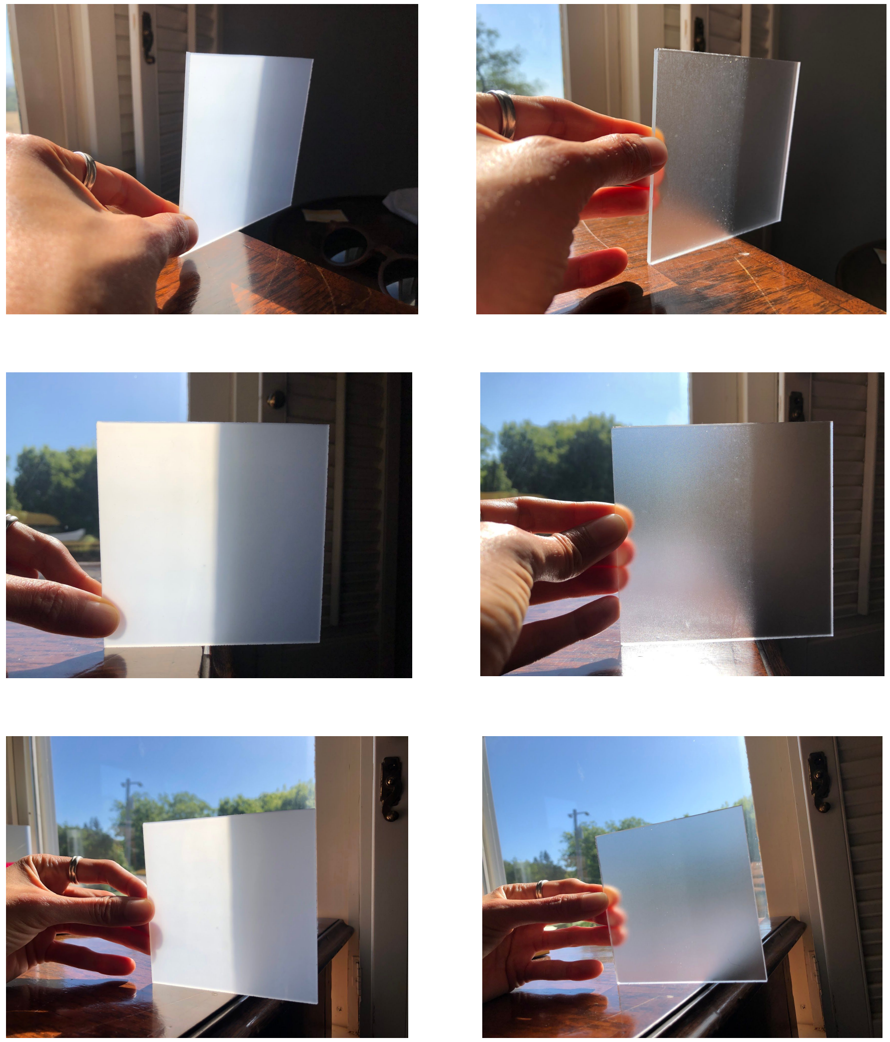

Figure 18: Figure demonstrates difference in translucency between P95 Clear and Lighting White 60% as sunlight hits the plexiglass. Photos taken by Emma Strebel.

Using Lighting White 60% Plexiglass, I create the prototype to observe the way the sunlight interacts with the structure. Living in San Francisco, I create the structure to be measured for San Francisco's latitude with a 76 degree June Solstice and a 29 degree December Solstice (see Figure 19 and 20).

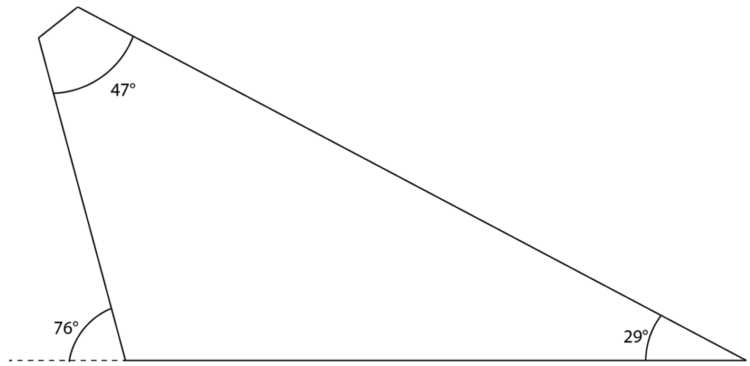

Figure 19: Angles of the design in San Francisco. Figure created by Emma Strebel.

Figure 20: Photos demonstrate the design prototype using Lighting White 60% plexiglass. The images show light enering into the structure. Note: In these photos the position of the structure is not pointing South nor is the bottom of the structure parallel to the ground. Images taken by Emma Strebel.

I set up the prototype to hang from two C-stands such that the opening faces 180 degrees South and the bottom is level to the ground (see Appendix 7). Once the prototype is set up, I document the movement of the sunlight through the structure (see Figure 21). The photos are taken on May 27, 2020. The light shows that summer solstice is soon arriving.

Before midday: 

At midday: 

View from under: 

Figure 21: Top two photos show prototype before and during midday on May 27, 2020. The bottom image demonstrates a view from under the structure. Photos taken by Emma Strebel.

The prototype is a successful proof of concept that the sunlight moves through the structure as expected. However, I still learn a lot from creating a model. It is important to have the model above eye level in order to see the bottom at midday. Additionally, the model should have a stable stand that does not interfere with the light. Furthermore, the plexiglass creates a slight reflection as the sunlight enters into the structure (see Figure 22). It is a happy accident for the model, but should be considered in greater detail in a final product.

Figure 22: Image demonstrates a slight reflection that occurs inside the structure. Image taken by Emma Strebel.

PERSPECTIVATION

This design concept can be implemented anywhere where there is a potential for sunlight year-round (thus would need to be changed in the arctic circle). The proposed design is a basic design that can be altered in many ways. What follows are ways I would like to bring the design in future work.

One iteration of the design is a fixture inside a black cube. With a skylight as the opening, the stripe of light is accentuated. The sunlight bounces off the diffuse glass and despurses throughout the structure. As the light bounces off the white glass, the light is diffused and illuminates the rest of the space. Placing it into a dark space allows viewers to see the stripe of light and the rest of the structure more clearly (see Figure 23).

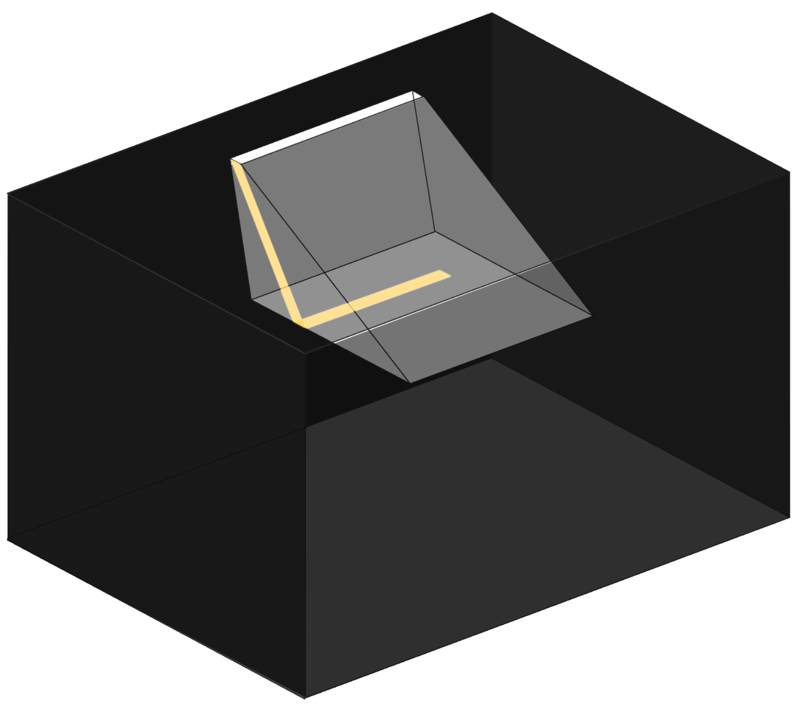

Figure 23: This figure demonstrates the design if it were placed into a black box. People could enter into the black box and see the glass structure as it is illuminated by the sun. This iteration is an object in a dark space that therefore accentuates the light in the design. Figure created by Emma Strebel.

Another iteration would scale this structure up so it is the size of a room that people can enter into. The space is filled with fog such that the thin rays of light entering in through the opening become visible as they travel from the opening to the walls and floor (see Figure 24). The sunlight will create a similar effect to Anthony McCall's *Solid Light* works, where projected stripes of light move through a space, creating the feeling that walls are moving. The light entering through the opening becomes a wall that moves with the rotation of the earth. At midday, the light hits the floor and the room is precisely split in two sections. This iteration would accentuate the noon moment while exposing the three dimensional nature of light. It would also further highlight the significance of the angles of the north and south facing walls.

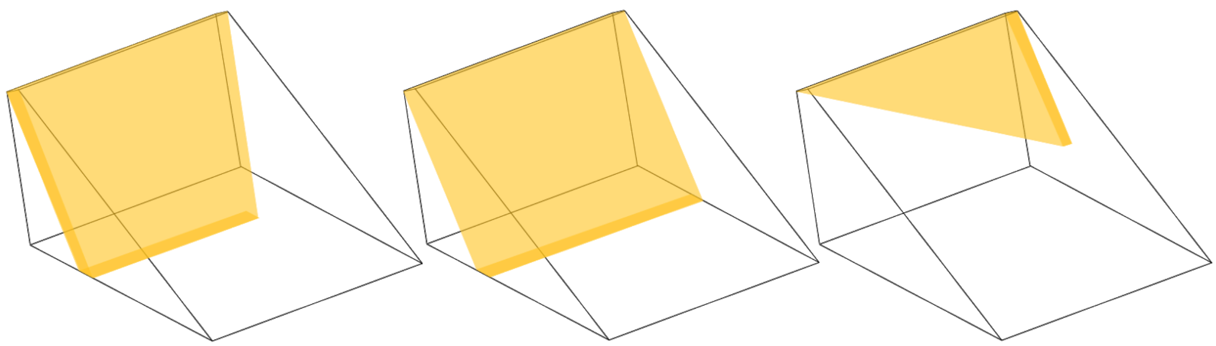

Figure 24: Figure demonstrates how light could enter into the space if fog filled the room. Figure created by Emma Strebel.

A third iteration could be changing the width of the design. Rather than the bottom of the structure creating a square at the equator, the opening could be a square, rendering the entire structure quite skinny. This would mean that the sunlight would move down the walls very slowly and move over the bottom of the floor relatively fast (see Figure 25). If the design was meant to keep viewers for a certain duration, this iteration of the design would be implemented where the width of the space correlates to a specific length of time (i.e. a screening or event).

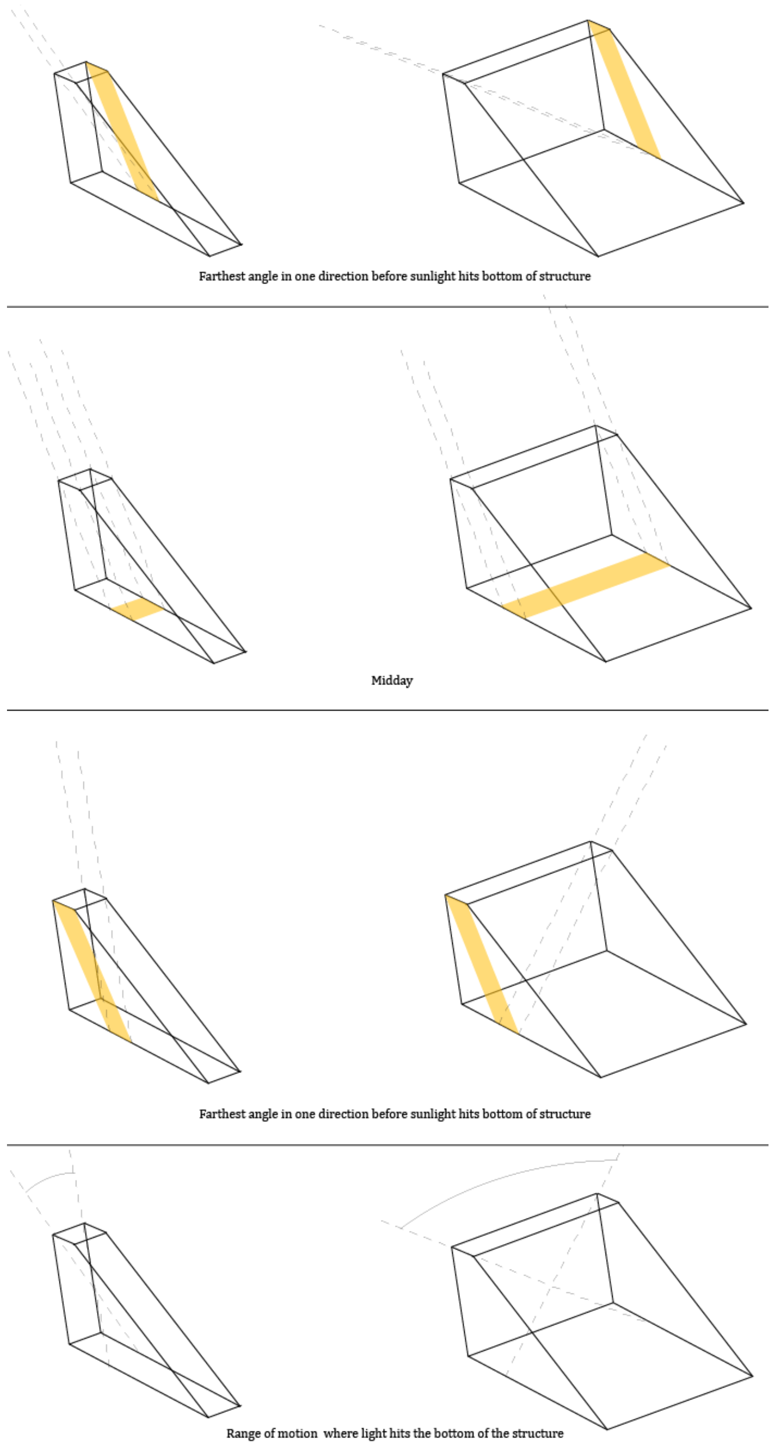

Figure 25: Figure demonstrates that the range of time when the sunlight hits the bottom of the structure is shorter if the opening is narrower. Using this knowledge, the piece can essentially curate time. If the structure is narrower, it takes less time for the sunlight to move from one wall to the other. Figure created by Emma Strebel.

As demonstrated, this basic design can be implemented in many different ways. Changing one aspect of the design alters the focus of the entire piece. I am interested in playing with different iterations of this basic design to explore the multitude of variations. Each iteration has a different purpose. The design can act as a light fixture, bringing daylight into a space, or a conceptual art space similar to James Turrell's *Skyspaces*. Each iteration incorporates the conceptual grounding of the proposed design: rooted in the light at a particular location on Earth and the experience of changes in sunlight that would otherwise go unnoticed.

These principles can be integrated into architecture and lighting design beyond this particular project. By creating design that is based on sunlight's relationship to a particular location on Earth, viewers connect to their surroundings at large. With a deeper connection to earthly changes, humans become more intune with diurnal rhythms, and their body's connection to daylight and sunlight. In doing so, architecture and lighting design is able to enhance the human connection to light and "set the internal world to the external world" and visa versa (Bragg, 2015).

CONCLUSION

I evaluate the success of the design concept in order to effectively combine the geometry of sunlight and connect people to their surroundings. I look back on the Research Question: **How can a design concept accentuate a fleeting moment of sunlight, thereby connecting people to their place on Earth?** The success criteria are examined in order to answer this question and evaluate the design.

The design works with the geometry of sunlight throughout a space to accentuate the viewer's place on Earth.

At any moment that someone encounters the design, it offers a visual comparison. The variations in the shape of the structure visualize the acute differences in sunlight based on location on Earth. Far from the equador, the angle of the sunlight is shallower and thus, the angles of the North and South walls are shallower. Since the structure is built in relation to its location on Earth, each aspect of the design is dependent on its location. Regardless of whether the sun is shining or not, the differences in the design's structural form visualizes the differences in sunlight at different places on Earth.

The design marks a moment of sunlight to accentuate a change that would otherwise go unnoticed.

This design specifically accentuates the experience of solar midday. While sunrise and sunset are inherently climactic changes in the experience of light throughout the day, midday often goes unnoticed. It accentuates the moment when a particular location on Earth transitions from rotating toward the sun to rotating away from the sun. As the earth constantly rotates, no two consecutive moments of sunlight are the same. This design calls attention to the midday change, because midday is the only moment at which the light hits the floor of the structure without hitting either east or west wall. Without this significant design element, midday would go unnoticed. Furthermore, the design highlights both solstices (when the beam of light reaches the southern and northern walls), which are also moments that would otherwise go unnoticed.

The design uses sunlight to accentuate daily and seasonal changes in order to connect viewers to their experience on Earth.

The space frames the sunlight in order to accentuate the daily and seasonal changes within one location. The design frames the gradual rotation towards and away from the sun over the course of a day and year.

During one day, sunlight is constantly entering into the space. For the first half of the day, the sunlight inches down the wall and across the structure. While the sunlight is constantly changing throughout the entire day, the moment of anticipation is for midday. The climactic moment builds up anticipation and offers a visual comparison for prior and following moments.

Over the course of a year, this design frames the light in a way which highlights Earth's more gradual rotation towards and away from the sun. As sunlight hits the bottom of the structure, it offers a visual representation of where the earth is on its journey around the sun. Over the course of 6 months, the position of the sunlight starts at the South wall, moves toward the North wall, and then reverses and moves back to the South wall. This element of the design accentuates the seasonal changes in light.

Every time one encounters the design, the light is different, creating a different experience. The design marks one moment of change at midday, the slower rotation of an entire day and the even more gradual fluctuations of the year. With these comparisons, viewers depart from their familiarity of clock time by connecting to visual changes and routines in sunlight. These connections help develop an understanding of the earth's constant fluctuations. Change has enabled our evolution, intertwined us with light and will continue to define our experience of life on Earth. This exploration of earthly changes is the inspiration behind this design which acquaints viewers with the inner workings of sunlight, in turn connecting them to their place on Earth and in the Cosmos.

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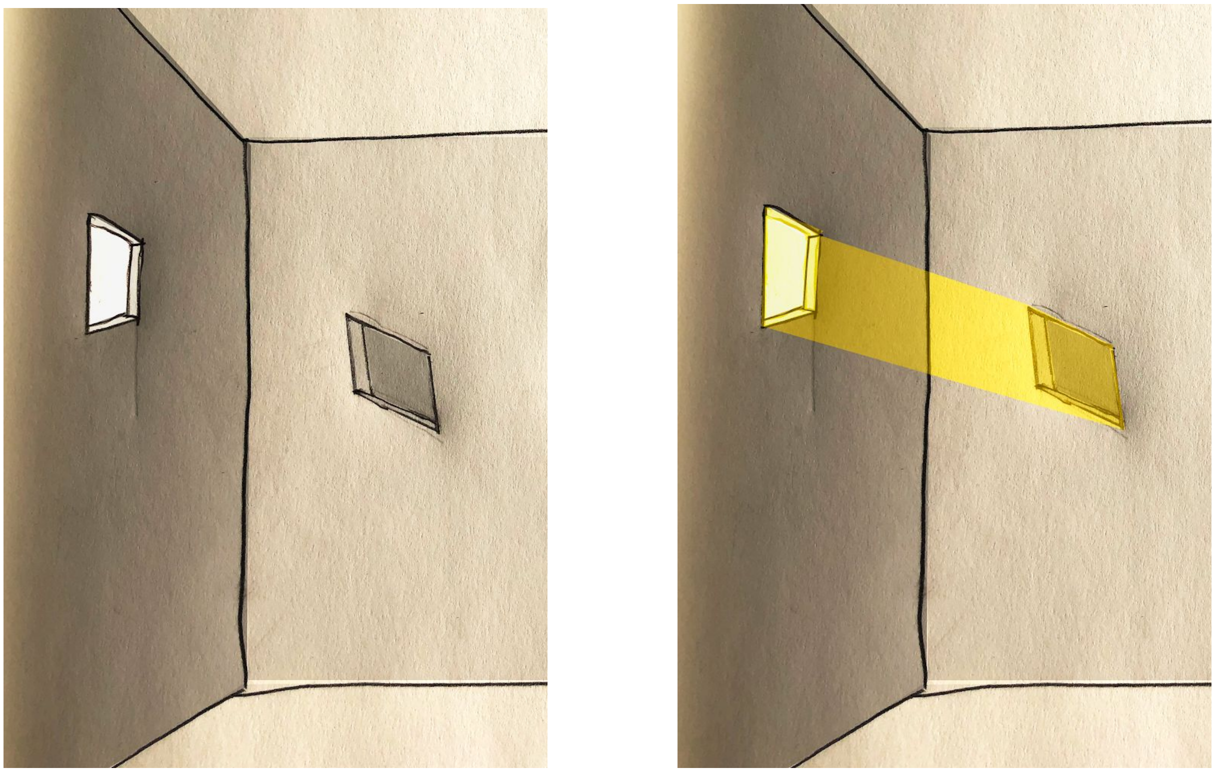
Figures and Tables:

All figures and tables created by Emma Strebel.

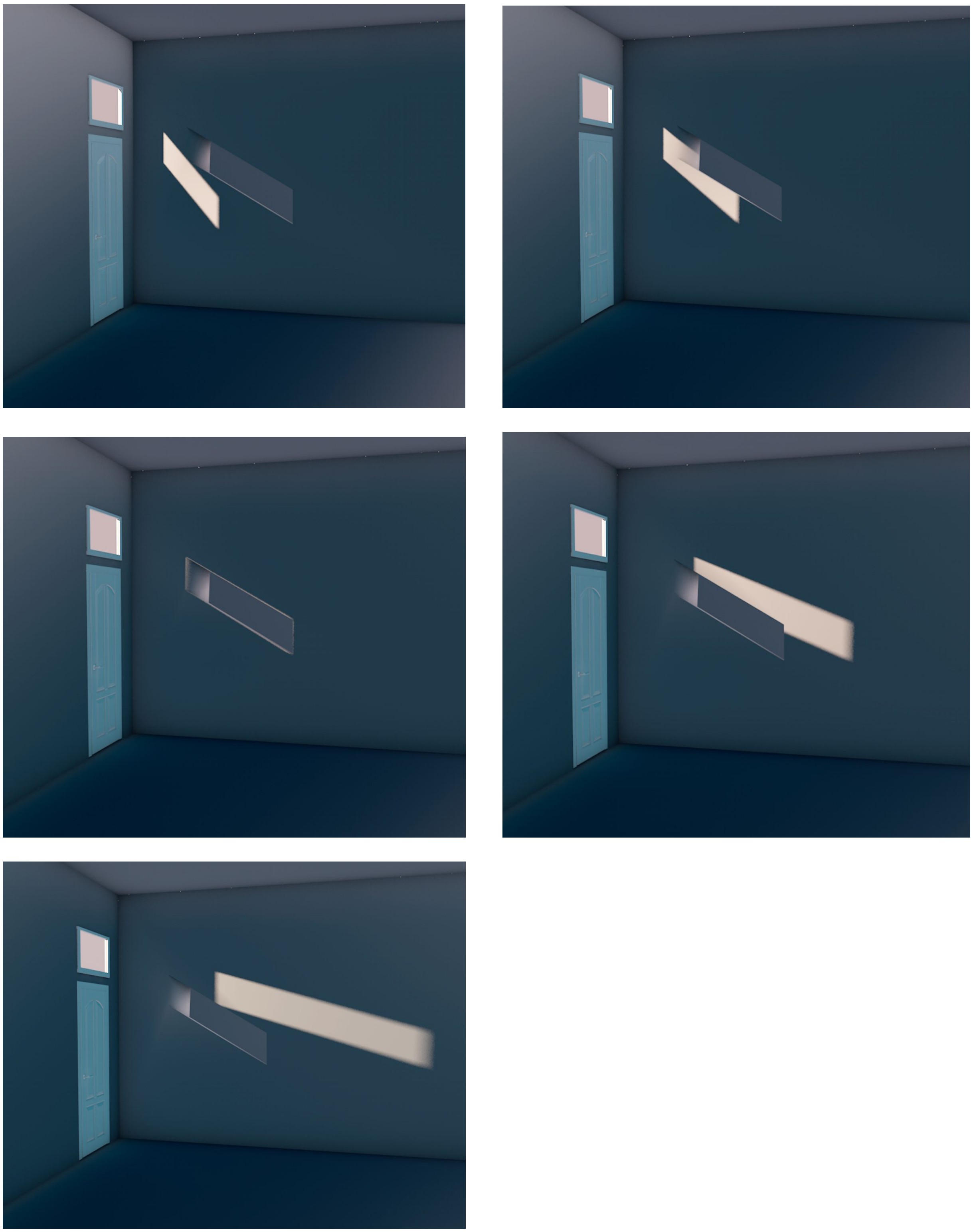
APPENDIX

1.



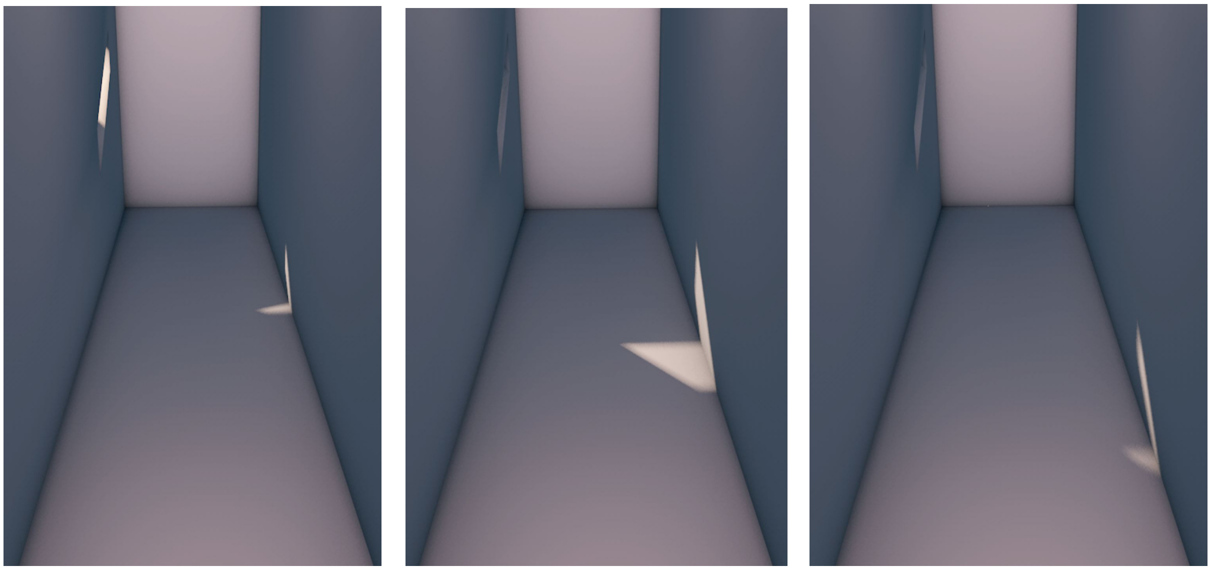
This figure demonstrates an opening cut through the wall (image on left). Light enters through the window and shines through the opening in the wall (image on right). At one moment the light precisely aligns with the opening.

2.



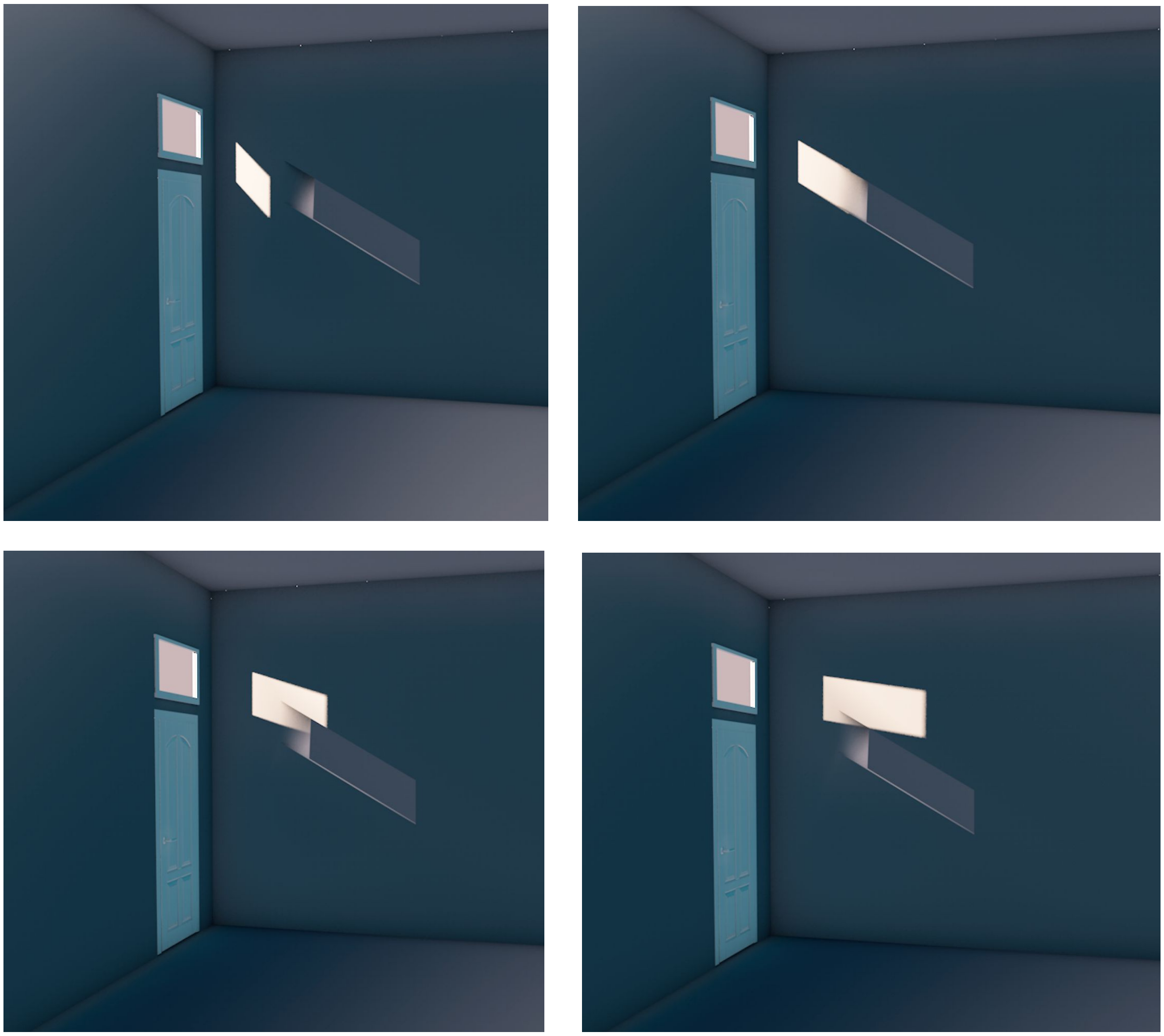
Figures show the movement of the sunlight through the space during Equinox. The sunlight overlaps with the opening for 80 minutes. Renderings created in Cinema 4D by Emma Strebel.

3.



Figures show sunlight moving through the window and opening on the equinox. The sunlight aligns with the opening for 80 minutes as it moves through the hallway. Renderings created in Cinema 4D by Emma Strebel.

4.



Figures show the movement of the sunlight through the space on Winter Solstice. Renderings created in Cinema 4D by Emma Strebel.

5.

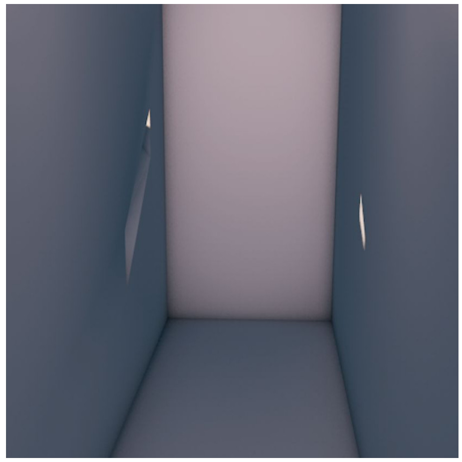
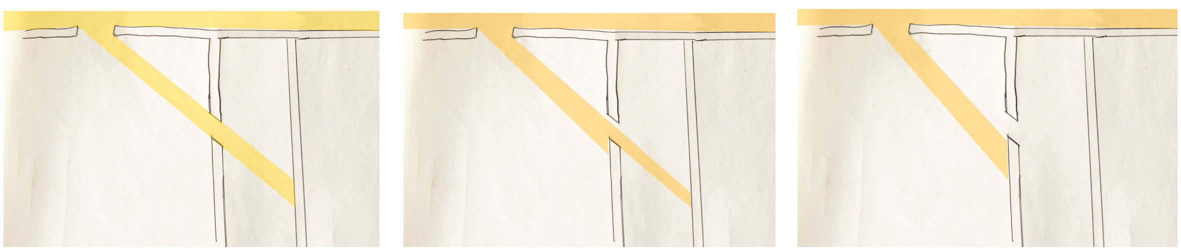


Figure shows a sliver of sunlight coming through the opening on Winter Solstice. Renderings created in Cinema 4D by Emma Strebel.

6.



Top view of sun entering into the window and through the opening in the wall to enter into the hallway. Image demonstrates that the opening is cut at the angle of the rays of light. The second and third images show the movement of the light over time, aligning and misaligning with the opening. Figures created by Emma Strebel.

7.

Images show the orientation and leveling of the prototype. Photots taken by Emma Strebel.