Spaces of the Device:
Camera Obscura

By

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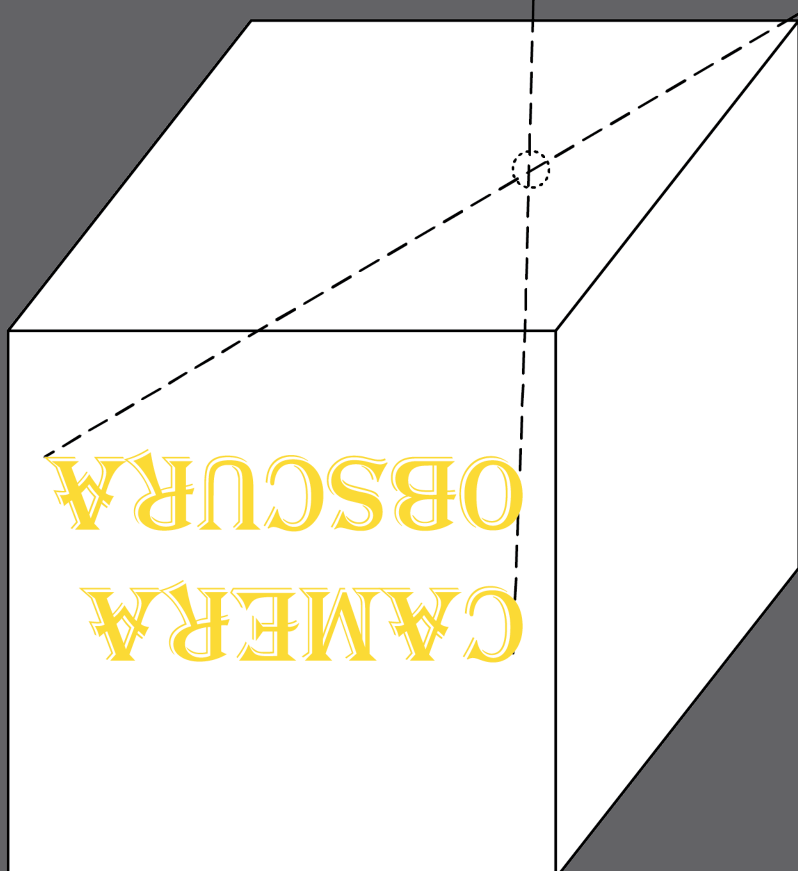
Spaces of the Device:

CAMERA OBSCURA



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ABSTRACT

The use of light in architecture presents two critical factors that can be applied for experiencing space when designing. The most intimately known is when the designer or artist uses light to invoke emotion through shadow and colour in the built environment, such as where light conducts a critical role in the design and the perception of space. Cameras, like eyes, receive light and translate them into an understandable medium, such as onto film. The Camera Obscura, a device changed through the centuries for scientific and artistic purposes, provides a useful lens for understanding the uses of light. Studying the origin and evolution of the camera and its impact on art and architecture presents a reimagined architectural form for daylighting design. To showcase this connection, the proposed buildings for this thesis will be an artist residency and an exhibit on optics. These two programs will be connected through their commonalities regarding daylighting. The light and optics exhibit will repurpose a building into a space fit for learning the functionalities of light and optics. The artist residency will have living quarters for up to two artists and a dynamic studio workshop that will be adaptable to suit the needs of the art. The studio space will then act as a showcase for the artists' works. The proposed buildings, named The Camera, and The Periscope Tower, will attempt to be dynamic structures that can adapt the lighting to the users' needs.

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Introduction

The use of light in architecture presents two critical factors that can be applied for experiencing space when designing. The most intimately known is when the designer or artist uses light to invoke emotion through shadow and colour in the built environment, such as where light conducts a critical role in the design and the perception of space. The perception of this light, by our eyes and brain, affect the perception we have of certain spaces. Cameras, like eyes, receive light and translate them into an understandable medium, such as onto film. The Camera Obscura, a device changed through the centuries for scientific and artistic purposes, provides a useful lens for understanding the uses of light. Through the Camera Obscura and its use of light, optics begins to shape our understanding of perspective and the properties of light and shadow. Studying the origin and evolution of the camera and its impact on art and architecture presents a reimagined architectural form for daylighting design. This is both the theoretical framework and methodology behind this proposal, which thoroughly aims to celebrate a connection between the arts and sciences. To showcase this connection, the proposed buildings for this thesis will be an artist residency with space dedicated to a learning exhibit on light and optics as a secondary program. These two programs will be connected through their commonalities regarding daylighting. The light and optics exhibit will repurpose a building into a space fit for learning the functionalities of light and optics, alongside a darkroom to learn how photochemistry and film work. The artist residency will have living quarters for one to two artists, and a dynamic studio workshop that will be adaptable to suit the needs of the art. The studio space will then act as a showcase for the artists' works. The proposed buildings, named *The Camera*, and *The Periscope Tower*, will attempt to be dynamic structures that can adapt the lighting to the users' needs. These ideas are to be explored through different aspects of the project, and due to the site's location, there will be an abundance of usable daylight. The project will be located on the same site as Science North's Dynamic Earth and Big Nickel, on a high rocky elevation in Sudbury, Ontario. Dynamic Earth is a science center and museum focusing on geology, the city's mining heritage and evolution, with an underground tour demonstrating different mining experiences. The artist's residence and exhibition space, *The Camera*, will be located just south of the main Dynamic Earth building, placed on stilts so they can sit delicately on the rocks. The exhibition on optics will reuse an existing tower on-site that connects with the underground tunnel. *The Periscope Tower* will be separated into different sections for learning about light and how it interacts with various optical elements. The building will also act as a periscope, projecting the surrounding city into the mines located beneath the site. The discoveries made for this project stemmed from a deep dive into the history of light and optics, phenomenology, and its use in art to create the architectural ideas presented in this thesis.

While reading this thesis, light and optics should be mainly understood as how optics could be used to manipulate and translate light. It is then understandable that optics can also be a method of perceiving the behaviour and property of how light interacts with matter.[1] We can also understand how light creates depth, as described in the book *Light and Space: On the Phenomenology of Light* by Gernot Böhme. He defines light as something that sheds brightness, which brings out a characteristic change in our surroundings, allowing us to perceive the distance between ourselves and the surrounding space through shadow, presenting freedom of movement.[2]

Within the discipline of photography, drawing, painting, and architecture, there has been a sustained examination of the representation of perspectival space and its relationship to light. Before photography, light in architecture was often best understood as a lived experience. Although drawings and paintings conveyed important intentions of an architect's work, these interpretations were not entirely faithful to the human experience. Throughout history, artists and architects studied light and the behaviour of optics to understand the perspective and the geometry of space. The information learned about perception, and the geometry of light emerged from the scientific findings published in the Book of Optics by the Arabic scientist Ibn Al-Haytham.[3] He derived his findings from Greek scientists and made changes that redefined the understanding of optics, even introducing the Camera Obscura and explaining how the pinhole effect works.[4] The Camera Obscura, which literally can be translated to "dark room," was an "invention" that allowed any dark room with a singular pinhole to produce an image of the exterior on the opposite side. However, it would be inverted and upside down due to the basic principles of light. After the 10th century and further advances in optical knowledge, people of various professions used small Camera Obscura boxes as drawing aids or even tools for solar observations of sunspots.[5] However, not much was written about using the Camera Obscura until the 16th century as an aid for artists. It was used to sketch perfect perspective through the use of the Camera Obscura as an aid in painting.[6] While the use of the Camera Obscura was not entirely common, and the knowledge about the Camera Obscura in painting was limited, it is suspected that several Dutch painters used it extensively during the Baroque period. The Camera Obscura eventually evolved into box cameras with the invention of photosensitive materials. As a result, the Camera Obscura gained increased purpose and became an essential tool for quick documentation.[7]

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1 Alhazen and A. I. Sabra, *The Optics of Ibn Al-Haytham. Books I-III: On Direct Vision*, Studies of the Warburg Institute, v. 40 (London: Warburg Institute, University of London, 1989), liii–lxiii.

2 Gernot Böhme, "Light and Space. On the Phenomenology of Light," *Dialogue and Universalism* 24 (January 2014): 9, https://doi.org/10.5840/du201424491.

3 Sven Dupré, "Inside the 'Camera Obscura': Kepler's Experiment and Theory of Optical Imagery," *Early Science and Medicine* 13, no. 3 (2008): 219–44.

4 Hans. Belting and Deborah Lucas. Schneider, *Florence and Baghdad : Renaissance Art and Arab Science*, 1st English language ed., Renaissance Art and Arab Science (Cambridge, Mass: Belknap Press of Harvard University Press, 2011).

5 Josef Maria Eder, *History of Photography* (New York: Dover Publications, 1978).

6 Dupré, "Inside the 'Camera Obscura': Kepler's Experiment and Theory of Optical Imagery."

7 Teller et al., Tim's Vermeer. (Toronto, Ontario: Mongrel Media, 2014).

At the beginning of the 19th century, experimentation with photosensitive materials, i.e., film, presented another use for the Camera Obscura. Throughout the next few centuries, the Camera Obscura evolved and adapted with the evolution of film. Both tools were incredible technical feats which consistently reduced the effort needed to capture moments and our environments. With the evolution of film, we were able to create images that were truer to tone, both in colour and black & white (B&W). For example, B&W film evolved from the orthochromatic spectrum to panchromatic, capturing deeper detail in shadow and taking quality photos in inadequate lighting.[8] With the basic invention of film, it became more than possible to capture a moment fixed in time, then share that information rapidly. The internal structures of cameras used to capture these moments are incredible at moving light through various methods of light exchange. The first cameras used were wooden boxes, much like the drawing aids used prior to photography. The first few cameras were two wooden boxes that slid back and forth for focusing with a sealed back to place the film, which was glass or metal plates for a few decades.[9] As the camera evolved, it became progressively more compact as the technology for the film was able to stay stable at a reduced scale. This thesis examines several elements in the evolution of the camera throughout the project, so as to determine the potential of useful elements which would helpful when designing a space for artists. Ones that could be transformable or malleable, allowing for possible large-scale light-based projects.

The research presented on light and optics covers different examples of optics in art and architecture, from the Baroque painters using Camera Obscuras to capture the moment to the structural works created by the likes of Olafur Eliason. By studying the Camera Obscura, one can see how geometric optics evolved from a study of perspective to capturing intimate detail of space and light, and how a small dark room can translate the information that light provides into visible information (an image). Can the act of passing light through optical arrays inform or even make architectural spaces? The works of Eliason and James Turrell are considered art installations that use light and colour that sometimes present a grand architectural feeling. These artists are able to create a sense of space through their work and have always sought ways to bring their thoughts and experiments to life in the form of structure and the manipulation of light. Eliason passionately believes that the studio is a place of magic and should be capable of doing things that would be hard to accomplish.[10] How can this learnt experience of light and optics, that create these structural elements, guide the design of a new space that can hone the ability to create with these mediums? Can the investigation of light, geometric optics, and photography guide the design of a malleable space and allow for continued exploration/experimentation, such as a studio and exhibition space?

8 Eder.

9 Ibid.

10 Jason Zeldes, "Olafur Eliasson: The Design of Art," *Abstract: The Art of Design* (Netflix, September 25, 2019), https://www.netflix.com/watch/80237093?trackId=13752289.

At the start of the research, cardboard Camera Obscuras were constructed to understand their properties more than what could be read in texts. In one iteration without a screen, the image was splayed across the box's walls, blurring and abstracting the information. This sparked the idea of sketching out spaces in an abstract way to see if plans or massing could be formulated. Then, a large 7ft Camera Obscura was constructed in order to begin manipulating and abstracting on a larger scale. The use of this portable Obscura was meant to provide a new perspective when it comes to designing a space. However, being inside this intimate structure provided a more respectful understanding of the camera as a habitable and functional space. So, a step was taken to go back and examine the camera and its elements. The newfound understanding and connection with the Camera Obscura became the new starting point for the design discoveries found in this thesis. This new understanding also anchors the ideas behind experimenting with light to create either full rooms or alter minor aspects of the building, allowing for space and lighting control adaptability.

1

Vision and the Historical Influence

The earliest comprehensive writing about optics comes from the Mohist School of Thought in China around the 5th century B.C.E. The writings contain basic knowledge of general optics and mirrors, as well as descriptions of how the Camera Obscura effect worked.[11] Unfortunately, no connection was made to the Mohist School until it was first translated in 1922.[12] Around the same time the Mohist school developed their knowledge of optics through empirical findings, Greek philosophers had completed similar yet largely anecdotal work. Much knowledge developed by the Greeks was based on myths, including the theory of vision and optics. Due to the influence of Western culture at this time, these theories were not debated for centuries. The ancient Greek writings found use in Arabic cities by scientific scholars, who significantly improved the research and expanded contemporary knowledge of light and optics. However, the Arabic findings did not see the light until two centuries after its publication. To keep things simple, we will look at how the knowledge of light and optics passed through the arts and sciences within a few countries in the early history of the study.

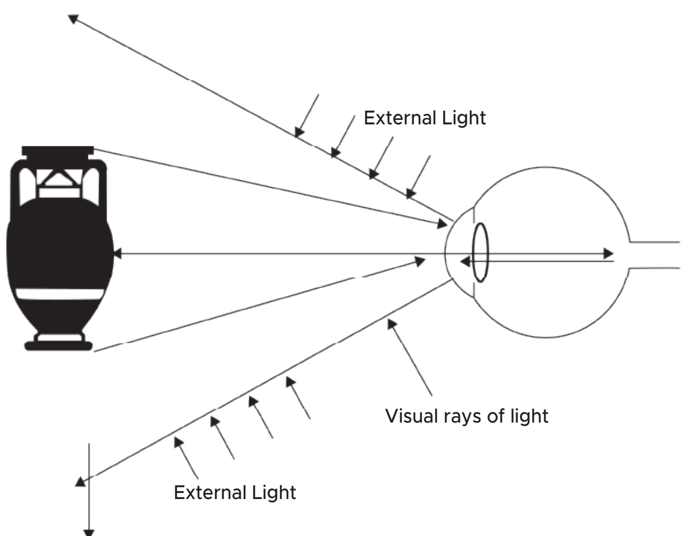


Figure 01 - Illustration of emmission vision theory, how vision and light worked according to Greek philoshpers.

11 Di Mo and Ian Johnston, *The Mozi a Complete Translation*, Translations from the Asian Classics (New York: Columbia University Press, 2010).

12 Michael. Loewe, *Early Chinese Texts : A Bibliographical Guide* ([Berkeley, Calif.]: Society for the Study of Early China : Institute of East Asian Studies, University of California, Berkeley, 1993), 390.

1.1 The study of light and optics historically

The philosophers of ancient Greece believed the gods created our eyes out of the four elements, with fire being used to ignite a light in our eyes, producing our sense of vision. This was theorized around 300 B.C.E by Euclid and other Greek philosophers. In his Book of Optics, Euclid wrote about the emission vision theory, which stated that humans emit rays of vision from their eyes that allow them to see.[13] [FIG 01] Around the 9th century, Euclid's book was translated to Arabic inspiring new theories of optics.[14] At the beginning of the 11th century, Ibn Al-Haytham published *The Book of Optics*, his groundbreaking understanding of optics and geometric optics. He created the first Camera Obscura and experimented with the pinhole effect.[FIG 02] In chapter 1, section six of the book, the effect was described as such:

> "Let several lamps be positioned at various points in the same area, all being opposite a single aperture leading to a dark place; opposite the aperture let there be a wall in that dark place or let an opaque body be held facing the aperture: the lights of those lamps will appear separately on that wall or body and in the same number as the lamps, each light being opposite one of the lamps on the straight line passing through the aperture."[15]

The knowledge generally presented in his book was an incredible discovery that changed mathematics and science forever. Unfortunately, it took quite some time for these studies to be translated and even longer to be expanded impactfully by other Scholars. Finally, Al-Haytham's writings received a Latin translation around the beginning of the 13th century enabling this knowledge on optics to be further shared and discovered. It significantly influenced Leon Battista Alberti's guide to drawing perspective and achieving proper dimension ratios.

13 Randy Wayne, "Light and Vision: There Is More than Meets the Eye an Historical Introduction to the Elements of Vision," n.d.

14 Elaheh Kheirandish, *The Arabic Version of Euclid's Optics: Edited and Translated with Historical Introduction and Commentary Volume I*, vol. 16, Sources in the History of Mathematics and Physical Sciences (New York, NY: Springer New York, 1998), https://doi.org/10.1007/978-1-4612-1452-6.

15 Alhazen and Sabra, *The Optics of Ibn Al-Haytham. Books I-III*, 90, para. 85.

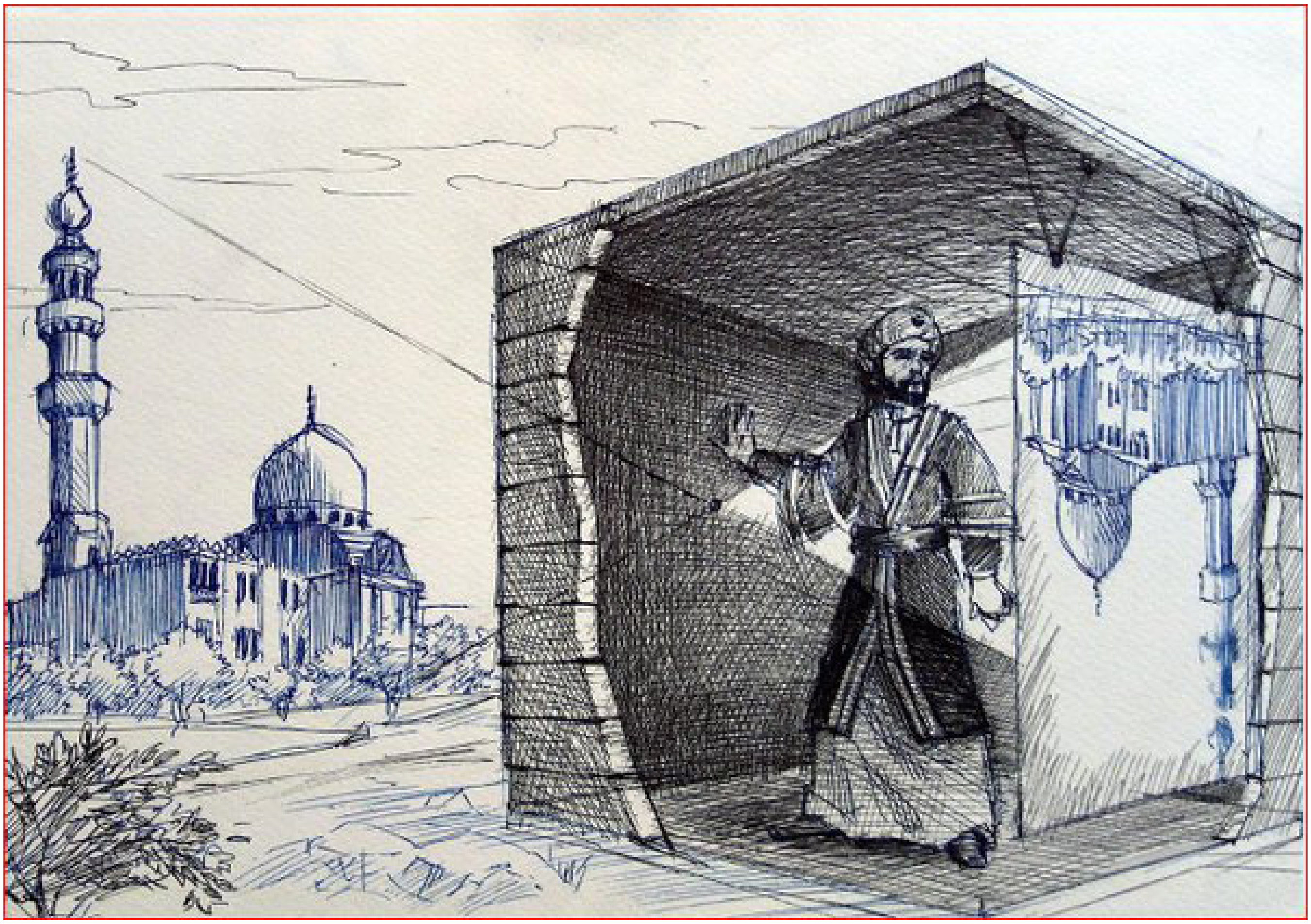


Figure 02 - An Illustration based off a description in Ibn Al-Haytham's *Book of Optics on* how he built and used a Camera Obscura.

1.2 Influence on Historical Art and Architecture

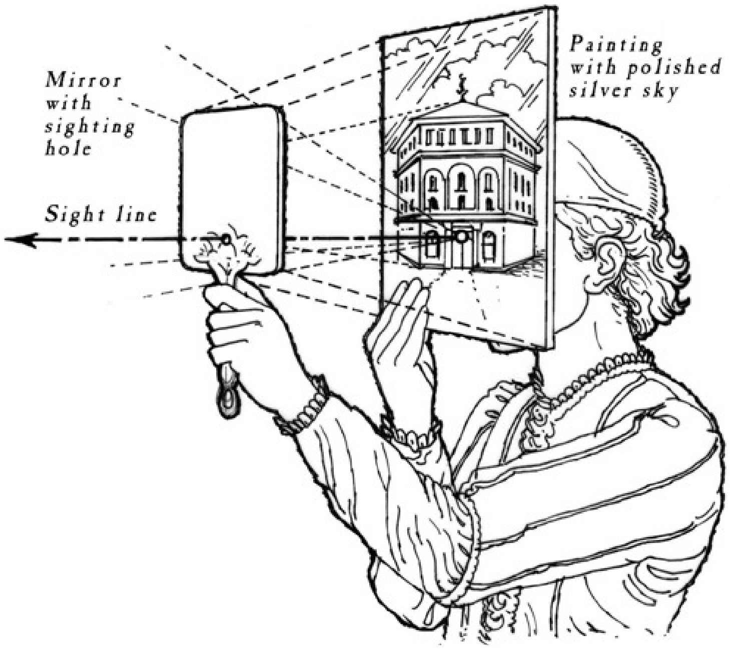


Figure 03 - An Illustration of Filippo Brunelleschi conducting his perspective expirements by matching his painting to the subject with a mirror.

During the 15th century the creative academic Leoni Alberti, was influenced by optics and science from his mentor, the academic Biagio Pelecani. Pelecani exposed Alberti to texts on perception, light and the power of the eye (vision) from different scholars. The most important of these was Al-Haytham's *Book on Optics*[16]. Alberti published the book *Della Pittura* (*On painting*) in 1435 CE, which was the first and most comprehensive guide on creating a drawing in perspective. It relied on its scientific content based on his understanding of optics which determined perspective as a geometric tool for artistic and architectural representation.

Alberti also dedicated his writing to artists alive at the time. One of which was Filippo Brunelleschi, who, from about 1415 CE to 1420 CE, created and explored his own methods of achieving perspective. Through a series of experiments, Brunelleschi arrived at a precise system for obtaining linear perspective. He systematically studied how and why objects, buildings, and landscapes changed, as well as how lines appeared to change when viewed from different distances or angles. He would make a grid on canvas and draw the façade of a building square by square to achieve proper perspective. To compare the accuracy of his image to the real thing, an observer would look through a small hole at the center of the drawing, and while looking through, a mirror would be lifted in front. The observer would witness a significant similarity between the painting and reality.[17][FIG 03] While these two works on perspective were essential to our understanding of light and perspective, the use of the Camera Obscura in painting expanded the depth of art.[18]

Evidence of the use of the Camera Obscura as a direct aid for painters before the

16 Leon Battista Alberti, Cecil. Grayson, and Martin. Kemp, *On Painting*, Penguin Classics (London: Penguin Books, 2004), 11.
17 "BRUNELLESCHI and the Re-Discovery of Linear Perspective," *MaItaly* (blog), April 28, 2011, https://maitaly.wordpress.com/2011/04/28/brunelleschi-and-the-re-discovery-of-linear-perspective/.
18 "Vermeer and the Camera Obscura, Part One," accessed March 24, 2022, http://www.essentialvermeer.com/camera_obscura/co_one.html.

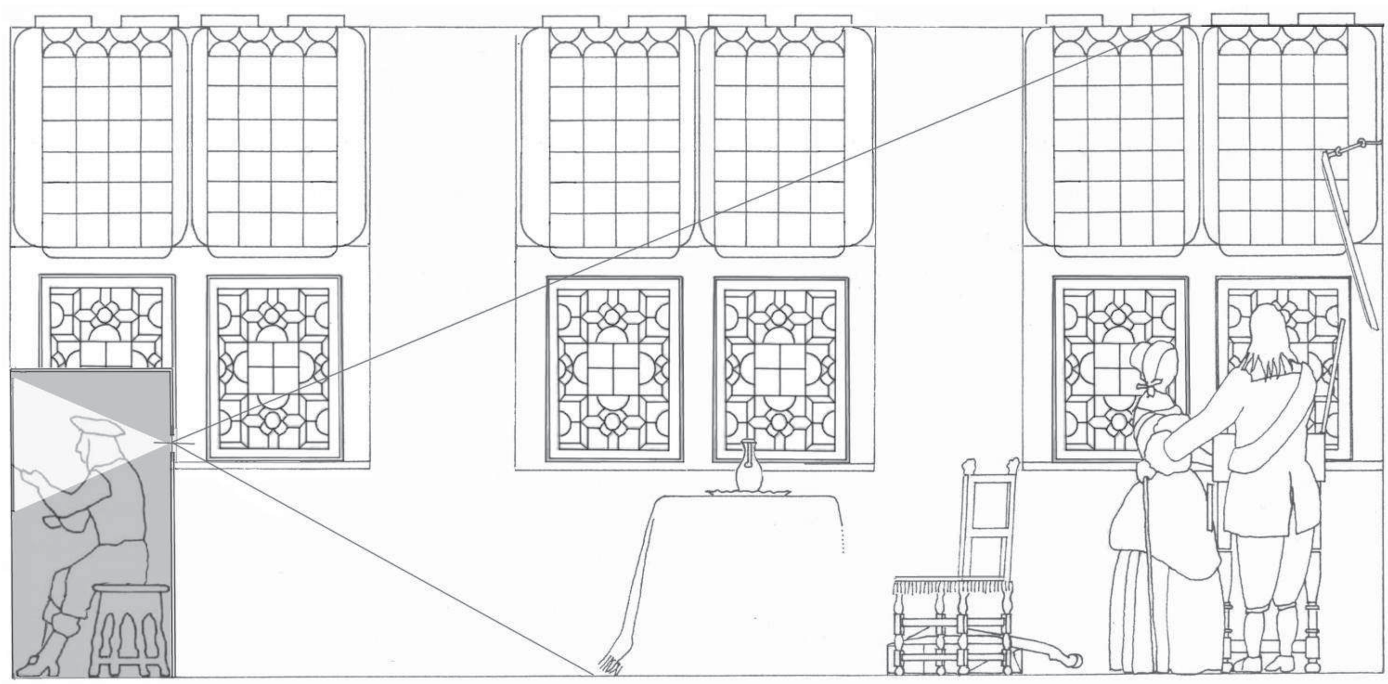
16th century was rare.[19] It is uncertain what artists and works were used by the Camera Obscura; there is plenty of belief that the Flemish master painters practiced and used the Obscura. However, it is a debated topic amongst art historians whether Obscuras were used and how they were used to benefit the final painting.[20] The debate stems from the almost perfect perspective, as seen in detailed reflection, and camera-like qualities seen in many of these paintings.[FIG 04] Today, one of the most prolific and studied painters is Johannes Vermeer from the 17th century. His paintings have convinced many historians of the possibility that Vermeer built a human-scaled Camera Obscura within his studio to achieve such lively works. In 2001 Philip Steadman published Vermeer's camera, where he dove deep into the works and history of Vermeer. To understand how Vermeer could have possibly used a Camera Obscura, Steadman digitally recreated Vermeer's studio and experimented with different methods of how the painter could have achieved proper positioning on the exact sized canvas.[21][FIG 05] Notably, in 2013, a documentary was released about Tim Jenison, who built a replica of Vermeer's studio, a tool for how he possibly thought Vermeer succeeded and created his own Vermeer painting. These reproductions showed the scalability of the camera and how Tim played with an array of optical tools on an architectural scale to produce interior projections and movement of natural light/imagery.[22]

The way light travels through this box to create images became so influential that each time it was investigated throughout the centuries, more tasks were assigned to it. This went from a drawing/painting aid to people testing it with photosensitive materials to achieve early photography. As a result, the camera evolved drastically for almost two centuries with many different capabilities and methods of moving the light and viewing the image. The following chapter will explore and dissect these evolutions to see what could be offered to the final thesis design. Whether the application was for art or science, these discovered tools could be translated back into built environments as a method of daylighting. The examination will specifically start in the mid-1800s when Camera Obscuras were outfitted to test photochemistry. Once photochemistry was understood, the camera drastically evolved within the first half-century and continued to do so even in today's age.

19 Ibid.
20 Philip Steadman, *Vermeer's Camera : Uncovering the Truth behind the Masterpieces* (Oxford ; Oxford University Press, 2001), chap. 1.
21 Ibid. chap. 6.
22 Teller et al., *Tim's Vermeer.*

Figure 04 - *The Music Lesson* By Johannes Vermeer is an example of one his paintings suspected to be created from a camera obscura. Key apsects that match camarea qualties in his paintings were: halation of highlights; precise reflections; precise convergence of parallel lines located in a plane perpendicular to the viewing axis; and dimensional precision and focus when rendering objects.

Figure 05 - One of the first methods was a set of drawings that recreated Vermeer's studio and possible painting set up.



2

The Evolution of the Camera: 1800 to present

Figure 06 - The very first fixed photograph taken by Joseph Niepce in a modified camera obscura in 1827. The photo is currently on view in a gallery at the University of Texas.

2.1 The Start of Photography in the 1800s

The camera and its predecessors have proved to be an essential design tool. With painters using the Camera Obscura to obtain proper perspective and can capture the detail of light and shadow accurately in the moment. Then as film was invented and perfected, documentation of everyday moments became commonplace. There were new ways of producing art and displaying one's talent. In architecture and design, there became a faster way to document the process and capture the intent of the work. The camera and optics were so pivotal in architecture through understanding perspective to capturing detail that there was more to the device than we give credit to. Not only can the structure and elements of the camera inspire the adaptation of space, but the light through optics may be able to draw layouts through interpretation.

At the start of the 19th century, experimentation with photosensitive materials, i.e., film, presented another use for the camera obscura. Joseph Niepce achieved the very first fixed photo in 1827, but the consistency was difficult.[FIG 06] Another man who was just an eccentric artist, Louis Daguerre, was also experimenting with photochemistry simultaneously. The two eventually met shortly after Niepces's successful experiment, and by 1835 they had developed a stable product ready for consumer use. Unfortunately, before they could have a product they were both happy with, Niepce passed away, leaving Daguerre to finish what they started. Niepce and Daguerre did all their work together through letters and sharing notes while doing their experiments in privacy. Daguerre's lab was quite peculiar since all of his science experiments were done out of a basement of a large theatre building, where he produced shows that played with daylight.

Daguerre's dioramas started in 1822 when he and his partner for this project, Charles Bouton, made two paintings on a semi-transparent canvas with the goal of bringing the painting to life. They achieved this by controlling the type of light hitting the painting and when it hit it. "By reflected light the front picture was visible; by transmitted light the rear picture was seen...Shutters and curtains controlled the skylights and windows of the new building so that one picture could be made to fade out while the other became visible." The entire building was built like a machine, and the section plan even resembles a more modern shaped camera.[FIG 07] These functionalities were a big inspiration for having everything controlled by the user in my design and ensuring the art and the building could work cohesively. While Daguerre had a crew displaying these dioramas, he was in the basement conducting experiments on fixing a moment in time through chemistry.

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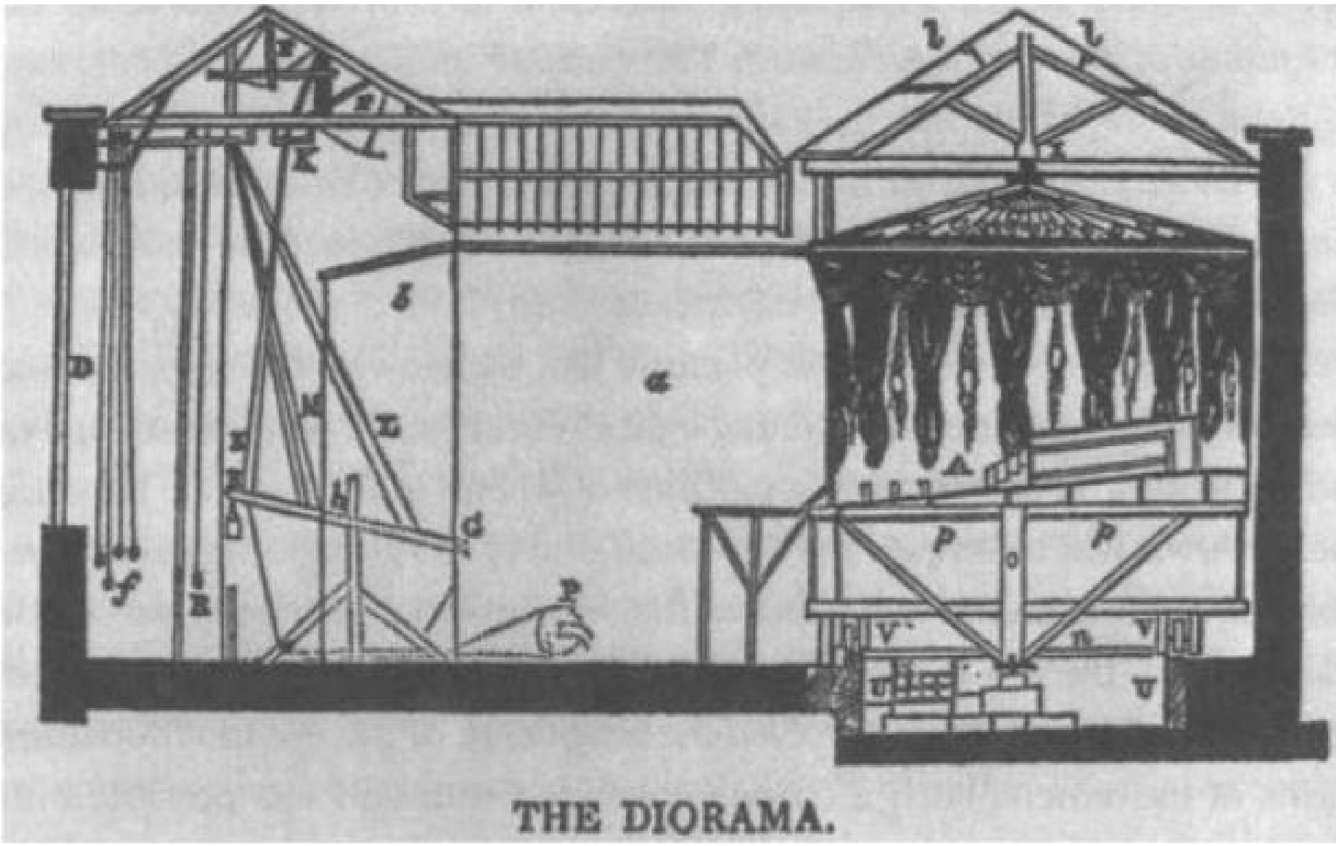


Figure 07 - Daguerre's Diorama made the painting feel like reality to the viewers, so much so that some spectators asked if they could walk up the stairs of the painting. When this section of Daguerre's Diorama was analyzed after reading what it could do, it felt like a proof of concept for my proposal since there is a system that controls daylight to change a space as if a camera would.

In 1839 his dream finally came true when Daguerre and carpenter Alphonse Giroux started selling the very first method of photography, The Daguerreotype and The Giroux Daguerreotype camera. The camera was as simple as two wooden boxes that slid back and forth for focusing with a sealed back to place the film holder, which used silver or silver-plated plates. [FIG 08] A film holder for many view cameras like this stayed roughly the same throughout the evolution of the camera. Typically a film holder will be a small light-tight box with a Darkslide that protects the film from accidental exposure and is removed once the holder is in the camera.[FIG 09]fig (camera and process)][23] The camera form quickly developed after a few decades with various flexible cameras, from collapsable boxes to foldable light baffles.[FIG 10]

23 Josef Maria Eder, *History of Photography* (New York: Dover Publications, 1978), 250–54.

Figure 08 - This is the Giroux Daguerreotype, first commercially produced camera.

“The camera itself consists of two boxes which are slide into each other and are made of different kinds of wood. The larger of the two, which has the lens attached to it, is fixed to the base plate. The back of the smaller box is either the ground glass plate or the holder insert and it fits into the forward box so that the whole is lightproof. The interior is lined with black velvet. In order to bring the image into focus the rear box is moved back or forwards along the wooden camera base.”

Figure 09 - As described for the Daguerreotype, most cameras in the first century of the invention used plate holders. (Bottom Right) The image on the left demonstrates this camera’s version of a darkslide, while some used metal or other materials. This is a mahogany wet-plate camera from 1860.

Figure 10 - The top two images are of the Ottewill's Registered Camera from 1853. This camera was a solution for the portability of box cameras since bellows did not become standard till later in the century. That same decade there were three other known bellow cameras. The bellows not only allowed for more portability but made the cameras lighter as well. The camera on the bottom left was invented in 1851 but made public in 1853 as the Lewis style Daguerreotype. A few years later, in 1856, there was another patent for a bellows camera from Captain Francis Fowke, the Fowke's Bellows camera. (Bottom Right)

Now for Daguerreotypes, the process as a whole was very involved since the setup was considerably large. In addition, in order to complete the developing process, a burner was needed, and the plates needed to be chemically fumed.[FIG 11 & 12] As other photography methods bounced around the same time, the most used successor to Daguerreotype film was the Collodion process or Wet Plate photography which became the most used method around the 1870s and "the greatest importance in photography."[24] Depending on the size of the cameras, both Wet Plates and Daguerreotypes were still able to use the same cameras, and other evolved forms. The difference between these photographic methods is the speed of the process. Wet Plates are faster and easier regarding exposure time and development, and the process works on many different solid materials.[25]

24 Ibid, 342.
25 Ibid, 357-360.

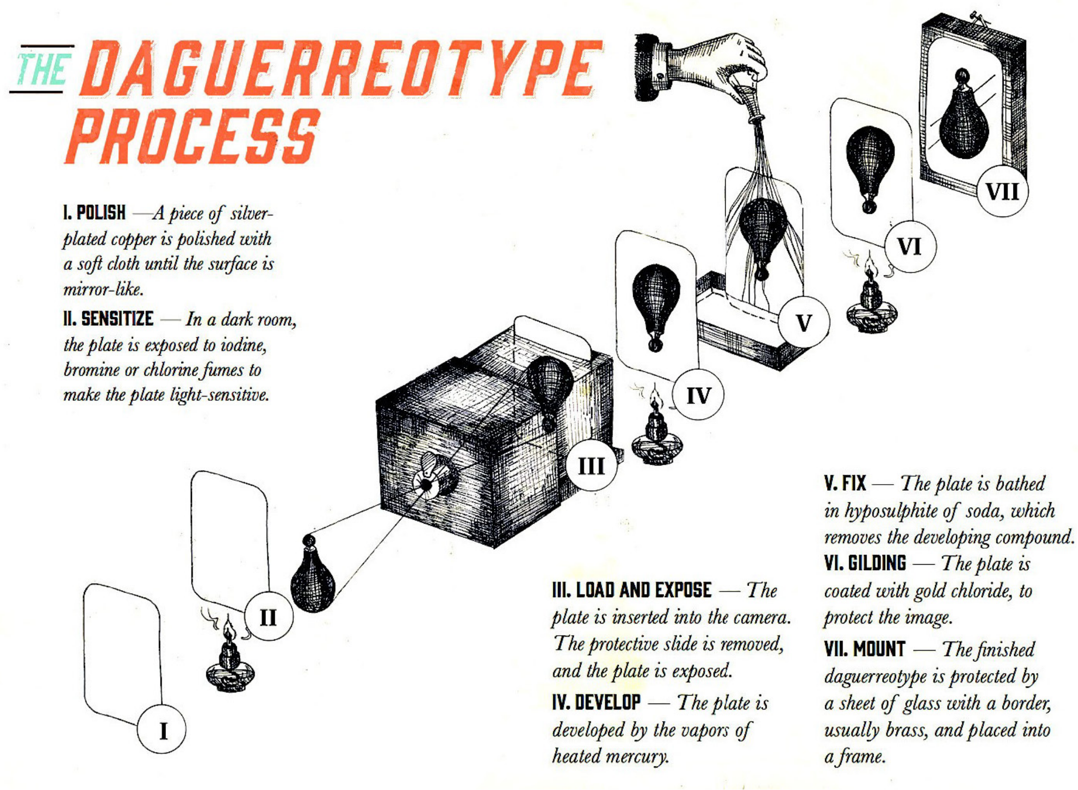
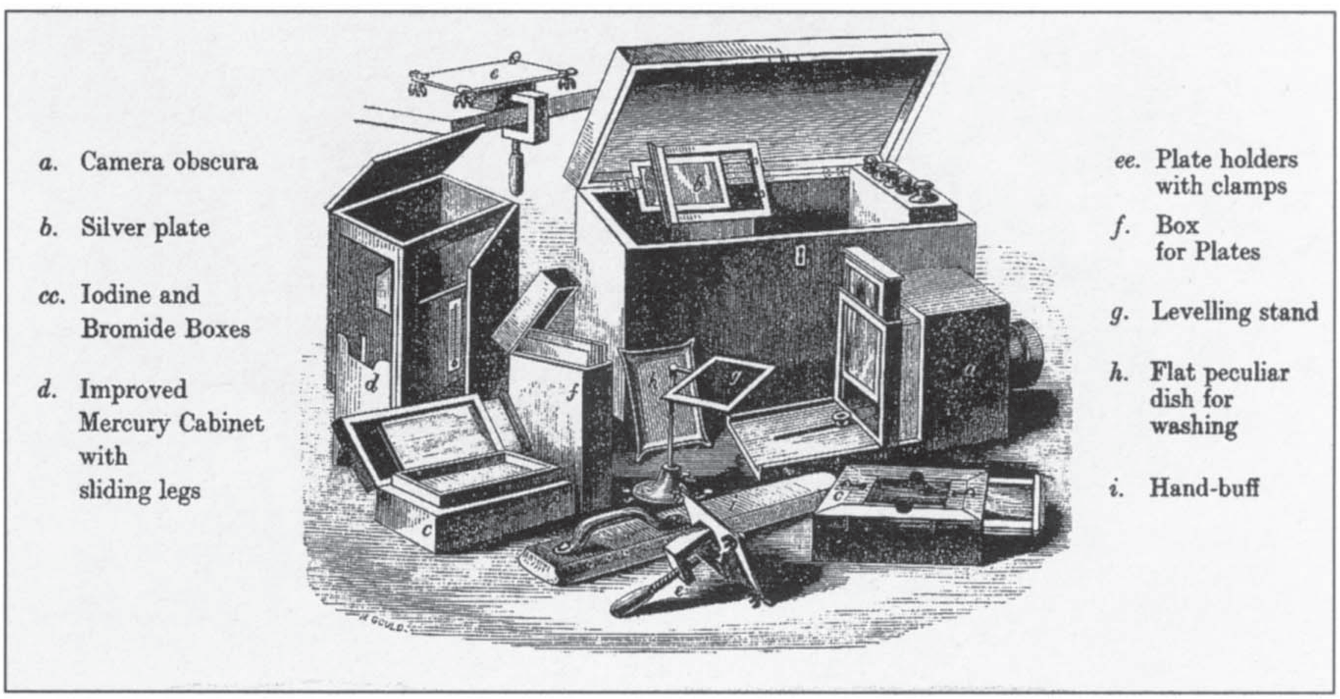


Figure 11 & 12 - The top image is a diagram explaining the process of the Daguerreotype. The bottom image is the kit that came with the camera; this kit is what allowed a photographer to work out in the field no matter the conditions since every box was light sealed, even the camera. The camera imagined at a larger scale for people presents a unique opportunity for art in the way its created and presented.



Even though Wet Plates were a faster photography method, a landscape shoot would still require a large-ish setup. Therefore, the cameras and developing setup as a whole became an inspiration for the design since this setup was most commonly used for Wet Plate photography. [FIG 13] As depicted in this image, the inspired idea is to have the proposed building on a stand or stilts overlooking a landscape and have the ability to develop photo paper and take pictures.[26]

Throughout the next few centuries, the camera evolved and adapted to the change in photographic methods. Both tools were incredible technical feats and constantly got easier to capture moments and our environments. With the evolution of film, we were able to create images that were truer to tone, both in colour and black & white (B&W). For example, B&W film evolved from the orthochromatic spectrum to a panchromatic, capturing deeper detail in shadow and taking quality photos in inadequate lighting.[27] In addition, it became more than possible to capture light fixed in time and share that information quickly, or depending on what was used, in an instant.

One vital invention to mention is Paper Negative photography, which debuted in the early 1840s; this medium allowed the user to make any positive prints from one photograph, which was not possible with Daguerreotypes and some Wet Plates.[28] It was also easier to produce photo-paper of custom sizes, which assisted the exploration of camera typologies and compact sizes. In the following section, the next inspirations for the proposed artist residency and exhibition space will date from when the flexibility of photo-paper allowed for more consumer-based and other compact designs for professionals. Several elements in this next phase of camera evolution will be helpful as a tool for artists on an architectural scale. We're going to dive in and see precisely how these elements could be helpful when designing a space for artists that could be transformable in space and have very controlled light.

26 "Wet-Plate Photography | American Experience | PBS," accessed July 22, 2022, https://www.pbs.org/wgbh/americanexperience/features/eastman-wet-plate-photography/.
27 Ibid,457-465.
28 Eder, 316–325.

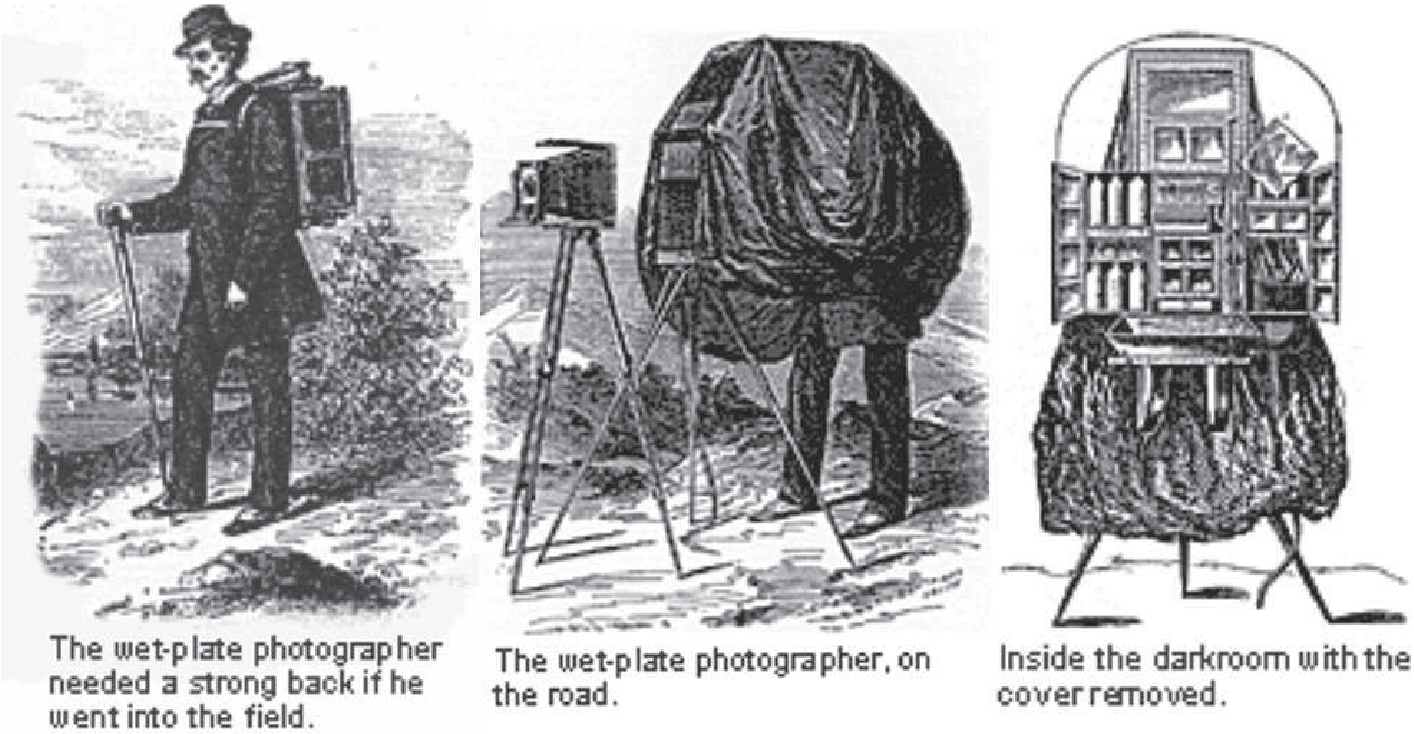


Figure 13 & 14 - An illustration of a wet-plate photographer hiking with their camera and processing kit. The darkroom tent in the right two images is used to sensitize the plate and develop it afterwards. In this bottom image, you can see the photographer looking through the top. The viewer will have red glass since wet-plates were not sensitive to red light, allowing the photographer to see without daylight ruining the work.

2.2 Mass Commercialization of the Camera and Photography

This subsection will focus on how the camera evolved for consumer use and the size of film changing. Since photography has been around for almost two centuries, the camera has undergone many interesting developments. The cameras mentioned will also highlight certain features that could prove helpful for dynamic daylighting in architecture and this project. The first thing to mention is the camera and company that changed and revolutionized commercial cameras and photography. In 1888, George Eastman, founder of Kodak, started selling small box cameras that came with roll film.[FIG 15] The film held 100 shots, and the produced images were around 3 inches in diameter.[29]

Figure 15 - The Kodak from 1888 was the first camera with a roll of film and was commercially available. The spool is held in place on a backplate and placed inside the light-tight camera for use. Cameras like this were usually loaded in darkbags with arm holes so daylight would not ruin the light-sensitive materials.

29 “Original Kodak Camera, Serial No. 540,” National Museum of American History, accessed July 25, 2022, https://americanhistory.si.edu/collections/search/object/nmah_760118.

The critical aspect to pull from this camera is the simple rolling system that connects the film roll to a spool with a reel for winding to the next shot. This could prove as a method to move large sheets of photographic paper throughout a space. The paper would need to move throughout a space that could transform into a darkroom with a Darkslide system, similar to what was mentioned in 2.1. With the invention of roll film, companies and camera makers started creating all sorts of different cameras and mechanisms to enhance the technology further. One such mechanism was the use of mirros and glass, which has been an undiscussed feature that is incredibly vital to cameras. Like the Camera Obscura, the previously mentioned view cameras would have an upside-down and inversed image on the camera’s ground glass. To fix this view, a mirror could be placed at a 45-degree angle inside the camera, redirecting the view up, and when it is time to take the photo, the mirror is turned back up. With the use of mirrors and glass we were able to produce more compact versions than the bigger box and accordion cameras. **[FIG 16 - 21]**

Figure 16 - These four cameras are an example of the simplest mirror sytstem as described above where the mirror sits on a 45-degree angle. This system is known as a Single-Lens Reflex (SLR) since the mirror reflects the image up to the viewing glass. From left to right these cameras date from 1897, 1935, 1936 and 1957. The Spiegel Reflex on the far left was the start of modular SLR cameras for larger film and eventually evolving into cameras like the Hasselblad where the system stayed the same size but allowed for the impletation of different systems for the lens, viewing and the film holder. The camera in the middle right is the Kine Exakta, it shot smaller film and the first cameras of this size to be an SLR. This type of flip up viewfinder later beame an ispiration for a part of the final buidling proposal.

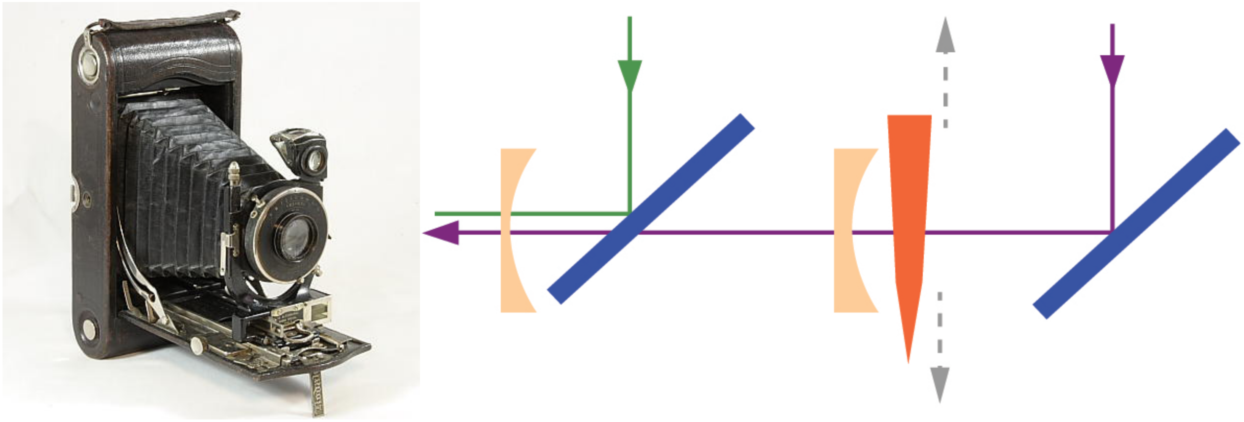


Figure 17 - No. 3A Autographic Kodak Special from 1916 was the first camera to use a coupled range finder focusing system. The camera door system eventualy became an inspiration for a door and bridge system. The illustration on the right shows how the rangefinder system works where two fixed mirrors are projecting a view at the viewing plane but the image from the lower mirror is deflected by a small amount by a lens combination so that you know you're focused when your subject goes from a double image to a single. As time went on this system was built into the top of the camera for easier viewing,

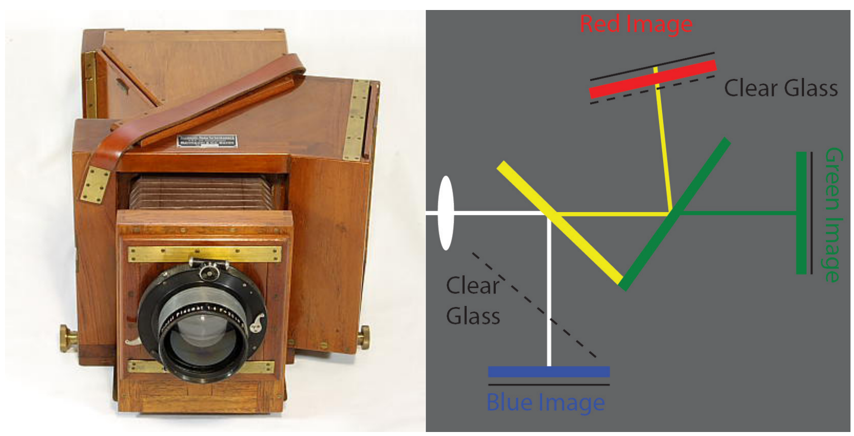


Figure 18 -Cameras can present such a fantastic opportunity for the inspiration of space creation and art installations. Before colour photography was perfected, some photographers used a specialized method called the Three-Colour Process, in which three B&W photos are taken with a red, green and blue filter. After they are developed, they can be projected together to see a true colour image. Some cameras like the Bermpohl Naturfarben Kamera is a german camera from the 1930s that allowed the user to achieve this process all in camera. As seen in the diagram, there is translucent coloured glass that reflects to each image plane to produce their respective colours.

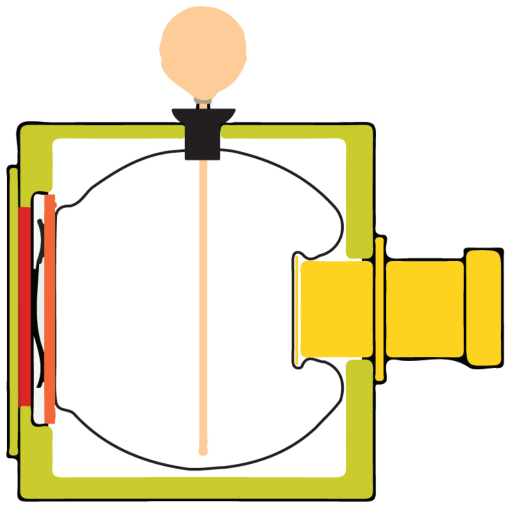
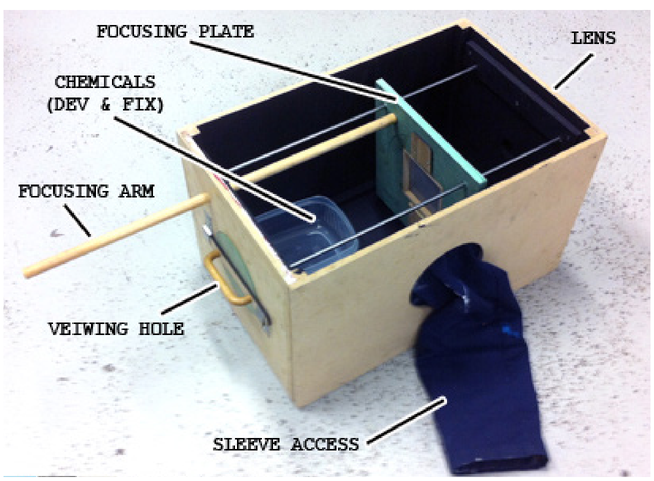
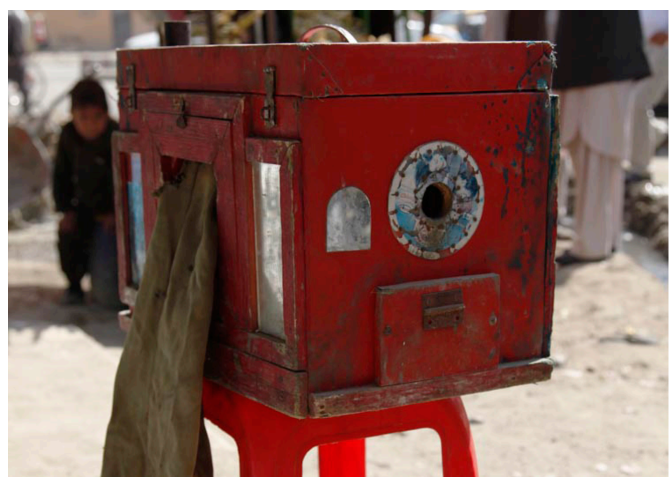


Figure 19 - The illustration on the left is a section of the 1864 Dubroni Developing Camera that allowed the photographer to develop each plate after use.

Figure 20 & 21 - These bottom two images are known as the street box camera or the kamra-e-faoree in Afghanistan where it has been primarily used for a very long time. The camera has a dark-sleeve where the user can place the photo in the developing bath and fixing solution, all inside the camera after taking the photo. A system like this felt integral for a building that focuses on optics and lighting for artists. In addition, it could present an opportunity to take photos with the building as the camera.





Like these, there have been many camera technologies that were unique and brilliant in form since they achieved niche ways of moving light. Taking that information and placing it anywhere that's needed for the user. When looking at the examples of the camera and how it started, it has always been the perfect tool for the artist. The lens and the box could be used in a multitude of fashions to produce the desired outcome for an artist and even help track a process by recording the process through photographs. This proposed building aims to be like the camera, to help aid the artist to create by manipulating light, structure and optics to achieve their goal. Before examining artists' particular needs, let us quickly observe the evolving uses of photography in the artistic process.

2.3 The Emergence of Instant Photography in the 1950s

The age of analog photography carries a magic that lingered from its inception into the digital era. Perhaps the act of images being viewed on the glass as something that seemed painterly fueled this perception, and later, this view was made permanent as an image, despite the length of the development process. The tangible excitement when viewing the final product remains to this day, due to the tangible and tactile nature of the medium. This magic then continued into instant photography, wherein the developing process is resolved in an instant, and the user can witness this "magic" before their eyes. The creator of Polaroid was a businessman named Edward Land, whose work prescribed a certain creativity in the research his company undertook. He understood the benefits of giving ideas time and resources for later benefits. The tools developed for this thesis each required time and investment, which remains a primary concern beyond this project's scope. Nevertheless, they are at a suitable level for the proof of concept nature of this stage of the thesis.

The first polaroid cameras came into mass public consumption in late 1948 and produced sepia-toned images. They were not regarded as the best, but they did what was advertised and provided an instant image which still had tremendous intrigue. However, the criticism was still there, stating that "it was not real photography" and nothing more than an amateur gadget.[30] Edward Land wanted to validate the polaroid camera and made friends with the renowned photographer, Ansel Adams. After meeting with Adams, the two hit it off, establishing a similar understanding of photography, so Land asked if he was willing to consult on new films. Both men understood that innovation takes time if you wanted to get it right, and for Adams, one of the most heavily coveted photographers, his expertise was very much sought after. He was brought into Polaroid as a consultant in 1949 to assist them in obtaining the "perfect" result for the professional and average consumer.[31] It took about a year to get a satisfactory result for the contemporary market, but the consultants and chemists at Polaroid were constantly striving to better the medium.

30 Christopher Bonanos, *Instant : The Story of Polaroid*, 1st ed. (New York: Princeton Architectural Press, 2012), 44.
31 Ibid, 45.

The work was never complete and Land kept striving for more and even better cameras for Polaroid's instant photography. In 1950 Land wanted to bring colour photography to the world, so he asked his director of research, Howard Rogers, to begin researching the production of colour instant photography. Rogers understood the importance of patience in innovation, and so it took two years to plan for this project. Finally, after seven years of synthesis and analysis, Polaroid was able to produce correctly coloured prints in-camera. As time passed, the colour instant photo was "perfected" in 1969, providing higher quality and large format photography options for both colour and panchromatic film. In addition, Polaroid's film and cameras evolved into more advanced tools and became more compact. Between 1950 and 1970, the reduction in size was significant, coming down from cameras which measured a foot long and half a foot wide, to devices roughly the size of cigarette cases, four inches by seven inches by a quarter inch. One camera even allowed the photographer to do in-camera manipulation (the act of changing exposure, aperture, lens, and taking double exposures for the sake of instant photography), which was revolutionary at the time in regards to instant photography.[32]

The most astounding thing about Polaroid was their admiration of artists that used their products. Since the collaboration with Ansel Adams as a consultant proved very fruitful, Polaroid had the idea to support artists who showed off their work and, in turn, sent them more products to use. Just like their cameras, Polaroid tried to make their relationship with the artist as versatile as possible, even making a large custom camera and film for some artists for special projects. They could produce up to six-foot by three-foot sheets of polaroid film and cameras to go with them.[33] Polaroid catered to the artist's needs on the macro and micro scale with the tool of the camera, as is the goal for the proposed artist workshop and dedicated exhibition space for this thesis. As design cues have come from the cameras mentioned above, the reason for a space like this will be encouraged by the work of Olafur Eliasson and other structures that play with natural lighting.

32 Ibid, 46–49.

33 Bonanos, *Instant : The Story of Polaroid*, chap. 4.

3

Case studies on the Influence of Light in Art & Architecture

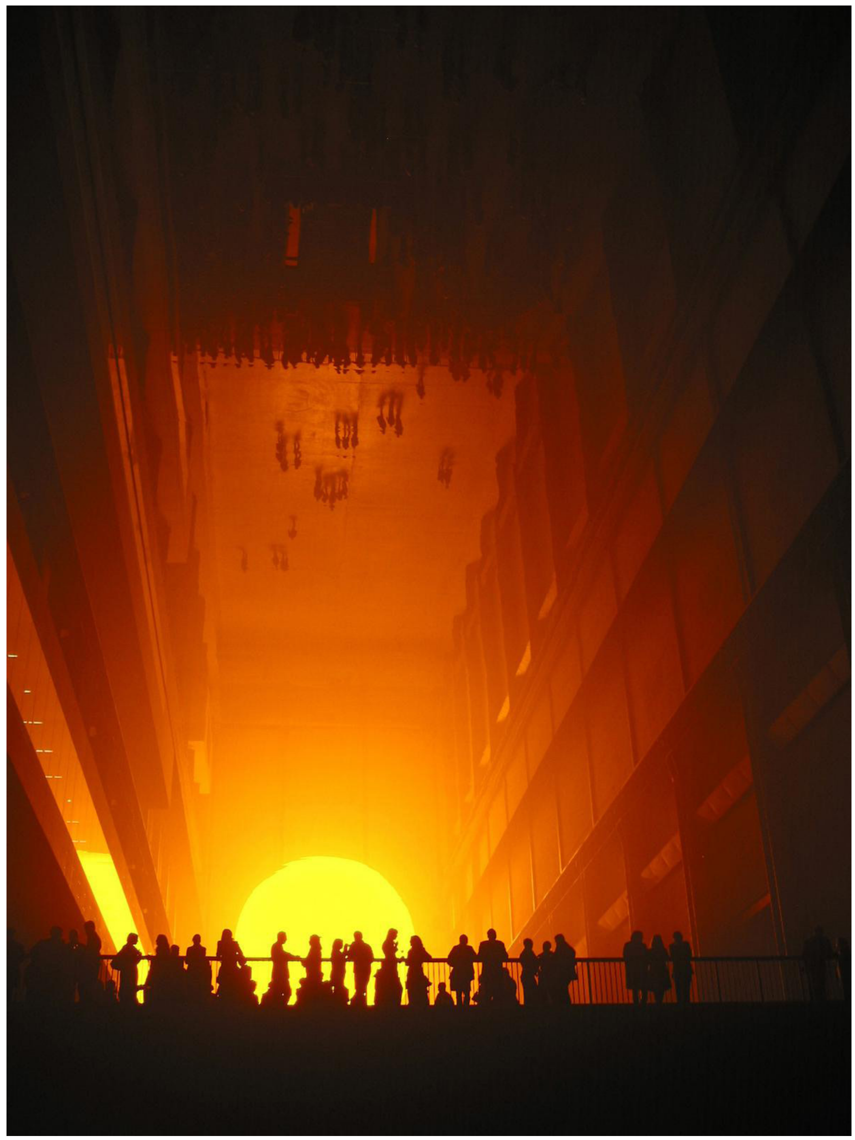


Figure 22 - The weather project by Olafur Eliasson, 2003. the project employed a semi-circular screen, a ceiling of mirrors, and artificial mist to create the illusion of a sun. The spaces atmosphere had drastically changed due to lights and optical elements.

3.1 Olafur Eliasson

As we already know, light has always been a significant aspect in architecture and as well in painting. Light and shadow are not just a way to brighten a space but the way it is used in art to add depth, the same could be done for architecture. This proposal aims to achieve this by using what was taken from the study of light, optics and the camera to create daylighting tools. However, another factor is the artist's need for a space to create and build. One modern artist to look at for this project is Olafur Eliasson, who follows a philosophy of prototyping in large spaces and using what nature has given us to create. His art is heavily inspired by the user and any environment or space that surrounds them. Eliasson likes to throw people into magical experiences that are not necessarily rational or programmatic, it is about looking into the world and the spectator turning space into art.[34] [FIG 22 - 25]

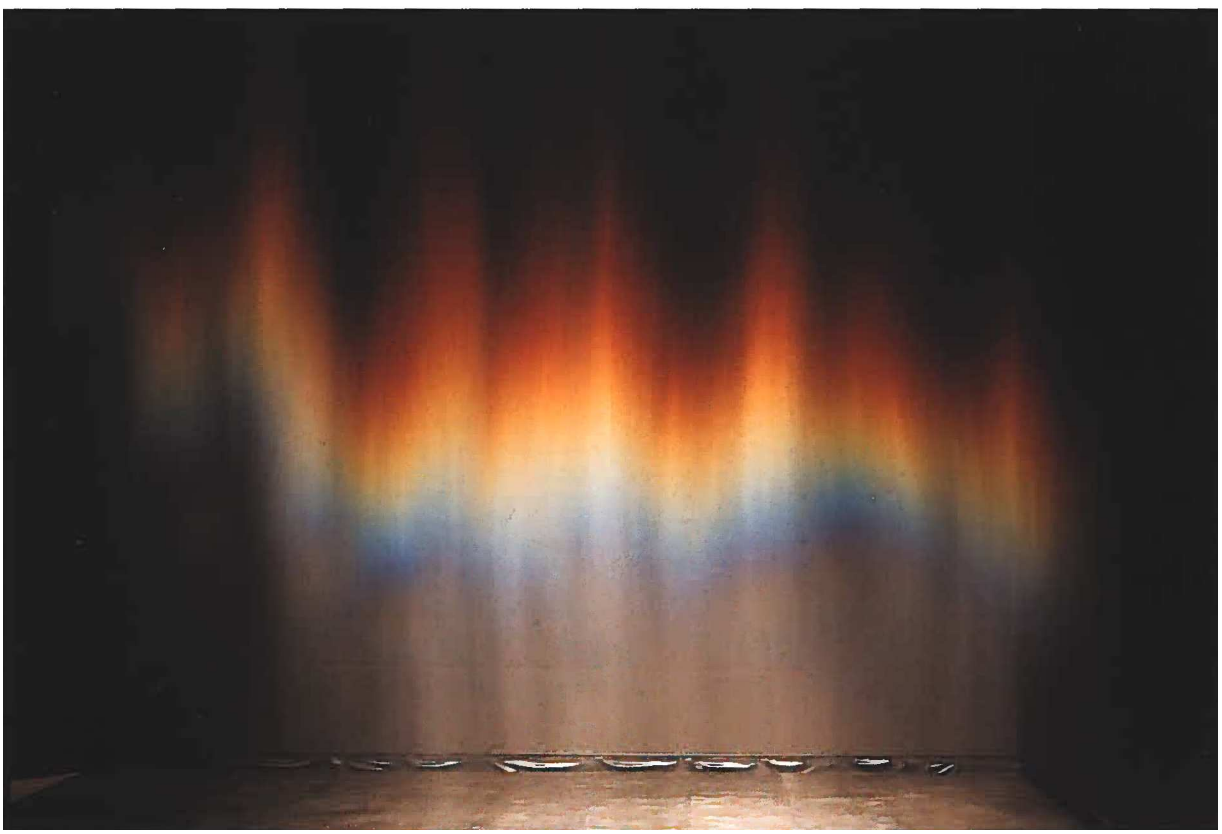


Figure 23 - Beauty by Olafur Eliasson, 1993. A simulated rainbow in a small room.

34 "Olafur Eliasson: The Design of Art," *Abstract: The Art of Design* (Netflix, September 25, 2019), https://www.netflix.com/watch/80237093?trackId=13752289.

Figure 24 & 25 - The Mediated Motion by Olafur Eliasson, 1993. This project was a series of small spaces that changed the atmosphreric qualities from room to room. This project shows a need for spaces to be pricesly controled and easily manipulated.

These projects tend to capture the ephemeral and atmospheric qualities of something that nature provides, sometimes making it feel like it is no longer an enclosed space. The exhibition spaces which Eliasson and his team prepare are relatively large, and his studio reflects this. Model making and prototyping are essential aspects of the artistic process, and Eliasson states that a studio should be magical and capable of doing things you could regularly not. This notion served as an important reminder to create a building with many practical innovations and dynamic capabilities to suit any need of the artist. Due to the size of his workshop, Olafur can prototype in his space to know what is necessary to make the project work; if the project needs light, it is precisely controlled. [FIG 26 - 33]

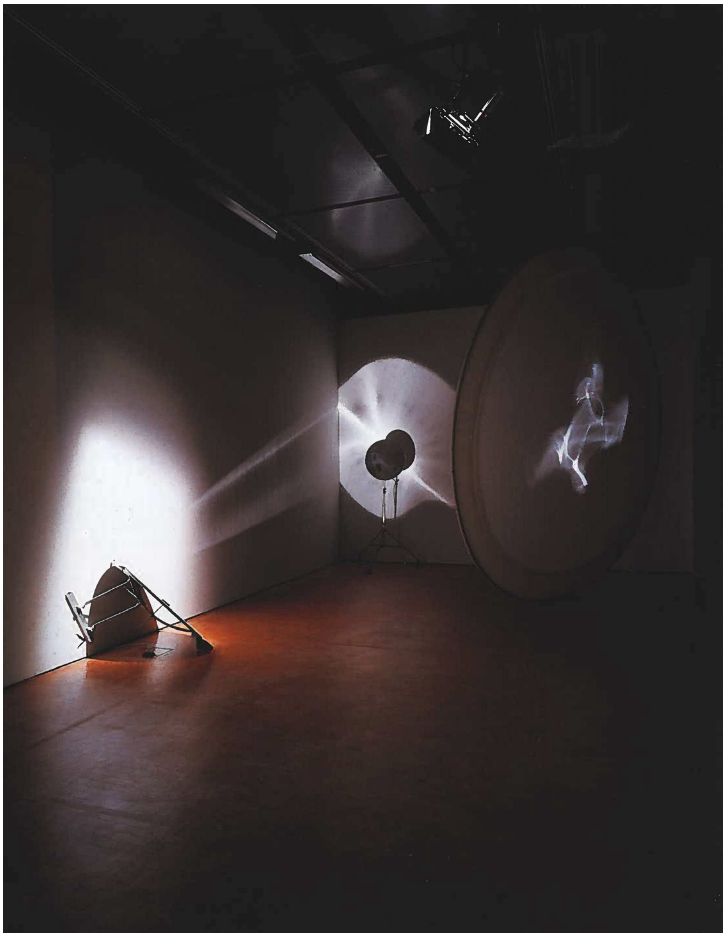
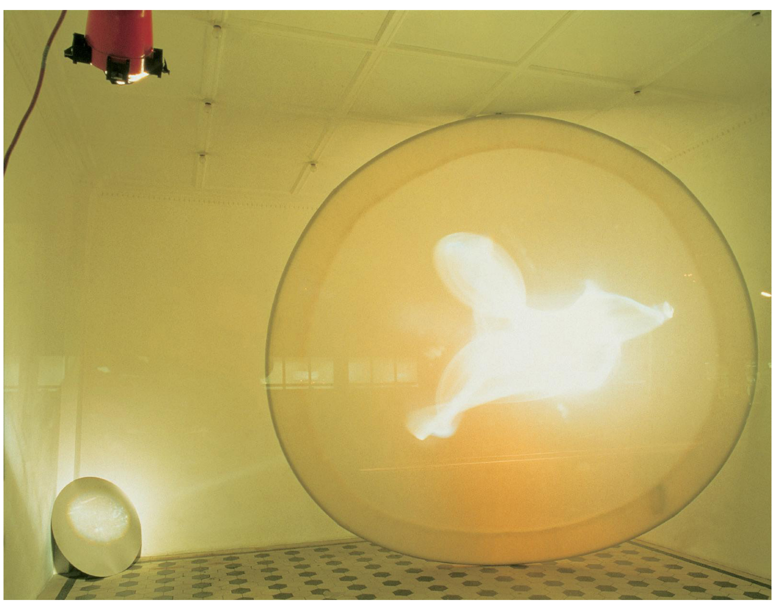


Figure 26 & 27 - Eine Beschreibung einer Reflexion, oder aber eine angenehme Übung zu deren Eigenschaften (A Description of a reflection, or a Pleasant Exercise on its Qualities), 1995. “A spotlight is mounted on the ceiling of a darkened room, facing a concave mirror with a 100 cm circumference. The mirror is located in the corner of the exhibition space and projects a shaft of light on a second, small curved mirror mounted on a tripod. This mirror completes a revolution in 30 seconds, and, as it revolves, it reflects an irregular light onto the reverse side of a round projection screen (a 400 cm), which is fixed to the ceiling at an angle and runs down to the floor, vertically blocking the space.”



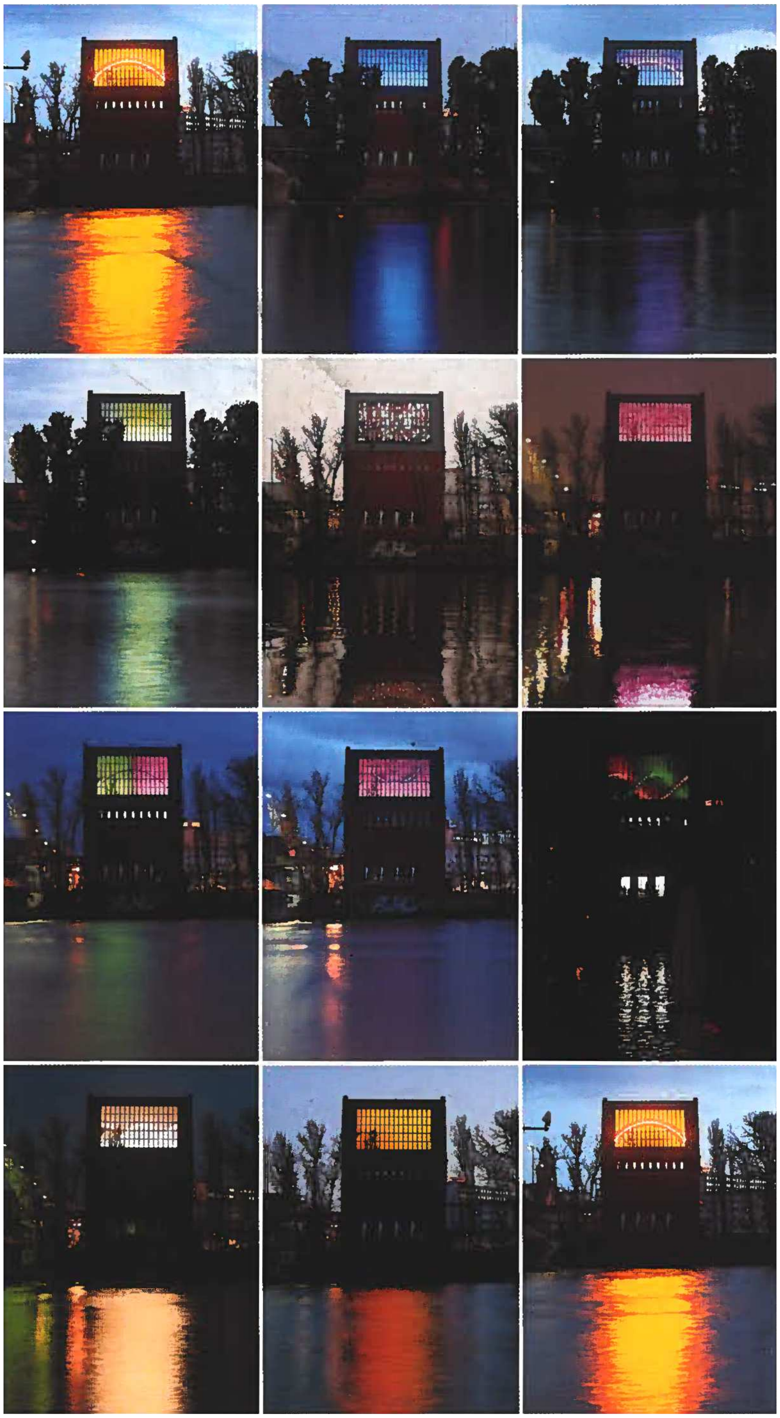


Figure 28 - Light Lab 1-12, 2006-2008 by Olafur Eliason. This project was a series of light installations that was meant to be experienced from afar since the building was easily visible and had a large window. Just like the location of the proposal for this thesis, the structure will be at a big advantage point in the city and could easily be seen below if it were to glow like this project.

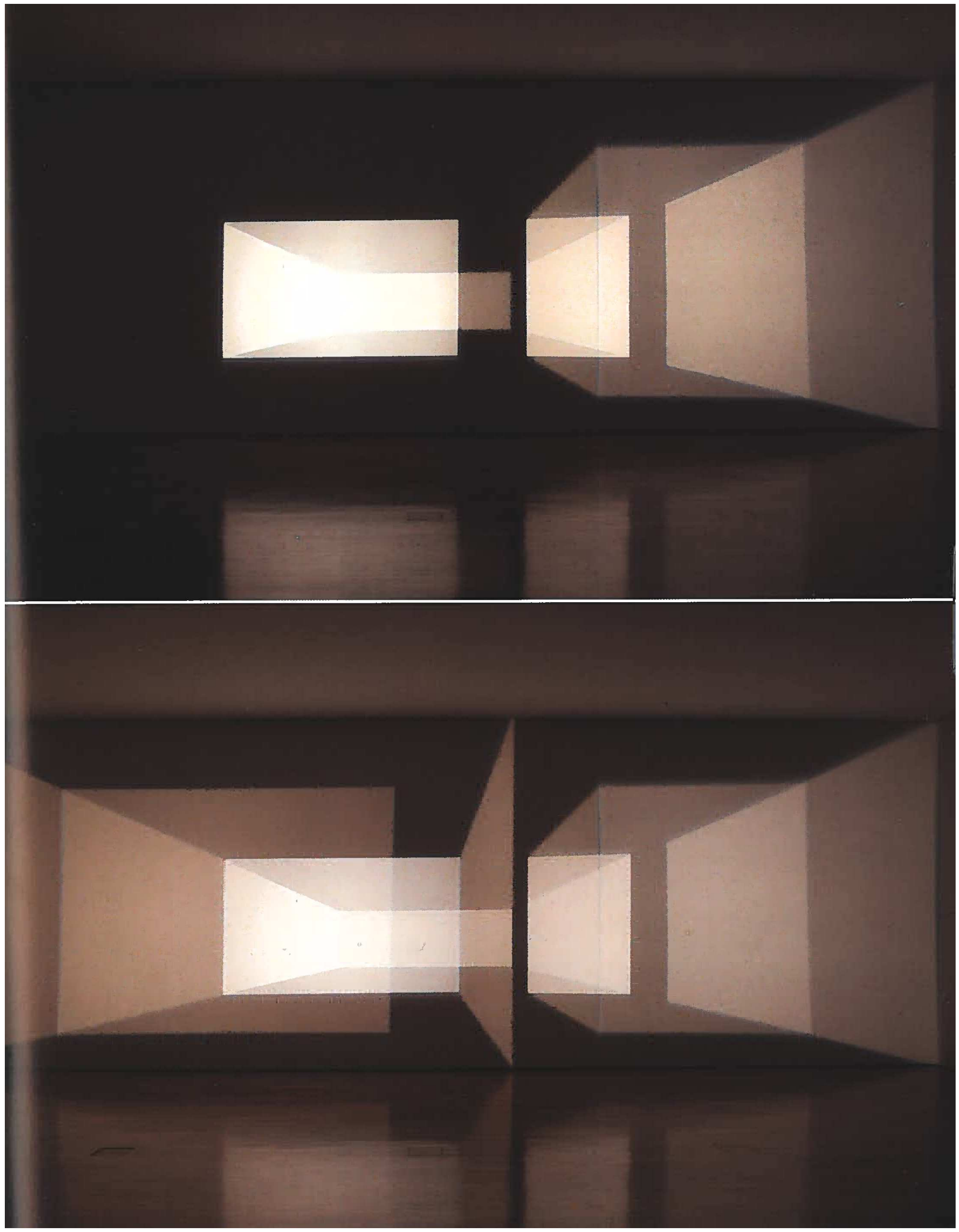


Figure 29 - Remagine by Olafur Eliason, 2002. Twelve spotlights projecting squares, trapezoids and rectangles turn on and off to create the feeling of shifting spaces.

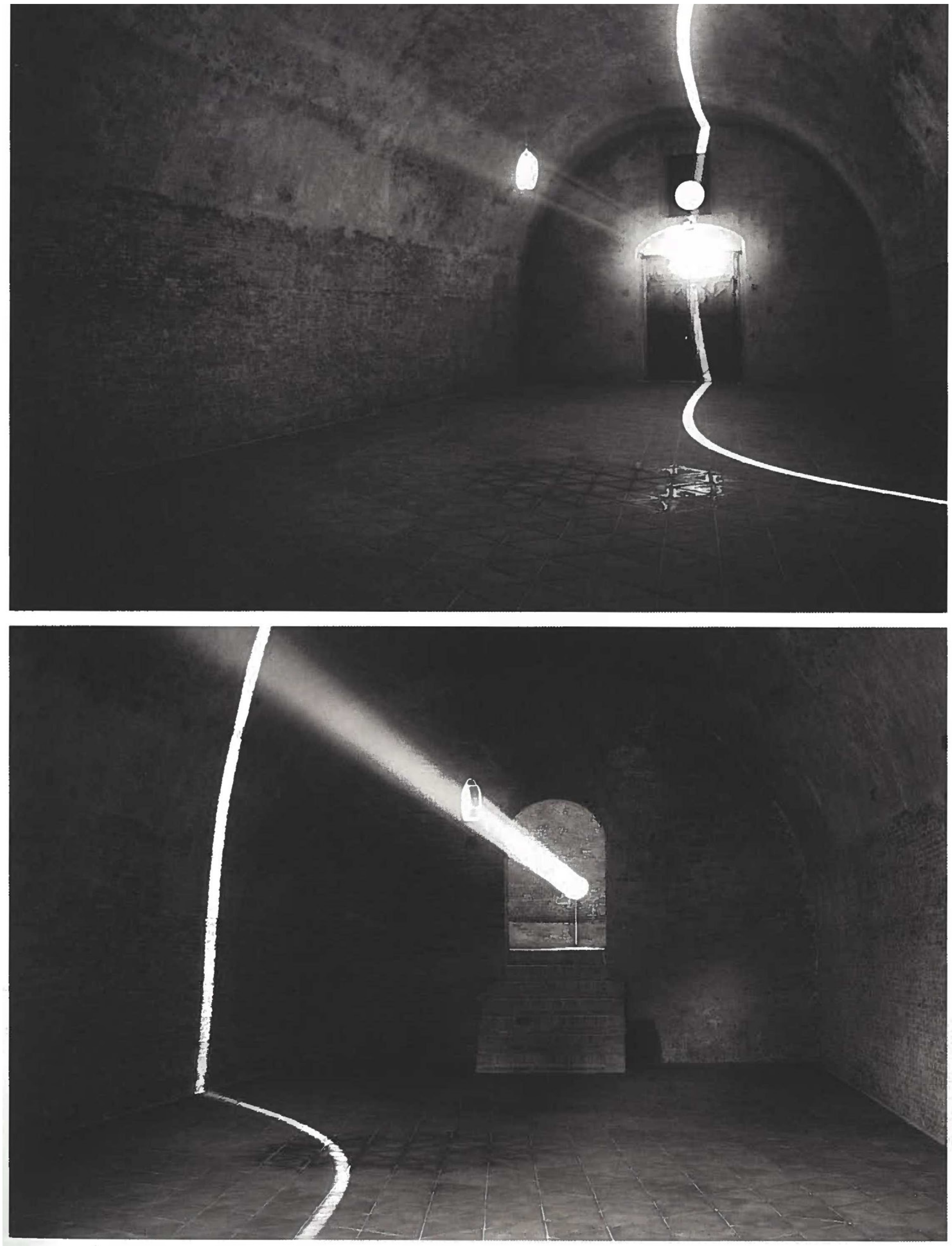


Figure 30 - Sunpath for San Basilio by Olafur Eliasson, 2011. This art piece is meant to light the darkened cellar of the Castello di San Basilioand with a beautifule light show.

Figure 31 - The front face of the building for the Sunpath project, where the reflective mirror sits in the top window while thers anpther mirror as well on the other side.

Figure 32 - Dream House by Olafur Eliasson, 2007.

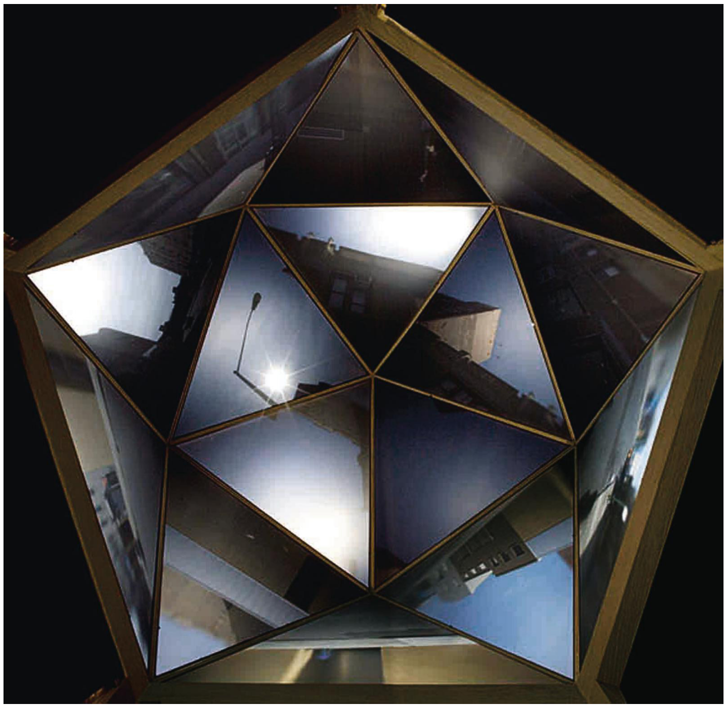


Figure 33 - Dream House by Olafur Eliasson, 2007.

This project was a human scaled camera obscura project. with 15 projected views.

Figure 34 - The Light Setup by Olafur Eliasson, 2005. This project has one skylight and one tungston light panel side by side in an empty large space.

Figure 35 - This project has a normally glazed facade but was covered for this project for a strict comparison and interaction between the daylight and artificial light.

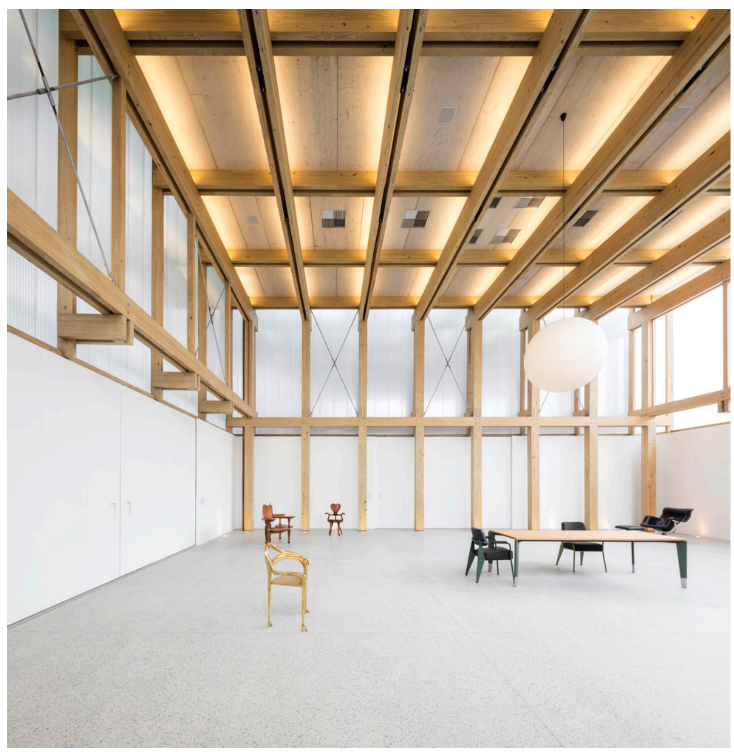
3.2 Micasa Vol.C

The light setup by Eliasson is also an exciting project where a glass façade building was set up with white panels in front of the windows. Then it has two skylights with translucent white paper covering and daylight behind one and fluorescent lights behind another. [FIG 34 & 35]

Similarly, the project *Micasa Vol.C* by Studio MK27 embraced the demand for a flexible program that allowed an internal space to have several possible uses: shop, exhibition space or temporary residence for invited artists, on a caravan that fits inside the space.[35] This architectural space uses a light frame wood structure and a substructure for the translucent skin façade. This project inspired me to ensure the workspace is just as flexible and to be fully glazed. The windows of this proposal should be easily accessible in a way that they can be changed in colour or opacity, have boards or curtains placed in front, and be operable. [FIG 36 - 38]

35 "Micasa Vol.C / Studio Mk27," ArchDaily, May 21, 2018, https://www.archdaily.com/894663/mica-sa-vo-studio-mk27.

Figure 36, 37 & 38 - These three images are of Micasa Vol. C by Studio MK27. The left image displays the translucent top faced that plays with the exterior refelction and the structure showing through. The top image on the right displays the ability for the structure to glow if needed. And the last image shows off the free open space and light structure that presents an amazing oppurtunity for art exhibition



3.3 The Arab World Institute

The proposed daylighting tools coming in the next chapter rely on technologies and the ability to move mechanically at the user's will. A building that comes to mind is The Arab World Institute, designed by Jean Nouvel and constructed in 1981. For the façade of the building, Nouvel was inspired by the traditional lattice work in the middle east that was used to regulate heat and sun exposure. He used a system that incorporated 30,000 light-sensitive apertures which contract and expand to regulate the amount of light entering the building. Due to the various shapes and phases of the apertures, there is a showcase of both light and void, dramatically changing the experience of internal spaces. This building and the work by Nouvel inspire the creativity of using mechanically abled devices to better the design experience.[36] [FIG 39 & 40]

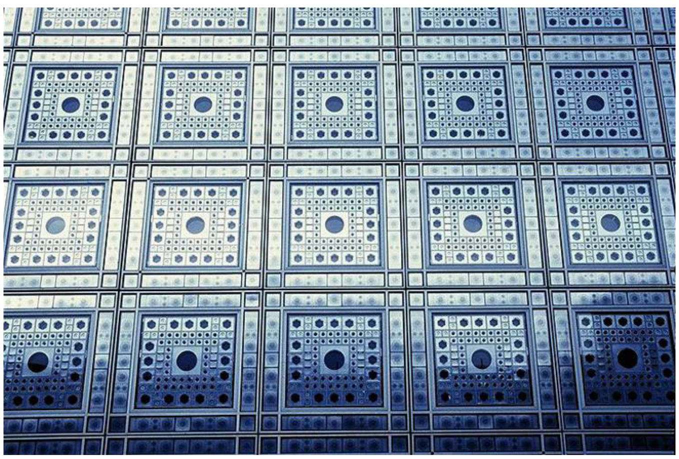


Figure 39 - The Arab World Institute, designed by Jean Nouvel, 1981. The image on the left shows how the facade is decorated in this pattern of apertures.

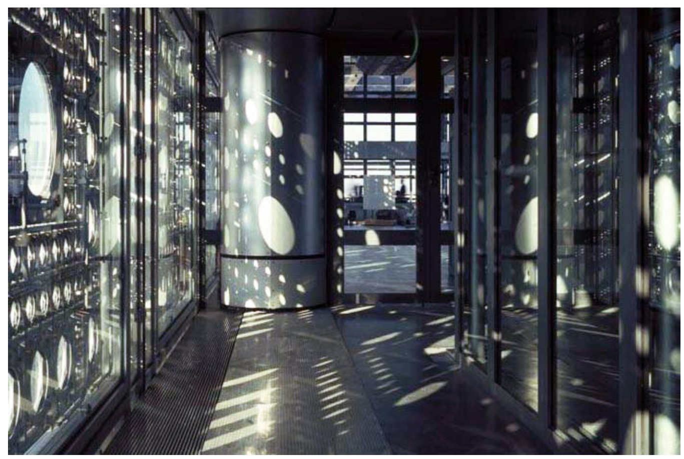


Figure 40 - The Arab World Institute, designed by Jean Nouvel, 1981. This image demonstrates the power it has over daylight. It is changing the space with dancing and changing the shapes of light.

36 "Jean Nouvel's Stunning Museum Façade Dilates to Let in Daylight," *Inhabitat - Green Design, Innovation, Architecture, Green Building | Green Design & Innovation for a Better World* (blog), September 17, 2010, https://inhabitat.com/jean-nouvels-stunning-museum-facade-dilates-to-let-in-daylight/.

3.4 Kimball Art Museum

To ensure the ability to light a space, the necessity to find ways to brighten them with materials became important. One discovery led to the Kimball art museum by Louis Khan, who embraced natural light inside a series of cycloid barrel vaults. They are rimmed with plexiglass skylights and have slatted aluminum reflectors sitting on translucent panels on the inside. The reflectors bounce the light off the concrete ceiling brightening the walls while the translucent panels are illuminated by the light passing through the slatted aluminum.[37] Slatted reflectors and white translucent glass should help move light from the research tower into the mines of Dynamic Earth. [FIG 41]

Figure 41 - The Kimball Art Museum by Louis Khan, 1972. In one of the gallery spaces, you can see how the ceiling is illuminated because of both the concrete and translucent glass.

37 “AD Classics: Kimbell Art Museum / Louis Kahn,” ArchDaily, March 31, 2011, https://www.archdaily.com/123761/ad-classics-kimbell-art-museum-louis-kahn.

4

A Design Proposed by light

Figure 42 - Image of Dynamic Earth and the Big Nickel Site taken by author

The history surrounding light and optics brought us from the literal Camera Obscura to the small handheld cameras we know today. Additionally, there is the exciting use of light installations that bring structures to life or how shadow and light can be used together to create space. By examining cameras, other optical instruments, and how light can be used for space creation, this thesis proposal will use this examination to explore their possibilities in architecture and their uses in shaping space. As well as how easily the user could manipulate the environment for controllable views, lighting, and space. The exploration will start with intensive prototyping and experimenting with different optical instruments, including homemade Camera Obscuras. Then, the prototypes become an experiment to see how these can become dynamic features and benefit daylighting in architecture. Before elaborating on the exploration, there should be a brief description of the program and chosen site. When examining elements for an adaptable space like this, we can start to see how optics can shape architecture and aid artists again. Therefore, the proposed main program will be an artist residency. The main building will obtain a dynamic range of natural lighting instruments that would make for an ideal studio and exhibition space. Since light and optics are an essential bridge of art and science to architecture, it seemed fitting to place the artist residency at Dynamic Earth, a science center dedicated to earth sciences and mining experiences. [FIG 42]

Also home to the Big Nickel, the site is located at a high point in Sudbury with clear views of the city and no light obstructing the proposed structure. Since it is already a scientific place of learning and discovery, an interesting secondary program would be an exhibit on optics that allows the exploration of sight and light. This exhibit would make use of an existing tower on site that Laurentian once used for research. Using this tower, now named *The Periscope Tower*, as a light and optics exhibit could provide an exciting contrast to the current exhibit on mining, which is exploitive of nature and digs deep into the earth to showcase mining and its history. While the optics exhibit already has a structure to be repurposed, the artist residency and exhibition space will be a proposed new build and delicately placed around the site without overly disturbing the current nature and landscape.

42

4.1 The Optical Tools for design: An Experimentation

Before this thesis began, I had prior knowledge of historical cameras and their various functionalities. Then the fascination with the camera led me to investigate the many possibilities that optics and the camera obscura can have in architecture. My first experimentation with optics was transforming a bedroom into a camera obscura. Through testing different pinholes and lenses, there was eventually a satisfying result of an image of the outside, in a way, a living image. [FIG 43] While studying the Obscura one day, an idea occurred; since the pinhole translates light from one space to another, theoretically, one room could be projected into another. So the idea occurred to create a smaller version of this, but more of a projection box. This built projection box had a sliding mechanism to focus on what was in the box, similar to the first Daguerreotype cameras focusing system. [FIG 44] When filled with enough light, the box projects whatever is in focus to the lens and, in this case, my upside-down face. [FIG 45]

Figure 43 - Image of the Camera Obscura effect contructed and taken by author.

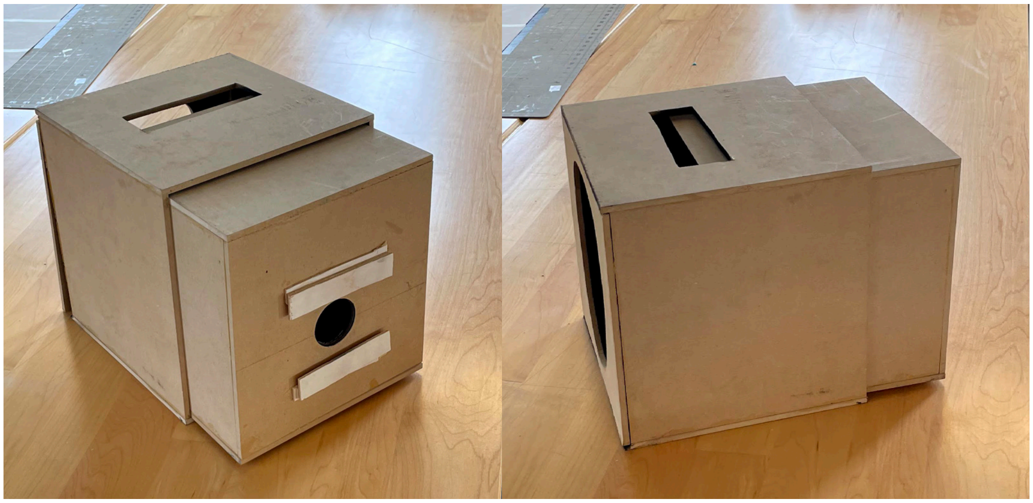


Figure 44 - Images of the homemade projection box that was made out of mdf panels.

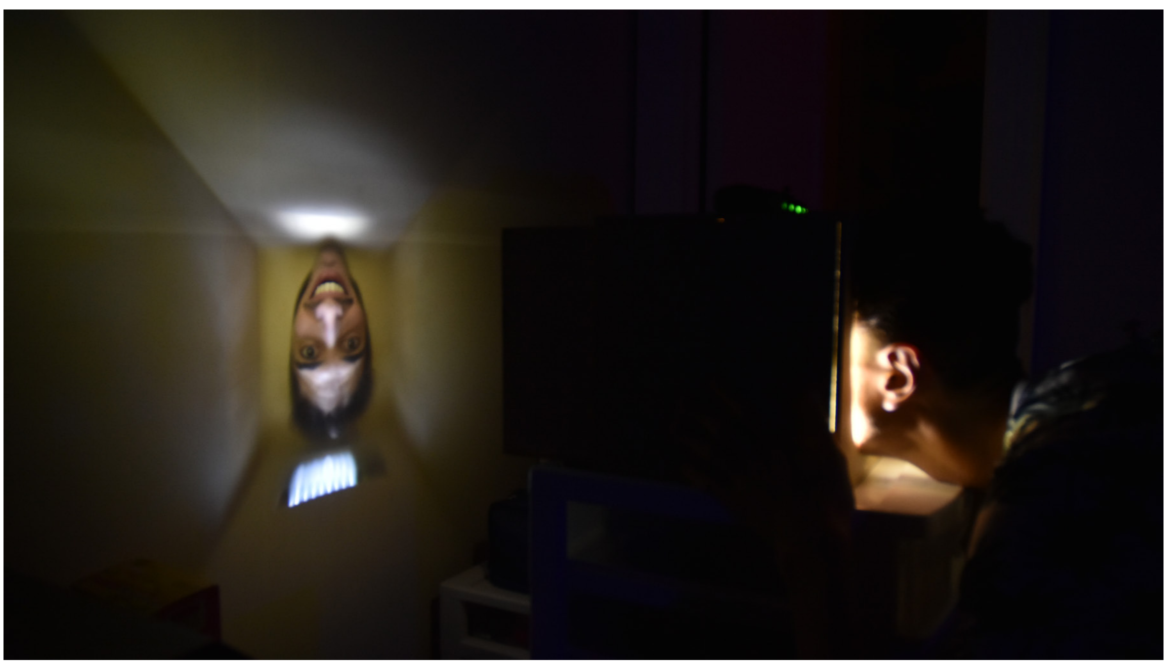


Figure 45 - Image of authors face being projected onto a wall using the projection box with an LED light on top to provide light for t he projection.

This simple projection instrument inspired a slew of experiments for this thesis conducted with different materials and tools. The idea was to start small and increase the size of the experiments to understand the implications, light, optics, and what this living image could offer architecture at any scale. For optical equipment, I was limited to personal camera lenses and store-bought optical lenses that could be combined for different focal distances. For the experiments, cardboard boxes were fitted with different lenses and pinholes to study the effects caused. [FIG 46 & 47] After testing different lenses, I saw several possibilities of where I could take these experiments. With one of the experiments sitting on its own, I noticed that the stray light coming into the box was creating rudimentary lines of light inside since there was no screen to capture. These light rays inspired an opportunity to somehow reimagine an existing space with these rudimentary lines. [FIG 48 & 49]

Figure 46 & 47 - Cardboard camera expirements conducted by author. in the left image are the three elements that allowed the view on the right. The carboard box with the tranlucent screen is slid in the box with the lens to provide the image.

Figure 48 & 49 - Image of viewer with magnifying lens by author.

When the viewing box was removed, the author noticed something interesting. The image still wanted to be projected, but there was no longer a controlled surface to display a view. So now the image is splayed across the box in these rudimentary lines of light and colour.

The next step was to make a larger camera obscura, something that could be inhabited and possibly dynamic. I started by using rigid plastic pipes to create a 7-foot by 7-foot cube frame with a dark blanket to make it lightproof. [FIG 50 & 51] At first, there was a foldable plywood face for adaptable lenses and lens placement, but it proved unsustainable for future portability. So the front and back faces were now adapted to have tarps velcroed on them to replace the plywood. [FIG 52] The cube was also a little unstable, so light concrete feet were made to stabilize the Obscura. When experimenting with lenses, I found that a convex and concave lens at 75mm in diameter were ideal for projecting at these long distances. [FIG 53 & 54]

After experimenting with different lens elements and finding the proper distance between the two to enable proper focus, I created a body to house them. Setting up the Camera Obscura in front of the proposed site allowed me to see and sketch any rudimentary lines of light or shape. [FIG 55] The intention was to sketch over the drawings done in the Obscura to see if any plans or elevations could be abstracted. While sketching in the Obscura, the sketches could already start to be abstracted as plans or even massing. [FIG 58 & 59] Although this experiment was valuable and curious, the drawing brought this dynamic process into something static.

Figure 50

Figure 51

Figure 52

Figure 53

Figure 52, 53 & 54 - The top imgae is the old plywood method that was replaced by a velcroed tarp in seen in FIG 56. The two images on the right are of the author playing with the focus inside the Obscura.

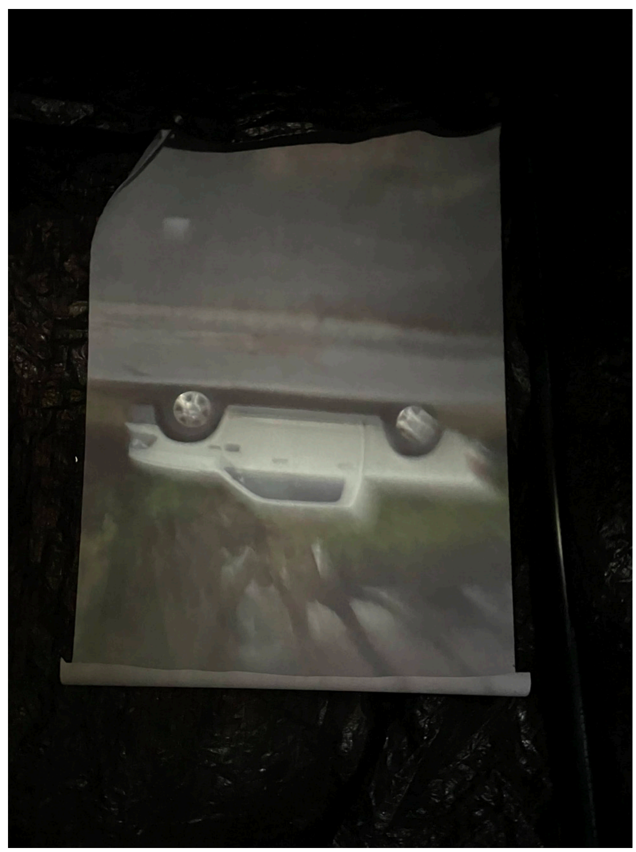


Figure 54


Figure 55


Figure 56


Figure 57

Figure 55, 56 & 57 - The top two images are of the velcro system used instead of the plywood and helped create a tighter lightseal. The image on the bottom left was taken inside the Camera Obscura on site at Dynamic Earth.

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Figure 58


Figure 59

Figure 58 & 59 - These images are of sketches done by the author inside the Camera Obscura at Dynmaic Earth. The drawing that were created had an architecural form to it but that wasn't what was needed for this design process.

Initially, the next step was to draw over the sketches and visualize possible plans or shapes on the site. However, this no longer felt like the appropriate step after further analyzing the results of the larger Obscura. The ambience and imagery created inside the Obscura were decidedly an aspect needed in the final design. With that decision, the next opportunity was to use the information gathered on optics and the evolution of the camera to design aspects of the building that add to its functionality through examining cameras, light, and optics and how these elements could provide a beautiful and dynamic architectural space. So the next step is to analyze Dynamic Earth and see how one could apply the arrangements of optical elements into a structure that works well with the site.

4.2 A Site best suited for Arts and Science: Dynamic Earth

When searching for a site, the initial criteria was to find a space surrounded by nature and overlooking Sudbury. Then, the idea was to pick a few sites to explore and bring the large Obscura to carry out experiments. One site I found intriguing is Dynamic Earth, which is one of two science learning centers in Sudbury owned by Science North. Science North is just a general learning center for science and exploration. Dynamic Earth is on top of a large rock formation to be Sudbury's earth sciences and mining history museum. After exploring Dynamic Earth, I found that it was the more accessible site and the untouched, relatively flat rocky areas around the building seemed perfect to host a new building. From the parking lot, there is a trail leading to the bottom of a 10ft rock formation and right below the Nickel. This location stuck out perfectly and has a great view looking from North to West and excellent sun exposure.

Now with Dynamic Earth being a geology and mining museum, they have a simulated mining experience that brings people through the evolution of mining technology and also simulated blasting. In order to do this, this tour takes place in the tunnel a couple of hundred meters underground. Since Dynamic Earth has already excavated a lot of rock and earth, it would not feel right to dig out more for this project. So from the inspiration of the first field photography setup, the proposed artist residency and exhibition space will sit on stilts, gently hovering over rock, counter playing on existing conditions. [FIG 60]

Originally the optics exhibit was meant to be directly connected to the artist's residency, but there was an unused building on site at the end of the parking lot that was more suited for this purpose. Laurentian University has a research tower on that site run by Professor Dean Millar in the faculty of science, engineering, and architecture. [FIG 62] The building houses an experiment for an air exchange process for mining purposes, but the project is currently on hold, so in the case of this thesis, it will be repurposed for the optics exhibit. The appealing part of this structure is that a shaft in the center connects down to the Dynamic Earth tunnel. Since this project focuses on light and controlling where it goes, the shaft seemed like the perfect method of bringing natural light back into this space that never sees daylight.

Figure 60 - A map of Dynamic Earth and the Big Nickel, as well as the proposals for this thesis. This map shows both above ground public paths in red and the underground tunnels for Dynamic Earth in orange. Periscope Tower can be seen off to the right of the Artist Residency.

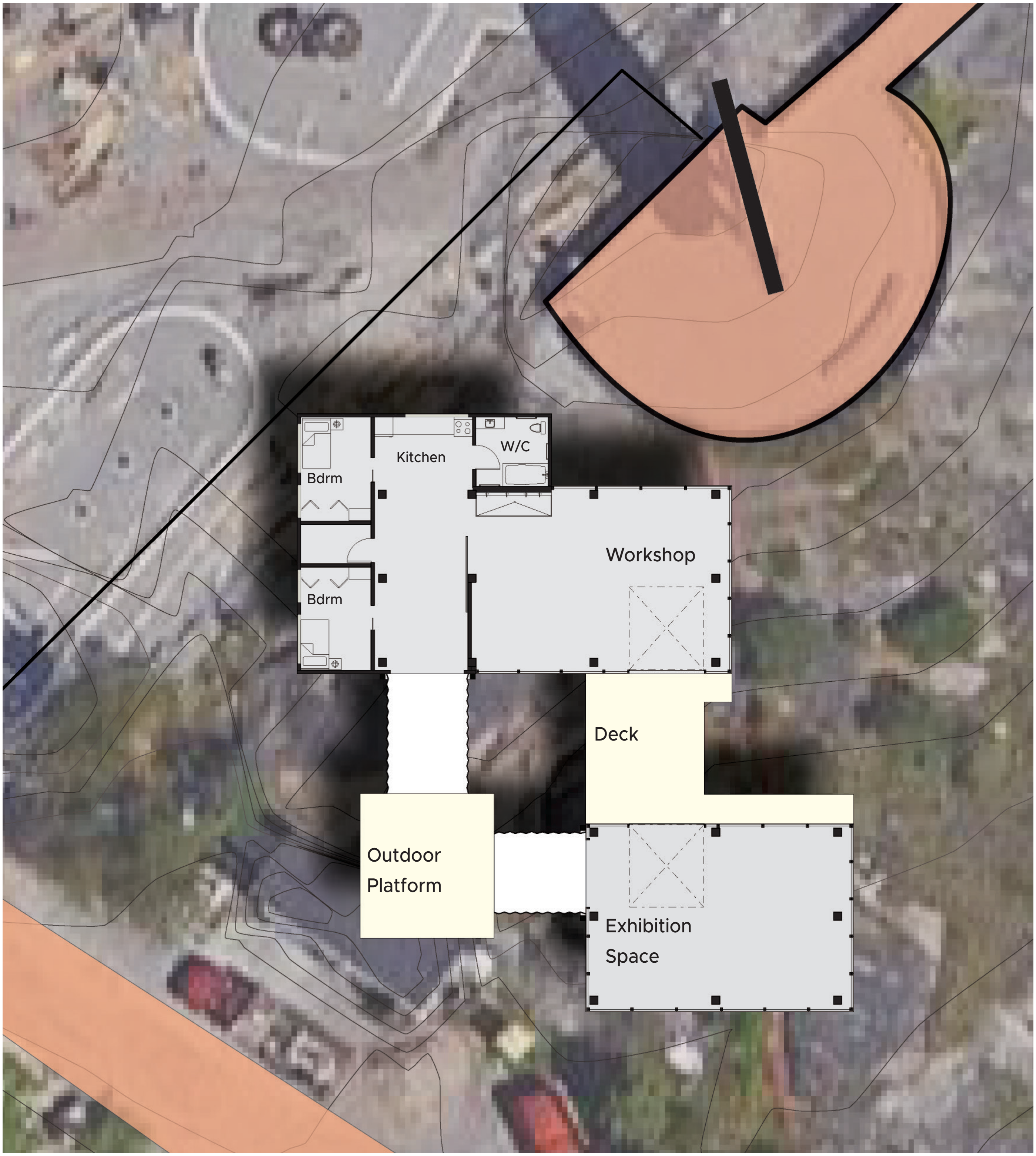


Figure 61 - Plan Drawing of Artist Residency by Author.

4.3 The design and Daylighting elements

To restate, the intent of this proposal is to have an artist residency as the main program and an exhibit on learning light and optics as the secondary program for this thesis. The artist residency will have 2 bedrooms, a bathroom, a kitchenette, a workshop, and an exterior exhibition space connected by a bridge. [FIG 61] The workshop and exhibition space were designed to be identical for a variety of reasons, one of which being that the artist can experiment in one space and present the final in the other space. The repurposed research tower will be across the artist residency at the edge of the parking lot. For this thesis it will be named *The Periscope Tower,* and its purpose is to teach people about optics and light, and to bring light down into the existing tunnels of Dynamic Earth.

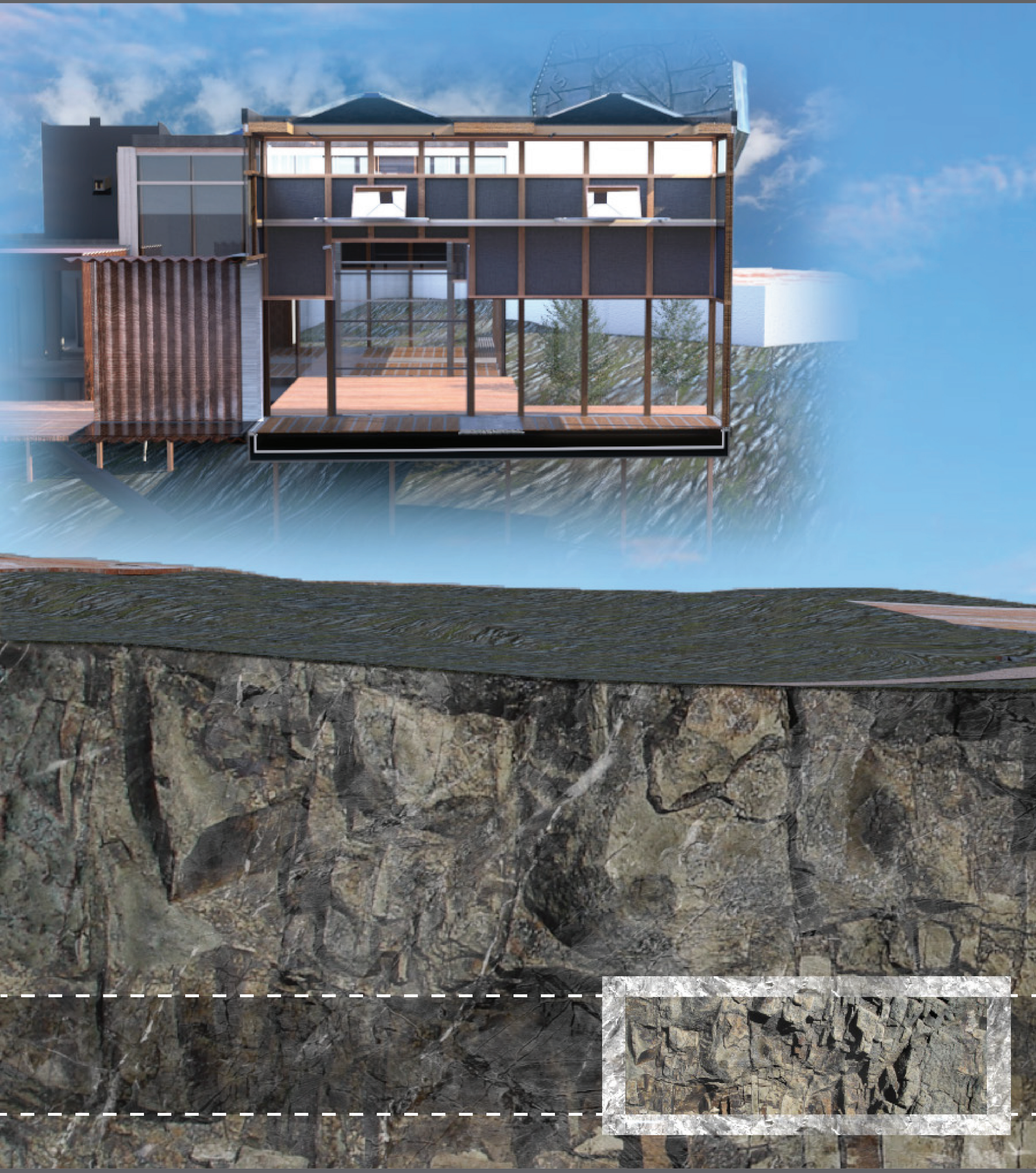
The Periscope Tower

When touring Dynamic Earth and the current research tower, I did not expect to find that the two were connected. The tower was a research project conducted by Laurentian University to test a method of air exchange. While it was a research tower, a large pipe ran down through a shaft into a tank at the bottom of the mines. The structure has six windows in the tower portion and one in the vestibule; the structure was clad with corrugated steel, and the interior was an uninsulated bare steel structure. To start, the structure was re-clad in a light-coloured cedar to match the artist residency and to contrast Dynamic Earth's darker main building. The interior now has solid exterior walls and the option to block out the windows with panels that match the interior walls.

Figure 62 - Image of the Laurentian Research tower by Author.

Figure 63 - On the next page is a section of the mines and the periscope tower. The distance between the tower and the artist residency was too large to fit both structures in the same section so the artist residency section is seen floating in the top right.

The undergorund mines in the section are highlighted at its openings in white stone and the hidden paths in dashed lines.



Since the space is now a blank canvas, the future of the tower could hold a floor or two, teaching different aspects of optics and the movement of light. For now, the tower will be retrofitted with two permanent daylighting and optical tools. The first is a translucent pipe that goes from the top of the tower into the mines of dynamic earth. [FIG 64] The roof will have a large rotating periscope head with three mirrors inside to assist with the collection of light down into the pipe. The periscope will sit on angled windows that point down onto a slatted aluminum ceiling. The light pouring down will then hit on a reflective bowl that bounces the light off the aluminum ceiling, brightening the pipe even more. [FIG 65]

The following piece is a more miniature periscope within the larger one, which travels down through the translucent pipe and into the mines. In an architectural section, we see that there is also a mirror at the bottom of the smaller periscope to aid in the projection of Sudbury down into the mines. This smaller periscope has turned the tower and mines into an active camera obscura and is projecting what it's seeing from the top of the tower down onto an angled platform in the mines at Dynamic Earth.

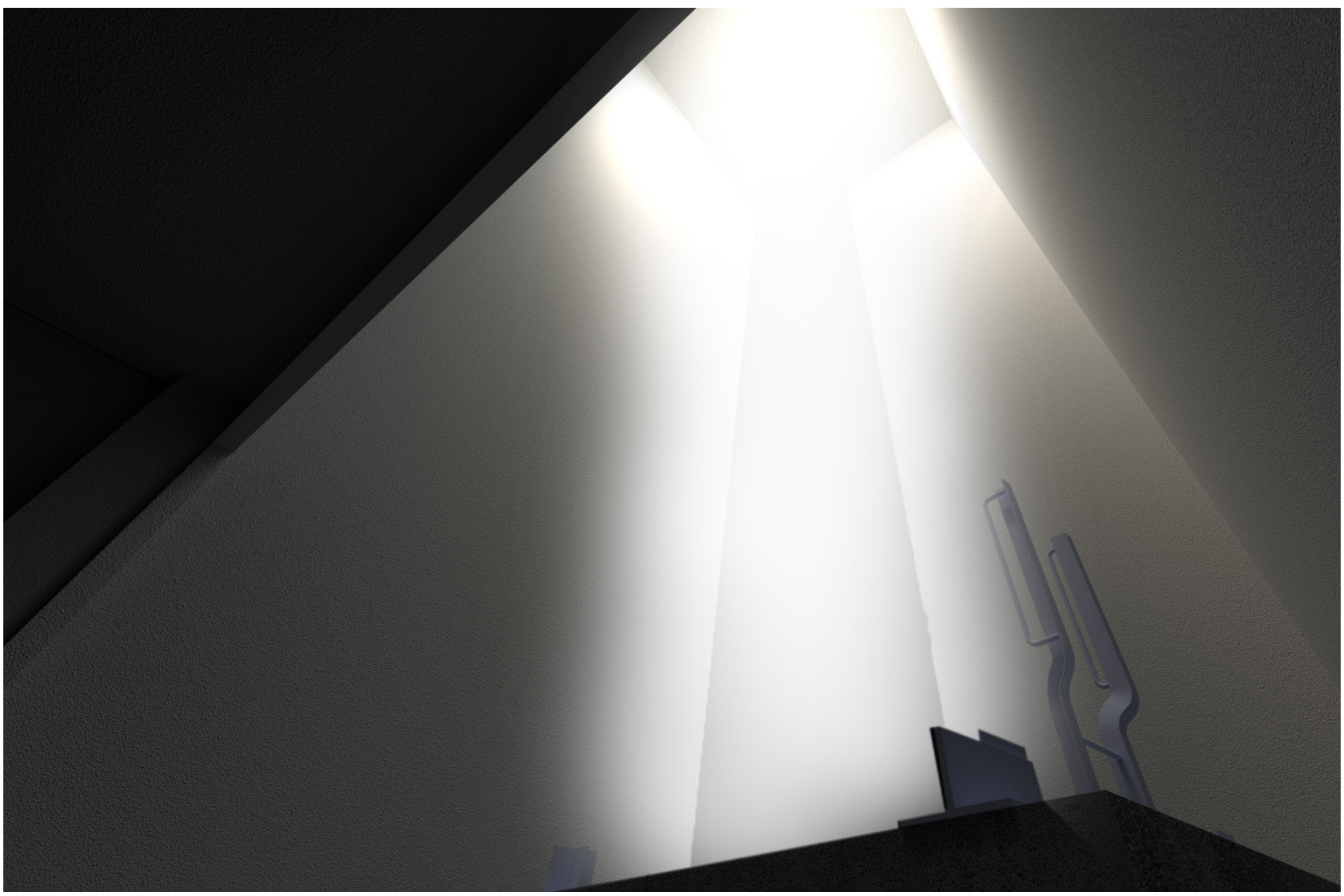


Figure 64 - Interior render of Periscope Tower by Author. In this render we can see the tower is being brighten by the translucent light pipe.

Figure 65 - Section of Persicope Tower by Author. In this section, you can see the interior periscope going down into the mines to project an image. We can also see the fully enclosed space full of natural light from both the pipe and glass ceiling.

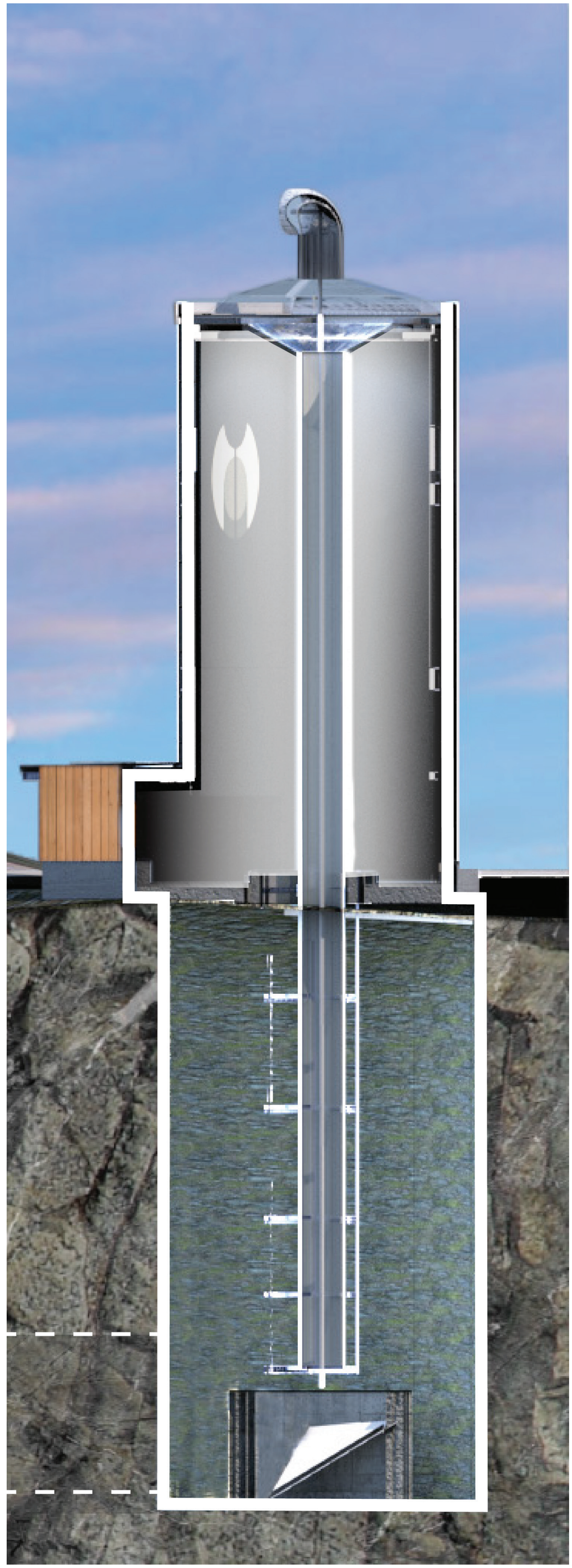


Figure 66 & 67 - Exterior renders of The Camera by Author. In the top image we can see the building sitting on stilts and how it connects to the Tripod platform. As well we can see the Viewfinder sitting on top to help achieve the camera aesthetic. The bottom image is a closeup render showing how exactly the Tripod platform is connected to the rest of the spaces.

Artist Residency

The residency and studio, named *The Camera*, will be placed just in front of the Big Nickel and will repurpose a pathway that was once the spot for the Big Penny. As mentioned in Chapter 2, the structure is designed so that the building's exterior aesthetic evokes the feeling of an early photography setup for shooting and development. The main two structures of the residency have been placed on stilts as if they were stands for a camera; the purpose here is to avoid as much damage to the rock and nature as possible. Adjacent to these main residency structures, there is a platform that serves as a showcase for art and a means of contemplating the art being displayed. [FIG 66]

Getting to the platform from either space felt like a challenge at first. There was a want to reach the platform like an old fold-out camera, similar to the Folding Pocket Kodak No1 [FIG 17], and have an accordion fold out to the tripod, yet I was uncertain about the practical aspects of the doors. After analyzing the forms of cameras, I realized I could use the door from the inside and have it perform as a bridge. When the door rotates down, the accordion folds out to the platform, transforming the look of the building into one which resembles a camera. [FIG 67] The accordion door of the residency space faces down to a spot underneath a large camera viewfinder. This viewfinder design is an homage to the waist-level viewfinder of some SLR and TLR cameras.

The design here works like a waist-level finder where the cover pops up to face forwards. The front face can only open and close, and a mirror is rotated outwards when it is fully open. [FIG 68] There is a mirror because the front face has a lens in the middle to project the view down onto the floor or anything an artist would want. One could imagine the artist placing a mirror under the Viewfinder to pass light or an image into the workshop space but then continuing to bounce that free-moving light and then maybe into the ceiling or even to the other space.

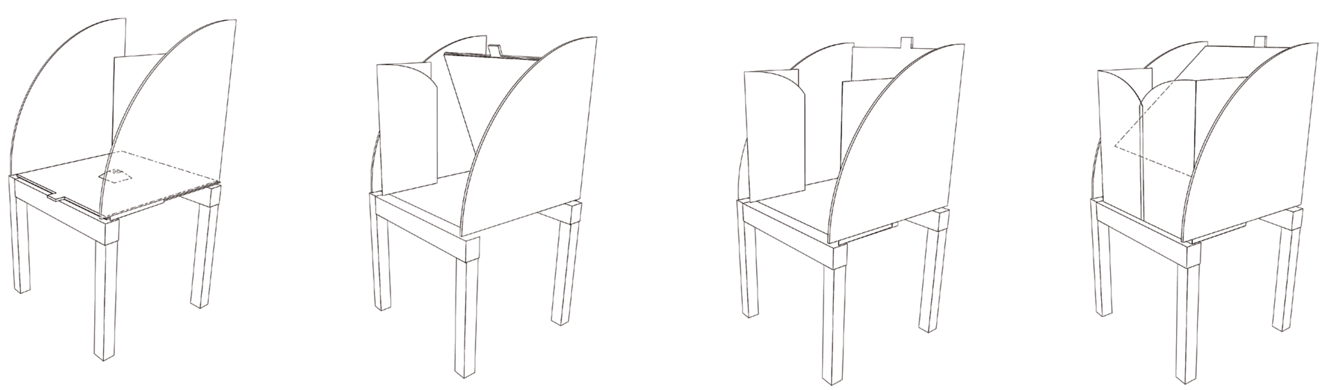


Figure 68 - Diagram of the viewfinder ceiling by Author. From left to right we can see how the system operates. The face with the lens pops up to face outward while the mirror also props out on a 45-degree to redirect the view downwards. The back of the unit is then closed by two doors to ensure no unwanted light to leak in.

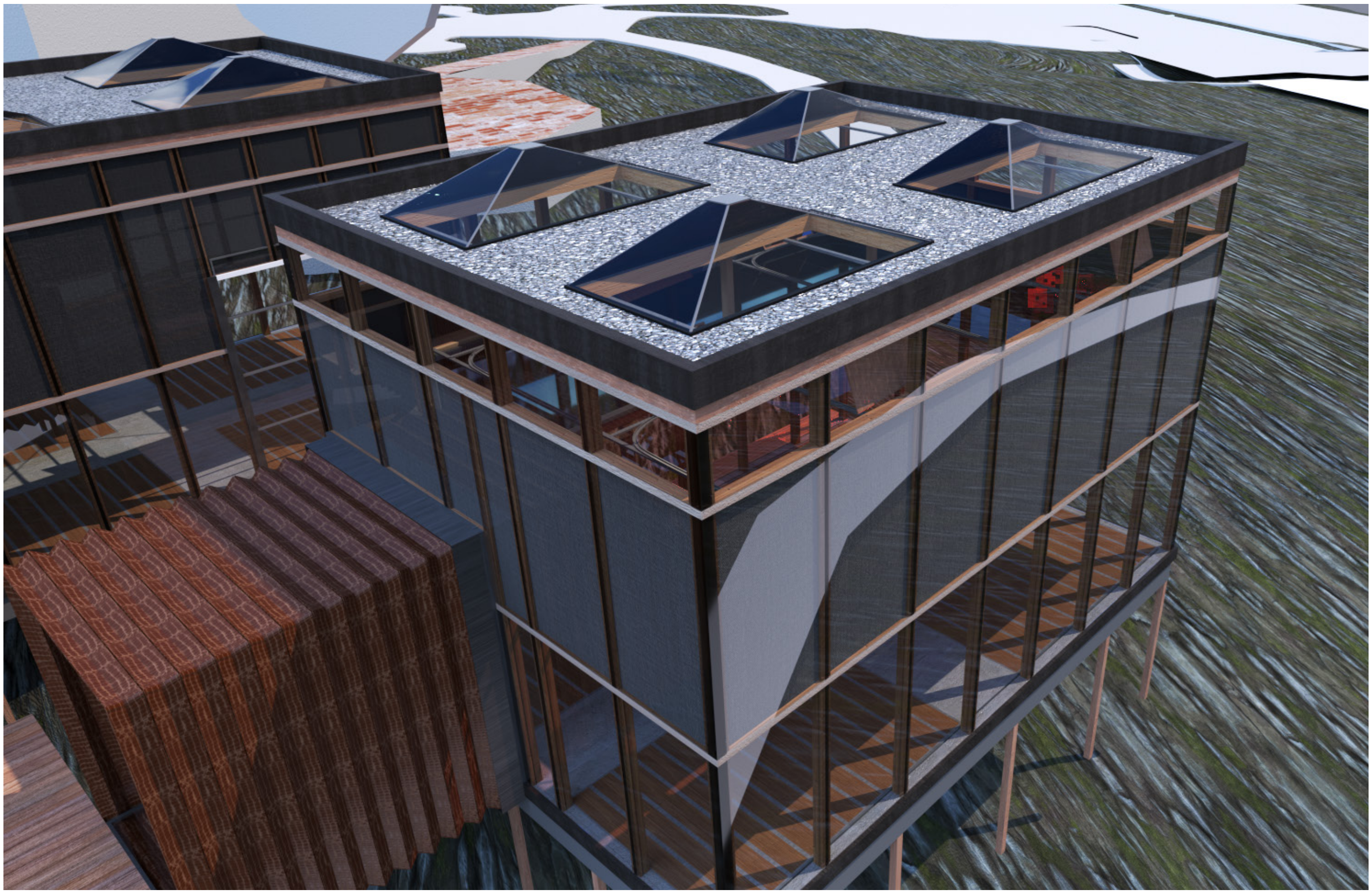


Figure 69 - Exterior render by Author showing the skylights anad curtain wall system.

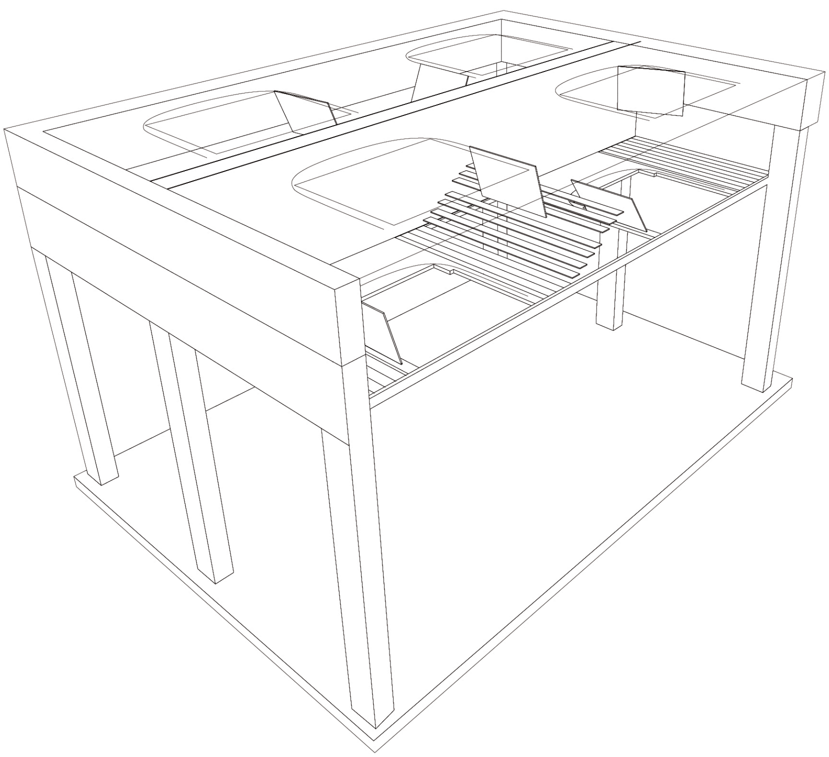
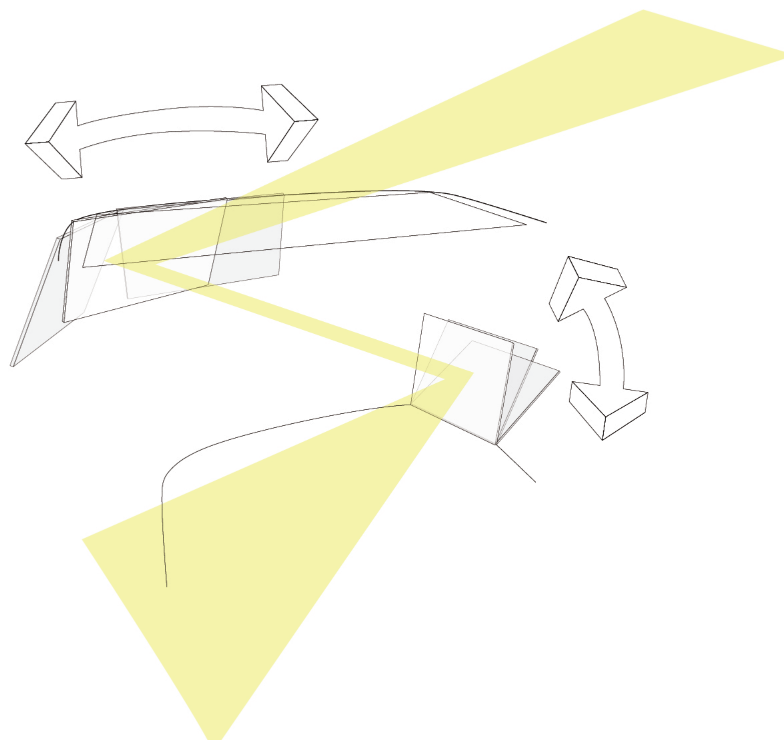


Figure 70 - In this Diagram on the left by the Author, you can see the mirror system as well as the paneling system used in the 6ft cavity in the ceiling.

The Workshop and Exhibition Space

The two spaces have been modelled almost the same with the exception that the Northwest corner and western wall are not fully glazed. The same corner also has a large sink that would be useful for any artist. Two folding walls can also enclose the corner if the artist wants to develop film in the sink. The working space is 20ft by 30ft and 20ft to the ceiling, fully glazed with three levels of glass, the first two with dimensions of 8ft by 4ft and the top level of windows being 2ft in height. All glass panels have operable curtains that slide down a track like a camera darkslide to ensure total darkness in the space. Now for modularity, there are also grooves on the ground and in the mullion above the window so that an artist could slide any sort of material in front of the glass. As for the structure's ceiling, four large rectangular skylights are placed in the middle of each quadrant of the roof. All eight skylights are designed to the same size, orientation and angles; the north-facing window is at a shallow 15-degree angle, while the other three windows are at a steeper 65-degree angle to allow for greater sun exposure inside. [FIG 69]

Figure 71 - Diagram of the mirror system by Author.



Now 14ft up in this structure is the start of a 6ft cavity that occupies the upper portion with more methods of lighting. Running down the length of the building in the middle and on the sides are support members for two different systems. The first is the ability to add panels to the wooden members for any atmospheric value that would want to be added, like coloured or opaque panels. [FIG 70] The next system can be analyzed by isolating the skylight. Under each skylight is a track on the ceiling and wooden supports, and on each track is a rotating mirror. [FIG 71] The artist could reposition the mirrors individually as the sun passes by to create different lighting conditions. For example, one could imagine some of the windows being blocked by mirrors to expand on the reflections coming from the ceiling. This mirror system was inspired by how some cameras can use a series of mirrors to control the reflected light.

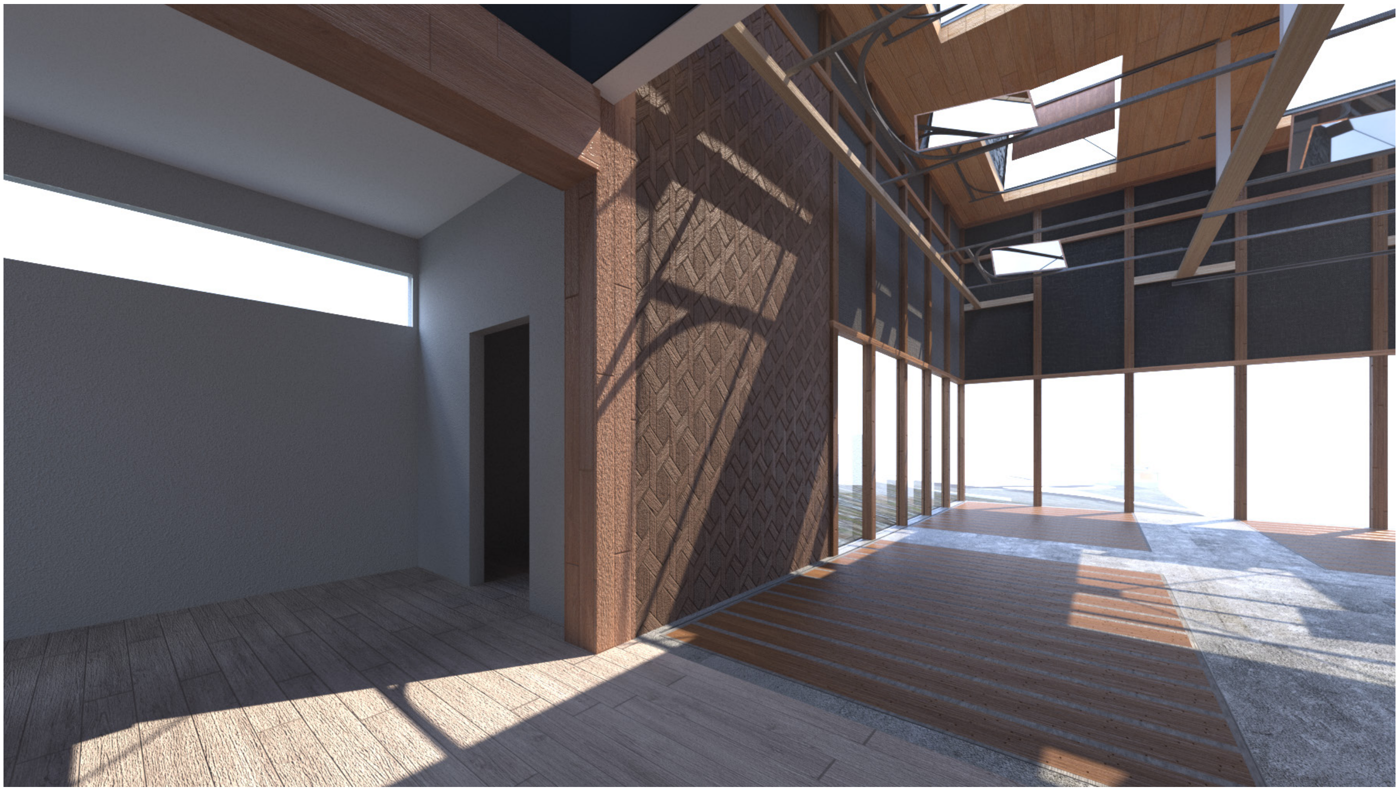


Figure 72 - Interior Render of the Kitchenette and workshop space.

Figure 73 - Interior Render of the workshop with a view towards the exhibition space.

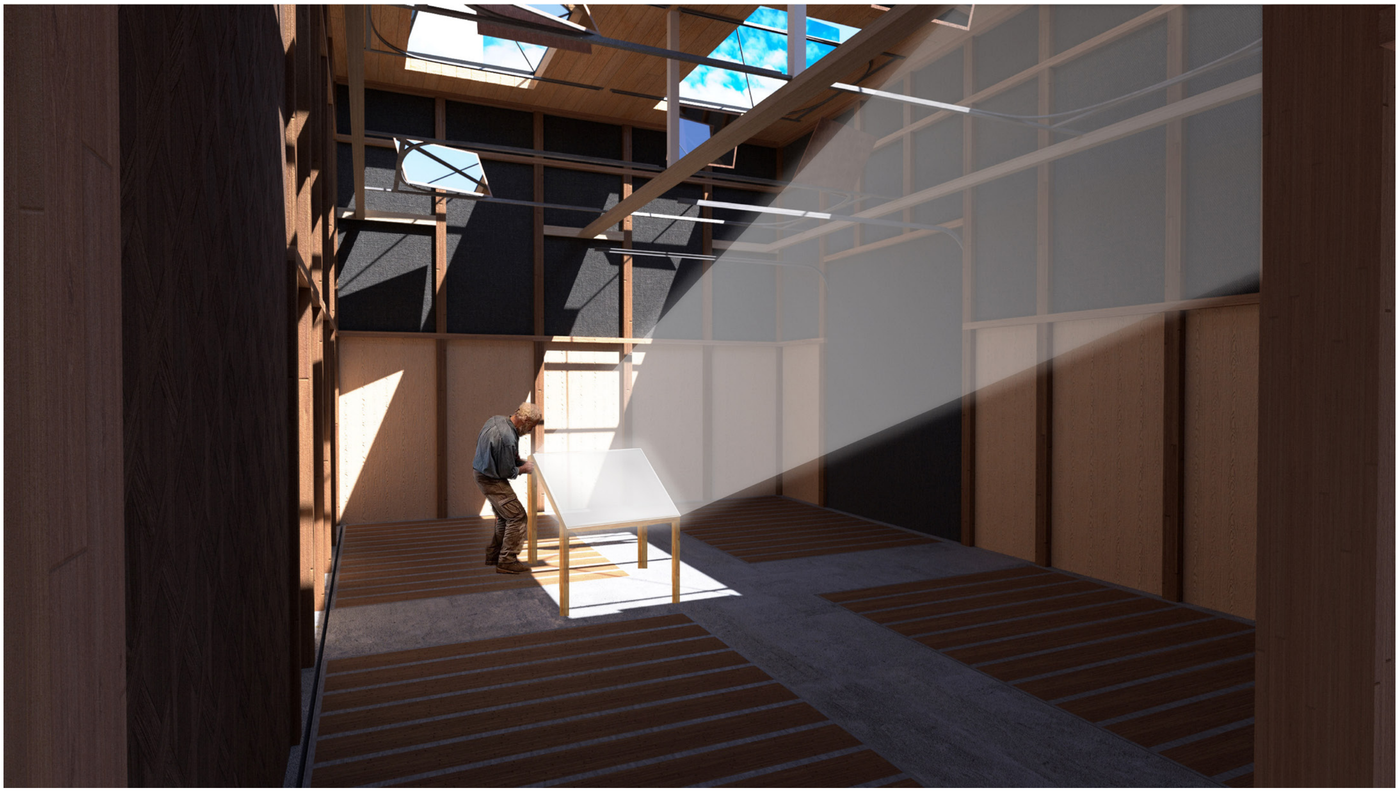


Figure 74 - Interior render of the workshop with a theoretical artist at work.

Figure 75 - Interior render of the Exhibtion space when playing with the colours of the glass panels for ceiling cavity.

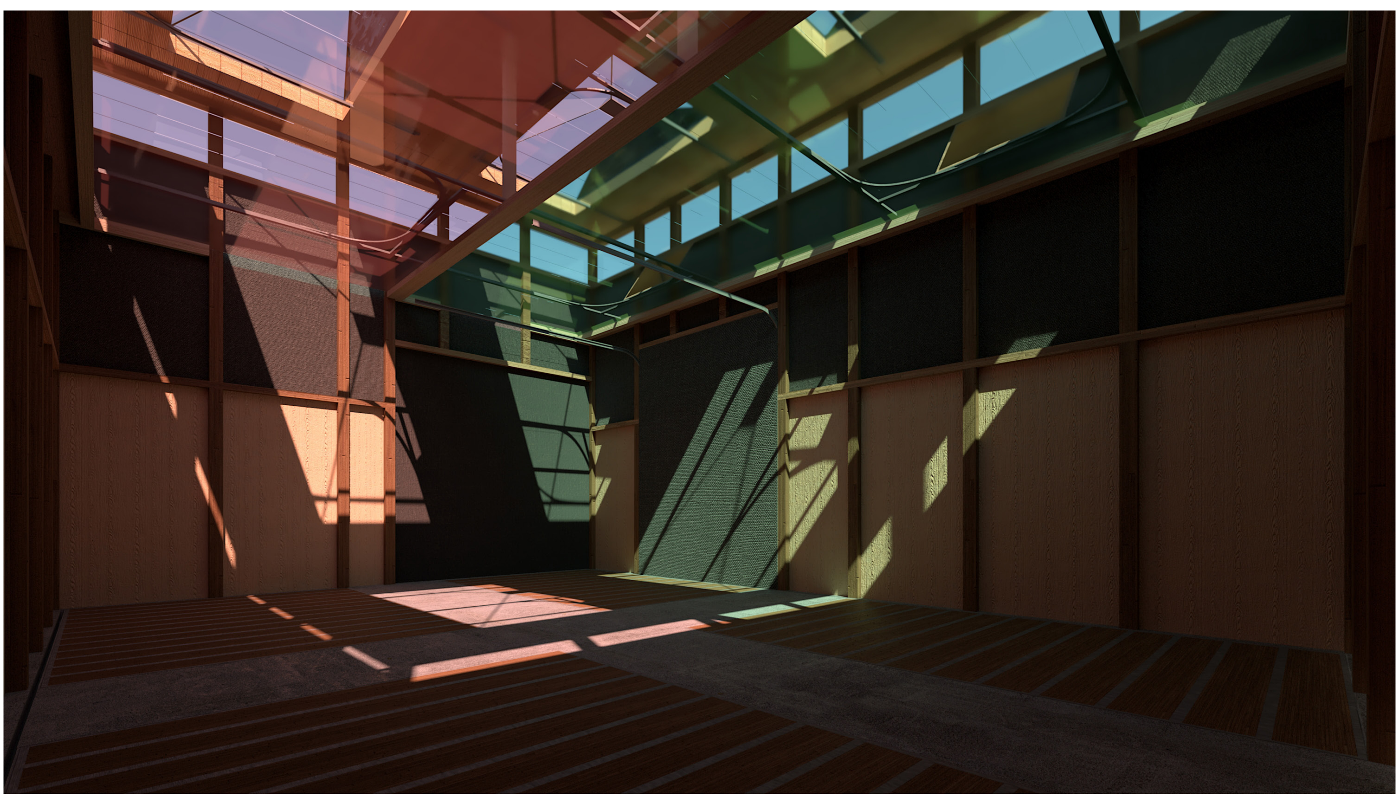
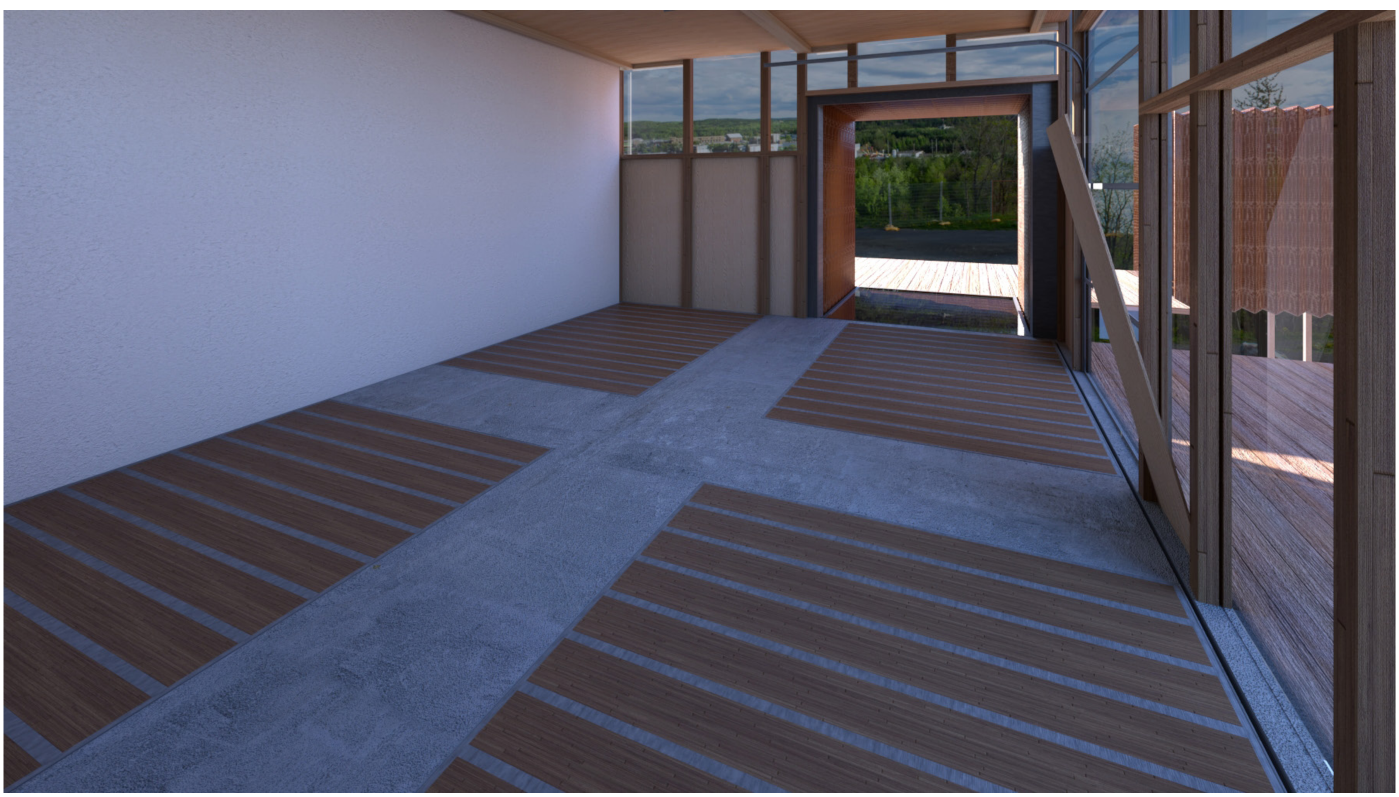


Figure 76 - Interior render of the exhibtion space preparing for a Camera Obscura type photo. On the back wall a projection screen is ready while the basin is filled with the proper chemistry to later develop. Once the room is dark, the photosensive material is placed over the projection screen and exposed to the camera obscura effect, to then be put through the developing basin.

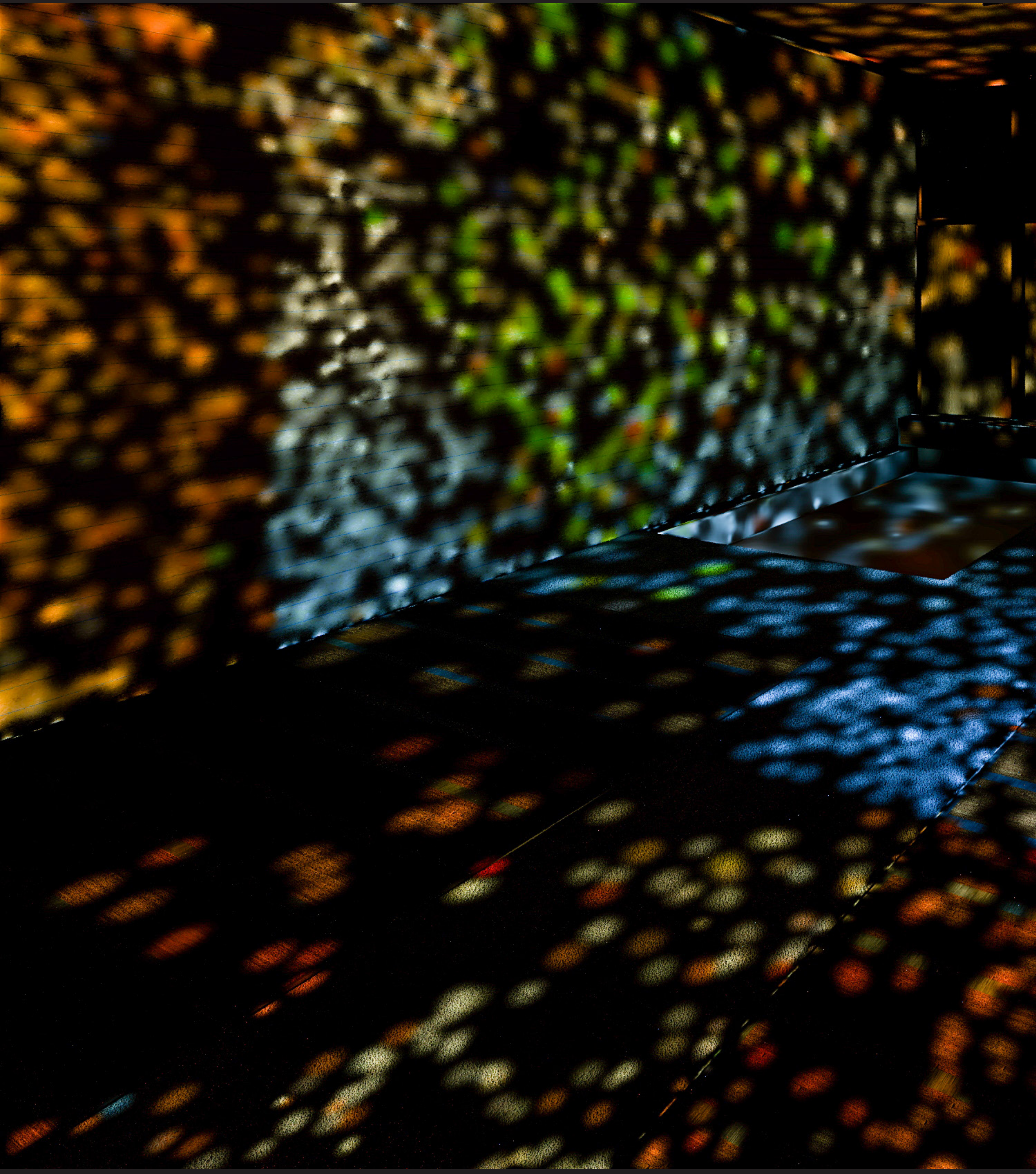
Figure 77 & 78 - In this bottom render the we can see the opaque ceiling panels and wooden window panels being put in. With the wooden window panel a lens could be added like seen in the image on the right,to help with the imaging. Otherwise, as we can see the building is fully blocked out from light in this state.

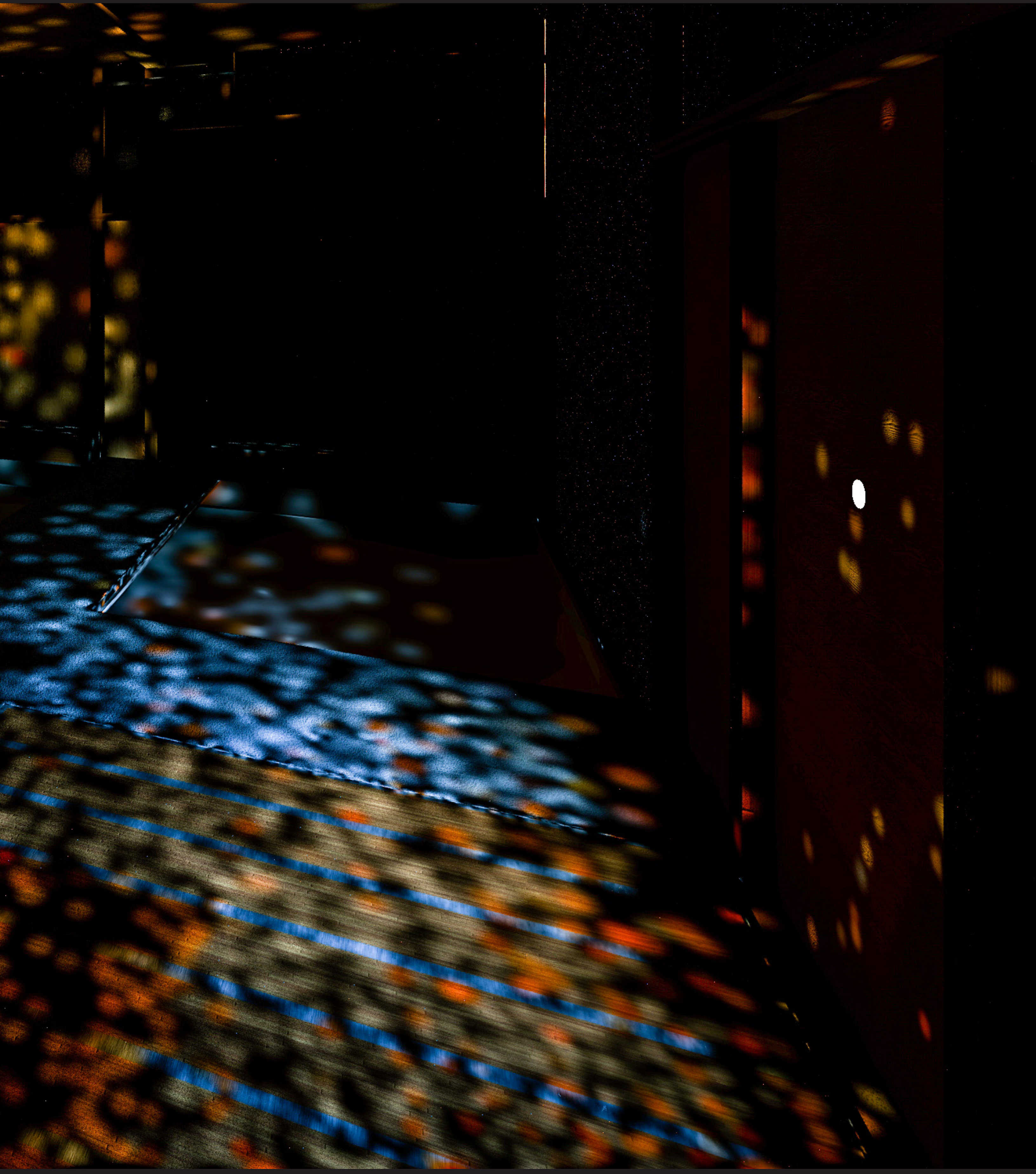


The space as a camera

Your Camera artist residency has invoked many aesthetics and technical qualities of a camera that it is very close to functioning like one. Like many early photographers, some professional photographers in the mid-1900s developed their film on site with a small developing kit or sometimes a camera that could take the photo and develop it inside the box. So that means there would have to be a method within the floor to allow the additive of chemicals and the processing of large photo paper. For the artist to move around the space without going into the tub of chemicals, the floor will open up in the four corners creating a 4ft wide bridge that forms a cross within the space. Then there is a channel allowing the paper to pass along the bottom perimeter around the tub. The top perimeter will have a pulley system to attach the photo paper to so it can be processed and developed through the tub of chemicals. [FIG 76]

To ensure this building works like a camera we were able to conduct a rudemntry test in computer aided modeling and rendering. If we were to place a piece of photo-paper on the wall the structure is at the start of being ready for a photo. The space is then fully darkened by the curtain's closing, plywood panels blocking the first level of windows and opaque panels on the upper members. [FIG 77 & 78] Now that space is fully enclosed, there is pure darkness but if a two inch hole appeared in the a wood panel then what would happen on the interior. If we look at image we can notice the trees are the greenry in the scene and if were to render the space with this aperture we achieve a rendered Camera Obscura. [FIG 79] [see next page] Due to limited software capabilities the rendering of camera obscura isn't how it would appear in real life, in fact it would be as clear as any regular image.





Conclusion

In conclusion, this project, The Camera & Periscope Tower, will attempt to evaluate light in architecture through a camera's lens and various optical components, which in turn affect the spacial quality and aspects of the various rooms and spaces of the project. It will showcase intensive research through making and experimentation with optics at an architectural scale. The Camera Obscura, a device which has changed throughout the centuries for scientific and artistic purposes, provides a valuable lens for understanding the uses of light. Its use of light changed throughout history to become even greater each time. Starting as just a projection in a small dark room to a tiny box that captures images. However, every discovery and light transition in between was monumental to the discoveries presented in this thesis.

In order to get there, the histories and knowledge of optics and the functionality of light were studied as the basis for the theoretical framework behind this thesis. Since the finding of the Camera Obscura in the 11th century, the camera has evolved into the typologies that we see today and has served as the basis upon which this thesis is built and designed. Cameras have proven to be essential tools in various subjects and sciences, as well as the arts, and as we see them now, as a tool for creating architectural concepts and spaces. However, their uses as tools for the architectural process are not well known despite their usefulness. This idea would serve as the methodology for the proposed project. Said project is to be located in Sudbury, Ontario, on Science North's Dynamic Earth and Big Nickel site. Dynamic Earth is a science center and geology museum exploring Sudbury's mining heritage through a simulated mining experience. Due to the elevated nature of the site and the connection between the arts and sciences, this area was deemed suitable. In order to further the connection between the arts and sciences, a proposed artist residency and exhibit on optics was designed.

The artist's space was crucial to the design since it needed to work for the artist, light, and both together, so more research had to be conducted. While there were case studies on a few architectural projects reviewed on light and the use of space, the most influential case study for this thesis was the works of Olafur Eliasson. With most of his projects being on light but mostly atmosphere, it was easy to understand the types of spaces an artist like him would need and how they work. The proposed artist residency includes living quarters for one to two artists, a studio workshop and an exhibition space, adjustable to suit the artist's needs. Adjacent to the artist residency and making use of an existing Laurentian University research tower, the exhibit of optics provides a flexible learning space in addition to a periscope inside a light pipe. These two buildings provide a space for continuing exploration and learning in the arts and sciences of optics.

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Figure 80 - The final render presented here is an exterior shot of the artist's residency but collaged with a Camera Obscura project by Olafur Eliasson.

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