

HAWAIIAN HEALING CENTER:
A WEAVING OF NEURO-ARCHITECTURE AND CULTURAL PRACTICES

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ABSTRACT

Architectural design and neuroscience at first glance may appear to be two seemingly different fields but for centuries intuitively, architects have been designing based on the principles of neuroscience. Architects through trial and error have gained knowledge of specific architectural elements and the potential these elements have to affect the user. Recently this intuition has been coined “neuro-architecture”. With the advancement of technology neuroscientist can accurately conclude how the human body will react to specific architectural stimuli. The proposal is focused on encouraging and furthering the symbiotic relationship between architecture and neuroscience in an attempt to promote architectural design that moves and elevates the human condition.

The purpose of this thesis is to investigate the findings of neuroscience and promote their implementation into architectural design, creating a deeper understanding of how the human body relates to architectural surroundings. The methodology assumed closely follows the research typologies used in evidence-based design. The first is a literature review of the findings in neuroscience research and their application to architectural design. Second is an understanding of the anatomy of the body, the senses, and neurobiology as this is the basis in determining the body’s primal reaction to architectural stimuli. The final step of the process will be to create a prototypical design in which research findings bridged and reinforce the connection between neuroscience and architecture, resulting in a design that potentially has the ability to elevate the human experience.

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CHAPTER 1 . INTRODUCTION

Project Statement

The goal is to incorporate the findings of neuroscience into an architectural design. The design should be one that enhances the human conditions in respect to health, social interactions, and knowledge.

The story of how Jonas Salk and his cure for polio captivated my attention since my early architectural education. I was deeply fascinated with his story of how early in his career, when he was still struggling to find a cure for polio; Salk retreated to Umbria, Italy, to the monastery at the Basilica of Assisi. Salk would insist, for the rest of his life, that something about this place—the design and the environment in which he found himself—helped to clear his obstructed mind, inspiring the solution that led to his famous polio vaccine. I thought to myself “How can architecture have such a deep influence on person and their emotions?” and “How can we, as architects, understand this idea and apply it to our designs to create architecture which is not mundane but rather purposeful and meaningful?”

The best way to approach the project is to research and understand the findings of neuroscience in relation to architecture and the case studies in which these findings implemented. An understanding of the various architectural spaces which have been to evoke inspiration or a sense of enlightenment and the key features that promote such reactions is also important. The design process begins with the understanding of the different stimuli, which contribute to a heightened sense of enlightenment.

The goal of this thesis is to display the integration of two seemingly unrelated fields, architecture and neuroscience, and how this integration can lead to more meaningful architecture, which is not mundane and provides more than simply a structure for housing varying functions. If successful, I believe this could contribute to the existing knowledge in the field of architecture by providing a new way of

approaching design and understanding of how architecture affects us on a psychological level. The integration of these two fields is important because we as architects are responsible for creating spaces that will influence mankind.

CHAPTER 2. NEUROSCIENCE AND ARCHITECTURE

Emerging Field

Architecture and neuroscience have always been two vastly disparate disciplines, yet they share a common background. There has been a rich history of interest in both the field of architecture and that of the sciences. There was Imhotep (2655-2600 BC), the famous Egyptian considered by many to be the first architect, doctor, and engineer. Then there is Leonardo da Vinci (1452-1519), who is considered the original Renaissance man, whose contributions to both science and architecture are well known.¹

“The premise is to consider how each variable of the environment affects certain brain processes, that in turn, alter a specific outcome measures.”²

In early 2002 Inspired by conversations between Norman Koonce and Jonas Salk, leaders in architecture and neuroscience convened to explore these opportunities.³ With support of the American Institute of Architects (AIA) College of Fellows, John Eberhard, the 2003 Latrobe Fellow, founded the Academy of Neuroscience for Architecture (ANFA).⁴ The mission of the Academy of Neuroscience for Architecture is to promote and advance knowledge that links neuroscience research to a growing understanding of human responses to the built environment.⁵

¹ “Academy of Neuroscience for Architecture,” New School of Architecture & Design, accessed March 18, 2014, <http://newschoolarch.edu/academics/school-of-architecture/academy-of-neuroscience-for-architecture/>.

² Eve A. Edelstein, “Summary Report on Neuroscience & Architecture of Health Care Facilities: 2nd Workshop” (summary report of discussions held at the Second Annual Woods Hole Workshop on Neuroscience and Healthcare, Woods Hole, 2004), accessed March 18, <http://www.anfarch.org/wp-content/uploads/2013/11/NeuroscienceHealthCareANFA2004.pdf>.

³ Ibid.

⁴ “Mission,” Academy of Neuroscience for Architecture, accessed March 18, 2014, <http://anfarch.org/mission/>.

⁵ Ibid.

What is Neuro-architecture?

Neuro-architecture can be defined as built environment designed with principles of neuroscience, which establishes spaces that encourage memory, improve cognitive abilities, avoid stress and/or stimulate brain.⁶ Neuro-architecture merges the fields of architecture and neuroscience with the scientific goal of gaining a better understanding of the relationship between emotions and design by observing people's responses and measuring the relevant regions of the brain, including the cerebral cortex, which registers and expresses emotions, the hippocampus, which is responsible for memories, and the hypothalamus, which receives messages from other parts of the body.

Developments

Before the coined term neuro-architecture came into existence, there have been historic records examining the effect of architecture on the human body and mind. Sthapatya Veda is a set of architectural and planning principles, which strictly govern the orientation, and proportions of a building⁷, with the most important factor being the entrance.⁸ Sthapatya Veda design principles originated from ancient Vedic texts, and substantiate the knowledge of establishing a relationship between man and house.⁹ It includes design principles conducive to well being. Similarly, a 5000-year-old text, YiJing where the term fengshui originated, also delivers a set of principles to create harmony between building and man.¹⁰

⁶ John P. Eberhard, *Brain Landscape: The Coexistence of Neuroscience and Architecture* (New York: Oxford University Press, 2008).

⁷ Brandy Welvaert, "Vedic homes seek better living through architecture," *Rock Island Argus*, August 5, 2005.

⁸ Niall Toner, "Houses that boost health and wealth," *Sunday Times* (London, U.K.), July 27, 2007, 10.

⁹ Deepak Bakshi, "Understanding of Sthapatya Ved Knowledge," *Sustainable Sources*, 1996, accessed April 6, 2014, <http://sustainable-sources.com/understanding-of-sthapatya-ved-knowledge/>.

¹⁰ *Ibid.*

Distributed Neurosemantics

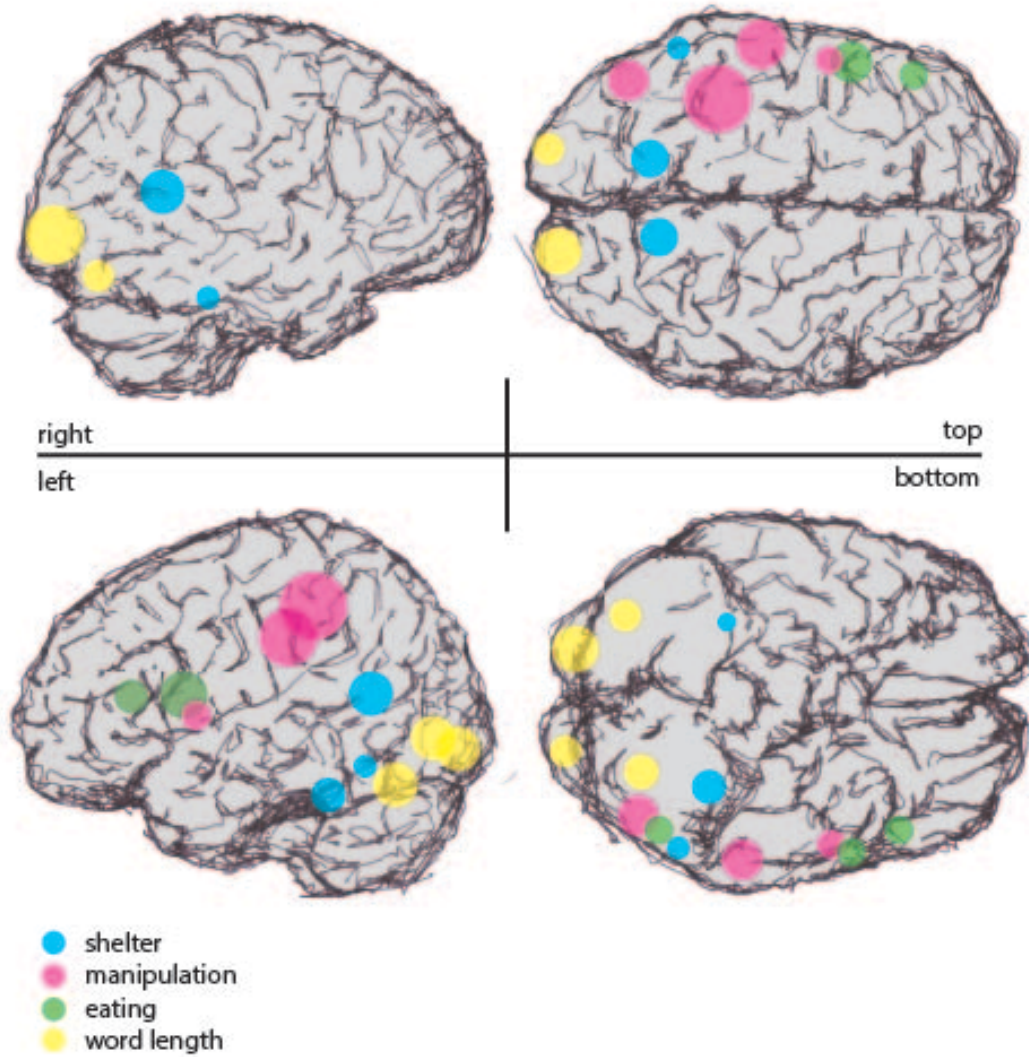


Figure 1 Distribution of Neurosemantics

[Data from <http://www.neurosemantics.com> | graphic by author]

Although the science or study of the relationship between man and architecture was not distinctively a field of study, a branch of knowledge that is taught and researched as part of higher education, it was an active study, meaning the relationship was studied through observation and participation outside an academic scope.

These early concepts and resulting design paradigms are closely related to environmental psychology and evidence-based design, and are derived from theoretical or observational techniques. Both fields are interdisciplinary, drawing knowledge from fields such as neuroscience, behavioral economics, architecture, and psychology, resulting in information that has been scientifically proven which explains the complex interactions between environmental factors and humans.

The study of neuro-architecture allows for an evolution in architectural design practices. Significantly, the purpose of neuro-architecture is to provide the answers to why an architectural space is able to provoke feelings of calmness, or awe, or how we are able to remember the smell of wet grass, the feeling of cool concrete walls, the sound of footsteps on hardwood floors, or the light as it passes through a slit in the ceiling.

Throughout history, architects and architectural theorists have attempted to provide meaning to architectural design. Meaning or understanding has been predominantly achieved through the lens of psychology, the social sciences, and observations.¹¹ Findings therefore tend to be subjective, interpretive, and qualitative. The study of the human brain, or neuroscience, attempts to give meaning or an understanding of the way our brain inputs, stores, and receives information gathered through our senses.

Neuro-architecture provides the link between how the brain processes information, the body's responses to external stimuli, and how this information is translated to inform architectural design.¹² The evolution of neuroscience, and introduction of neuro-architecture, presents the opportunity to reconceive perceptual and emotional attributes as objective qualities asserting to architectural design application. Neuro-architecture as a process addresses an opportunity, a reaction, and a projected outcome by providing the answers to why we react to certain conditions and spaces.

¹¹ John P. Eberhard, "Applying Neuroscience to Architecture," *Neuron* 62, Issue 6 (2009): 753-756.

¹² *Ibid.*

Although the field is relatively new, the use of neuro-architecture to inform building design is highlighted in an interview from the 2003 Fall issue of *Society for Neuroscience*, where Eberhard and Gage explains why architects and neuroscientists are beginning to work together.¹³

“Architecture has the most impact when the ideas used in building design reflect our understanding of how the brain reacts in different environments. Neuroscientists can help architects understand scientifically what have historically been intuitive observations.” - Eberhard

“Neuroscience has reached a point in its understanding of the brain and how it is influenced by the environment that neuroscientists can work with architects in their designs for environments that enable people to function at their fullest within those environments.” - Gage

Gage further explains that, “...changes in the environment change the brain, and therefore they change our behavior.”¹⁴ He argues that the brain does not stop growing during our 20’s as previously thought. Neurogenesis, or the growth of new neurons in adults, occurs in part by a changing environment.¹⁵ This information is available due to advances in technology within the sciences. EEG machines are able to peek into the human brain in order to understand how we understand the world. These advances in technology allow scientists to empirically understand how the brain reacts to a variety of stimuli, and therefore allowing architects to design for effective buildings. Neuro-architecture is not simply a design inspiration or poetic concept, it is a design tool.

¹³ John P. Eberhard and Fred H. Gage, “An Architect and a Neuroscientist Discuss How Neuroscience Can Influence Architectural Design,” in *Neuroscience Quarterly* Fall (2003), accessed April 6, 2014, http://www.sfn.org/~media/SfN/Documents/NQs/2003/NQ_Fall_2003.ashx.

¹⁴ Emily Badger, “Corridors of the Mind,” *Pacific Standard*, November 5, 2012, accessed April 6, 2014, <http://www.psmag.com/culture/corridors-of-the-mind-49051/>.

¹⁵ *Ibid.*

Architects including Juhani Pallasmaa, Steven Holl, and Peter Zumthor have expressed the importance of how the brain interprets information or stimuli in regards to architectural spaces and processes this data into an experience. The experience of architecture is therefore enhanced by the knowledge of brain function and interpretation. It is just another stepping-stone in the evolution of architectural design.

“Architecture articulates the experiences of being-in-the-world and strengthens our sense of reality and self...” - Juhani Pallasmaa¹⁶

Applications

The Academy of Neuroscience for Architecture (ANFA) since its creation in 2003, explores ways to link research conducted in neuroscience towards the practice of architecture. The ANFA has held a number of workshops to identify hypotheses derived from the functional requirements of healthcare facilities, elementary schools, correctional facilities, sacred places, facilities for the aging, and neuroscience laboratories.¹⁷ The workshops resulted in over 70 hypotheses, which have created the basis for current and future research. Through the development of these hypotheses, three main areas of application have been explored and implemented by professionals, including facilities for the aging, work environments and sacred places.

Memory and Alzheimer, Elderly

According to Alzheimer’s Association, alzheimer’s is a type of dementia that causes problems with memory, thinking and behavior.¹⁸ According to statistical figures, over 5 million Americans are living with the disease and an estimated 16 million will be

¹⁶ Juhani Palasmaa, *The Eyes of the Skin Architecture and the Senses* (Hoboken: John Wiley & Sons, 2005), 12.

¹⁷ John P. Eberhard, “Applying Neuroscience to Architecture,” *Neuron* 62, Issue 6 (2009): 753-756.

¹⁸ “Alzheimer’s Disease,” Alzheimer’s Association, accessed March 12, 2014, http://www.alz.org/alzheimers_disease_1973.asp.

have the disease by 2050.¹⁹ Architecture affects not only how we perceive the world, but also how we interact within it, and for Alzheimer's patients, design is a crucial element that influences behavior. For example, People with Alzheimer's disease who have private rooms containing their own personal objects exhibit less aggression and anxiety and fewer psychotic symptoms.²⁰

For two decades John Zeisel, president and co-founder of the Heathstone Alzheimer's Family Foundation and Heathstone Alzheimer Care, has been developing ways to improve the quality of life of Alzheimer's patients taking cues from such studies as mentioned above. His professional development has allowed him to link his training in sociology to architecture and neuroscience. Zeisel uses many of the neuro-architecture concepts to design specialized therapeutic environments, for instance, the use of familiar visual cues such as pictures to assist with wandering behaviors.

Another example is his approach of therapy gardens, involving patients with plants to strengthen the patient's memory, making them suggest the time/seasons with environmental modifications.²¹ Trezevant Terrace, an assisted living community with a resident Alzheimer's care home, located in Memphis, Tennessee serves as an example of these design implementations. Askew Nixon Ferguson Architects sought the advice of John Zeisel, in designing the memory care facility. The main feature of the facility is the easily accessible garden comprising a simple circular path. Zeisel explains, that gardens are crucial in helping dementia care residents feel less trapped and more attuned time.²² The circular path is also used as a tool to aid wayfinding. The path allows residents to explore and enjoy the outside surroundings while providing a visual element, which guides them back into the facility in the event they have an episode where they forget where they are or how to return to their private quarters.

¹⁹ "Latest Facts and Figures Report," Alzheimer's Association, accessed March 12, 2014, <http://www.alz.org/facts/overview.asp>.

²⁰ John Ziesel et al., "Environmental Correlates to Behavioral Outcome in Alzheimer's Special Care Units," *The Gerontologist* 43 (2003): 697-711.

²¹ John Zeisel, *Inquiry by Design* (New York: CUP Archive, 1984).

²² John Ziesel, "Environmental correlates to behavioral outcome in Alzheimer's special care units."

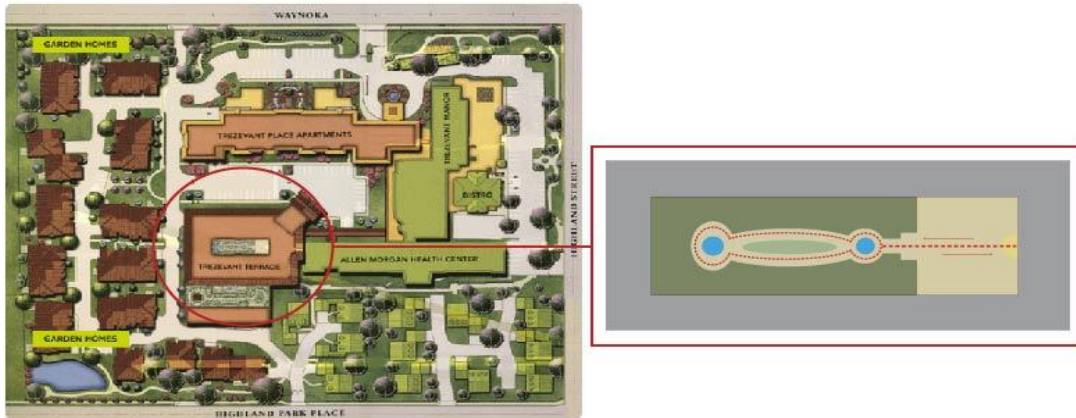


Figure 2 Trezevant Terrace Site Plan

[Data from Site Map, <http://www.neurosemantics.com> | graphic by author]

Work Environments

The Academy of Neuroscience for Architecture presents Salk Institute, which was designed by well-known architect Louis Kahn, as one of the early examples involving neuroscience in work environments.²³ Jonas Salk often shares his own anecdotal story about his personal experiences in his attempt of finding a cure for polio and his retreat to a 13th-century monastery to help explain how neuroscience impacted the design. Salk had reached a point where he felt intellectually stuck and retreated for several weeks to the Abbey at Assisi, Italy. Salk claimed that the architectural setting of the abbey was helpful in stimulating his imaginations and providing mental clarity that he created the concept for what would later become the polio vaccine as well as how to produce it.²⁴ Believing that the human mind continuously reacts to architectural settings and from his personal experience at the Abbey, Jonas Salk together with Louis Kahn collaborated in developing an environmental design creating workspaces that would enhance creative ability.

²³ “Genesis of the Salk Institute: The Epic of Its Founders Academy,” Academy of Neuroscience for Architecture, accessed February 8, 2014, <http://www.anfarch.org/news/genesis-of-the-salk-institute-the-epic-of-its-founders/>.

²⁴ John P. Eberhard, *Brain Landscape: The Coexistence of Neuroscience and Architecture* (New York: Oxford University Press, 2008).



Figure 3 Basilica of Assisi
[Photo by Aaron Logan, <http://www.buswelt.de>]



Figure 4 Salk Institute Courtyard
[Photo by Alfred Essa, <https://www.flickr.com/photos/tatler/>]

Salk Institute achieves this by providing spacious, unobstructed laboratory spaces that could be adapted to the ever-changing needs of science. Kahn flooded the laboratories with daylight, creating per Salk’s request, a welcoming and inspiring environment for scientific research.²⁵ The building materials chosen were concrete, teak, lead, glass and special steel, all which aided in creating the awe inspiring space envisioned by Salk.



Figure 5 Salk Institute Walkway
[Photo by author]

²⁵ “About Salk,” Salk Institute for Biological Studies, accessed February 20, 2014, <http://www.Salk.edu/about/architecture.html>.

Sacred Places

More than two thousand years ago, Hippocrates observed that our well-being is affected by our settings and throughout history, architectural settings have had profound effects on people, changing our mood, behavior, sense of security, and even spirituality. The human brain registers sensations through sight, sound, touch and elements of architecture such as natural light, nature, materials, and silence impact the human psyche.²⁶ Sacred places have served to soothe and inspire. Sacred spaces can be defined as any space that evokes special transcendent feelings within the visitor.²⁷ Thorncrown Chapel is an example John Eberhard uses to illustrate how design can impact the human brain and mind.



Figure 6 Thorncrown Chapel
[Photo from Photo Gallery, <https://www.thorcrown.com>]

²⁶ Esther Sternberg, *Healing Spaces: The Science of Place and Well-Being* (Cambridge, Mass: Belknap Press of Harvard University Press, 2010).

²⁷ John P. Eberhard, *Brain Landscape: The Coexistence of Neuroscience and Architecture* (New York: Oxford University Press, 2008), 11.

Thorncrown Chapel is located in Eureka Springs, Arkansas. In 1971, Jim Reed, an Arkansas native purchased land in Eureka Springs, Arkansas to build his retirement home. The property was located in the Ozark Mountains, where people would often stop to admire the natural surroundings. This inspired him and his wife to build a glass chapel, creating a space that would stimulate and emotional response in the visitors mind. The chapel was to be a place for travelers to rest, reflect, and refresh.

The chapel itself is only 24 feet wide, 60 feet long, and 45 feet tall and constructed of organic building materials. One of the main features of the chapel are the elaborate trusses, which provide a constantly changing pattern of light and shadow throughout the day.

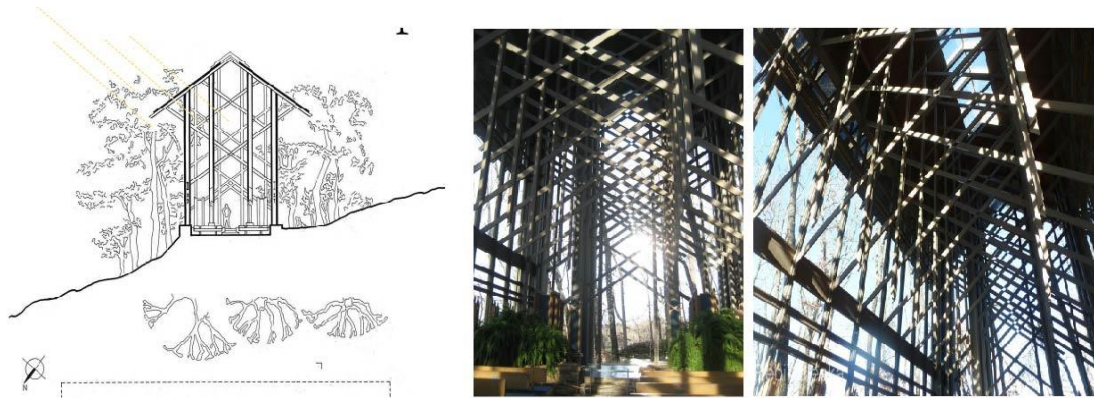


Figure 7 Thorncrown Chapel Structure

[Section by E. Fay Jones, <https://eslave.wordpress.com> | Photo from <http://rebivaleska.deviantart.com/art/Thorncrown-Chapel-4-340477257> | graphic by author]

According to Eberhard, the available knowledge of the brain and mind can provide plausible hypothesis about the cognitive and emotional experiences associated with Thorncrown Chapel:

- *Our sense of awe is influenced, in part, by having space above our head that is not visible until we move our eyes (and probably our head) upward. Semir Zeki once suggested that raising our eyes upward to see a spire on a cathedral was transformative—it stirs some primal notions of something ethereal.*

- *The sensitivity of our suprachiasmatic nuclei (SCN) to light—driving the circadian rhythms—influences our alertness. The play of light and shadow may trigger the SCN to “play with alertness” in a way that we find stimulating.*
- *The hush of nature deep in the woods provides a “quiet” experience for our auditory cortex that could be soothing, which suggests that the sense of “quiet” experienced by urban dwellers may be more soothing (because of the ambient noise where they live) than the experience of rural dwellers.²⁸*

Thornycrown Chapel serves not only as an example of the impact architectural elements can have on the human mind and brain but also as an example of the symbiotic relationship between architecture and neuroscience.

²⁸ John P. Eberhard, “Applying Neuroscience to Architecture,” *Neuron* 62, Issue 6 (2009): 753-756.

CHAPTER 3. PERCEPTION

“Every significant experience of architecture is multi-sensory; qualities of matter, space and scale are measured equally by the eye, ear, nose, skin, tongue skeleton and muscle.” – Juhani Pallasma²⁹

The human mind and body are in a constant mode of perceiving, seeking out experiences that are relevant, meaningful, pleasant, empathetic and motivational. Perception is multi-sensory involving memory, emotion, visual, and tactile experiences, all of which influence human behavior and response. Perception is a way in which human beings keep track of our relationship to the world³⁰, directing our experiences towards things, in an attempt to uncover and understand both the world and our physical environment. Architecture has the ability to evoke such responses from us, propelling us to think and understand the relationships created with our surroundings through our experiences.

Memory

Memory differs from perception in that the event or stimulus is not happening in the present moment. Although similarly guided by the senses, perception is the way in which we view the world, and memory is the way we create identity and position within the world.³¹

Memory allows for the accumulation of knowledge and the ability to recall events, faces, objects, and places. It is important in evaluation, decision-making, emotions, interaction, and movement.³² With every new experience, consciously or unconsciously, we access memory to understand and provide meaning to experience.

²⁹ Steven Holl, Juhani Pallasmaa and Alberto Perez-Gomez, eds., “An Architecture of the Seven Senses,” in Questions of Perception: Phenomenology of Architecture (Tokyo: a+u Publishing Co., Ltd., 1994), 29-37.

³⁰ Alva Noë, Action in Perception (Cambridge, MA: MIT Press, 2004).

³¹ Robert Kirkbride, Architecture and Memory (New York: Columbia University Press, 2008) Gutenberg-e edition, accessed March 20, 2014, <http://www.gutenberg-e.org/kirkbride/chapter4.html#s4.3>.

³² “Memory Processes,” The Human Memory, accessed March 22, 2014, <http://www.human-memory.net/processes.html>.

The study of memory and the brain is a complex relationship that originated within the disciplines of philosophy and psychology.³³ Previous research has been theoretical, observational, and subjective or qualitative. The study of memory, within the field of neuroscience and related disciplines, provide key insights into the physiological workings of the brain in regards to the formation, storage, and recollection of information.

To understand the role of memory within the field of neuro-architecture, we must first understand the process of memory and the mechanics of the brain. Advancements in neuroscience have concluded that the area of the brain responsible or linked to memory in relation to architecture is the hippocampus. The hippocampus is responsible for analyzing and determining which informational inputs are committed to long-term memory. More specifically, neuroscience has connected the architectural experiences to the parahippocampal place area (PPA) of the brain. The PPA uses the recognition of scenes versus the recognition of faces or objects, insinuating or reinforcing a multi-sensory experience in the creation of long-term memory.³⁴

Memory process is divided into three parts: encoding, storage, and recall. Memory requires a combination of physiological and neurological processes as explained by *The Human Memory*.³⁵

Encoding

Contrary to previous metaphors describing memories as files stored in a filing cabinet, or books on a shelf, memories are comprised from a combination of individual and separate sensory inputs stored in neurons that are connected through synapses. Encoding uses perception through the senses in addition to attention causing neurons

³³ Robert Kirkbride, *Architecture and Memory* (New York: Columbia University Press, 2008) Gutenberg-e edition, accessed March 20, 2014, <http://www.gutenberg-e.org/kirkbride/chapter4.html#s4.3>.

³⁴ "Memory Processes," *The Human Memory*, accessed March 22, 2014, <http://www.human-memory.net/processes.html>.

³⁵ Russel Epstein et al., "The Parahippocampal Place Area," *Neuron* 23 (1999):115-125, accessed March 12, 2014, [http://dx.doi.org/10.1016/S0896-6273\(00\)80758-8](http://dx.doi.org/10.1016/S0896-6273(00)80758-8).

to fire more rapidly. The experience is therefore considered to be more intense, increasing the chance to be encoded as a memory. The brain deciphers the information through the central executive within working memory (formally known as short-term memory) determining the importance of the information as long-term memory.³⁶ Memory is also associative. New pieces of information are more easily remembered if it can be related to previously acquired knowledge.

Memory Storage

Different stages of the memory storage process, allows or are used as filters for the surplus of sensory information. Sensory storage lasts for 1-2 seconds. Short-term or working memory can hold information for approximately 30 seconds. Long-term memories can last a lifetime.³⁷ As mentioned earlier, information related to one specific memory is stored in different areas of the brain and are connected through synapses. Memories are based on neural pathways, connections, and parallel processing of information.

Memory Recall

Commonly known as remembering, memory recall is the process of re-playing a pattern of neural activity. Memories are always representations of the past allowing for an awareness and differentiation of the current situation, also called creative reimagination. It is suggested that memory retrieval is an automatic process. The accuracy of retrieved memories are not reliant on focused attention as in the encoding process. However, the retrieval process becomes more efficient as the neural connection pathways are reinforced and strengthened.

³⁶ Saul Mcleod, "Working Memory," Simply Psychology, last updated 2012, accessed February 25, 2014, <http://www.simplypsychology.org/working%20memory.html>.

³⁷ Jeffrey S. Nevid, *Essentials of Psychology: Concepts and Applications* (Boston, MA: Houghton Mifflin Co., 2006).

Relation to Architecture

We experience the world through our senses. Therefore, we also experience architecture through our senses. According to Esther M. Sternberg, in *Neuroscience and Architecture*,³⁸

“...advances in neuroscience are now able to explain the ways in which we perceive the world around us and navigate in space and the way our physical environment can affect our cognition, problem-solving ability, and mood. Thus, an understanding of the principles of neuroscience, particularly in the area of perception and spatial orientation, can inform the design of built spaces to include environmental features that minimize negative physiological, cognitive, and emotional effects.”

Sternberg further continues to communicate the relationship between neuroscience and sense of place.

Memory and Sense of Place

Sense of place is often discussed in architecture literature. Daniel Liebskin, Peter Zumthor, Juhani Pallasmaa, to name a few. Sense of place creates or promotes a sense of identity. Sternberg differentiates space from place by the requirement of interaction by the user. Place is constructed through movement and the connections from one space to another. In the same way we process memories, we experience or remember architecture through a series of connections.³⁹ Within the realm of sense of place, memory offers understanding and meaning through spatial memory, internal sense of space, and orientation.

³⁸ Esther M. Sternberg and Matthew A. Wilson, “Neuroscience and Architecture: Seeking Common Ground,” *Cell* 127 (2006):239-242, accessed April 2, 2015, [http://www.cell.com/cell/fulltext/S0092-8674\(06\)01304-3](http://www.cell.com/cell/fulltext/S0092-8674(06)01304-3).

³⁹ *Ibid.*

Architecture therefore can be viewed as a journey of remembrance, having the ability to impact what and how we remember and the strength or significance of that memory. Architecture also holds the potential to create new neurons through a process called neurogenesis. Neuron generation in the hippocampal region of the brain is linked to enriched environmental stimuli and exercise.⁴⁰

“We now know enough about how memories are stored and retrieved to demolish another long-standing myth: that memories are passive or literal recordings of reality...we do not store judgement-free snapshots of our past experiences but rather hold on to the meaning, sense, and emotions these experiences provided us.” – written by Harvard Professor Daniel L. Schacter⁴¹

To remember architecture is to remember not only the object, but the associative feeling and emotion embodied within the experience. Zumthor eloquently recalls a memory as an experience filled with vivid detail and emotion.⁴²

”There was a time when I experienced architecture without thinking about it. Sometimes I can almost feel a particular door handle in my hand, a piece of metal shaped like the back of a spoon. I used to take hold of it when I went into my aunt’s garden. That door handle still seems to me like a special sign of entry into a world of different moods and smells. I remember the sound of the gravel under my feet, the soft gleam of the waxed oak staircase, I can hear the heavy front door closing behind me as I walk along the dark corridor and enter the kitchen, the only really brightly lit room in the house.

[...] Memories like these contain the deepest architectural experience that I know. They are the reservoirs of the architectural atmospheres and images which I explore in my work as an architect.”

⁴⁰ April Holladay, “How Does Human Memory Work,” USA Today, March 15, 2007.

http://usatoday30.usatoday.com/tech/columnist/aprilholladay/2007-03-12-memory-first_N.htm.

⁴¹ Daniel L. Schacter, *Searching for Memory: the Brain, the Mind, and the Past* (New York, NY: BasicBooks, 1996).

⁴² Zumthor, Peter, Maureen Turner, and Catherine Schelbert, *Thinking architecture*, 2nd expanded ed. (Basel: Birkhäuser, 2006).

Highlighted by Zumthor's narrative, sensory input is integral to the formation of memory and other architecturally related brain function, which will be further discussed in subsequent chapters. They also lend to reactionary emotions and sentiments, which are also important aspects in memory. The strength of a memory or the strength of the connection between neurons can be increased by certain factors, producing easier recall and a deeper sense of meaning and understanding.⁴³

In sensing architecture, Lehman explains the role of memory in architecture as:

"Architecture uses human memory to help occupants both "do" and "learn. Yet, what occupants probably remember most are the meaning, sense and emotion that an environment helped provide. Perhaps it is out of these qualities that a truly great work of architecture can simply help someone make a decision or even impact a culture." ⁴⁴

Perception, sensation, memory, and emotion are inherently connected and vital to the study of neuroscience and architecture. Emotion is imperative in the formation and retention of memory. Emotion increases attention. Attention increases neural firing. Emotional elements of an event are processed as an unconscious pathway to the amygdala. Emotion is therefore a response both neurological and physiological.⁴⁵

Emotions

The word emotion dates back to 1579, when it was adapted from the French word *émouvoir*, which means, to stir up.⁴⁶ There are numerous theories, which attempt to explain the origin, experience, and function of emotions, of these three major theories have emerged. The three major theories include: physiological, neurological, and cognitive. Physiological theories suggest that responses within the body are

⁴³ Jeffrey S. Nevid, *Essentials of Psychology: Concepts and Applications* (Boston, MA: Houghton Mifflin Co., 2006).

⁴⁴ Maria Lorena Lehman, "What is the Role of Human Memory in Architecture," *Sensing Architecture*, June 15, 2009, accessed April 20, 2014, <http://sensingarchitecture.com/1328/what-is-the-role-of-human-memory-in-architecture/>.

⁴⁵ Karen Lawrence, "Neuroscience, Memory and Social Manipulation," *Suite 101*, September 21, 2008, accessed May 9, 2014, <https://suite101.com/a/memory-reliability-brain-science-and-society-a69750>

⁴⁶ "Emotion," Merriam-Webster, accessed July 12, 2014, <http://www.merriam-webster.com/inter?dest=/dictionary/emotion>.

responsible for emotions. Neurological theories debate that activity within the brain leads to emotional responses. Finally, cognitive theories propose that thoughts and other mental activity play an essential role in the formation of emotions.⁴⁷

Emotion is often applied to a wide variety of phenomena, such as anger, sentiments, moods and feelings. These phenomena are a reaction to an experience conjured by the senses due to a specific subject, space, or event. Although the word emotion lacks an exact definition, some theorists place emotions within a more general category of affective states.⁴⁸ The 4 different affective states include: emotions, moods, emotional traits, and sentiments.

1. Emotions

Emotions are intentional because they imply and involve a relation between the person experiencing them and a particular event, object or surrounding: one is afraid of something, proud of something, in love with something and so on.⁴⁹ In addition, people are usually able to identify the subject of their emotion.⁵⁰ We know whom we love, and we know with whom we are angry. Besides being object-related, emotions are acute, and exist only for a relatively short period of time. Usually, the duration of an emotion is limited to seconds, or minutes at most. The cause that elicits an emotion (the stimulus) can be an event in the environment (e.g. someone calling our name, catching sight of a building), or some change within us, such as thoughts or memories.⁵¹

⁴⁷ Kendra Cherry, "Theories of Emotion," About.com, accessed June 4, 2014, <http://psychology.about.com/od/psychologytopics/a/theories-of-emotion.htm>

⁴⁸ Norbert Schwarz, "Feelings as information: Informational and motivational functions of affective states," in *Handbook of Motivation and Cognition: Foundations of Social Behavior*, volume 2, ed. E.T. Higgins and R. Sorrento (New York: Guilford Press, 1990), 527-561.

⁴⁹ N.H. Frijda, "Varieties of affect: emotions and episodes, moods, and sentiments," in *The Nature of Emotion*, ed P. Ekman and R.J. Davidson (New York: Oxford University Press, 1994), 59-67.

⁵⁰ Paul Ekman and Richard J. Davidson, *Nature of Emotion: Fundamental Questions* (Series in Affective Science) (New York: Oxford University Press, 1994).

⁵¹ Paul Ekman and Richard J. Davidson, *Nature of Emotion: Fundamental Questions* (Series in Affective Science) (New York: Oxford University Press, 1994).

2. Moods

Moods and emotions share similar characteristics but differ in that moods are essentially non-intentional, while emotions are intentional. A secondary difference in distinguishing between the two is moods are not directed at a particular subject but as in the words of Frijda, at *“the world as a whole.”*⁵² Moods have combined causes, which we are generally unable to specify. It is difficult for us to isolate what specifically caused a particular mood⁵³ and at times are unaware we are in a certain mood.

3. Emotional Traits

Often confused with mood, emotional traits are not temporal. Emotional traits define or characterize a certain individual.⁵⁴ Personality is comprised in part by emotional traits. Emotional traits range from compassion, love, joy, passion, appreciation, knowledge, empowerment, happiness, positive expectation, optimism, hopefulness, contentment, and apathy, to boredom, pessimism, frustration, disappointment, doubt, jealousy, anger, hatred, guilt, grief, and fear.⁵⁵ Emotional traits attribute to the reason that people have different feelings toward the same architectural object.⁵⁶

⁵² N.H. Frijda, “Varieties of Affect: Emotions and Episodes, Moods, and Sentiments.”

⁵³ Ekman and Davidson, Nature of Emotion.

⁵⁴ D. Watson and L.A. Clark, “Emotions, Moods, Traits and temperaments: Conceptual distinctions and empirical findings,” in *The nature of emotion: Fundamental questions*, eds. P. Ekman and R.J. Davidson (New York: Oxford University Press, 1994), 89-93.

⁵⁵ “Emotional Traits Scale,” to be Account Able, accessed April 6, 2014, <http://2baccountable.wordpress.com/emotional-traits-scale/>.

⁵⁶ D. Watson and L.A. Clark, “Emotions, Moods, Traits and temperaments.”

4. Sentiments

Sentiments are similar and often confused with emotions but the main difference between the two is that, sentiments are dispositional states, which could persist over a lifetime. The confusion between emotions and sentiments is attributed to the involvement of a person-subject relationship.⁵⁷ Frijda explains the difference by the following example: being afraid of dogs (sentiment) and being frightened by a dog (emotion), are essentially different states. Our sentiments are our likes and dislike, or our attitudes towards particular architecture or events.⁵⁸

Mechanism

Emotional responses to a given stimuli can vary from person to person and culture to culture and although different variables can influence the way we react to our surroundings, the way in which emotions are elicited is universal. In his research, *Designing Emotions*, Pieter Desmet has created a basic model of emotions, which describes the eliciting conditions of emotions with the use of three key variables: appraisal, concern, and stimulus. Desmet uses this model with the three key variables to examine if a stimulus elicits an emotion, and if so which particular emotion is experienced.

⁵⁷ N.H. Frijda, "Varieties of Affect: Emotions and Episodes, Moods, and Sentiments."

⁵⁸ N.H. Frijda, *The Emotions* (Cambridge: Cambridge University Press, 1986).

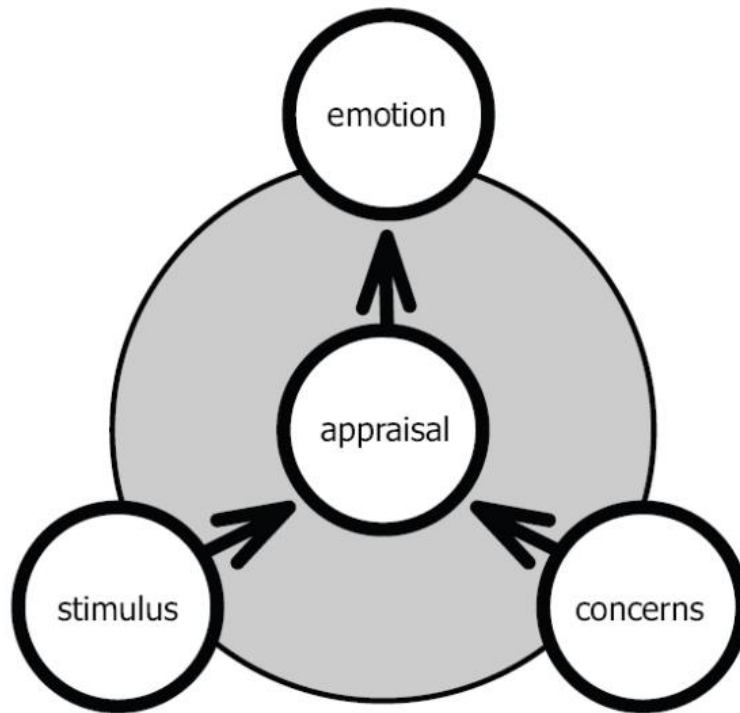


Figure 8 Desmet Model of Emotion

[Diagram by Peter Desmet, <http://experiencingarchitecture.com/2010/02/11/how-do-emotions-work-basic-model-of-emotions/>]

He uses the following example to explain the basic model of emotion in an architectural context to explain the three key variables:

Imagine Anne and Thomas searching for a new house:

The second house they visited was what Anne was looking for. The house reminded Anne of the house of her favorite uncle. She immediately had the desire to buy it. Although it was not the favorite architectural style of Thomas they decided to go inside. To Anne's (unpleasant) surprise there were holes in the wall. Thomas on the other hand, was inspired by these strange holes and thought that they could become very interesting windows. Anne already started to feel better about the idea of buying this house. When they bought the house Anne was very proud about the windows they made in the holes.

1. Appraisal

According to appraisal research, all emotions are preceded and elicited by an appraisal.⁵⁹ An appraisal is a non-intellectual, automatic evaluation of the significance of a stimulus for one's personal well-being. It is this personal significance of a product, rather than the product itself, which causes the emotion. Because appraisals mediate between products and emotions, different individuals who appraise the same product in different ways will feel different emotions. Thus, the occurrence of Thomas's inspiration versus Anne's unpleasant surprise in response to the holes in the wall is the result of their different appraisals. Thomas, who felt inspiration, evaluated the holes as beneficial, whereas Anne evaluated it as harmful. Similarly, a given individual who appraises the same building in different ways at different times will feel different emotions. At first, Anne felt unpleasantly surprised because she appraised the holes as harmful to her well being, but later she felt proud because she appraised the same holes as beneficial. Furthermore, a person can also appraise a given building in different ways simultaneously, and thus experience 'mixed emotions.'

2. Concerns

Every emotion hides a concern, that is, a more or less stable preference for certain states of the world.⁶⁰ According to Frijda, concerns can be regarded as points of reference in the appraisal process. Thus, the significance of a stimulus for our wellbeing is determined by an appraised concern match or mismatch: stimuli that match our concerns are appraised as beneficial, and those that mismatch our concerns as harmful. This principle also applies to architecture: a building elicits an emotion only if it is appraised as relevant to a person's concern. Why was Anne proud of the windows in the holes? Because it matched with her concern for social acceptance. Why was Thomas inspired by the holes in the wall? Because it matched his concern for creative

⁵⁹ Roseman et al., "Appraisal theory: Overview, assumptions, varieties, controversies," in *Appraisal processes in emotion*, eds. K.R. Sherer, A. Schorr, and T. Johnstone (UK/New York: Oxford University Press, 2001).

⁶⁰ N.H. Frijda, *The Emotions*.

stimulation. The number and variety of human concerns is vast. Types of concerns reported in the research literature are, for example, drives, needs, instincts, motives, goals and values.⁶¹ Some of our concerns are universal, for example the concern for safety, for love and for self-esteem. Others are more personal, like Thomas' concern that the house was not in his favorite architectural style. Some concerns, such as the concern for happiness and righteousness, are abstract. Others are more concrete, such as the concern for being home before dark or for owning a house.

3. Stimulus

According to Frijda⁶², any perceived change has the potential to elicit an emotion. This can be some event, e.g. someone saying something to us or encountering something in a space. Anne's unpleasant surprise was evoked by the event of seeing the holes in the wall. Not only actual events but also remembered or imagined events have the potential to elicit emotions. We all know from experience that thinking of someone we love is sometimes enough to elicit strong emotions. Or merely fantasizing about a planned summer vacation can fill us with anticipatory excitement. Similarly, Anne's concern that the house reminded her of the house of her favorite uncle. Below are specific examples of how the basic model of emotions works for architecture.

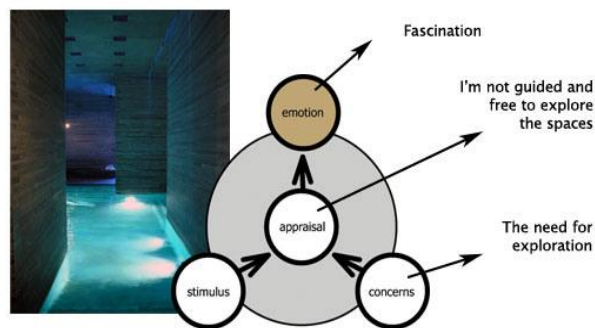


Figure 9 Therme Vals

[Diagram by Peter Desmet, <http://experiencingarchitecture.com/2010/02/16/how-do-emotions-work-4-examples/>]

⁶¹ Klaus R. Scherer, Appraisal considered as a process of multilevel sequential checking (Oxford: Oxford University Press, 2001).

⁶² N.H. Frijda, The Emotions.

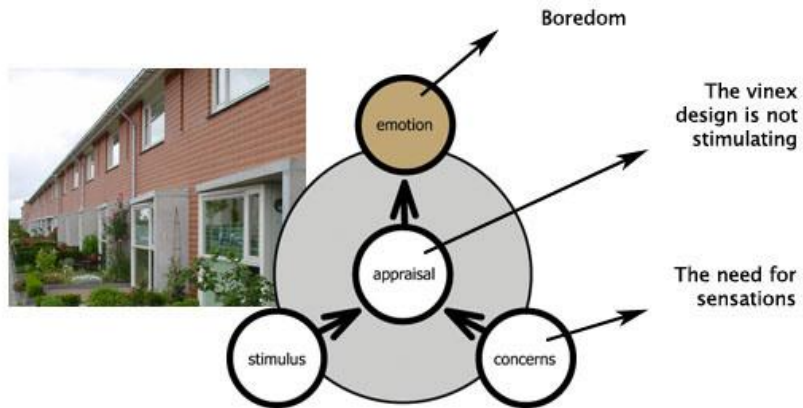


Figure 10 Vinex Neighborhood

[Diagram by Peter Desmet

<http://experiencingarchitecture.com/2010/02/16/how-do-emotions-work-4->]

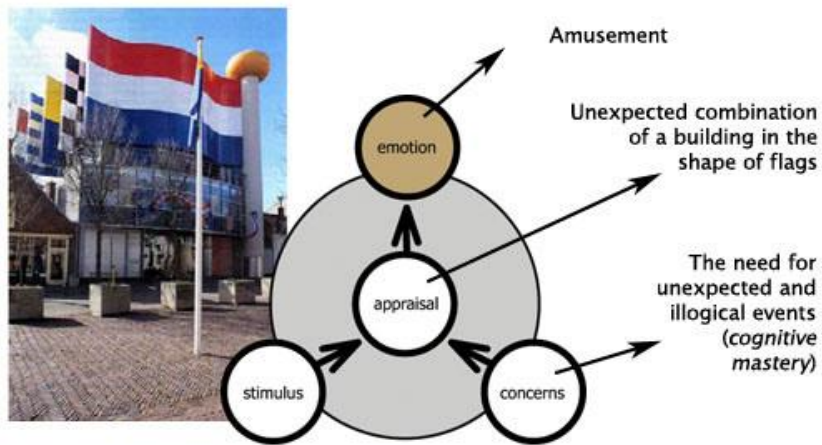


Figure 11 Circus Zandvoort, Soetera

[Diagram by Peter Desmet,

<http://experiencingarchitecture.com/2010/02/16/how-do-emotions-work-4->]

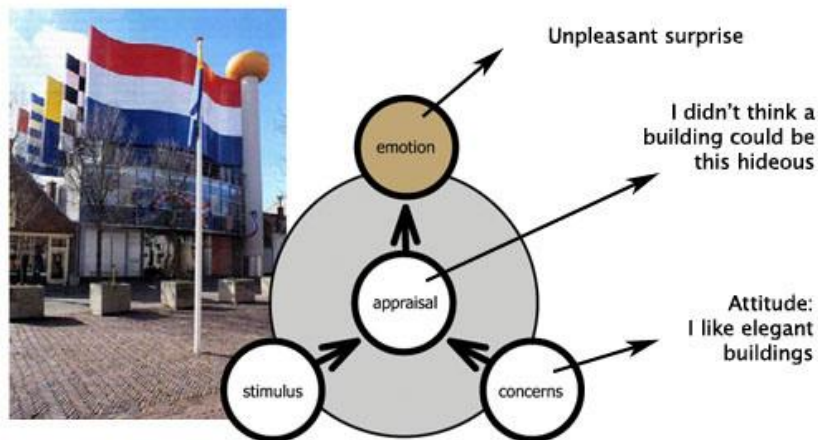


Figure 12 Circus Zandvoort, Soetera

[Diagram by Peter Desmet,

<http://experiencingarchitecture.com/2010/02/16/how-do-emotions-work-4->]

The basic model of emotions can apply to all human emotions as presented in the examples above. These examples serve to explain the model in an architectural sense in order to help us understand how architectural design and space can elicit an emotional response according to our concerns. What is particularly interesting about the examples presented involves examples 2 and 3, which use the same building, the Circus Zandvoort. Although the stimulus remained constant, the concern varied, affecting the appraisal process, which in turn changed the outcome of the elicited emotion. Despite the fact that one stimulus can elicit various emotions, the basic model of emotions can serve as a tool to understand and predict a desired emotion from an architectural experience.

CHAPTER 4. VISUAL SPACE

Regarded by Plato (in 360 BC) as humanity's greatest gift, vision remains the dominant source for sensory input. He believed that sight was the sense that creates the pathway to God and truth.⁶³

“The sight in my opinion is the source of greatest benefit for us, for had we never seen the stars and the sun and the heaven, none of the words we have spoken about the universe would ever have been uttered [...]”⁶⁴

If sensation is the process of gathering information, then perception is the process of interpreting that information gathered from the environment. Bruce Goldstein stresses that “the way in which neurons are wired together in the nervous system influences our perception.”⁶⁵ This signifies that perception is reliant on the relationship between the self and the world. In regards to architectural objects and spaces, visual perception allows for the interpretation and understanding of spatiality, atmosphere, and visibility.⁶⁶ Visual perception is the ability to interpret our surrounding environment by processing information that is contained in visible light. Using visual cues, impressions of space, form, surface/texture, color and light are formed and then processed or translated to provide an understanding of the environment. The eye is the only organ in the human body capable of interpreting visual stimuli, allowing the ability to see.⁶⁷

The process of seeing begins when the lens of the eye focuses an image or an object in the surroundings onto the retina, which consists of a light-sensitive membrane in the back of the eye. The retina itself is a part of the brain that serves as a transducer

⁶³ Plato, Paul Negri ed., *Gorgias and Timaeus* (New York: Dover Publications, Inc., 2012).

⁶⁴ *ibid.*

⁶⁵ Bruce Goldstein, *Sensation and Perception*, 9th Edition (Belmont, CA: Cengage Learning, 2013).

⁶⁶ Ciro Vidal Fontenelle, “The importance of lighting to the experience of architecture- the lighting approach in architectural competitions,” KTH Royal Institute of Technology, 2008, accessed June 2, 2015, http://www.kth.se/polopoly_fs/1.176688!/Menu/general/column-content/attachment/1%20Ciro%20Fontenelle%20-Lighting_in_architecture.pdf.

⁶⁷ Robert Feldman, *Essentials of Understanding Psychology*, Seventh Edition (New York; McGraw-Hill, 2006).

for the conversion of patterns of light into neuronal signals. The retina contains photoreceptive cells that detect the photons of light producing neural impulses or signals, which are then processed in a hierarchical fashion by different parts of the brain. The lens focuses on an image, focusing light on the photoreceptive cells of the retina, producing neural impulses, which travel from the retina to the central ganglia in the brain to be processed.⁶⁸ Light therefore allows us to define what is around us, changing the way we perceive the objects which it impacts. Light or the absence of light has the ability to transform and shape a space.

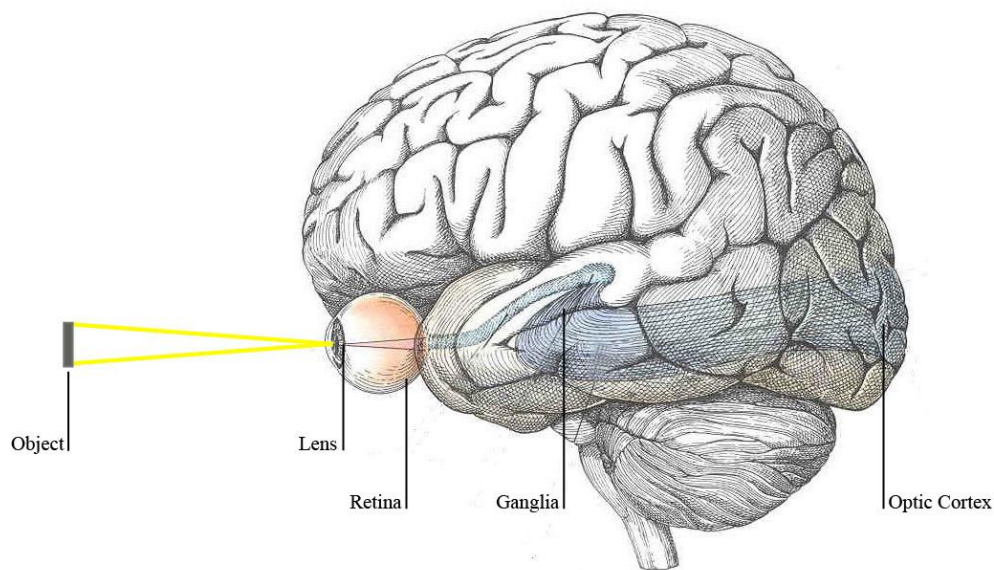


Figure 13 Vision and the Brain

[Photo from Research, <https://www.opth.wisc.edu/research/stemcell/> | graphic my author]

Light

Vision or the facility of seeing, begins with light.⁶⁹ The interaction between light and material provide environmental cues to the understanding of our environment. According to Neisser, the brain uses a combination of top-down and bottom-up processing known as the perpetual cycle to decipher and interpret information. Top-

⁶⁸ Neil R. Carlson, "6," *Physiology of Behaviour*, 11th ed. (Upper Saddle River, New Jersey, USA: Pearson Education Inc., 2013), 187-189.

⁶⁹ Goldstein, *Sensation and Perception*, 69.

down processing is based on pattern recognition. Bottom-up processing is a direct linear pathway of information from the retina to the visual cortex.⁷⁰ Consequently, light is not viewed as a single entity, but as a stimulus used in context. The focus is therefore on the effects of light versus the physical properties of light.

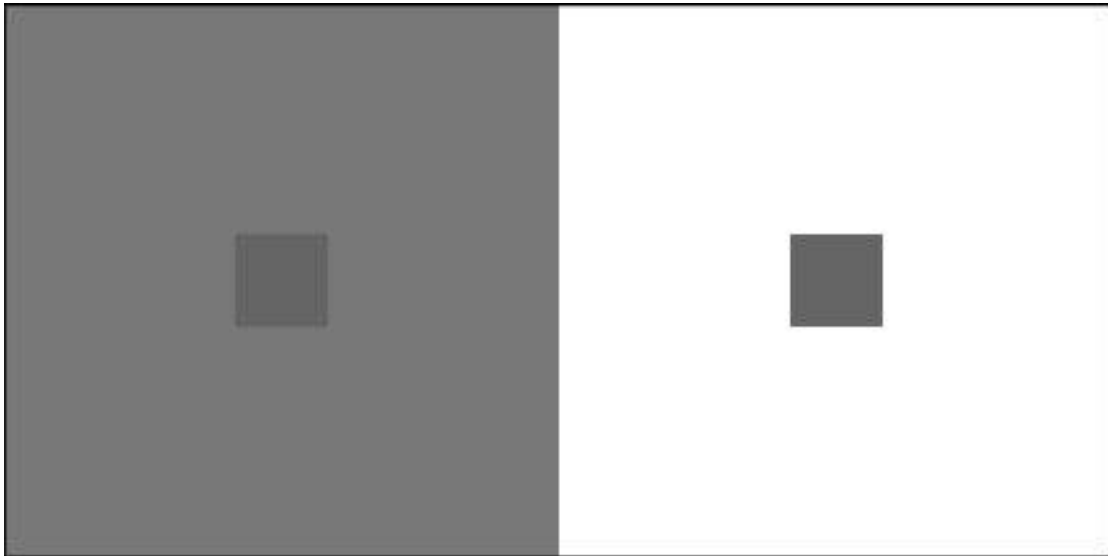


Figure 14 Black and White Diagram

[Photo from Basic Visual Functions, <http://www.skidmore.edu/~hfoley/Perc4.htm>]

Light + Architecture

Light is categorized into three categories: general or ambient, task, and highlights.⁷¹ The source can be either artificial or natural light. The effect of light has the capacity to influence physical properties, atmosphere, and emotion. In *Experiencing Architecture*, Rasmussen explains the importance of light within the realm of architecture.

⁷⁰ Saul Mcleod, "Visual Perception Theory," *Simply Psychology* (2013), accessed February 25, 2014, <http://www.simplypsychology.org/perception-theories.html>.

⁷¹ "Light In Architecture and Psychology of Light," *RS Lighting Design*, accessed March 22, 2014, http://www.rsltg.com/images/ArchID_-_Light_in_Architecture_and_Psychology_of_Light.pdf.

*“Light is of decisive importance in experiencing architecture. The same room can be made to give very different spatial impressions by the simple expedient of changing the size and location of its openings.”*⁷²

Light as a visual experience was categorized into 7 descriptive terms by Alders Liljefors including: level of lightness, spatial distribution of brightness, shadows, reflections, glare, color of light, and color.⁷³

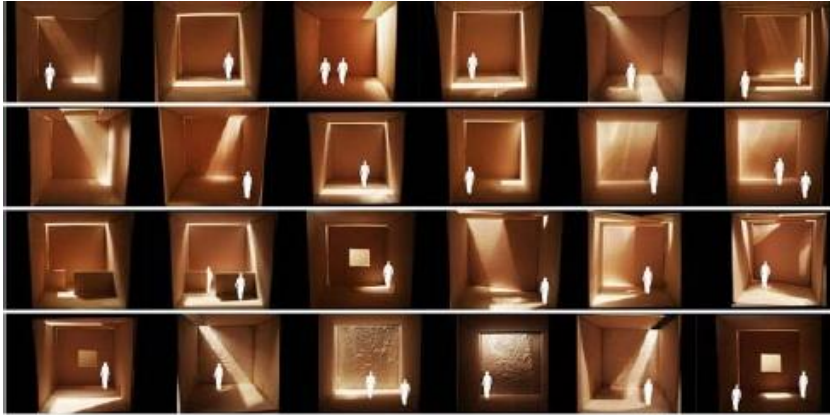


Figure 15 Light and Shadow Variations

[Photo by Pandelitsa Lazari, <http://degreeshow.mmu.ac.uk/2012/images/l/2960.jpg>]

1. Level of lightness

“Every light is a shade, compared to the higher lights, till you come to the sun; and every shade is a light, compared to the deeper shades, till you come to the night.”⁷⁴ By definition, Adelson explains that lightness is the perceived reflectance of a surface, representing the visual system’s attempt to extract reflectance based on the luminance in the scene.⁷⁵ Various levels of lightness or darkness affect the way in which we

⁷² Steen Rasmussen, *Experiencing Architecture*, 2nd ed. (Cambridge, Mass.: MIT Press, 1962), 187.

⁷³ Ciro Vidal Fontenelle, “The importance of lighting to the experience of architecture.”

⁷⁴ John Ruskins, *The Works of John Ruskin* (London: George Allen, 1879).

⁷⁵ Karin Fridell Anter and Ulf Klaren, Herald Arnkil ed., *Colour and Light-Concepts and Confusions* (Finland: Aalto University, 2012), accessed March 4, 2014, http://www.academia.edu/3666388/Colour_and_Light_-_Concepts_and_Confusions.

immediately perceive space. Being contrast sensitive, the variance of light levels lead to differentiated perceptions of space including:⁷⁶

spaciousness | confinement

visual clarity | haziness

relaxation | activation

private | public

pleasant | unpleasant

Lightness is often confused with brightness. Although both terms signify a value of light, brightness is the perceived intensity of light coming from the image itself, rather than any property of the portrayed scene. As Gilchrist explains, lightness differs from brightness as: “lightness is the perceptual dimension that runs from black, through grey to white... Lightness is perceived reflectance.... Brightness is the perceptual dimension that runs from dim to bright. Brightness is perceived luminance.”⁷⁷ Therefore, lightness is how the brain explains the intensity of light within a complete scene, and brightness is the perceived luminance of a material or object.

2. Spatial distribution of brightness

Similarly to lightness, variable levels of brightness and distribution of light affects the psychological perception of a space. A contrast in light distribution creates a stronger visual stimulus, demanding attention.⁷⁸ In addition, these contrasts also provide clues to importance, orientation, wayfinding, and spatial borders while creating atmosphere.⁷⁹

⁷⁶ “Light In Architecture and Psychology of Light,” RS Lighting Design, accessed March 22, 2014, http://www.rsltg.com/images/ArchID_-_Light_in_Architecture_and_Psychology_of_Light.pdf.

⁷⁷ Alan L. Gilchrist, “Lightness and brightness,” *Current Biology* 17 (2007), accessed April 8, 2014, [http://www.cell.com/current-biology/abstract/S0960-9822\(07\)00878-0](http://www.cell.com/current-biology/abstract/S0960-9822(07)00878-0).

⁷⁸ J Ejhed and A. Liljefors, *Bättre belysning (Better lightening)* (Stockholm, Sweden: Statens rad for byggforskning, 1990).

⁷⁹ Ciro Vidal Fontenelle, “The importance of lighting to the experience of architecture.”

3. Shadows

Shadows are the resulting effect of the interference of light sources. Shadows and darkness are essential for the sense of vision to determine the depth and distance. “In great spaces of architecture, there is a constant, deep breathing of shadow and light; shadow inhales, and illumination exhales, light.”⁸⁰

The importance shadows play in our observation and understanding of spatiality is considerable. Shadows can delineate between sharp or diffused edges and create a sense of softness or rigidity. Differences in the brightness between light and shadow inform our understanding of spatiality by creating differences in ambience and depth perception.⁸¹

4. Reflections

Reflections are the way that we predominantly perceive light. Reflectance is the proportion of incident light that is reflected from a surface. Reflectance, also called albedo, varies from 0 to 1 or, equivalently from 0% to 100% where 0% is ideal black and 100% is ideal white. In practice, typical black paint is about 5% and typical white about 85%.⁸² Reflection is dependent on materiality and light absorption and remittance.

⁸⁰ Juhani Pallasmaa, *Polemics: Architecture and the Senses* (Great Britain: Academy Group Ltd., 1996), 33.

⁸⁰ JPallasmaa, *Polemics*.

⁸¹ http://www.kth.se/polopoly_fs/1.176688!/Menu/general/column-content/attachment/1 *Ciro Fontenelle*

⁸² E.H. Adelson, “Lightness Perception and Lightness Illusion,” in *The New Cognitive Neurosciences*, 2nd ed., ed. M. Gazziniga (Cambridge, MA: MIT Press, 2000), 339-351.

5. Glare

Dissimilar to reflection, glare can come from a direct or reflected light source. Glare is the effect of extreme high contrast of light to the scene or environment. This phenomenon can be a hindrance or an advantage. For example, a car headlight at night directly in your field of view can cause an uncomfortable brightness contrast in one's field of vision. In opposition, the glare of the sun on a lake surface can be perceived as beautiful or tranquil.⁸³

6. Color of light

Light is electromagnetic radiations, which is the fluctuation of electric and magnetic fields or simply put, light is energy. The interaction of energy and matter results in color.⁸⁴ Similar to color, the color of light can have both a physiological and psychological effect on the human body. The main difference between color and light is the fact that light travels in wavelengths allowing its absorption through skin. When colored light is absorbed into our body, it produces chemical reaction that can affect the functions of various systems.⁸⁵ Light can also have the ability to stimulate higher cognitive brain activity, independently of vision.⁸⁶

⁸³ Harold Arnkil et al., "PERCIFAL: Visual analysis of space, light and colour," (AICC 2011, Interaction of Colour & Light in the Arts and Sciences-Proceedings), Zurich, 2011, accessed March 18, http://www.academia.edu/3664218/PERCIFAL-Visual_analysis_of_space_light_and_colour.

⁸⁴ Samina T. Yousuf Azeemi and S. Mohsin Raza, "A Critical Analysis of Chromotherapy and Its Scientific Evolution," *Evidence-Based Complementary and Alternative Medicine* (2005): 481-488, accessed July 4, 2014, doi: 10.1093/ecam/neh137.

⁸⁵ Gilles Vandewalle, et al., "Blue Light Stimulates Cognitive Brain Activity in Visually Blind Individuals," *Journal of Cognitive Neuroscience* Vol. 5, No. 12, (2013): 2072-2085, accessed July 3, 2014, doi:10.1162/jocn_a_00450.

⁸⁶ Ibid.

7. Colors

Color is a sensory quality that has to be experienced.⁸⁷ The ability to distinguish different wavelengths, or colors allows us to gather more information from our surroundings in order to differentiate objects from one another in our field of view. Color can also affect our psychological state. There are four psychological primary colors: red, blue, yellow, and green. Red is the most powerful of the four primary colors although it is not technically the most visible. The effect of the color red is physical; it is stimulating and raises the pulse rate, at time activating the “fight or flight” instinct. Blue on the other hand is soothing, unlike red, it affects us mentally not physically. Lighter hues of blue calm the mind and aid in concentration while darker blues stimulate clear thought. Yellow on the other hand stimulates emotion, making it the strongest color psychologically. Certain yellow help lift the spirit and self-esteem. Green stimulates restfulness due to the fact that our eyes do not need to adjust to it. Green also gives a sense of balance and harmony.⁸⁸ Although colors can affect us on various levels, our perception of the color of an object depends on several things.⁸⁹

The range of wavelengths present in the incident light.

The wavelengths of light that the object reflects or absorbs.

The receptor cells in our eyes that detect the reflected light.

Our brain's interpretation of the signals from those receptors

⁸⁷ K Fridell Anter ed., *Forskare och praktiker om färg, ljus, rum* (Stockholm: Formas, 2006) 21–30.

⁸⁸ “Psychological Properties of Colours,” *Color Affects*, accessed March 28, 2014, <http://www.colour-affects.co.uk/psychological-properties-of-colours>.

⁸⁹ “Light and Colour Perception or Why are Leaves Green,” *Bensimonds.com*, accessed March 21, 2014, <http://bensimonds.com/2013/05/30/light-and-colour-perception-or-why-are-leaves-green/>.

CHAPTER 5. TACTILE SPACE

The eye is the organ of distance, whereas touch is the sense of nearness, intimacy and affection. The eye observes and investigates, whereas the touch approaches and feels. So when the light makes space for shadow our other senses are sharpened including the sensitivity to touch.⁹⁰

In neurobiology touch is defined as “the special sense by which contact with the body of an organism is perceived in the conscious mind”.⁹¹ Descartes balanced vision with touch; he believed the sense of touch to be more certain and less vulnerable to error than vision. As people age the senses begin to deteriorate with the exception of touch. The ability to touch or feel the world around us allows us to learn, protect ourselves, relate to others, experience pleasure, and aids us in understanding.

The sense of touch allows individuals to navigate through spaces, touching what is perceived and perceiving what is touched. It gives one the ability to deduce, interpret and make meaning of it in our memory and through learning.

The skin is the sensory organ for touch and it is the largest organ of the body with an area of eighteen square feet and weight of nine pounds.⁹²

Touch is comprised of various somatic senses (senses we feel with our body), kinesthetic senses that, give us a conception of our bodies in space (proprioception), and visceral senses, such as stomachaches or nausea. The skin has sensory neurons each of which contains a specialized capsule on its peripheral end, which physically links the nerve ending to surrounding skin tissue. Nerve endings, called

⁹⁰ David Michael Levin, *The Opening of Vision – Nihilism and the Postmodern Situation* (New York and London: Routledge, 1988).

⁹¹ Esther P. Gardner, *Touch* (Chinchester: John Wiley & Sons Ltd, 2010), accessed June 6, 2014, <http://www.els.net> [doi: 10.1002/9780470015902.a0000219.pub2].

Tiffany, Field, *Touch* (Cambridge, Mass.: The MIT Press, 2001).

⁹² Esther P. Gardner, *Touch* (Chinchester: John Wiley & Sons Ltd, 2010), accessed June 6, 2014, <http://www.els.net> [doi: 10.1002/9780470015902.a0000219.pub2].

mechanoreceptors, detect changes in shape of the capsule surrounding nerve endings, producing an action potential, which is then propagated to the nervous system. These nerve receptors known as touch or pressure receptors are one of several types of receptors found in the human skin. Other touch receptors in the skin respond to pain, temperature and to the presence of chemicals on the skin.⁹³ When these receptors are stimulated they send electrical pulses to neurons, which are specialized cells that relay electrochemical impulses.⁹⁴ The sensory neurons then work as a relay passing electrical impulses from neuron to neuron until it reaches the spinal cord. The spinal cord transmits the neuron's electrical impulses to the thalamus where it is relayed to the brain. In the brain the specific location at which each neuron synapses determines how the electrical impulse is interpreted.⁹⁵ The sense of touch is one of the most informative senses, informing us of the way we “see” the world we live in.

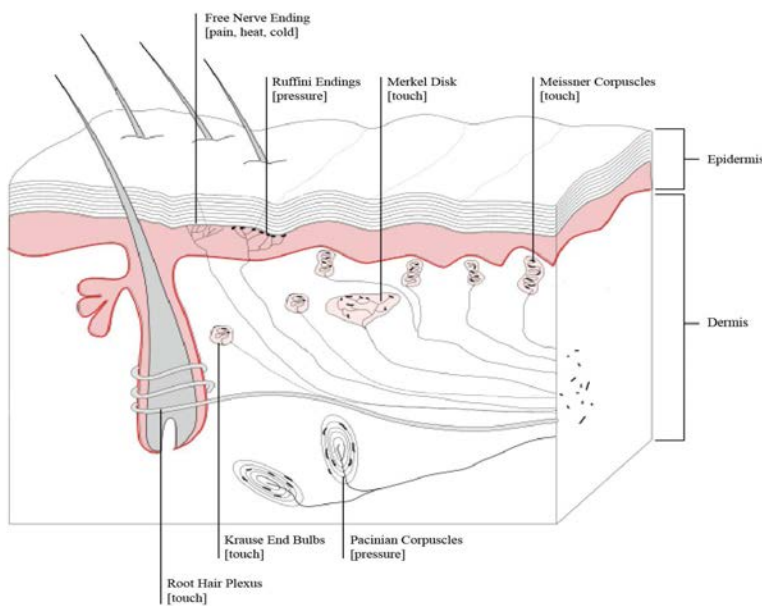


Figure 16 Skin Diagram

[Diagram by Thomas Haslwanter, http://commons.wikimedia.org/wiki/File:Skin_proprioception.svg graphic by author]

⁹³ Esther P. Gardner, *Touch* (Chichester: John Wiley & Sons Ltd, 2010), accessed June 6, 2014, <http://www.els.net> [doi: 10.1002/9780470015902.a0000219.pub2].

⁹⁴ “Nervous System,” Penn Medicine, accessed July 5, 2014, http://www.pennmedicine.org/health_info/body_guide/reftext/html/nerv_sys_fin.html.

⁹⁵ Elise Hancock, “A Primer on Touch,” Johns Hopkins University, accessed March 12, 2014, <http://www.jhu.edu/jhumag/996web/touch.html>.

Relation to Architecture

Touch is an intimate sense, bringing us into an intimate contact with the world. Touch is the sensory mode, which integrates our experiences of the world and ourselves. Touching can also serve to amplify other senses such as sight. For example we can see sunlight but it is not until it touches our skin that we truly experience it. By touching the light, we enter into a relationship that invites us to leave behind superficial ideas of what something is and find a deeper meaning. Skin has the ability to sense more than sunlight; it can read texture, weight, density, and the temperature of matter.⁹⁶

Architecture is more frequently experienced through sight but sense of touch allows us to experience architecture in a more intimate approach. Through the sense of touch we can experience more components of a structures construction than through vision. Visually architectural components can appear to be similar giving the illusion of the same visual impression and in this sense; touch can help distinguish the hardness, depth, and temperature of seemingly similar components. Through touch, architecture can be experience and unfolded in a series of parts, allowing a more intimate connection to a particular structure. An example of the intimate relationship between touch and architecture is the Holocaust Memorial in Berlin. The smooth concrete entices the hand into stroking the surface.⁹⁷ Through visual perception it can be concluded that the concrete appears to be cold and the skin is known for mapping out temperature spaces with absolute meticulousness⁹⁸, further enticing our curiosity to explore and experience such architectural elements.

⁹⁶ Juhani Palasmaa, *The eyes of the Skin Architecture and the Senses* (Hoboken: John Wiley & Sons, 2005).

⁹⁷ Juhani Palasmaa, *The eyes of the Skin Architecture and the Senses* (Hoboken: John Wiley & Sons, 2005), 41-45.

⁹⁸ Zinat Yusufzai, "The Lucidity of Place," (Master of Architecture thesis, Virginia Polytechnic Institute and State University, 2001), 10-20, accessed April 4, 2014, <http://scholar.lib.vt.edu/theses/available/etd-11302001-161439/unrestricted/thesis-low-res.pdf>.

Pallasmaa states:

“Architecture connects us with the dead... and enables us to see and understand the passing of history, participating in time cycles that surpass an individual life”⁹⁹

Touch enables visitors to the Holocaust Memorial to tie together generations and history. The design of the concrete slabs “stelae” produce an uneven, confusing and uneasy feeling which is experienced and interpreted by the sense of touch through the feet. By walking on the stelae the feet sense the uneven surface reminding the visitor of the turmoil experienced during the Holocaust. Sight dominates how architecture is experience but the sense of touch has proven to be as important if not so more, in creating a stronger relationship between oneself and architectural experiences.



Figure 17 Children Playing on Holocaust Memorial

[Diagram by Chocolatemedial, http://en.wikipedia.org/wiki/Memorial_to_the_Murdered_Jews_of_Europe]

⁹⁹ Juhani Palasmaa, *The eyes of the Skin Architecture and the Senses* (Hoboken: John Wiley & Sons, 2005), 52



Figure 18 Walkway at Holocaust Museum

[Diagram by Chocolatemedi, http://en.wikipedia.org/wiki/Memorial_to_the_Murdered_Jews_of_Europe]

Case Studies

The two examples chosen for case studies use the principles of neuro-architecture and serve as examples outside the healthcare and educational facilities. The Academy of Neuroscience for Architecture had various examples of how neuroscience findings have been used to shape architectural design. Currently there are few examples of this relationship outside the educational and healthcare fields and the two examples chosen are analyzed not for the type of facility they are but their use of neuroscience in the design. The first example is Thurston Chapel, which is located on the grounds of a school on the island of Oahu. For this analysis I will omit the religious aspect of the facility and view it as a place of enlightenment. The second example is Salk Institute, which is located in La Jolla, California. The institute is a research facility for the study of neuroscience and the first structure that combined neuroscience and architectural design. For this example I will also disregard the type of facility and only focus on the applications of neuroscience it implemented into its architectural design.

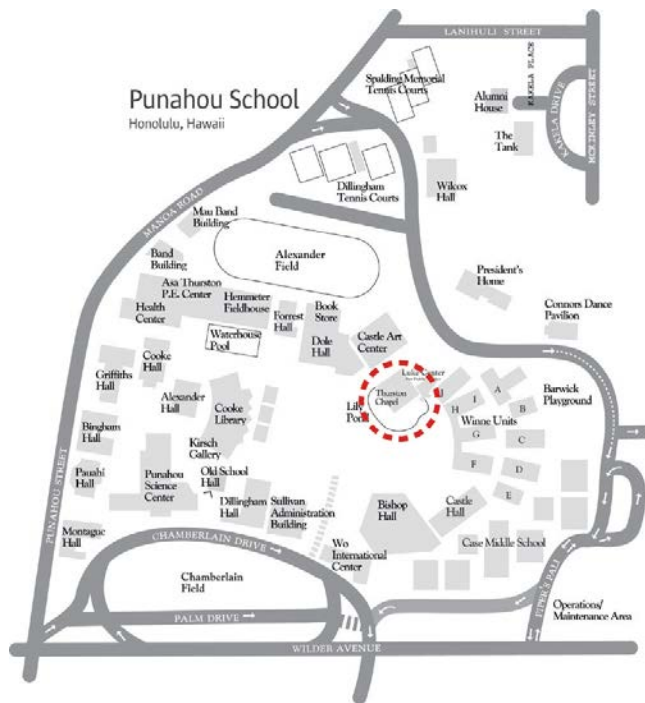


Figure 19 Punahou School Map
[Map from About, <https://www.punahou.edu> | graphic by author]

Thurston Chapel is located on the grounds of Punahou School, which is located in Honolulu, Hawai'i. Although the chapel is located on school grounds, it is open to the public. The chapel is situated on top of the Ka Punahou natural spring. The location allows for a direct visual and psychological connection to nature. Neuroscientists have researched this connection to natural surroundings extensively and it has been concluded that facilities with visible natural surrounds positively impact the human psyche. The landscaped courtyard on chapel's north side aids in providing an oasis of serenity amid the bustling campus. Further integration of the pond is achieved by the lowering of the chapel floor below the courtyard in order to bring it physically closer to the pond.



Figure 20 Thurston Chapel Pond

[Photo by Katherine Crosier, <http://insanity.blogs.lchwelcome.org/2013/07/27/retired-hardly/>]



Figure 21 Thurston Chapel Courtyard

[Photo by Ronald Loui,

http://en.wikipedia.org/wiki/Punahou_School#/media/File:Punahou_Chapel_and_Round_House.jpg]

Natural light and a variety of light color are introduced into the design of the chapel. Color and natural lighting have the ability to affect the mood of the user. By using subdued light inside the chapel, it creates a calmer atmosphere and attenuates the high energy of the youth attending mass. The use of color aids in influencing mood within the chapel. The roof design is square in plan and bisected diagonally; with the north side raised nearly 2ft to create an opportunity for daylighting. In order to create an atmosphere to promote enlightenment, natural daylight is crucial as seen in Thorncrown Chapel.

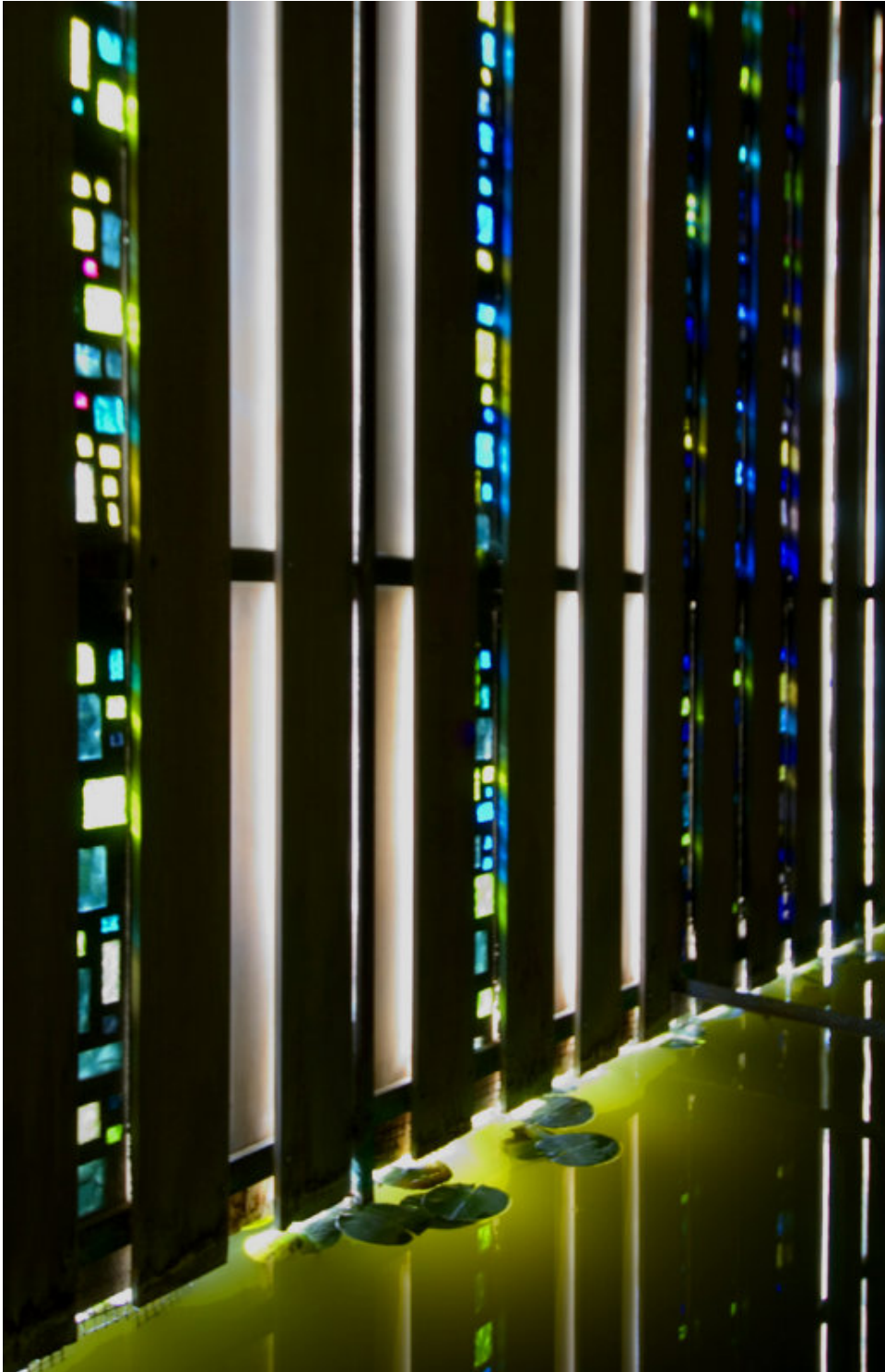


Figure 22 Thurston Chapel Stained Glass Window

[Photo by Debra DiCandilo, <http://www.pbase.com/debradicandilo/image/78555460>]

The rich expression of materiality found throughout the chapel is another key concept. Materials influence our sense of touch and the visual impression architecture leaves us with. Through the use of local material such as Koa wood and clay tiles, the user is intimately linked to a sense of place. The contrast between the stucco, clay tiles, copper, and wood serve to create a sense of calmness and tranquility through out the grounds. The materials allow for an emotional connection to the chapel. It is wise to note that Thurston Chapel was design and completed parallel to the emerging field of neuro-architecture. This implies that architects have been instinctually designing architecture in relation to neuroscience before the emergence of the field.



Figure 23 Thurston Chapel Exterior

[Photo from Punahou School: Campus Virtual Tour, <http://www.punahou.edu/about/campus-and-facilities/campus-tour/index.aspx>]

Salk Institute, La Jolla, California

The Salk Institute was established in the 1960s by Jonas Salk, M.D., the developer of the polio vaccine. His goal was to establish an institute that would explore questions about the basic principles of life. He wanted to make it possible for biologists and others to work together in a collaborative environment that would encourage them to consider the wider implications of their discoveries for the future of humanity.¹⁰⁰ Salk Institute serves as an example where neuroscience and architecture came together to produce a new type of architecture, which responds to the entire realm of the human being.

The institute in plan is designed as a mandala, an ancient art that represents natural order and hierarchy through the use of concentric shapes. The building is designed to radiate inward from the exterior service areas (body). After the service areas are the biological laboratories (mind), followed by the walkways, which serve to represent gathering spaces (society). Finally to the central courtyard, which is dissected by a simple band of water running its length, representing a place of stillness (spirit). Salk Institute takes the visitor through a physical and psychological progression from the body to the spirit, thus representing the human being as a whole.



Figure 24 Salk Institute Courtyard

[Photo by Liao Yusheng, <http://figure-ground.com/salk/>]

¹⁰⁰ “History of Salk,” Salk Institute for Biological Studies, accessed February 1, 2014, <http://www.salk.edu/about/history.html>.

The institute employs a few key design features, which employ the findings of neuroscience. The first of these features is the materials used in construction. Sense of touch is one of the most important ways in which we experience architecture. Our vision stirs up our curiosity and our touch satisfies that curiosity. Neuroscience tells us that seemingly smooth concrete surfaces entice us to feel that surface and this is true at the Salk Institute. When standing in the courtyard the visitor is drawn to the material.



Figure 25 Salk Institute Construction
[Photo from History of Salk, <http://www.salk.edu/about/history.html>]

The next two features go hand in hand, water and visual connection to nature. Water has the ability to create a sense of tranquility and purity. The water that intersects the courtyard serves two purposes, the first being that it aids in creating a certain atmosphere to induce clarity of mind and the second to guide the eye in creating a visual connection with the surrounding ocean. As stated in the previous example, the presence and ability to see/interact with nature promotes our physical and psychological well-being. The structure itself frames the view, which is subtly guided by the water.

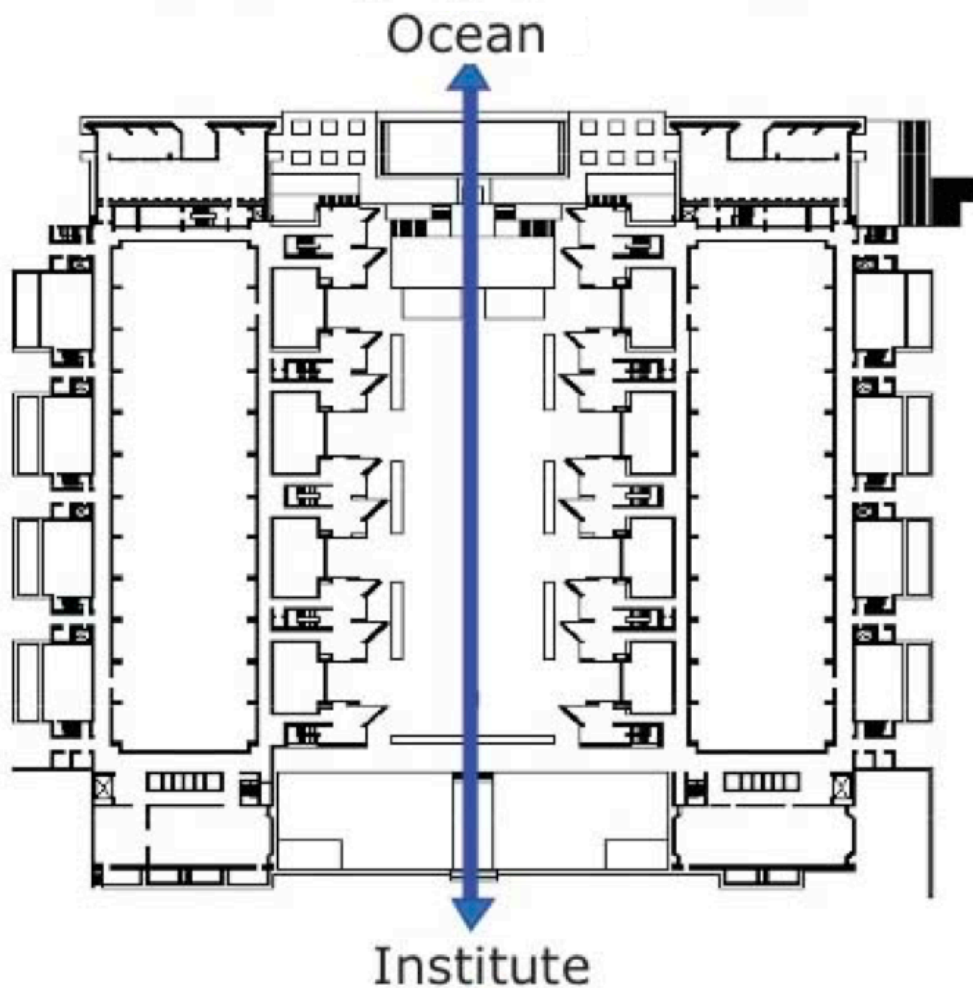


Figure 26 Salk Institute View Corridor Diagram
[Photo from AD Classics: Salk Institute, <http://www.archdaily.com> | graphic by author]

The third key feature is the use of light and shadow. Light and shadow can have a profound effect on our emotions and on the way we perceive a space. Kahn used the interplay of light and shadow eloquently in the institute. The lack of light in the exterior walkways creates a sense of depth and drama. The movement of the sun creates constantly changing shadows allows the visitor to experience the institute in many different ways.

The changing light affects not only shadows but also our visual impression of the materials, concrete that looked white/grey during midday, looks warmer with a light orange hue. Although the material stays constant the way we visually see it changes the manner in which we interact with the architecture. Salk Institute is the first building that consciously attempted to create a symbiotic relationship between neuroscience and architectural design. It has changed the way we view architecture and ones own self in relation to the built environment.



Figure 27 Salk Institute Corridor Shadows

[Photo from Louis Kahn: The Space of Ideas | Essays, <http://www.architectural-review.com/essays/louis-kahn-the-space-of-ideas/8637503.article>]



Figure 28 Salk Institute Corridor Shadows
[Photo by Alexander Zovic, <http://www.zovic.se/?p=347>]

CHAPTER 6. WAI 'ANAE

The proposed project site is located in Wai 'anae, on the southwestern coast of the Island of Oahu. The site was selected due to various factors of which the most important being that the project site area is located in a community that is underserved. The Waianae Coast contains a high percentage of Native Hawaiians. The community is gravely underserved in public transportation, markets, community areas, schools, healthcare facilities and such. Neuro-architecture has the ability to provide an architectural environment that is conducive towards learning and healing. The site was chosen primarily for this reason, architecture should inspire and motivate its users, and the population of the Wai 'anae Coast would greatly benefit from a healing center that could have the potential of bringing the community together and bridging the gap between generations. Local Hawaiian culture is very much about family gatherings and social interaction making this site the ideal location.

History

The city of Wai'anae is located on the southwestern coast of the Island of Oahu. Wai'anae is one of the most developed rural or country areas on the island, secluded from the hustle and bustle of modern city living. This coastal city also holds the largest population of Native Hawaiian, which roughly comprises 30% of 10,506 local population.¹⁰¹ The 3.4 square miles in which Wai'anae is located is commonly known for its sugar mill, fishing, agriculture and religion.

This community holds the oral history of the Hawaiian people, told by storytellers from generation to generation. Through chant, which had been sung for generations in their native land in the South Pacific, Hawaiians sailed thousands of miles following the stars and eventually came upon what we now call Hawaii. The

¹⁰¹ "Waianae," Places, accessed June 28, 2014, <http://places.findthehome.com/l/26886/Waianae-HI>.

Wai'anae coast was named after the mullet that was once farmed in the area. The name Wai'anae is broken down into two words, Wai (pronounced why) means water and enae (eh na ee) means large mullet. The community has a rich history, which was first glimpsed upon by Captain James Cook in the late 1700's. Captain George Vancouver wrote in his reports of the fertility of the lands of Wai'anae, having spotted a fertile coconut grove.¹⁰² In the early 1800's, a man named Boki, was chosen by King Kamehameha I as a chieftain for the village of Wai'anae. The year of 1811 gave rise to the global trade industry of this community, when Western travelers noticed the abundance of sandalwood of these fertile lands. By the early 1900's the fertile lands of Wai'anae became one of the main sites for the sugar production industry. Although the rich lands of Hawaii produced bountiful harvest of sugar cane, the industry soon came to an abrupt end due to the effects of World War II.

After the war, many of the Hawaiian communities began rebuilding leading to Hawaii becoming a prime holiday destination. The tourism and commercial industries began to take hold in Hawaii, ultimately changing the pre-war character of the islands. While many places in the Hawaiian chain experienced the impact of these industries, Wai'anae became one of a few places within Oahu that was able to preserve its pre-war character. In modern times, this community has successfully developed a balance between the tourism industry and Hawaiian culture. Wai'anae to this day is still considered country, avoiding the downfalls of more tourism-oriented cities such as overdevelopment, vehicular and pedestrian congestion and loss of culture. Although Wai'anae and the surrounding communities have avoided commercialization, not all the resulting effects have been beneficial.

Located only 30 miles from the bustling center of Honolulu, Wai'anae rarely benefits from \$14.52 billion yearly visitor expenditures.¹⁰³ A White House press release in November of 2012 stated the Wai'anae Coast is one of the most economically

¹⁰² "Waianae, Honolulu County, Hawaii," Hawaii State Info, accessed July 6, 2014, <http://www.hawaiistateinfo.com/waianae.php>.

¹⁰³ Daniel Nahoopii et al., 2013 Annual Visitor Report (Hawaii: Hawaii Tourism Authority, 2013), accessed July 6, 2014, [http://www.hawaiitourismauthority.org/default/assets/File/reports/visitor-statistics/2013%20ANNUAL%20REPORT%20\(final\).pdf](http://www.hawaiitourismauthority.org/default/assets/File/reports/visitor-statistics/2013%20ANNUAL%20REPORT%20(final).pdf).

challenged communities in the state.¹⁰⁴ Wai‘anae had the fifth-highest poverty rate at 18.8% according to analysis of U.S. Census data. This community is also home to the largest homeless encampment in the United States. The encampment is commonly referred to as “tent city” and of the 200 people currently residing in it 90% are native Hawaiians.¹⁰⁵



Figure 29 Homeless Camp in Wai‘anae
[Photo by Author]

¹⁰⁴ Michael Levine, “White House: Waianae Among Hawaii’s Poorest Areas,” Civil Beat, November 2, 2011, accessed September 4, 2014, <http://www.civilbeat.com>.

¹⁰⁵ Robert Johnson, “The Other Side of Paradise: Inside Hawaii’s Giant Homeless Community,” Business Insider, August 2, 2013 <http://www.businessinsider.com/what-homelessness-looks-like-in-hawaii-photos-2013-8?op=1>.



Figure 30 Homeless Camp in Wai'anae
[Photo by Author]

Homelessness is not the only issue faced by these communities. Wai'anae and the surrounding communities are gravely underserved from infrastructure, education, and public facilities to health services. Farrington Highway is the only access road into these communities and constantly under construction with temporary road repairs lasting for months at a time. Public transportation system consists of older generation busses unlike the newer more efficient busses that service other cities.

There are only 3 schools located within the Wai'anae city boundaries and compared to other schools in Hawaii using 2010 test averages, the schools rated 7, 4 and 30 respectively based on a scale from 0 (worst) to 100 (best).¹⁰⁶ All three of these schools ranked among the worst in the state. The city is also home to the island's only industrial waste disposal site, the PVT Landfill, and immediately adjacent to the Wai'anae mall is a wastewater treatment plant whose unpleasant smell lingers in the area.

¹⁰⁶ "Waianae, Hawaii," City Data, accessed August 30, 2014, <http://www.city-data.com/city/Waianae-Hawaii.html#b>.

Although this community faces many adversities and is often overlooked, it is home to some of Hawaii's best beaches, fishing, and cultural richness. With 30% of its population comprised of Native Hawaiians, Wai'anae offers a unique opportunity to learn and perpetuate the Hawaiian Culture. There are 8 major farms, which grow traditional crops such as taro, banana, papaya, guava, lilikoi and lua leaf as well as other crops such as corn, lettuce and eggplant. The farms promote the local agricultural industry while also providing a variety of community and educational programs for both youth and adults. The programs promote aina (land)-based community development.¹⁰⁷

Aside from the 8 larger farms, there is hundreds of local community and family gardens scattered throughout Wai'anae. These farms are not only providing an opportunity towards becoming sustainable but are also a tool in an effort to revitalize traditional Hawaiian culture and practices. Through these farms, the community is instilling cultural ideas such as proper balance of mana (spiritual energy, power), which is believed to be essential in maintaining harmony not only with oneself, but also with others, the gods and nature itself.¹⁰⁸ Hawaiian culture and practices are based on spirituality and maintaining a proper balance between all things. This idea translates to other aspects to traditional Hawaiian practices such as healing.

Traditional Hawaiian Healing

Traditional Hawaiian healing was at the core of Hawaiian culture prior to western contact. The Hawaiian people believed that in order to be physically, mentally and emotionally healthy, one must maintain a proper balance between the body, spirit and nature. Illness was believed to be a result of a loss of pono (spiritual balance/harmony

¹⁰⁷ Hawaii Business Magazine Staff, "More Than Just Farming," Hawaii Business Magazine November 2010, accessed January 22, 2015, <http://www.hawaiibusiness.com/more-than-just-farming/>.

¹⁰⁸ R.K. Blaisdell, "Historical and cultural aspects of Hawaiian health," in *Social Process in Hawaii-The health of Native Hawaiians: A selective report on health status and health care in the 1980's*, Special Issue ed., Vol. 32, E. L. Wegner ed., (Honolulu:University of Hawaii Press, 1989), 1-21.

or right order).¹⁰⁹ Unlike western views on healing, Hawaiian healing involved healing the spirit in order to restore proper balance or pono, because it was believed that the body, mind and spirit were one and therefore the body could not be healed without healing the spirit first.¹¹⁰ The healing process followed several protocols beginning with an individual first recognizing and assessing the actions that led to their imbalance, which resulted in their illness. Taking accountability and responsibility for these actions was a vital part of the healing process. After an individual determined the root cause of the imbalance a kahuna or priest would assist the individual in performing chants and prayers to invoke the mana of the gods to restore spiritual balance along with the use of medicinal plants. The kahuna played a vital role in the process of healing both in an individual and within the community at large, providing guidance for the Hawaiian people in maintaining a proper balance between the body, spirit and nature.

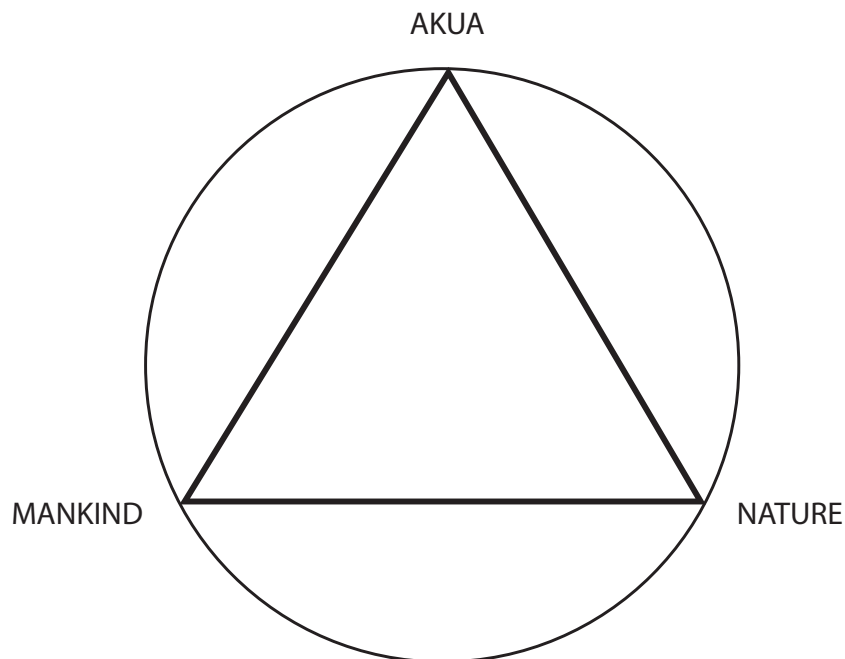


Figure 31 Hawaiian Triangle of Life

[Data from *Mai Iluna Mai* by Kahu Kapiihookalani Lyons Naone | graphic by author]

¹⁰⁹ Kahu Kapiihookalani Lyons Naone, *Mai Iluna Mai: It Comes From Above :General Native Hawaiian Healing* (Hawaii: Kumu A’oand Manawa Inc., 2005).

¹¹⁰ M. F. M. Oheha, “Ka maui o ka ‘aina a he maui kanaka: An ethnographic study from a Hawaiian sense of place,” *Pacific Health Dialogue* 8 (2001): 299-311.

In 1778 traditional Hawaiian culture and healing practices began to change with the introduction of diseases through western contact. The Hawaiian people who believed that illness was a result of imbalance now faced diseases such as smallpox, measles and tuberculosis, which could not be cured through traditional healing methods. The introduction of these new diseases to which the Hawaiian people had little to no resistance to had a dramatic affect not only on the kahuna but the core of traditional healing practices. The kahunas' lack of success in treating these new diseases led to doubt and lack of faith in traditional methods of healing among the Hawaiian people. The lack of success by the kahunas led the Hawaiian people to look towards western medicine instead of traditional healing practices for treatment, which ultimately resulted in the abandonment of traditional cultural and healing practices.

In recent years there has been a call for the restoration of Native Hawaiian culture and traditions including the Hawaiian language, music and dance and traditional practices regarding healthcare. In an effort to preserve Hawaiian cultural traditions, The Wai'anae Coast Comprehensive Health Center through federal and private funding built a facility for Native Hawaiian healing. Its doors open in August 2009, providing a range of traditional healing practices offered by master practitioners. A Council of Elders or Kupuna are responsible for preserving and upholding cultural Hawaiian ways of practice oversees the center. The Native Hawaiian Traditional Healing Center promotes traditional Native Hawaiian healing and cultural education, practices and traditions. The primary practices, which begin with Pule and Oli, prayer and chant, include LomiLomi (Hawaiian massage), La'au Lapa'au (healing with herbal medicine), La'au Kahea (spiritual healing), Pule (healing through prayer) and Ho'oponopono (conflict resolution). It is said that when walking the grounds of the center, one can feel the mana or power of the area.¹¹¹

¹¹¹ "Healing," Waianae Coast Comprehensive Health Center, accessed February 2, 2015, <http://www.wcchc.com/Healing>.

The recent interest in restoring traditional cultural practices in the Wai‘anae coast has created an opportunity to heal a community that has been plagued with social and economical issues such as homelessness, poverty and loss of cultural identity. Of the various healing practices mentioned above, Ho‘oponopono could be an ideal tool in the healing process of the community and individual alike. The Ho‘oponopono process was traditionally used by Native Hawaiians, primarily kahuna, to resolve and discuss arguments, hurt feelings and deal with interpersonal problems.¹¹² The process is a family-based form of conflict resolution used to maintain harmony within an `ohana (family) and within a community. The Hawaiian cultural values of collectivism and community are instilled in Ho‘oponopono, where both the nuclear family and extended family play a key role in restoring harmony within the individual, family, and community.¹¹³

The Ho‘oponopono process consists of several stages, including a protocol that dictates how family members must conduct themselves during the process, which must be strictly followed. The process begins with a kupuna (elder) or kahuna (priest) calling for family members to gather. Family members gather with the understanding that their participation is required until the process is completed, which is important as the process may take several hours or several days. The family must observe two rules during the process; the first is that all communication is controlled by the kupuna or kahuna, the second is the prohibition on expression of emotional excess.¹¹⁴ Before the process begins the practitioner is required to preform Ho‘oponopono on himself or herself in order to avoid the transferring of any imbalance and to insure proper spiritual balance.¹¹⁵ Afterwards once the family is gathered and the rules understood, the process is initiated with a pule (prayer).

¹¹² Mary K. Pukui, et al., *Nana I Ke Kumu*, Vol. 1 (Honolulu: Hui Hanai, 1972).

D. N. Ishida, T. Toomata-Mayer, and J. F. Mayer, “Samoans,” in *Culture and nursing care: A pocket guide*, eds. J. G. Lipson, S. L. Dibble, and P. A. Minarik (San Francisco, CA: UCSF Nursing Press, 1996), 250-263.

¹¹³ Ibid.

¹¹⁴ E. V. Shook, E. V., *Ho‘oponopono: Contemporary uses of a Hawaiian problem-solving process* (Honolulu: University of Hawaii Press, 1985).

¹¹⁵ Kahu Kapiihookalani Lyons Naone, *Mai Iluna Mai: It Comes From Above :General Native Hawaiian Healing* (Hawaii: Kumu A`oand Manawa Inc., 2005).

The pule is then proceeded by identifying the problem, which includes describing the hala (transgression) that has been created or believed to have happened.¹¹⁶ During the process the feelings of those involved are acknowledged and discussed in regards to the hala. The discussions during Ho'oponopono can be intense and during this time, family members may take periods of silence to reflect on their feelings. Once the hala has been thoroughly discussed and proper harmony restored, family members kala or release one another from past transgressions and at this point, the issue is resolved. Traditionally the Ho'oponopono process is then concluded with a ceremonial feast or pani.¹¹⁷

All Hawaiian healing including Ho'oponopono is based on pono (right order; spiritual harmony), which entails not only curing or providing relief from illnesses but determining the root of the illness. In Hawaiian culture it is understood that ones own actions can lead to an imbalance between the body, nature and the gods, these imbalances manifested themselves as illnesses. Traditional healing practices focus on first and foremost determining the root of the imbalance, it is believed that in order to cure the illness, the root of the imbalance must first be addressed.

Healers to provide comfort from the symptoms, which manifest themselves in a patient, often use medicinal plants but only as an aid, they are not the primary form of healing. Kahuna often begin the healing process by first spending time speaking with the patient, this allows the healer to better understand the person and most importantly aid in determining the root of the problem.¹¹⁸

¹¹⁶ Ibid.

¹¹⁷ E. V. Shook, E. V., Ho'oponopono: Contemporary uses of a Hawaiian problem-solving process (Honolulu: University of Hawaii Press, 1985).
Pukui, Nana I Ke Kumu, 60-80.

¹¹⁸ Kahu Kapiiobookalani Lyons Naone, Mai Iluna Mai: It Comes Form Above :General Native Hawaiian Healing (Hawaii: Kumu A'oand Manawa Inc., 2005).

Traditional Hawaiian healing is based on the premise that any form of healing cannot take place without first identifying the true cause of the imbalance. This fundamental idea can serve as a tool to heal a community that has forgotten their cultural ties and often marginalized by western culture. The fundamentals of traditional Hawaiian healing have the ability to be the foundation for a new type of healing center, one that uses all aspects of Hawaiian culture along with the principles of neuro-architecture to create a center that heals not only the individual but the community at large.

CHAPTER 7. NEURO-ARCHITECTURE AND TRADITIONAL CULTURAL PRACTICES

When thinking of neuro-architecture and traditional Hawaiian culture, the link between the two is not always apparent but much of Hawaiian cultural practices follow the same principles outlined by neuro-architecture. These include understanding the effects of natural elements such as water, sunlight and greenery, the importance of touch and sight as well as the implications our emotions and memories can have on the built environment.

Nature

One of the most important links between Hawaiian culture and neuro-architecture is the importance of nature. Neuroscience research has expanded on the effect the natural environment can have on both our physical and psychological well being, Hawaiians understood the importance of nature long before research concluded this. In Hawaiian culture nature is revered and provides healing of the mind and body. It is important to note that in traditional Hawaiian culture, all aspects of the land, forest and ocean, and people are interrelated. Hawaiians believed that respecting and caring for nature would in turn lead to nature caring for the people.

This regard for nature in modern times is further illustrated by research, which informs us of the effects the natural environment, can have on our well-being. Hawaiians understood the healing powers of nature, such as the medicinal properties of plants and fruits and of the balance created by the presence of nature. In modern times the effects the natural environment has on our physical and psychological well-being has been extensively documented. Neuro-architecture research has shown that being in or viewing nature triggers parts of the brain, which are associated with empathy and

love to become more active.¹¹⁹ The presence of nature helps in reducing stress, fear and anger therefore changing our mood to a more calm and balanced state. Hawaiians had a similar belief in nature, understanding that harmony in nature creates harmony in the person.¹²⁰ Similar to ancient times and beliefs, neuro-architecture research supports the idea that nature connects us to each other and the world at large ultimately positively affecting our state of being.

Water

Water is another important link between neuro-architecture and Hawaiian culture. Water was and is a major aspect in Hawaiian culture; it played an integral role in both lifestyle and cultural practices. Wai (water) was believed to be sacred in Hawaiian culture, and along with the land belonged to the gods. Wai was an essential source of life giving prosperity to the Hawaiian people and provided a source of healing.¹²¹ Hi'uwai is an ancient Hawaiian healing practice of cleansing the body, mind and spirit creating mind balance through the use of fresh and salt water. In this traditional practice water serves the function of purification renewing a persons sense of happiness and vitality.¹²²

The healing practice of hi'uwai by Hawaiians meant there was an understanding of the positive effects water can have on the body and mind. Similar to the Hawaiians' understanding of the importance of water to the well-being, neuro-architecture has made similar conclusions. It is understood that water affects us on various levels. On the physical level water at different temperatures has the ability to alter our physical state of being. Cold water for example whether splashed on the face or bathed in,

¹¹⁹ Richard M. Ryan et al., "Vitalizing effects of being outdoors and in nature," *Journal of Environmental Psychology* 30 (2010): 159, accessed January 5, 2015, DOI: 10.1016/j.jenvp.2009.10.009.

¹²⁰ Kahu Kapiihookalani Lyons Naone, *Mai Iluna Mai: It Comes Form Above :General Native Hawaiian Healing* (Hawaii: Kumu A'oand Manawa Inc., 2005).

¹²¹ Julie S. Williams, *From the Mountains to the Sea - Early Hawaiian Life* (Honolulu: Kamehameha Schools Press, 1997), 77.

¹²² 'Ōlohe Lua Aīwāīwa and La'akea Sukanuma, "Keeping Our Traditional Purification Practices Pure," Awa Development Council, accessed February 18, 2015, <http://www.awadevelopment.org/wp-content/uploads/2014/01/KEEPING-OUR-TRADITIONAL-PURIFICATION-PRACTICES-PURE.pdf>.

stimulates the body's muscles increasing blood flow and oxygen to the brain, stimulating the mind.¹²³ Cool water's stimulation of the body similar to the effects of hi'uwai in traditional Hawaiian healing, promotes increased vitality and resistance to disease. Warm water has the effect of relaxing muscles, increasing circulation in the body and through steam, allows the mind to enter a state of relaxation.

Traditional Hawaiian healing used water as a medium for creating balance and harmony in an individual's overall state of being and in recent years neuro-architecture research has led to scientific evidence supporting this idea. Water can have a therapeutic effect on the mind by placing us back in touch with the balance and harmony of nature. The sound of flowing water, we associate with meditation and relaxation soothes the mind and the body. The sight of water similar to that of nature evokes feelings of delight and serenity. Hawaiians were well aware of the profound effects water had on a person's mind, body and spirit which in modern times is now a guiding principle in neuro-architecture design.

Touch

Neuro-architecture through research and investigations has greatly emphasized the importance of touch, even more than sight, in our understanding of the built environment as well as in our psychological state of mind. French philosopher, Denis Diderot states, "I found that of the senses, the eye is the most superficial; the ear the most arrogant; smell the most voluptuous; taste the most superstitious and fickle; and touch the most profound and philosophical."¹²⁴ The sense of touch not only allows us to understand the world around us but also provides us with a channel of communication. Of all the senses, touch is the most social sense, providing a fundamental means to the world around us.¹²⁵

¹²³ Dian D. Buchman, *The Complete Book of Water Healing* (New York: McGraw-Hill, 2002).

¹²⁴ Freddie L. Peaco, "Braille in the Environment," in *Braille into the next millennium*, Judith Dixon ed. (Washington, D.C.: National Library Service for the Blind and Physically Handicapped: Friends of Libraries for Blind and Physically Handicapped Individuals in North America. 2000), 314-333.

¹²⁵ R. L. Klatzky, and S. J. Lederman, "Touch," in *Experimental Psychology, Volume 4, Handbook of psychology*, ed., A. F. Healy and R. W. Proctor and I. B. Weiner (New York: Wiley, 2002), 147-176.

In regards to neuro-architecture, touch serves as a medium, which ties us to our past, evokes emotion and can at times heal. Hawaiian culture uses touch in ways that are similar to those applications in neuro-architecture. In Hawaiian culture and healing practices touch is an important tool used in creating deep bonds within an ohana (family), a way to teach and to heal. Lomi Lomi (softening) is a form of Hawaiian massage that utilizes touch to manipulate the body to heal and restore balance.¹²⁶ Another form of touch employed in Hawaiian culture is the practice of honi ihu, which is the touching of the nose when greeting. This practice is an expression of family members or members of a community exchanging ha (breath), which conveys the degree of closeness in the relationship. This type of interpersonal touch releases oxytocin, a hormone linked to stress, whose effects help in reducing stress experienced in everyday life.¹²⁷ Through touch kupuna taught younger generations arts such as weaving, navigation, cultivation and healing. The sense of touch played an integral role in Hawaiian spirituality, healing and overall way of life.



Figure 32 Sharing of Ha or the Breath of Life through Honi Ihu

[Photo by Richard Walker, <http://archives.starbulletin.com/2003/09/10/news/index2.html>]

¹²⁶ Kahu Kapiiiohookalani Lyons Naone, *Mai Iluna Mai: It Comes From Above* :General Native Hawaiian Healing (Hawaii: Kumu A'oand Manawa Inc., 2005).

¹²⁷ Di Simplicio M. et al., "Oxytocin enhances perception and memory for positive versus negative emotional information in healthy male volunteers," *Journal of Psychopharmacology* 23 (2009): 241-8.

CHAPTER 8 . DESIGN

The purpose of this thesis is to investigate the findings of neuroscience and promote their implementation into architectural design, therefore creating a deeper understanding of how the human body relates to architectural surroundings. This understanding was the driving force for the design. The design creates a weaving of neuro-architecture and traditional Hawaii cultural practices in an attempt to formulate a different type of design, one that would have the ability to begin to heal a community riddled with various social issues.

Site Selection

The process of site selection first began with the decision to concentrate on the Wai 'anae coast. This decision was made due to various influences. The first came from the understanding of what neuro-architecture attempts to create through design. Its purpose is to create a design that is holistic; taking into account the needs of the user, cultural values and the effects the design will have on the user. This led to the decision to focus on the Wai 'anae coast because of the many social issues that plague the city. Wai 'anae provided an opportunity to develop a design, which integrates the findings of neuro-architecture and cultural practices to provide an architectural environment that is conducive towards healing of both the ohana and the community as a whole. Selection of the site came after a deep exploration of the city. Wai 'anae, although riddled with many social issues such as homelessness, poverty, unemployment and breakdown of family relationships holds many treasures. The city is home to some of the richest soils in the world, providing the opportunity for small farms and families to grow their own crops. Some of the larger farms such as Ma'o Farms has seized this opportunity not only to provide locally grown produce to the island but to also provide opportunities to the youth of Wai 'anae through their youth leadership program.

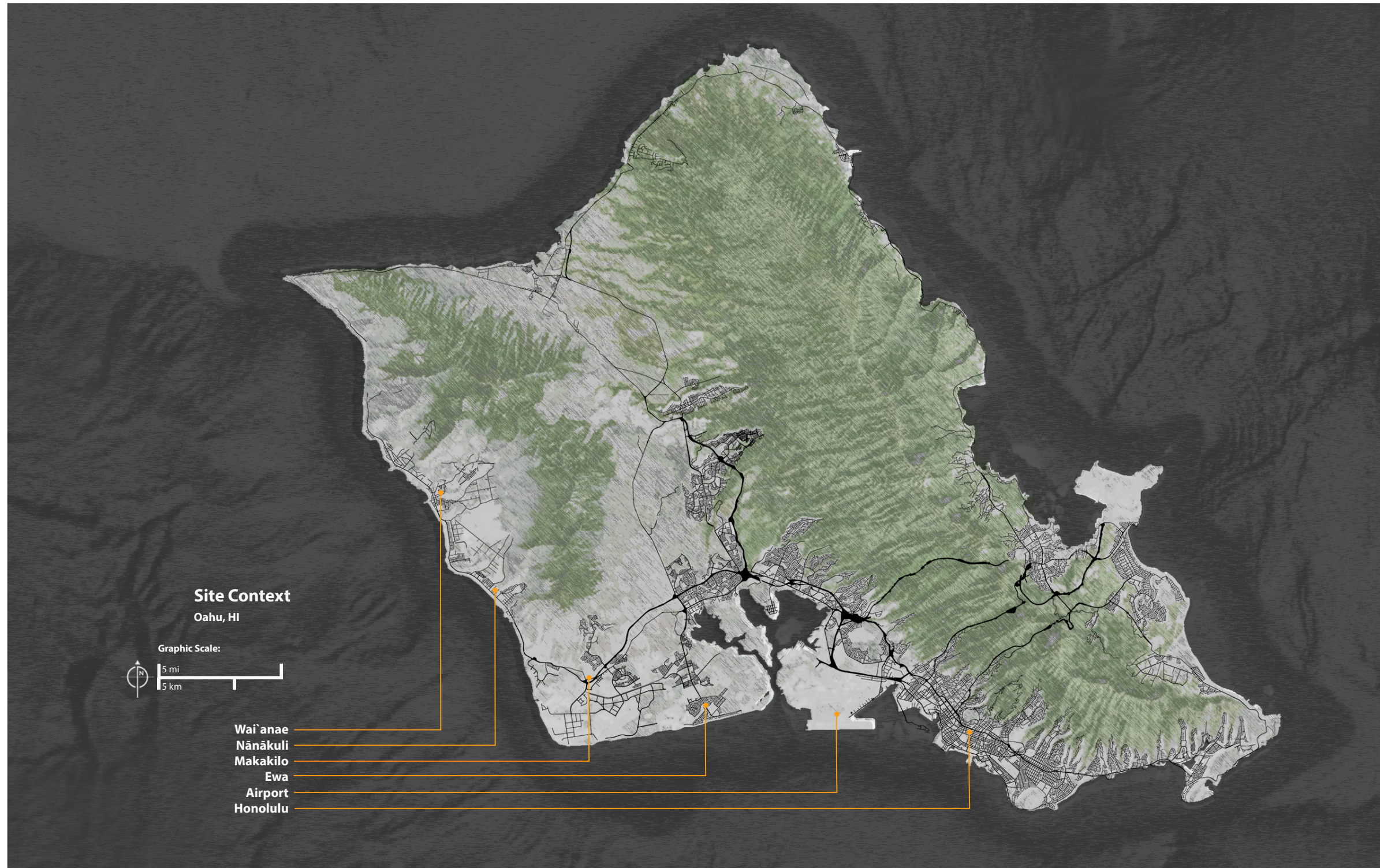


Figure 33 Map of Oahu
 [Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]



Figure 34 Students working at Ma‘o Organic Farms

[Photo from Ma‘o Organic Farms, <http://ulupono.com/portfolios/ma-o-organic-farms>]

The Wai ‘anae is one of the island’s most abundant fishing grounds. Traditionally fishing played a vital role in Hawaiian spirituality and relationship to nature, which still holds true in modern times. The coast of Wai ‘anae is home to some of the most spectacular beaches and sunsets. The water, beaches and natural environment create a welcoming spirit to residents and visitors alike. Here the sense of ohana is not lost. Local families often gather for festivities and social interactions near the cities healing waters. The issues faced by the city often overshadow these qualities, but represent parts of a culture that once thrived in the area and is the foundation of the culture of Wai ‘anae.



Figure 35 Hawaii Fisherman

[Photo by Susan Seubert, <http://travel.nationalgeographic.com/travel/city-guides/undiscovered-maui-photos->]

After exploring Wai ‘anae, the focus shifted to selecting a site that would be appropriate and conducive to goals of the design. Since Native Hawaiians make up 30% population of Wai ‘anae the process of selecting a site concentrated around Hawaiian Homestead Lands that were either developed or in the process of development. Unfortunately the development of lands designated for homesteading in Wai ‘anae was a low priority for the Department of Hawaiian Homelands (DHHL), the governing body over Hawaiian lands. This complicated the process since lands, which had been previously developed, were not conducive to the goals of the design.

The first site, Wai ‘anae Valley Homestead is home to 369 single-family residences located in the Wai ‘anae valley. The community is set in the lush landscape of the Wai ‘anae valley. Although the setting creates a beautiful backdrop, the overall design of the community is lacking. The Wai ‘anae Valley Homestead community is a continuous line of homes and fences, lacking any sort of open area such as parks or playgrounds for community interactions.



Figure 36 Wai ‘anae Valley Homestead Housing
[Photo by Author]



Figure 37 Fences Seperating Properties
[Photo by Author]

The homes in the homestead range in drastically, some having a more modern design while others resemble old Hawaiian plantation homes creating a divide on a social level. Many of the homes are run down and unkept distracting from the beauty which surrounds them. Some of the homes are not used at all, boarded up as a result from the loss of integrity. There is little social interaction that occurs between neighbors as yards are fenced in and cars often litter those yards that are not. Overall while the homes provide a shelter for many Hawaiian families their condition and design do not promote the collectivism valued in Hawaiian culture.



Figure 38 Home Riddled with Vehicles
[Photo by Author]



Figure 39 Example of Newer Homes
[Photo by Author]



Figure 40 Example of Plantation Style Home
[Photo by Author]



Figure 41 House Boarded up by DHHL
[Photo by Author]

The second Wai 'anae Kai Homestead, is located near the coastline off of Farrington Highway in Wai 'anae. These homes vary drastically from those of the previous homestead site. Here dilapidated homes are replaced by new identical homes, much in the cookie cutter sense. Although this particular community provides Hawaiian families with newer more modern homes, the same issues regarding community and lack of social interactions exist.



Figure 42 Homes of Kai Wai 'anae Homestead
[Photo by Author]



Figure 43 Homes in Kai Wai 'anae Homestead
[Photo by Author]

The homes provide little to no yards for families and neighbors to interact. There are no parks, playgrounds or open areas to invite gatherings and social interactions. The Hawaiian culture is one based heavily on community and both social and personal relationships, which neither of these two communities seem to value or implement through their design. After considering the pros and cons of these two sites, it was concluded that neither would be appropriate for the intended design.

Later investigations of the area led to a site that proved to be conducive to the overall design. The site is located on the city's eastern most boundary, surrounded by lush natural landscapes and local farms. The site is located on a parcel of the Kahuman Complex. The Kahumana Complex consists of 4 distinct campuses situated on over 50 acres in the Lualualei Valley in west Oahu. The complex is an alternative farm-based community that helps in addressing the needs of those who reside in the community. The community has a diverse mix of people including farmers, social workers, and social entrepreneurs, people transitioning from homelessness, visitors,

locals, youth and people with disabilities. The organization's goal is to create a balanced individual as well as community through their holistic approach and social programs. Kahumana's social programs focus on:

Homelessness

- Transitional housing program for 130 families
- Wrap around supportive services and case management with the goal of long term permanent housing.

Disability

- Day Program for Adults with developmental disabilities
- Personal Assistant Services
- Youth
- Day Care, Pre-school, After school programs, Farm to School Program, Intersession Camps.

Kahumana's social ventures are revenue generating social businesses, 100% part of our non-profit 501(c)3, that directly serve their social mission by providing work and training opportunities for the people they serve. They also provide a venue for the general public to get involved:

Retreat and Learning Center

- Retreat Programs related to sustainability, permaculture, organic farming, wellness, youth
and leadership development, disabilities studies, social justice in Hawaii, spirituality, hawaiian
& world culture.
- Farmstay opportunities on the Organic Farm

Organic Farm and Cafe

- An expanding diverse fruit and vegetable organic/biodynamic farm that offers work/training opportunities for staff / interns / woofers.

- An on-farm café that serves farm-fresh food while teaching culinary and hospitality skills to people in the programs.

Commercial Kitchen: School Meals and Catering

- Commercial kitchen currently delivers over 5000 meals per week to over 35 schools using healthy balanced menus and local organic produce from the on-site farm.¹²⁸



Figure 44 Collage of Kahuman Complex

[Photo by Author | From left to right: Kahumana café, café special of the day, agriculture field, agriculture service]

¹²⁸ “Kahumana Organic Farm,” Kahumana Community, accessed January 8, 2015, kahumana.org.



Figure 45 Wai 'anae Boundary Map
 [Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]



Design

The complex provided an opportunity to integrate traditional Hawaiian healing and neuro-architecture into a design that could strengthen and heal the community. The design takes principles from both field and attempts to integrate them in a way that would allow both residents and visitors alike to find a balance, whether it is emotional, physical, or spiritual. The transitional housing is located on an adjacent site providing an opportunity to create a stronger cohesion between public and private spaces.

The site is located between the café, retreat and organic farm, which are mainly used, by visitor, and the transitional housing that is primarily for residents only. One side of the complex is public with a sense of openness and the ability to wander. The other side is the private section, which is the location of the transitional housing. This portion of the complex gives a sense of being private with its large stone gate and signs requesting visitors to sign in at the office. By developing a design that is placed between these two spectrums, it allows for a more holistic integration between the existing structures, workers, visitors and residents. One of the goals of the design is to promote social interaction and heal the connections lost among neighbors, visitors and community.

The proposed design incorporates features such as agriculture, landscape and water, which are currently found on the site. These features play an important role in creating the desired atmosphere of relaxation and tranquility. The decision to incorporate these features relates to the Hawaiian culture view of nature. It is revered and is one of the three aspects of maintaining balance. For this reason the natural elements of the site were used as a guiding aspect and highlighted in the design.

The design of the site focused around creating a journey for residents and visitors, where they can begin the process of being pono or in balance. A major component of the design is the idea of Ho'oponopono, which translates to conflict resolution or cleansing of the mind. In traditional Hawaiian Healing it is important to solve the root of the problem versus only treating the symptoms. Healers will begin healing sessions by first spending up to 3 hours talking with their patient. This allows the healer to understand and discover the root of patient's ailments. It is believed that symptoms are not the issue but merely an indication that one of the three points stated earlier is off balance. The design uses this thought process to create an environment which allows visitors and residents to get to the root of their problems while providing support services to aid in achieving balance. The site consists of two different journeys, that of the visitor and that of the resident.

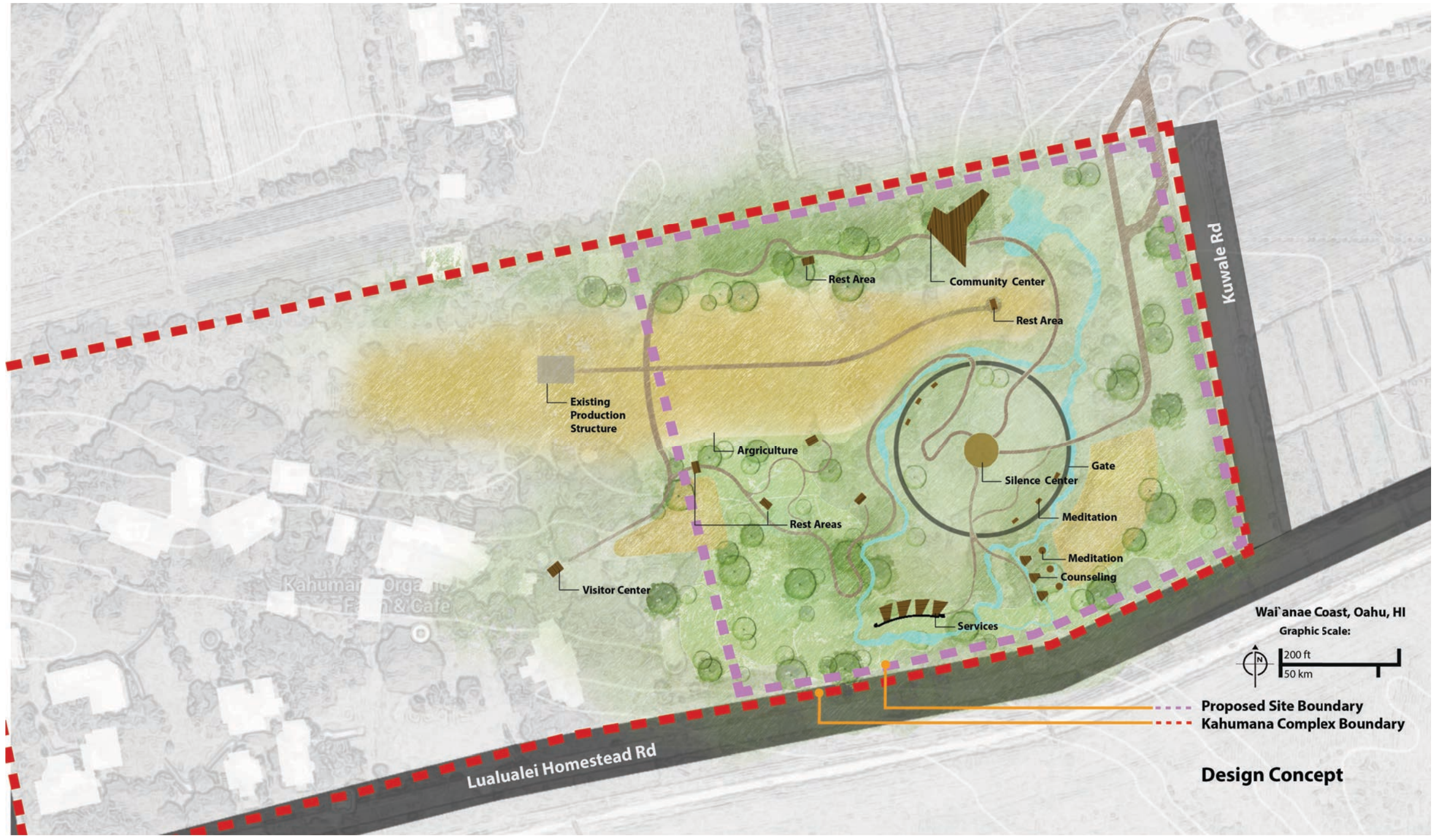


Figure 49 Design Concept

[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]



Although both residents and visitors share the same site, their experiences will differ. The main difference in experience is that the visitor will be given the opportunity to learn about the healing center and kahumana complex, where the resident is already aware of this. The goal of the resident's journey is to create an opportunity for the person to be open and confront their issues at the core. The journey begins by preparing them for ho'oponopono by introducing a natural environment, which will aid in creating an atmosphere of tranquility and relaxation. Natural environments such as greenery and water and have shown reduce a persons stress levels and clear their and altering their state of mind. The journey leads to a great rock wall signifying a change in mood and behavior. The wall serves as a threshold creating a sense of spirituality, by evoking memories of Hawaiian sacred places. The path continues to what is called the place for silence. In traditional healing it is said that in order for a person to learn they need to be silent. This space allows for that. The architecture and the scale express a change in behavior in needed.

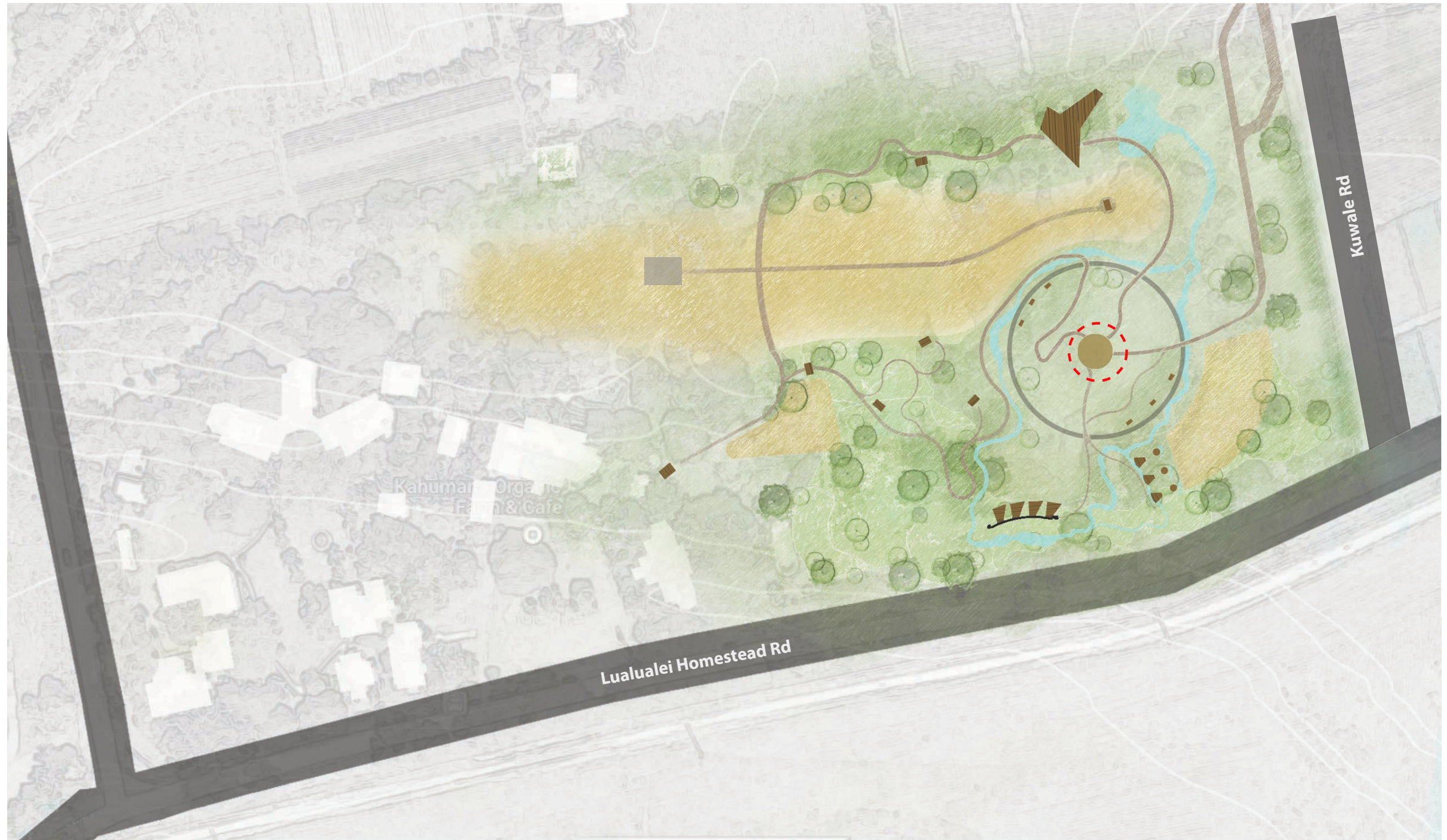


Figure 50 Site Plan | Silence Center

[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]





Neuroarchitecture Principles:

- Materiality
- Atmosphere
- Scale

Figure 51 Silence Center Render
[Pillars from San Francisco Botanical Garden, <http://sfbotanicalgarden.org>,
graphic and photo by author]



After experiencing the space of silence residents are directed to individual counseling areas or ho'oponopono spaces. These areas are primarily open air allowing the participants maintain a visual connection with the natural environment. Water is incorporated into the design and serves two purposes. The first being to create a physical separation from other counseling spaces as well as to create a sense of privacy. The second is to aid in creating an atmosphere of tranquility. The white noise produced by the water walls allows residents to feel a sense of privacy while also mitigating the any ambient noise.

The materials wood and stone create a sense of warm and spirituality respectively. The stone is black basalt reminiscent of that used in sacred places such a heiau. The slat design of the walls allows sunlight to enter and for the resident to feel the warmth of the sun and the coolness of the light breezes that flow through the site. The design takes into consideration the effects natural lighting can have on a person's mood and psychological state utilizing them to create an environment appropriate for mental cleansing.



Figure 52 Site Plan | Ho'oponopono

[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]





Neuroarchitecture Principles:

- Nature
- Materiality
- Water



Figure 53 Ho'oponopono Center Renders
[Photo from Streatham, <http://gertsamtkunstwerk.typepad.co.uk>,
graphic by author]



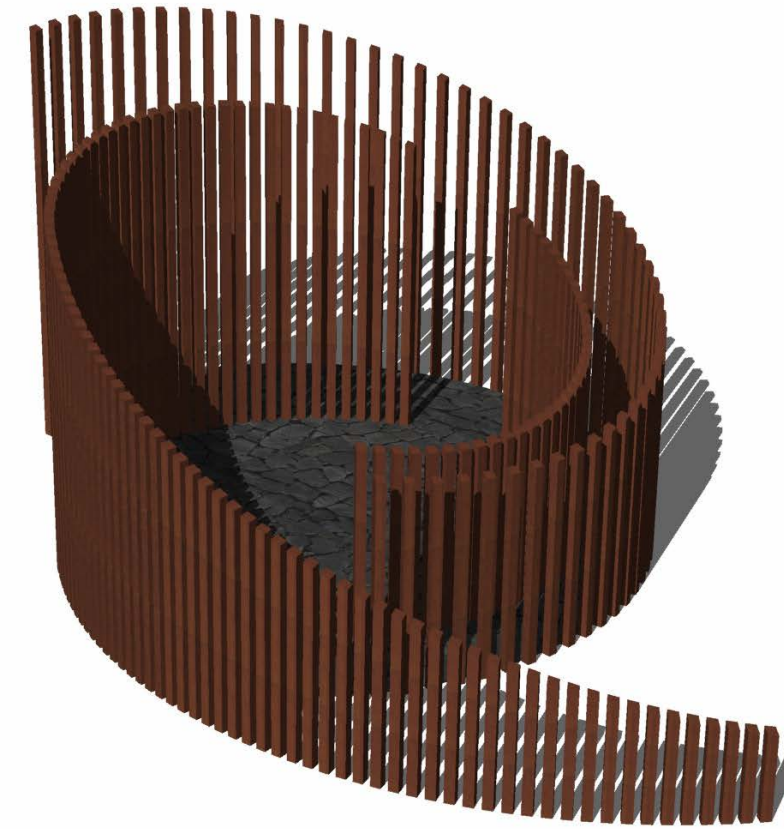
From here residents have the option to retreat into a private meditation area to collect and gather their thoughts after their counseling session or to proceed to the service area. Traditionally during the process of ho'oponopono, members often have the option of taking what is called silence time, to think about what has transpired during the session. The private meditation spaces provide a place for a member to retreat and think. The meditation spaces are surrounded by natural vegetation to aid in relaxing and creating calmness in the mind and body. The structures, which consist of thin vertical slats, create a circular space in which the individual will feel protected and have a sense of privacy without being completely enclosed.

The meditation space is situated adjacent to a water pool, allowing an individual, if he/she chooses, to partake in the calming and invigorating effects of water. The water allows the individual to enter a different state of mind, momentarily releasing any stress or worries they might have. Ho'oponopono can be an intense and exhaustive process, and by providing individuals the ability to interact with water, the design promotes the balance of mind and body.



Figure 54 Site Plan | Ho'oponopono Meditation
[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]





Neuroarchitecture Principles:

- Nature
- Water
- Perception

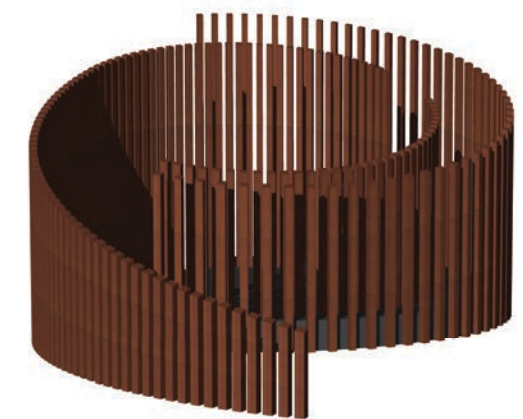


Figure 55 Ho'oponopono Meditation Area Renders
[Photo from Sundry House, <http://www.tripadvisor.com> | graphic by author]

The service area provides residents the tools to achieve balance. Once the root of the problem is discovered, residents will have access to services, which will enable them to heal the symptoms of the problem. The services are a collection of four structures connected by a walkway. The service structures were design in this manner to evoke feelings of community. The concept of the healing center is not only to heal the individual or family but also to heal the community as a whole. By providing residents service structures that evoke these feeling, the resident will feel more inclined to participate and interact with other residents partaking in the services offered. By promoting a sense of community the design create an opportunity for residents and visitors to socialize and learn from one another.

The design of the service structures is similar to that of the of the ho'oponopono areas, which is reiterated throughout the healing complex. The design is open air to provide natural daylighting with the slats providing enough cover from the sun. But unlike the counseling spaces, these structures use the slats to provide a sense of privacy instead of water. The privacy the slats create is not necessarily to separate but to give individuals a sense of intimacy. The ability to see into the service spaces allows for residents and visitors to join services already in progress. By presenting a sense of openness, the design promotes participation and interaction among individuals. The use of water is also incorporated but not in the structures themselves. It is located adjacent to the services, creating a similar effect that of the meditation pools. The services signify the process of healing is complete.



Figure 56 Site Plan | Services Center

[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]





Neuroarchitecture Principles:

- Nature
- Water
- Memory



Figure 5/ Service Center Renders
[Photo and graphic by author]



Once residents feel that the root of their imbalance is discovered and have begun the healing process, they are given the option to a private meditation area without having to attend a counseling session. This area is primarily for those who have gone through the previous journey and simply need a space to get away to be alone with their thoughts. These meditation areas differ from those found at the ho'oponopono area by their design.

The first meditation space is designed to be more natural, using stones found on the site and surrounding areas to form a grotto where meditation and contemplation can take place. By designing a more natural environment the design allows the user whether it be the resident or visitor to feel a deeper connection with nature. The grotto partially encloses a person giving a sense of security and privacy, while still allowing a direct view to nature and water. The design of this meditation area uses nature, water and materials to create an atmosphere allowing individuals to find harmony and balance with nature.

The second meditation area consists of a wooden platform surrounded by the natural landscape. The space can also serve as a rest area for visitors to gather their thoughts and relax. The wood gives the individual a feeling of warmth and comfort, blending in to the landscape around it. The materials and the landscape allow individuals to enter a different state of mind, one that is more in balance. Nature creates strong feelings of unity with others experiencing the healing center and a stronger connection with nature.

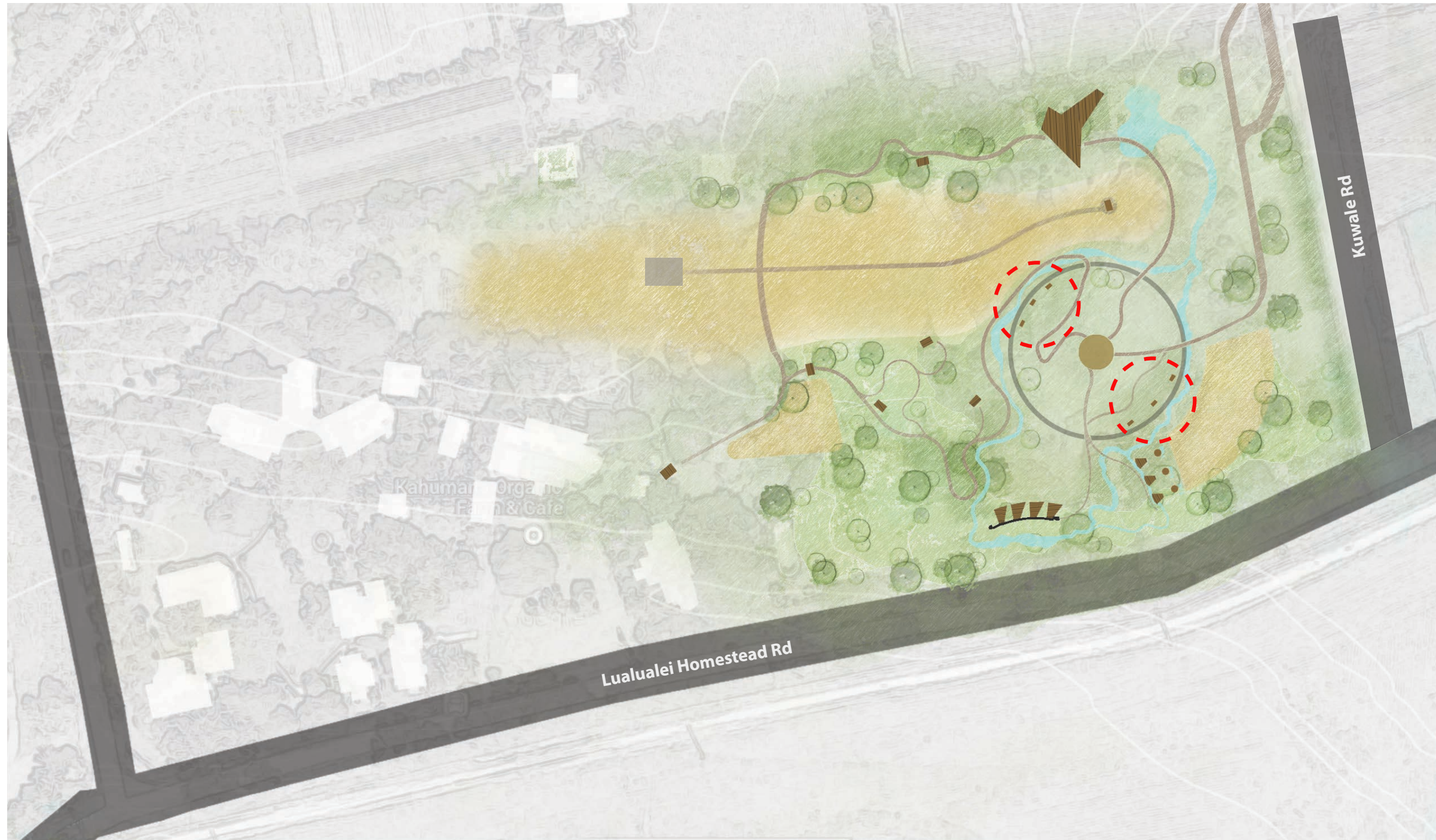


Figure 58 Site Plan | Meditation Grotto | Meditation Platform
[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]





Neuroarchitecture Principles:

- Nature
- Water
- Materiality

Figure 59 Meditation Grotto Render
[Photo from Miuki Mikado, <http://miuki.info> | graphic by author]





Neuroarchitecture Principles:

- Nature
- Materiality
- Atmosphere

Figure 60 Meditation Platform Render
[Photo from Explore, <http://mbgarden.org> | graphic by author]



The community center is a part of the experience at times. It provides a space where residents and staff can have their own area for ho'oponopono. The community center is also for the farming community to discuss issues or hold meetings as well as for the community at large. Although the space is designated as area for conflict resolution, it can also be used as a place of celebration for the Kahumana community.

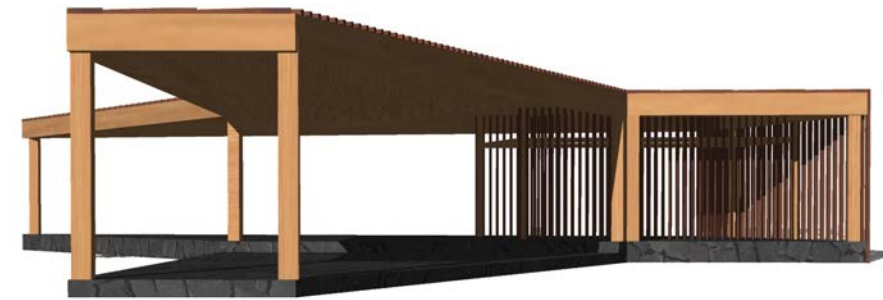
Similar to the other designs the community center uses slats to create a sense of openness while providing protection from the natural elements. The lack of walls allows for flexibility and encourages social interaction. The community center provides a place where visitors, residents and workers can begin to strengthen and heal social bonds allowing the expression of ideas, beliefs and culture. While the other services aim at healing the individual or the family, the community center aims at healing the community as a whole.



Figure 61 Site Plan | Community Center

[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]





Neuroarchitecture Principles:

- Nature
- Water
- Atmposhpere



Figure 62 Community Center Renders
 [Photo and graphic by author]



The visitor experience differs slightly, not necessarily in the process of healing but in how one begins that process. The visitor enters through the public side allowing them to experience the café and retreats. If a visitor chooses to enter the healing center they must first pass through the visitor center. The visitor center serves two purposes, the first is to inform about the healing center and the efforts of the kahumana organization. This provides an opportunity for visitors who are interested, to become further involved in the healing center. Since a majority of the services currently offered are based on volunteering, a visitor who feels they can be an asset to the goal of the healing center can partake in providing others their own expertise, whether it be financial or emotional.

The second purpose is to invite visitors to participate in the healing center. The visitor center is meant to create a sense of belonging and inclusivity for those who are not residents of the complex. The goal of the healing center is to heal not only the individual but the community at large and by developing a structure that allows visitors to feel comfortable it become more inclusive creating a sense of belonging within the center itself. The design of the visitor center is open air with slat walls to allow the visitor to view what is beyond the center evoking a sense of curiosity. The sense of curiosity will lead visitors to explore the different aspects of the healing center from the services, meditation spaces to the agriculture allowing them to fully experience all the healing center has to offer.



Figure 63 Site Plan | Visitor Center

[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]



MEDICINAL PLANTS



NONI



TI



KUAWA



AWA

GROUND COVER



NEHE



IHI



EWA HINAHINA

SHRUBS



POHINAHINA



KULUI



NAIO

TREES



LOULU



WILIWILI



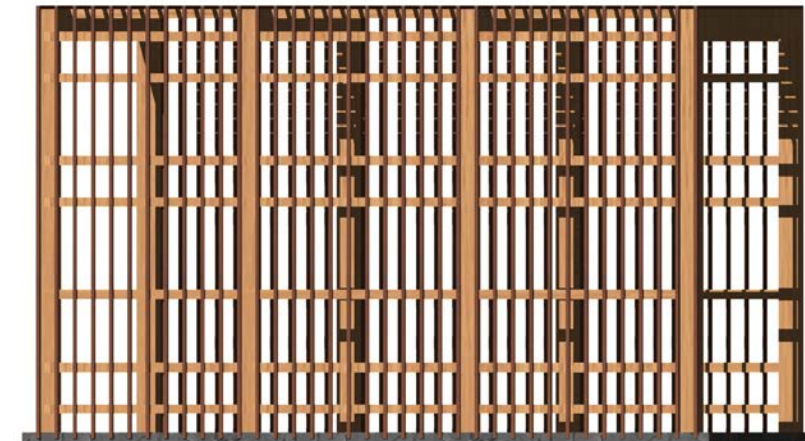
OHIA



ILIAHI

Figure 64 Native Hawaiian and Medicinal Plants

[Data from Native Plant Propagation Database, <http://www.ctahr.hawaii.edu/hawnprop/>,
<http://www.hawaiinativeplants.com/ourplants/> | graphic by author]



Neuroarchitecture Principles:

- Nature
- Materiality
- Light

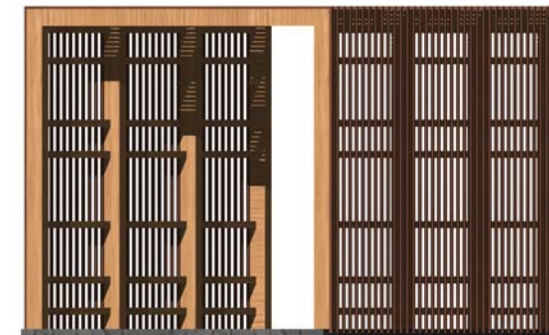


Figure 65 Visitor Center Renders
[Photo and graphic by author]



Rest areas are scattered along the paths providing visitors the opportunity to pause in an environment that promotes relaxation and reduces stress. Some of these rest areas are located within the agricultural section of the site. Here visitors can learn and experience traditional agricultural practices and produce. For example they can learn how taro is cultivated, participate in the process of pounding taro into poi and finally enjoy this product at the café. The landscape itself is a tool, which can be used to teach visitors about traditional healing practices and medicinal plants. Native Hawaiian and medicinal plants are incorporated into the landscape to strengthen the emotional connection between the body and nature. The visitor experience is about learning not only about the healing center but how traditional Hawaiian culture and healing practices are interwoven into the design.

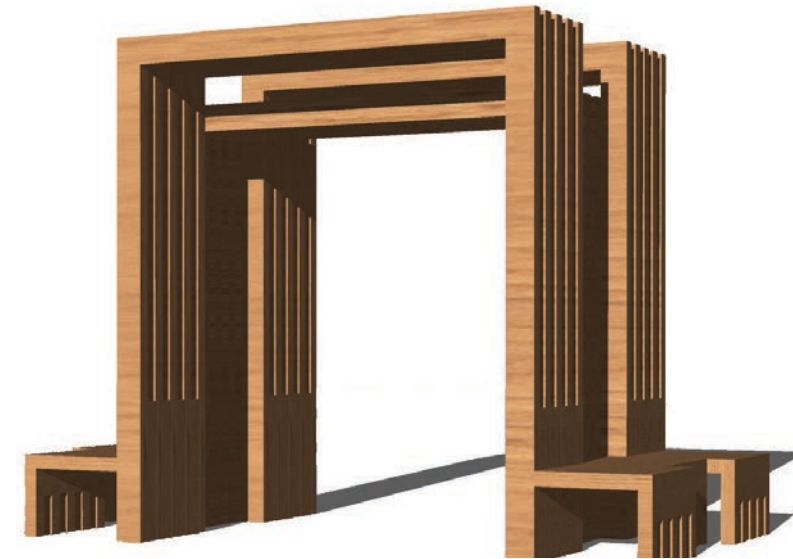
Similar to the residents' experience, the visitor experience will involve natural landscaping to aid in changing moods from stressed or anxious to one more calm and balanced. Being surrounded by nature a visitor is compelled to be more open and embrace the effects each portion of the healing center will have on their mind, body and soul. The visitors are not provided with a direct path to the threshold of the center, instead they are given glimpses of structures on their experience further engaging their curiosity. As mentioned earlier this is meant to prepare them for the healing process. The visitor can partake in any one or all of the services, their experience once they cross the threshold will be the same as that previously described in the resident experience.



Figure 66 Site Plan | Rest Area A | Rest Area B

[Image from Google Maps, <https://www.google.com> | Data from HoLis, DPP, C&C of Honolulu, <http://gis.hicentral.com>, graphic by author]





Neuroarchitecture Principles:

- Nature
- Materiality
- Light

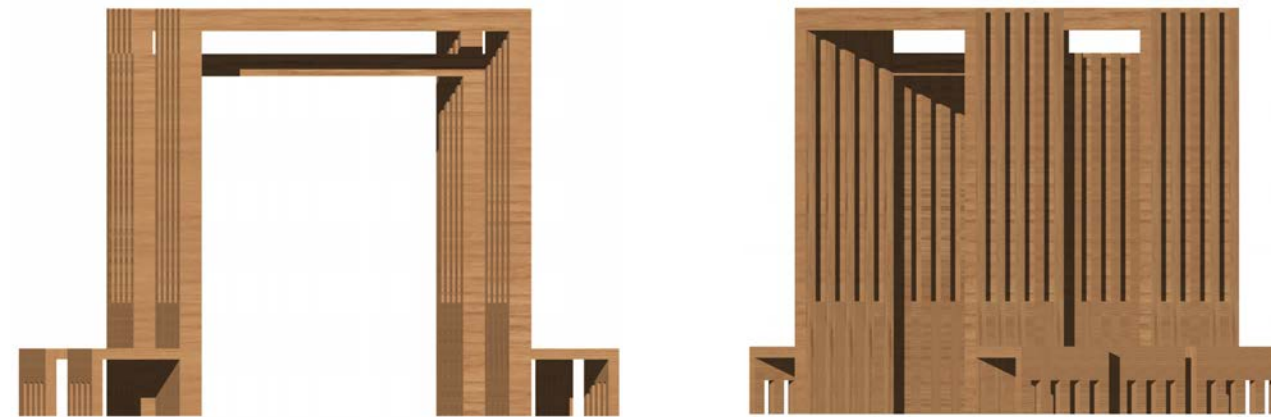
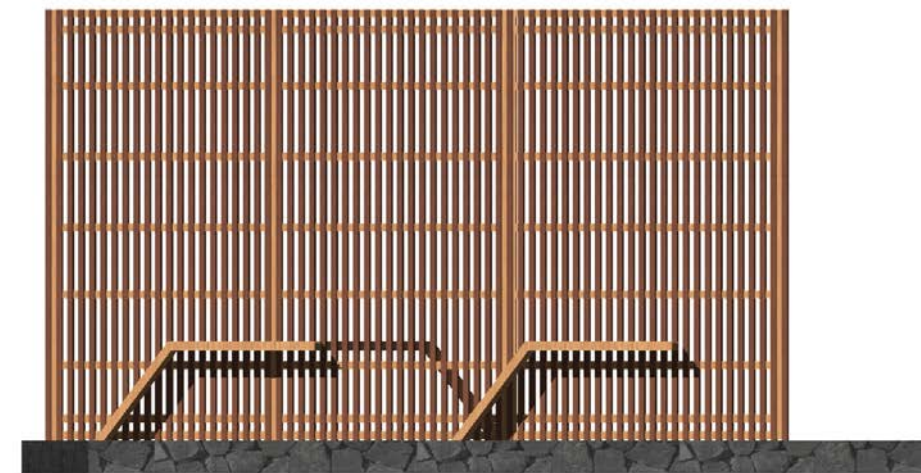


Figure 67 Rest Area A Renders
[Photo and graphic by author]





Neuroarchitecture Principles:

- Nature
- Materiality
- Memory

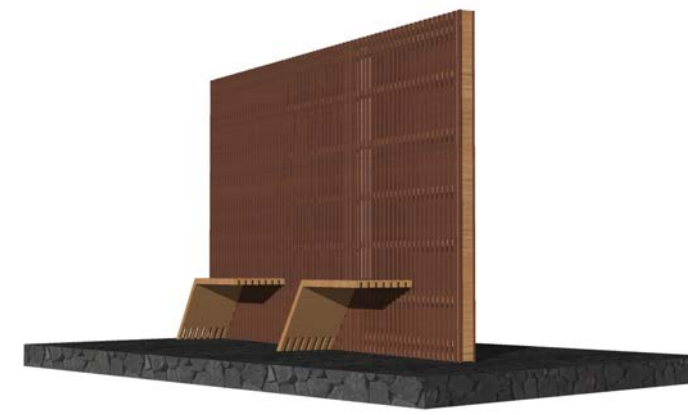


Figure 68 Rest Area B Renders
[Photo and graphic by author]

CONCLUSION

This Hawaiian Healing Center has brought to light the undeniable link between architecture and neuroscience and how through neuro-architecture, architects can begin to develop spaces and structures better suited for our needs. The goal of this research was to investigate the findings of neuro-architecture and promote their implementation into an architectural design, in order to create a deeper understanding of how the human body relates to architectural surroundings. By understanding how the human body reacts to various stimuli, I believe that architects in the future will be able to provide designs that are more meaningful.

Neuro-architecture is a fairly new field that is rapidly progressing towards the development of guidelines that can ultimately be integrated into the design process. Through the research and various case studies, it became apparent that long before the development of the field of neuro-architecture, people were aware of the positive and negative effects the environment can have on our mind, body and spirituality. The Hawaiian people were greatly attuned to this and had a culture centered using this knowledge to create balance and harmony.

The research not only created an understanding of how the human body is affected by external stimuli on a neurological level and an understanding of how the information gathered by neuroscientists can be used to guide architectural design but it has demonstrated through the design of the healing center, that cultural values and practices can be strengthened through neuro-architecture. I believe the design of the health center demonstrates the ability of neuro-architecture, as a tool, to develop architecture that has a deeper meaning and effect on a community and its users.

The links between neuroscience and architecture are constantly discussed and investigated by the Academy of Neuroscience for Architecture (ANFA). Currently the body of work has primarily focused on the fields of health care and work environments. This has limited the body of work available to architects, planners and students to learn from and the possible areas of implementation. Neuro-architecture has captured the attention of architects and scientists alike driving the future exploration into other fields.

I believe that this research can serve as an example and catalyst for students and architects in gaining knowledge through the findings of neuro-architecture to ultimately gaining a better understanding of how every aspect of a design can affect the user. Neuro-architecture steers architects towards a somewhat new way of thinking about the relationship between the structures we design and the effects they can potentially have on the human body both physical and psychological. I truly believe that neuro-architecture is the link that will allow architects to implement knowledge about the human body into future designs in an effort to create architecture that is more meaningful, attuned to our needs and can improve our overall wellbeing.

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