

Patterns of Connection in Architecture: The Paradox of Light and Shadow

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Arch 548
Fall 2009



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Abstract:

There exists a dialectical relationship between light and shadow. This relationship reflects the inherent paradoxical qualities of nature. Light and shadow continually move and evolve, never static, as nature continually moves and evolves. The movement of daylight continually generates its opposite, shadow, leading to a reconciliation of opposites. This continual mirroring between light and shadow creates a holistic image that gives dimensionality and life to the illuminated structure.

I present this exploration of light and shadow as a set of ideas, as one example of a “poetic map”, to help architects develop an awareness of how to “think about their thinking.” This awareness reflects a way of “Being-in-the-world” that taps into a deeper consciousness of what makes us human. It reflects a way of thinking about who we are, what our fundamental needs are and what our role is in the larger world. It is essential that architects “think about their thinking”. They must reflect on the impact of their thoughts and ideas on their work. They must contemplate a connection to nature through their work and, in turn, a connection to the larger world. Ultimately, every work of architecture reflects this awareness, or lack thereof.

Learning how to think and developing this awareness can be taught. A “poetic map”, such as that presented here, suggests a path along which this awareness can be developed. From this “map”, it is up to each of us to explore and develop our own understanding of the “territory”. The “territory” is a way to think and to be. The “territory” is not shown on the map.

In nature, light and shadow are one “pattern which connects”. Light and shadow play an important role in our perception of, and response to, space. Furthermore, humans, “are by nature phototropic --- they move toward light, and when stationary, they orient themselves toward the light” according to Christopher Alexander et al in their book

Pattern Language.¹ It is the paradox of light and shadow that engages our senses, gives architecture life and connects us, through architecture, to nature and to that which is sacred.

Unfortunately, architecture has become primarily a visual experience. We have lost our sensory engagement, through architecture, to nature. Because our connection to nature, or to that which is sacred, is fundamental to our being, we have lost a part of ourselves. We must step back and engage all our senses with architecture that highlights nature and becomes “the pattern which connects” us to the “change and flow of climate, season, sun and shadow, constantly tuning our awareness of the natural cycles which support all life.”²

In this DArch project, I clarify the paradox of light and shadow in architecture. I explain the role of our senses in our perception of space, specifically with respect to light and shadow. I also explain how light and shadow influence materiality, memory, wayfinding and cycles of time in architecture.

The successful manipulation of light and shadow frames our experience of architecture. Case studies of buildings that manipulate light and shadow to create full sensory engagement are presented to enhance our understanding of the relationship between light and shadow and the impact of that relationship on our experience of architecture. This relationship is critical to man’s connection to nature through architecture. It is this connection to nature that, in turn, enhances our response to the built environment.

¹ Christopher Alexander et al., *Pattern Language* (New York: Oxford University Press, 1977), 645.

² <http://www.ecodesign.org/Portfolio/Commercial/bateson.html> accessed 9/17/208.

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Preface

With sincere gratitude to my committee whose support was immeasurable.

David Rockwood, MArch, Chair
Luis Longhi, MArch, MFA
Lawrence R. Allman, Ph.D.

A. Kim Suman
December, 2009

POETICS

"I look for the way
things will turn
our spiralling from a center,
the shape
things will take to come forth in

so that the birch tree white
touched black at branches
will stand out
wind-glittering
totally its apparent self:

I look for the forms
things want to come as

from what black wells of possibility
how a thing will
unfold:

not the shape on paper—though
that, too—but the
uninterfering means on paper:

not so much looking for the shape
as being available
to any shape that may be
summoning itself
through me
from the self not mine but ours."

A.R. Ammons³

³ "The Poetic Mind: Further Thoughts on an 'Aesthetic Preference'" by Lawrence R. Allman, *Family Process*, Vol. 21, December 1982, p. 419-420.

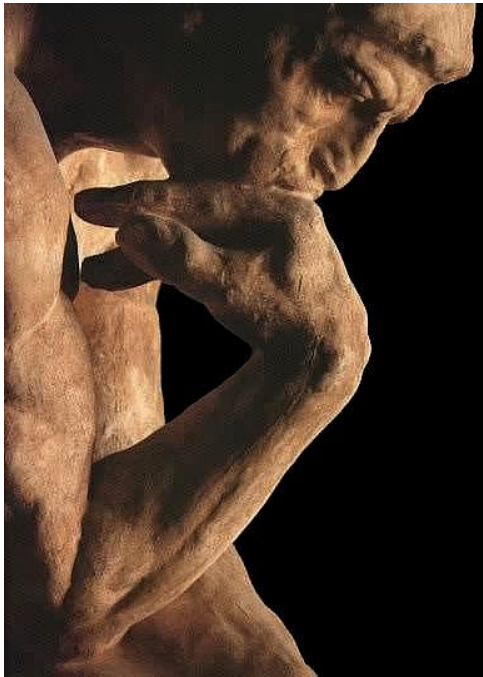


Figure 1
Rodin's "The Thinker"
originally titled "The Poet"

Introduction

“For poetic thinking transpires in an unfamiliar zone, making its own course as it proceeds, speaking all the while in peculiar accents. Rigorous in its own way, it is at once playful and sober, innovative and traditional, carefully argued and arbitrarily avowed.”⁴

David Halliburton

I came to architecture from a successful career as an engineer in the oil industry in Hāwai‘i and California. In the oil industry, my focus was on fossil fuels: crude oil, gasoline, diesel fuel, bunker fuel oil. The oil business is a gritty business. While working for Getty Oil and then Texaco in Ventura, California, I spent many a night at a dusty, remote wellsite managing downhole operations intended to increase production. I wore a hardhat, steel toed boots and communicated via two-way radio. We detonated 32 gram charges set downhole in hollow pipe strung on a wireline. One of my jobs, as engineer, was to ensure these “perforating guns”, as they were called, were in the correct vertical position downhole, across from the intended production interval. I worked with the “roustabouts” and the “roughnecks”, traditional names for the well workers in the predominantly male oilfields. Later, while working for Union Oil and then ConocoPhillips in Hāwai‘i, my job was to keep my employees, the public and the environment safe by keeping everything “in the tank” so to speak. So much human energy is spent worldwide searching for, extracting, refining, transporting, and cleaning up fossil fuels. Fossil fuels have allowed man to reach technological heights not previously imagined. Paradoxically, fossil fuels have been identified as a primary contributor to global warming which may ultimately destroy us.

There are other options to fossil fuel. Harnessing the sun’s energy is one of those options and, in combination with others, may ultimately replace fossil fuels. In contrast to fossil fuel that is found in limited quantities and only in specific geographic areas, the sun is infinitely available everywhere on earth. The sun produces clean energy,

⁴ David Halliburton, *Poetic Thinking: An Approach to Heidegger* (Chicago: University of Chicago Press, 1981) vii.

renewable energy, energy that is free to all of us, not only to those who can afford to pay \$3.50/gallon. The power and benefits of the sun have been recognized by every civilization that has ever existed. The sun has even been revered and worshipped as a god.

Growing up, I experienced life through the outdoors; the smell of salt air and kelp at the beach, the soothing breeze across my skin, the monuments of the Sierra Nevada. As a young girl, I lived in California where I developed an appreciation for nature and the environment. The ocean, the sun and their daily rhythms became my touchstone. As a teenager I backpacked the mountains of California. I felt a sacred and timeless connection to the wilderness. The mountains became another touchstone, point of reference, a guide. Without a touchstone, I felt disoriented, disconnected, and hemmed in.

As an adult, I lived by the coast in California and Hāwai'i. In Hāwai'i, I spent 15 years on the north shore of Oahu where the rhythms of the ocean, the sun, and the weather dictate daily life. On the north shore, life and nature are integrated, inseparable. Large north swells sometimes flooded over the Kam Highway and prevented me from getting home from work in town. Rockslides at Waimea Bay affected my driving route. Daily weather favored some activities over others. Even though I live in town now, the ocean continues to be a touchstone for me. I need to visually connect with the water.

When I was growing up, we moved every few years. My Dad, also an engineer in the oil industry, was transferred from one job to another. Unlike most other girls my age I excelled in math and science. I pursued engineering in college as a member of a minority (women) that made up no more than 10% of the engineering students. Fortunately, I attended a university on the west coast to have my touchstone, the ocean, nearby.

As an engineer and middle manager in the oil industry in Hawaii, I always looked for connections between the way things were and the way they could be. As with the pieces of a jigsaw puzzle, I looked for the right fit. I sought to understand the “bigger picture” and what it meant to our island operation. I started to think “laterally” as well as “vertically”.

Ultimately, the oil company I worked for decided to pull out of Hāwai'i. They sold their Hāwai'i assets including the gas stations, the petroleum storage terminals, the pipelines and the gasoline trucks on Oahu as well as on the Big Island. I considered my options which included moving back to the mainland to work for the company in Houston or some other non-coastal location. I decided to change careers. I quit my job and went back to school.

Exposure to the extraordinary architecture of Hāwai'i architect Vladimir Ossipoff inspired me to consider architecture for my second career. My experience of architecture is shaped by my experience of nature. Ossipoff's buildings connect with nature through deep eaves, integrated interior and exterior space, and site orientation. Through a connection to nature, Ossipoff's architecture engages our senses on multiple levels, links us to the cycles of time and orients us within the larger world. As I became more aware of my sensory response to Ossipoff's buildings relative to that in other buildings, I felt the need to explore the basis for my response. Ultimately, I narrowed down my exploration to the human response to light and shadow in the built environment.

This DArch project establishes a connection between man and his environment through light and shadow in architecture. The fundamental relationship between light and shadow is explored because it is critical to man's connection to nature through architecture. It is this connection to nature that, in turn, enhances our response to the built environment.

I will show writing and examples of work by those who have made this connection and whose architecture reveals an awareness of this relationship. This awareness reflects a way of "Being-in-the-world" that taps into a deeper consciousness of what makes us human. It reflects a way of thinking about who we are, what our fundamental needs are and what our role is in the larger world. It is essential that architects "think about their thinking". They must reflect on the impact of their thoughts and ideas on their work. They must contemplate a connection to nature through their work and, in turn, a connection to the larger world. Learning how to think and developing this awareness can be taught. Every work of architecture reflects this awareness, or lack thereof.

There is no design process that tells us or shows us how to think and design. Design is a very individual endeavor and varies from person to person. For a good chef, a recipe provides a guideline, an orientation, and a set of ideas to integrate into their work. However, a good chef does not follow the recipe word for word. He or she only pulls the most important information, according to their needs, from the recipe. Likewise, a “map” can guide a traveler along a journey. However, the map only provides a suggested path. Understanding the “territory” takes more than just following a “map”. The “territory” is a way to think and to be. The “map” is a set of ideas to reflect upon and from which to generate more ideas.

It is a set of ideas, or a “poetic map”, that I present in this DArch project to help architects develop an awareness of how to “think about their thinking”. I use light and shadow in architecture as one example of a “poetic map”. This “map” suggests a path along which this awareness can be developed. From this “map”, it is up to each of us to explore and develop our own understanding of the “territory”. The “territory” is not shown on the map.

Light and shadow are part of nature. In the “poetic map” presented, light and shadow in architecture provide a set of ideas, or steps, to help us connect to nature. This connection to nature develops through our consciousness of the larger world.

This consciousness is evident in ancient architecture. The megalithic tomb of Newgrange in Boyne Valley, Ireland, and the temple of Ramesses II in Abu Simbel, Egypt both reflect this awareness of the larger world. These two examples connect to nature through light and shadow. They were sited and constructed specifically to allow solar illumination of their deepest recesses for a sliver of time each year as the sun cycles through the winter solstice. Their solar alignment is intentional and exact and reflects a conscious connection to nature and to the larger world.

We have lost this connection in our architecture today. However, a handful of architects are working to re-establish it. The work of Louis Kahn, Alvar Aalto, Tadao Ando and others reflects this connection to nature and to the larger world. This re-emerging consciousness is also reflected in the “green” movement that is permeating every aspect of our lives. Concerns about the potentially dire consequences of global climate change



Figure 2
Example of a "Poetic Map"

and an increasing awareness of man's contribution to climate change undeniably connect us to nature. This awareness has provided fertile ground for the "green" movement to get underway as we consider our role in climate change, individually and as a society, our options and the potential meaning to humanity of its consequences.

The relationship between architecture and nature is fundamental to our response to, and affects every interaction with, the built environment. Architecture becomes the stage on which nature performs her dance. This dance resonates deeply within each of us, connecting our biological cycles and rhythms to those of nature. As the cycle of each day inches across the wall, as we glance periodically to synchronize to the bigger world ever changing outside, we connect to something much larger than ourselves.

Light and shadow are one "pattern which connects" us to nature through the built environment. Anthropologist Gregory Bateson coined the phrase "the pattern which connects" and used it to describe the relationship between nature, man and the built environment. Architect Sim Van der Ryn borrowed this term from Bateson, his mentor, in describing his design for the Bateson building in Sacramento. The Bateson building, an office building built in the 1970's, is an early example of designing with nature. Daylighting and open space connect us to nature in the Bateson building. In Van der Ryn's words, "We are most alive when we experience subtle cycles of difference in our surroundings. The building itself becomes the 'pattern which connects' us to the change and flow of climate, season, sun and shadow, constantly tuning our awareness of the natural cycles which support all life."⁵

Light and shadow reveal to us the cycles of difference in our surroundings as they cycle throughout the day, throughout the seasons, dissolve at times, fade in and out, wave and heave in the wind. We experience the cycle of the sun and its accompanying shadow in our buildings, in our spaces, on our walls and on our ceilings. Architectural space becomes a template onto which the sun shines infinite patterns of movement. The building comes alive through the movement of light and shadow.

⁵ Sim Van der Ryn, <http://www.ecodesign.org/Portfolio/Commercial/bateson.html> accessed on 9/17/2008.

The movement and the rhythms of light and shadow are the rhythms of nature. Consciously or subconsciously, the rhythms of nature are within us. “Biological rhythms represent the coordination of external time cues with internal metabolic activities. These synchronizations occur throughout the plant and animal kingdoms and include day-night cycles (circadian rhythms), sleep-wake cycles, lunar cycles, and seasonal cycles.”⁶ Successful architecture resonates with our biological rhythms by manipulating light and shadow to connect us to nature. Architecture becomes man’s link to nature.

It is important to note the difference between natural light and artificial light. Artificial light is a very consistent, uniform light source. It does not change. Natural light from the sun changes throughout the day and throughout the seasons as the earth cycles around its axis and travels around the sun. It is this variation in natural light, described by world-renowned architect Louis Kahn as “a light of mood”⁷, and its shadow, that forms this critically important link to nature. It is natural light that is the subject of this DArch project.

There exists a dialectical relationship between natural light and shadow. This apparent generation of opposites reconciles, creates tension, heightens our awareness and increases our connection to nature. It is through this heightened awareness that light and shadow become “the pattern which connects” us to the ebbs and flows of nature.

The contradictory or paradoxical relationship between light and shadow is not surprising as paradox resides in nature. In fact, paradox is a rule of nature. Nature, seemingly static, is forever changing right before our eyes. She never stands still but is continually changing throughout the day, evolving so slowly at times the change is imperceptible. Paradox also comes from what appear to be two separate phenomena, light versus shadow. However, as two sides of the same reality, light and shadow are inseparable. They are one pattern, intertwined, always connected. Shadow cannot exist without light. Shadow is generated from light.

Tension from paradox has been described by others. In his book “Deconstructing the Kimbell”, Michael Benedikt talks about the cycloid roof vaults of the Kimbell Art Museum

⁶ M. David Egan and Victor Olgyay, *Architectural Lighting* (New York: McGraw-Hill Higher Education, 2002), 45.

⁷ Louis Kahn, *Light is the Theme* (Fort Worth: Kimbell Art Foundation, 1978), 17.

in Fort Worth, Texas. According to Benedikt, the support columns appear unable to hold the weight of the vaults due to their slenderness. “Yet there is pain here, a tension under the serenity and ease of the geometry both literal.....and phenomenalThe result is paradoxical, or should one say tense?” It is this tension of paradox, or tug-of-war, that emerges from the relationship of light and shadow as well. As we experience this tension, our sensory awareness increases. This multi-sensory engagement deepens our experience of the space.

Man’s connection to nature through the built environment is fundamental to our health and happiness. Access to the sun’s light affects our health, productivity and wellbeing. For example, it is known that inadequate exposure to natural light leads to seasonal affective disorder, generally affecting those in higher latitudes during winter months. Unfortunately, the health and productivity benefits of natural light have not been well documented. However, recent efforts to measure these benefits are leading to positive results. According to one report, tracking absenteeism and sales in daylit commercial and retail spaces revealed significant productivity benefits resulting from natural light.⁸ These benefits result when architecture connects us to nature through light and shadow.

Further, light and shadow are necessary to our development as human beings. According to psychoanalyst Carl Jung, we all have a “shadow” side, a side hidden from view, as well as our “sunny” side. We cannot be “good” without sometimes being “bad”. evolution, providing the testing ground to develop his inner nature.”⁹ Darkness in man resonates with darkness, or shadow, generated from natural light. This shadow represents constant struggle and change as we evolve throughout life. It also represents man’s need to not reveal too much of himself. We each need to be able to tuck into the shadows, figuratively and literally, at times. Shadow generated by natural light provides this needed refuge. On a deeper level, some cultures believe shadow also represents the soul. If so, then man’s connection to architecture through light and shadow runs very deep.

⁸ Burke Thayer Miller, “Daylighting and Productivity at Lockheed,” *Solar Today*, vol. 9, issue 3 (May/June 1995): 28.

⁹ John P. Conger, *Jung & Reich: The Body as Shadow* (Berkeley: North Atlantic Books, 1988), 84.

Man's Connection to Nature Through the Built Environment

“The more visible nature’s cycles and processes, the more anchored are we in the truths underlying daily life.”¹⁰

Christopher Day

We spend a major portion of our lives inside buildings, whether for work, education, recuperation, recreation or spiritual pursuit. Buildings affect our mood and state of mind, positively and negatively. As architects, we have a responsibility to design buildings that positively impact the building occupants and enhance quality of life.

In order to successfully design a space, architects must understand the psychological impact of certain design decisions on the future occupants of that space. Design failures such as St. Louis public-housing project Pruitt-Igoe underscore the social responsibility of architects to understand the human impact of our designs. No one set of factors: social, economic, architectural or policy, led to Pruitt-Igoe’s decline. Instead, a combination of factors led to the failure.¹¹

However, architecture may have been the “tipping point” as evidenced by other low-income housing projects whose tenant profile matched Pruitt-Igoe’s but whose architecture differed with respect to development density, building height and spatial layout. These projects did not experience the crime, destruction and fiscal challenges of Pruitt-Igoe.

The question is: How much affect on people’s lives can architecture truly have? Architecture appears to operate in the realm of influence rather than control. However, we now understand how significant this influence can be. Architecture engages all our senses, influences the spirit of a place and connects us to nature. An understanding of the human response to the built environment as well as the importance of a connection to nature are critical to the design of space that minimizes anxiety and stress and enhances emotional wellbeing.

¹⁰ Christopher Day, *Spirit and Place* (Oxford: Elsevier Ltd., 2002), 119.

¹¹ Kim Suman, “Pruitt-Igoe: What Did We Learn?”, Summer 2008 (Arch 699).

What did architect Sim Van der Ryn mean when he said “We are most alive when we experience subtle cycles of difference in our surroundings. The building itself becomes “the pattern which connects” us to the change and flow of climate, season, sun and shadow, constantly tuning our awareness of the natural cycles which support all life.”?¹² According to Van der Ryn, our buildings provide a vital connection to nature. Patterns within the building resonate deeply with our biological rhythms and cycles, fundamentally impact our state of mind and provide a link to the natural world. If designed well, the building impacts us positively. If not, the building impacts us negatively, as was the case at Pruitt-Igoe.

Van der Ryn’s hero, mentor and friend was Gregory Bateson, British anthropologist, social and systems scientist. Bateson’s life work intersected many areas of study including anthropology, cybernetics, communications theory and included studies of alcoholism and schizophrenia. Bateson coined the term “the pattern which connects” to refer to patterns in relationships, communication, evolution, and nature. This term describes a pattern of mutual dependence, such as that between light and shadow that repeats throughout nature on infinite levels of complexity or as a “hierarchy of differences” as described by Gregory Bateson. To Bateson, “the word ‘idea’, in its most elementary sense, is synonymous with ‘difference’.”¹³

Patterns within the building that connect us to nature are many and include natural shapes and forms, natural patterns and processes, light and space, environmental features and human-nature relationships.¹⁴ Natural color, water, sunlight, plants, shell and spiral shapes, tree and columnar supports, sensory variability, growth and efflorescence, light pools, and prospect and refuge are just a sampling of these many patterns. Scale is another pattern. Fractals, described as self-similarity across multiple levels of scale, mimic nature and provide a connection as well.

Light and shadow are one pattern in nature that connects architecture to the living world. Light and shadow are infinitely changing, never static. Included in the pattern of light and shadow are natural light, filtered and diffused light, reflected light, pools of light,

¹² <http://www.ecodesign.org/Portfolio/Commercial/bateson.html> accessed on 9/17/2008.

¹³ Gregory Bateson, *Steps to an Ecology of Mind* (London: Jason Aronson, 1987), 459.

¹⁴ Kellert, Heerwagen, Mador, *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life* (New Jersey, John Wiley & Sons Inc., 2008), 6.

warm light and light as shape, form and material. Because of continual change, light and shadow capture our curiosity and highlight the built environment in a way that is never ordinary. However, we can never capture light. We can only set it on a course. As light and shadow track and change throughout the day on the surfaces of a building, they give life to the building. Perhaps, they give a soul to the building as well.

Light and shadow reveal cycles of time in architecture and connect man to something larger than himself, something outside his lifespan. We each have a need to connect to time not limited by the span of our own life. Seeing the context of our life within the past as well as the future gives our life meaning. The architecture of Louis I. Kahn exceeds the span of man's life literally as well as through its timelessness. Kahn's architecture expresses a sense of monumentality that belies its age and links us to times past as well as to future possibility. In its connection to the past and the future, it anchors us in the larger world.

In a similar way, we connect to architecture on a deeper level when it evokes memories. "Places hold memories.....Memories are part of knowing who you were – the foundation of who you now are. Visiting – and particularly touching – places of our childhood evokes long forgotten memories.....Childhood places are part of us, old places part of our cultural identity. We musn't be trapped by the past – but without it, we are rootless."¹⁵

Light and shadow play a role in memory because they connect us to place and to cycles of time. We all have memories of cities and buildings we have experienced. We recall places because our mind makes momentary associations based on how that place smells, how it sounds, how it feels, how it tastes and what we see. Vivid images flood back through these sounds, smells, taste and variations of light and shadow from our past. Our clearest memories are those based on multiple senses. These multi-sensory perceptions associate with physiological responses that are imprinted on our memory. The same physiological response can be evoked many years later by revisiting the place or perhaps a similar one. It is the unique sensory agglomeration experienced before that recalls the same physiological response. Patterns through which we make a connection to that place include the way the light flickers and how the shadow heaves, in addition to

¹⁵ Christopher Day, *Spirit and Place* (Oxford: Elsevier Ltd., 2002), 113.

how still the air is, how the snow floats down, or perhaps how the breeze blows. Patterns of light and shadow are a component of our architectural memory. Through these patterns, we feel a vital connection to the built environment.

Light and shadow are also linked to sense of place or navigation. It has been determined that navigation and memory are integrated brain functions. As we experience spatial features or navigate a spatial sequence, we form memories of that experience. A determination “in the neurobiology of spatial memory is the involvement of the hippocampus in navigation as well as the formation and retrieval of memory of autobiographical events.”¹⁶ The hippocampus is considered part of the forebrain but is located more centrally below the hypothalamus and appears to be necessary for both of these brain processes (memory and navigation). Because memory and navigation appear to be functionally integrated and because light and shadow are a component of our architectural memory, it is likely that light and shadow also play a role in our sense of place and navigation.

We have said the relationship between architecture and nature is fundamental to our response to architecture and that this relationship affects every interaction with the built environment. Architecture becomes the stage on which nature performs her dance. This dance resonates deeply within each of us, connecting our biological cycles and rhythms with those of nature. As the cycle of each day inches across the wall, as we glance periodically to synchronize to the bigger world ever changing outside, we connect to something much larger than ourselves.

The movement and the rhythms of light and shadow are the rhythms of nature. Consciously or subconsciously, the rhythms of nature are within us. “Biological rhythms represent the coordination of external time cues with internal metabolic activities. These synchronizations occur throughout the plant and animal kingdoms and include day-night cycles (circadian rhythms), sleep-wake cycles, lunar cycles, and seasonal cycles.”¹⁷ When our biological rhythms synchronize with the cycles of nature, specifically the cycles of the sun, we tend to be balanced and calm. Successful architecture resonates

¹⁶ “Neuroscience and Architecture: Seeking Common Ground” by Esther M. Sternberg and Matthew A. Wilson, *Cell*, Vol. 127, October 20, 2006, p. 239-242.

¹⁷ M. David Egan and Victor Olgay, *Architectural Lighting* (New York: McGraw-Hill Higher Education, 2002), 45.

with our biological rhythms by featuring light and shadow to connect us to nature's rhythms. Sunrise, sunset, and the cycles of natural light in between become visible when architecture orchestrates the performance of light and shadow. Architecture becomes the "pattern which connects" us to nature through the movement and rhythms of light and shadow.

According to Christopher Day, "light works on us both psychologically and physiologically. Indeed daylight's endlessly changing qualities, set within the rhythms of nature, connect us to time and to the energies of life....it influences social, as well as physical and psychological health."¹⁸ Patterns of light and shadow in architecture free us from the present and slow us down to experience the "healing flow of time." They "lull" us into stepping back, slowing down and re-orienting ourselves within the rhythms and cycles of nature. Through our connection to cycles of time, light and shadow promote healing.

Because humans are phototropic, humans move toward light and when stationary, orient themselves toward light. The word "phototropic" is defined as "any positive or negative movement of a part of a plant toward, or away from, light sources."¹⁹ Because humans are phototropic, variations in light and shadow facilitate wayfinding. Wayfinding describes our ability to orient ourselves between two points and to sense the path between those two points. Variations in light and shadow can be used to draw us to or direct us along a particular path. In addition, variations of light and dark can be used to denote interactive space or solitary space for withdrawal. As we move toward light, we encounter others in interaction or circulation. We move away from light toward the shadows or dimly lit space when we seek detachment or mental repose. Phototropism allows variations in light and shadow to guide and orient us.

Our environment, both built and natural, impacts us physically, emotionally and spiritually. Further, we know that our physical, emotional and spiritual wellbeing are interconnected. For example, our psychological state affects our hormone balances. Our hormone balances, in turn, affect our immune system, either strengthening or weakening it. More and more research is focused on the impact of the environment on

¹⁸ Christopher Day, *Spirit and Place* (Oxford: Elsevier Ltd., 2002), 206.

¹⁹ Webster's New World College Dictionary, Fourth Edition, (USA, MacMillan), p.1085.

our health and wellbeing. Specifically, an interest in the impact of nature on our health and wellbeing is a major focus. This interest is no doubt driving the “green” movement now in full swing. It has been recognized that a connection to nature is vital to our emotional, physical, and spiritual health. Understanding the three-pronged relationship between nature, the built environment and man’s health is fundamental to the practice of architecture. The built environment can provide man a vital connection to nature.



Figure 3

Light and Shadow in the Built Environment

“Shadows can be used to reconstruct the world. And indeed we continually use them to understand the shape of our environment.”²⁰

Roberto Casati

In nature, the pattern of light and shadow is a fundamental one. The light of the sun strikes the entire surface of the earth at one time or another. Natural light and its accompanying shadow impact all structures, built and natural, on earth. Because light and shadow play an important role in our built environment, they also have an impact on us. Unfortunately, not all architects realize this or give much thought to light and shadow in their buildings.

According to Ulrike Brandi and Christoph Geissmar-Brandi in *The Secret of the Shadow: Light and Shadow in Architecture*, “We have seen that 20th century architects do not necessarily tie the essence of their designs to the influence of light and shadow. A great deal of concentration is required to consciously perceive shadows and to study them, but that in return leads to far-ranging insights that can be expressed in words or images.”²¹ To design for light and shadow requires analysis of the sun’s patterns and affects, experimentation with those patterns and study of how to use them in a building. This additional effort pays off, however, in benefits to the building occupants. Today, most architects do not want to exert this extra effort, however. In fact, they do not even seem to ascribe any kind of meaning to light and shadow other than as a source of illumination. Instead, they eliminate shadow and uniformly illuminate space.

This is unfortunate. Light and shadow infuse architecture with a dimensionality not present in uniform, or almost uniform, illumination. Material and space develop depth with light and shadow. In light and shadow, our visual sense gives way to our tactile and other senses. We develop a deeper spatial awareness through sensory engagement on

²⁰ Roberto Casati, *The Shadow Club* (New York: Alfred A. Knopf, 2003), 7.

²¹ Deutsches Architektur Museum, *The Secret of the Shadow: Light and Shadow in Architecture* (Berlin: Ernst Wasmuth Verlag Tübingen, 2002), 12.

many levels. Through our senses we perceive depth and dimensionality in a way not possible with uniform illumination.

Fortunately, some architects understand how light and shadow can give architecture meaning and incorporate this understanding into their design thinking. Tadao Ando is one such architect. Louis Kahn was another. In their buildings, light and shadow highlight textures and contrasts in materials, designate gathering or sacred spaces, and highlight movement. These affects are seen in Church of the Light by Tadao Ando and the Kimbell Art Museum by Louis Kahn. In these buildings, light and shadow frame our experience of the space. "Light is the theme".²² The architecture becomes "the pattern which connects" us to the natural environment through sun and shadow. In Church of the Light and the Kimbell Art Museum, we experience something sacred, a connection to a higher power, perhaps, or energy because of the orchestration of light and shadow through the space. Later, we explore these case studies, as well as others, in detail to understand the affect of light and shadow on our spatial experience.

Earlier, we talked about how variation in light and shadow can be used to define social or interactive space. This gradient of light can provide an imaginary boundary around a group that defines the group and promotes cohesiveness within it. Without such a boundary, it is difficult for the group to form. This is the case with uniform illumination. Because there are no light gradients that correspond to the boundary of the group, the ability of the group to form is weakened as is the social nature of the space. Essentially, uniform illumination "makes people feel disoriented and unbounded."²³ For this reason, variation in light and shadow is critical to our human need for social interaction.

Similarly, shadow or dim light is critical to our need for withdrawal or mental repose. Shadow and dim light allow us to turn inward in solitary contemplation. Sometimes we need to just sit in the shadows and think. Further, the ambiguity of shadow, in contrast to light, awakens all the senses, deepening our spatial experience. Because our visual sense is hampered by the dim light, our other senses engage to evaluate the situation. In architecture, that which is not illuminated becomes just as important, if not more so, than that which is illuminated. Therefore, a building must have many spaces of

²² Louis Kahn, *Light is the Theme* (Fort Worth: Kimbell Art Foundation, 1978).

²³ Christopher Alexander et al., *Pattern Language* (New York: Oxford University Press, 1977), 1160.

alternating light and dark, or a “tapestry of light and dark”²⁴ to provide a rich variety of settings to satisfy our many human needs.

An extreme case of the effect of uniform illumination is torture under uniform, bright, constant illumination. Under such illumination, there is no place to withdraw to mentally or for privacy. The “self” is completely exposed and, in effect, violated to force revelation of secrets. Understanding the psychology of uniform illumination, as well as other light and shadow affects, is needed for successful integration of light and shadow into architectural design.

The benefits of natural light are many. More and more evidence indicates man actually needs a minimum level of daylight to maintain the body’s circadian rhythms. The variability and cycle of the sun throughout the day provide an essential constant by which we maintain our relationship to the environment. The beneficial effects of natural light on seasonal affective disorder are also well established. According to Egan and Olgyay, light therapy has been used successfully to realign biological rhythms with external time cues.²⁵ Light therapy uses light sources in the visible range. Sunlight, incandescent, cool white fluorescent, and “full-spectrum” lamps are all in the visible range and, therefore, meet this criteria.

Alvar Aalto was another architect who recognized man’s need for natural light. He became a master of using natural light to provide secondary sources of illumination in his buildings. In addition, his tuberculosis sanatorium in Paimio, Finland, was designed to be “naturally disinfecting through a combination of building orientation and south-facing porches where the patients could bask in the beneficial germicidal rays of the sun.”²⁶ Additionally, we know that vitamin D is produced in the skin during exposure to UV radiation. Vitamin D is necessary for numerous metabolic functions, including the absorption of phosphorus and calcium.²⁷

²⁴ Christopher Alexander et al., *Pattern Language* (New York: Oxford University Press, 1977), 1160.

²⁵ M. David Egan and Victor Olgyay, *Architectural Lighting* (New York: McGraw-Hill Higher Education, 2002), 45.

²⁶ M. David Egan and Victor Olgyay, *Architectural Lighting* (New York: McGraw-Hill Higher Education, 2002), 44.

²⁷ M. David Egan and Victor Olgyay, *Architectural Lighting* (New York: McGraw-Hill Higher Education, 2002), 46.

Studies show that a person's perception of their workspace has an impact on their productivity and health.²⁸ Daylighting is one workspace characteristic that influences this perception.²⁹ Measuring occupant productivity and health by tracking absenteeism and sales in daylit commercial and retail spaces has revealed significant improvements in these measurements. Lockheed Corporation moved into naturally daylit offices in 1983 and measured a 15% reduction in absenteeism following the move. The financial benefits of reduced absenteeism outweighed the cost of improvements by three times each year.³⁰ Similarly, retail giant Walmart analyzed sales in daylit areas and found sales were significantly higher than in non-daylit areas.

Light and shadow in the built environment are critical to our perception of space. We respond to this perception either positively or negatively. This perception impacts us physically, emotionally and spiritually on many levels. It is through our perception of space that we, in turn, connect to nature through light and shadow. Architecture becomes extraordinary through patterns of light and shadow.

Natural Light versus Artificial Light

It is important to note the difference between natural light and artificial light. Artificial light is a very consistent, uniform light source. It does not change in intensity, distribution or color. In contrast to artificial light, natural light from the sun changes throughout the day and throughout the seasons as the earth cycles around its axis and travels around the sun.

The color temperature of light expresses, in degrees kelvin (K), the "warmth" or "coolness" of the light, whether it be daylight or electric light. The entire scale of color temperature ranges from 1,000 to 28,000 degrees K. The color temperature of daylight spans this entire range. Sunlight is at the lower end of the scale and ranges from 1,000

²⁸ Janis L. Magin, Making Old Building 'Green' Cuts Utility Costs, Reduces Sick Days, Pacific Business News, Feb. 13, 2009, vol. 46, no. 51, p. 18.

²⁹ Kim Suman, "The Financial Benefits of Improved Environmental Quality: Post Occupancy Evaluation of Three 'Green Projects' in Hāwai'i", Spring 2009 (Arch 550).

³⁰ Burke Thayer Miller, "Daylighting and Productivity at Lockheed," *Solar Today*, vol. 9, issue 3 (May/June 1995): 28.

to almost 5,000 degrees K. Skylight picks up where sunlight ends, at almost 5,000 degrees K, and ranges up to 28,000 degrees K and above. In contrast, no single source of artificial light spans this entire range. Instead, incandescent and candle flame are at the lower end of the scale with a color temperature from 1,000 to almost 3,000 degrees K. Above this range are fluorescent lamps that range up to 8,000 degrees K. Above 8,000 degrees K are various combinations of fluorescent lamps that achieve a color temperature of up to 28,000 degrees K.

It is this variation in natural light, described by world-renown architect Louis Kahn as “a light of mood”³¹, and its accompanying shadow, that forms this critically important link to nature. It is natural light that is the subject of this DArch project.

The Dialectical Relationship Between Light and Shadow

“Nature!.....She creates eternally new forms; what is there has never been; what has been does not recur – everything is new and yet always the [same] old [thing].”

Goethe, 1783

There exists a dialectical relationship between light and shadow. We think of shadow as the opposite of light and of light and shadow as separate phenomena.

However, light generates shadow, leading to a reconciliation of apparent opposites. This reconciliation of light and shadow contradicts our basic understanding of the relationship between light and shadow. As apparent opposites, they appear separate. However, they are one pattern, always connected, infinitely variable. We always experience light and shadow together, never one without the other. Shadow cannot exist without light. Shadow comes from light. It is this dialectical relationship between light and shadow that deepens our experience of architectural space.

³¹ Louis Kahn, *Light is the Theme* (Fort Worth: Kimbell Art Foundation, 1978), 17.

The paradox of light and shadow creates tension, engages our senses, heightens our awareness and increases our connection to the forces of nature. It is through our heightened awareness that light and shadow become “the pattern which connects” us to the ebbs and flows of nature. It is this connection to nature that gives movement, depth, dimensionality, and, therefore, life to architecture.

Light and shadow are one example of paradox in nature. Goethe describes this paradox above. Nature is paradoxical on many levels. In our minds, nature never really changes while in reality it transforms and evolves every moment of every day and every year.

In paradox, or contrasting sides of one reality, there is also unity. These contrasting sides, or poles, are mutually dependent and, therefore, inseparable. It is this pattern of mutual dependence, such as that between light and shadow, that repeats throughout nature on infinite levels of complexity or as a “hierarchy of differences” as described by Gregory Bateson. It is the pattern of relationship between light and shadow that connects us, through architecture, to nature.

Changes in the sun’s continuous cycle and weather conditions display infinite variety in light and shadow. Each day is different, whether we take the time to see this difference or not. We ignore subtle changes as we get busy with our life, work and family. If we do not see this infinite variety, seemingly, nature never changes. However, if we take the time to look closer, on a deeper level, we see nature’s changes moment-to-moment and day-to-day. This is one paradox of nature. The built environment is the stage onto which nature projects this moment-by-moment change in light and shadow.

Similarly, on a longer term, nature evolves, transforms and adapts. Change in nature can also involve extinction. Evolution, adaptation or extinction occurs over long spans of time. Change is so gradual there appears to be no change at all.

The paradox of light and shadow generates tension. This tension alerts our senses and heightens our awareness. It is this heightened sense of awareness that connects us to nature. In her 1982 masters thesis about Hāwai’i architect Vladimir Ossipoff’s residential designs, Diane Dericks discusses this feeling of tension associated with contrasts and a “blend of opposites” in architecture. According to Dericks, “Ossipoff has set up a variety of contrasts, visually and experientially, so that the viewer is poised between them,

partakes of each separately and as a blend of opposites, and is left with an understanding of an expanding experience. The constant tension of contrasts is always being resolved, either by surprise, recognition, or becoming and the resolution gives, at once, a secure and liberating feeling. Recognition of the tensions and their resolutions within the house produces a catharsis, an understanding and a relief, and at the same time imparts an identity and character that is unique to the house. The house has suggested that it is no more than exactly what it is, but in the resolutions of the tensions, it becomes more.”³²

It is this same recognition of tensions and, ultimately, resolution that architect Kisho Kurokawa describes in his discussion of *ma* in “Rediscovering Japanese Space”. According to Kurokawa, “*Ma* is the temporal interval between two different phenomena or between two contradictory elements or between dimensions of varying natures. Spatially, one might call *ma* the ‘buffer zone’.”³³ Kurokawa continues “One of the features of Japanese architecture is the way the layout of rooms in a building is designed not only to be functional, but also to accommodate aesthetic factors that cannot be explained in functional terms. This involves nonfunctional, “silent” spaces--spaces of withdrawal or detachment such as a corridor, a veranda, a tokonoma alcove, or a study (*shoin*). This is the *ma* of architectural design, and the skill in placing these *ma* where they will achieve the best balance with the overall design is called “inserting the *ma*,” or *madori*. In Japan, these *ma* are spaces of spiritual or philosophical significance that respond to the need for mental repose and detachment.”³⁴

When we experience this “tension of contrasts” as described by Dericks or the “temporal interval” described as “*ma*” by Kurokawa, our sensory awareness increases. During a very brief, momentary pause, time is suspended and our multiple senses tune in to activities and conditions around us. Man, nature and architecture connect.

Why does paradox lead to tension and, ultimately, to a heightened sense of awareness? Paradox is mysterious. As humans, we have biological or psychological needs for visual as well as for other sensory information. We need to be able to confirm our physical

³² Diane Dericks, “A Study of Characteristics underlying the Form of a Vladimir Ossipoff House,” (1982): 38.

³³ Kisho Kurokawa, *Rediscovering Japanese Space* (New York: Weatherhill, 1988), 55.

³⁴ Kisho Kurokawa, *Rediscovering Japanese Space* (New York: Weatherhill, 1988), 56.

orientation and location to facilitate wayfinding. We need to feel secure, to be able to relax, orient ourselves within time, have contact with nature and people, and to be able to define our personal territory. With paradox, it takes a brief moment for our brain to process the apparently contradictory information before us. Initial mystery and tension give way to understanding and enticement as our senses engage to evaluate the unfamiliar situation before us. The resulting multi-sensory engagement heightens our awareness.

The role of instinct in architectural pleasure was theorized by Grant Hildebrand in his book, *Origins of Architectural Pleasure*. In his book, Hildebrand proposes several “ways in which our present-day relationships to our surroundings may be influenced by those most basic and essential survival-advantageous behaviors of our early ancestors.”³⁵ According to Hildebrand, such characteristics as prospect and refuge, enticement and peril and order and complexity guide our selection of satisfying spaces. In other words, as we experience architecture, our senses gather information that allows us to monitor our safety and wellbeing. Staying safe from attack is important but so is preventing falling, tripping, etc. Instinct may not be the only factor which determines our reaction to architecture, but it undoubtedly plays a major role.

Clearly, the paradox of light and shadow enhances our experience of architecture. It is the interaction of light and shadow, as apparent opposites, with architecture that connects us with the bigger world outside, to the world of nature. Paradox in light and shadow engages our senses. It is through this sensual engagement that light and shadow become “the pattern which connects.”

³⁵ Grant Hildebrand, *Origins of Architectural Pleasure* (Berkeley: University of California Press, 1999), xv.

Light and Shadow Defined

“Shadow is the lack of light.”³⁶

Leonardo da Vinci

There are numerous views and descriptions of what light and shadow are composed of, or not. Leonardo da Vinci described shadow as the “lack of light.” Certainly, shadow cannot exist without light. Shadow is a slave to light, tracking light’s every movement. Light and shadow, ever changing, peek our curiosity like a candle flame that grabs our attention as it swirls and flickers in the dark.

If shadow is the lack of light, then what is light? Light is “at once a particle and a wave, invisible yet rendering the physical world visible.”³⁷ Visible light covers a small portion of the electromagnetic spectrum which ranges from 160 nanometers (nm) to 1500 nm. Within this range, the visible portion occurs from 380 to 780 nm. Both the visible and invisible portions of the electromagnetic spectrum affect us and, therefore, must be considered in design. Of the invisible spectrum, ultraviolet (UV) and infrared (IR) are noteworthy. These two regions straddle the visible region in terms of wavelength. UV is shorter in wavelength than visible while IR is longer in wavelength than visible. In the visible spectrum, colors are seen as violet, blue, green, yellow, orange and red. When combined, these colors appear as white light. Different colors of white light result from different intensities of the various wavelengths or colors throughout the visible spectrum.

Light has different characteristics at different wavelengths. At certain wavelengths, light can produce ozone, has germicidal and bactericidal affects, can cause skin burn, or produce black light. Infrared (IR) radiation is typically felt as heat or thermal radiation and is produced from surfaces warmed by visible light. In cold climates, buildings can benefit from thermal radiation associated with light. Such an affect is referred to as radiant heating.

³⁶ Roberto Casati, *The Shadow Club* (New York: Alfred A. Knopf, 2003), 168.

³⁷ M. David Egan and Victor Olgay, *Architectural Lighting* (New York: McGraw-Hill Higher Education, 2002), 50.

Point, line and area sources produce light. Depending on distance from an object, the same source can be a point or an area source. Point sources produce the sharpest shadows. Further, illumination from a point source decreases inversely with the square of the distance from the source. This is because light from a point source covers more area as the distance from the source increases. Examples of area sources are uniformly overcast skies, luminous ceilings and panels, and secondary illumination sources. Illumination from area sources does not decrease with distance.

When light shines on a material, the material will reflect, absorb or transmit the light. If the material has a very polished surface, the light will reflect specularly, meaning the angle of the reflected light is the same as the angle of the incoming light. For materials with slight irregularities on the surface, the light will be reflected at the same angle but the beam will form a wider cone. For materials with a matt surface, the reflection will be non-directional resulting in the widest distribution of light.

Shadow is represented by different cultures in different ways. "Certain non-Western cultures seem to prefer a conception of shadow as an object animated by a life of its own; they attribute various powers to shadow and consider shadow to be an image of the soul. In other words, alongside the Western kind of shadow there is also a 'primitive' kind of shadow."³⁸ One of these cultures is the Yoruba of sub-Saharan Africa whose word for shadow, *vovoli*, is interchangeable with the word for soul, *luvo*. According to the Yoruba, this interchangeability is "because a shadow is what makes a person recognizable: a shadow is the visible form of the soul."³⁹ To these cultures, a person's shadow represents the depths of the psyche or the soul itself.

According to psychoanalyst Carl Jung, light and shadow are inseparable and form the basis for man's development as an individual. According to Jung, we all have a "shadow" side that is hidden from view and represents the opposite of what is good in a person. Light is viewed as uplifting, positive, open, predictable, civilized, balanced, sane, providing reason, and all that is good and logical in life. Shadow, on the other hand, represents that which is unconscious, hidden, dark, confused, rebellious,

³⁸ Roberto Casati, *The Shadow Club* (New York: Alfred A. Knopf, 2003), 21.

³⁹ Roberto Casati, *The Shadow Club* (New York: Alfred A. Knopf, 2003), 22.

uncivilized, bad, elusive and as something one may prefer to ignore.⁴⁰ As man develops these opposites provide lessons, both good and bad, that lead us along the way. There is no man, according to Jung, who can be expected to be good all the time. There will be moments of rage along with moments of sanity. The path to higher consciousness is through a deepened sense of awareness rather than through good behavior 100% of the time. Jung believed enlightenment is not achieved through submission and obedience. Rather, he felt opposites lead to the development of a tough inner resolve necessary to meet challenges and awaken us to profound transformation.⁴¹ Jung believed to “see life as most powerfully alive in its opposites is to live vitally, intelligently, and cooperatively with one’s spiritual path.”⁴² Essentially, it is in the shadows that our potential awaits, along with what we dare not see.

Darkness in man resonates with darkness, or shadow, generated from natural light. This shadow represents constant struggle and change as we evolve throughout life. Dim light and shadow provide a refuge for us to “tuck into the shadows” both figuratively and literally. In shadow, we don’t have to reveal too much. In shadow, we find refuge for contemplation.

In *The Secret of the Shadow: Light and Shadow in Architecture*, Roberto Casati provides five definitions for shadow. They are shading, attached shadow, inter-reflection, cast shadow and penumbra as shown in Fig. 4 below. None of these definitions of shadow would exist without light to form a contrast between the two.

From the micro-shadows that form on the surface of a material exposing its textural subtleties to the cast shadow seemingly separate from its original object, shadows (and their partner, light) highlight, in different ways, the three dimensional nature of objects. Some aspects of shadow in Fig. 4 are clarified below. “Shadows that fall on the body which creates them are called ‘attached shadows’. A common example is the shadow of

⁴⁰ John P. Conger, *Jung & Reich: The Body as Shadow* (Berkeley: North Atlantic Books, 1988), 87.

⁴¹ John P. Conger, *Jung & Reich: The Body as Shadow* (Berkeley: North Atlantic Books, 1988), 92.

⁴² John P. Conger, *Jung & Reich: The Body as Shadow* (Berkeley: North Atlantic Books, 1988), 92.

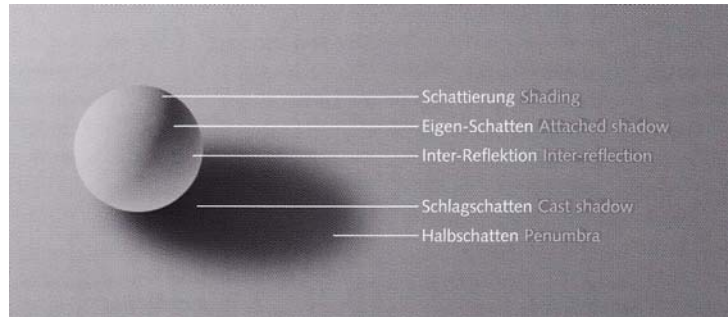


Figure 4

your nose on your upper lip that occurs almost irrespective of the angle of light.”⁴³ According to Casati, “the surface qualities of all materials first become apparent through (micro) shadows, and touching them jells with the visual perception.”⁴⁴ Micro-shadows expose materiality in architecture. They are important to reveal texture and contrast in materiality. Opposites in texture, as in lighting levels, create a similar tension or interplay that heightens our sense of awareness. Another form of shadow, projected or cast shadows, is formed by the overlay of one object onto a second object or separate surface. Shadow, seemingly simple, becomes complex as we develop an awareness of its various subtleties.

The duality, or paradox, of light and shadow develops from the sometimes difficult relationship between the two. Similar to a black hole in space, light and shadow are one reality consisting of negative forms of each other. According to journalist and architectural publisher Ingeborg Flagg, “There is no light without shadow. The interaction of these two unequal brothers has been described in ways as different as the notion that shadows are ‘holes in the light’ through to the opposite idea that they are ‘the remaining representatives on earth of the cosmic darkness, otherwise torn apart by light’.”⁴⁵ The perpetual tug-of-war that exists between light and shadow never truly reconciles. Cast shadow tries to pull away yet is pulled back as the sun cycles to its peak. After the sun peaks, cast shadow attempts to once more pull away but is never truly liberated.

⁴³ Quoted in Deutsches Architektur Museum, *The Secret of the Shadow: Light and Shadow in Architecture* (Berlin: Ernst Wasmuth Verlag Tubingen, 2002), 12.

⁴⁴ Deutsches Architektur Museum, *The Secret of the Shadow: Light and Shadow in Architecture* (Berlin: Ernst Wasmuth Verlag Tubingen, 2002), 11.

⁴⁵ Deutsches Architektur Museum, *The Secret of the Shadow: Light and Shadow in Architecture* (Berlin: Ernst Wasmuth Verlag Tubingen, 2002), 8.

The duality of light and shadow can be further explored through their tension of contrasts. This tension of contrasts is described by architect Kisho Kurokawa's term "symbiosis". Kurokawa's "definition of symbiosis encompasses opposition and contradiction; it refers to new, creative relationships through competition and tension."⁴⁶ Kurokawa's philosophy of symbiosis is widely applicable. There is the symbiosis of history versus the present, of tradition versus the latest technology, of nature versus man, the symbiosis between different cultures, and of art versus science. Kurokawa's concept of symbiosis is applicable to light and shadow as well. In referring to the Noh stage, he describes "the symbiosis of disparate aesthetics or simultaneous coexistence of distinct moods" ...for example, "bringing a sense of darkness into the bright atmosphere of a daytime performance, so that opposites interpenetrate to create a wholly other beauty."⁴⁷ It is the simultaneous existence of light and shadow as apparent opposites or "disparate aesthetics" that, in reality, interpenetrates, causes tension and enhances our experience of architecture.

The Japanese characters 'ku' and 'ke' also describe the relationship between light and shadow. 'Ku' is an interrelated concept to 'ma' (described earlier) as they both relate back to the Japanese word for space, kukan. 'Kan' is also read as 'ma'. According to Kurokawa, 'ku' means emptiness or void, one of the core concepts of Mahayana Buddhism and Japanese Buddhist thought. There is no distinction between existence and non-existence, "they both exist simultaneously in the state of 'ku'." Likewise, light and shadow, or light and non-light, can be thought to exist simultaneously in a state of 'ku'. 'Ku', then, describes the contradiction and paradox of light and shadow. "Further, 'ke' represents the intermediary spaces; the sense of suspension between interpenetrating spaces is the feeling described by ke. In design, then, 'ke' is a gray zone of sensation."⁴⁸ 'Ke', therefore, also denotes the interpenetrating space between light and shadow, its tension of contrasts and our resulting multi-sensory experience.

Light and shadow are physical phenomena and, therefore, can be understood through physics. However, light and shadow can also be understood poetically. As such, there

⁴⁶ Kisho Kurokawa Architects and Associates, *The Philosophy of Symbiosis From the Age of the Machine to the Age of Life* (New York: Edizioni Press, Inc., 2001), 8.

⁴⁷ Kisho Kurokawa, *Rediscovering Japanese Space* (New York: Weatherhill, 1988), 82.

⁴⁸ Kisho Kurokawa, *Rediscovering Japanese Space* (New York: Weatherhill, 1988), 61.

are many different definitions, descriptions, concepts and meanings for light and shadow. Through exploration, we see that light and shadow are not as simple as first thought. In their simplest form, they represent a tension of contrasts that peaks our interest and enhances our experience of the built environment. As we peel away layers of understanding, we reach a deeper meaning for light and shadow and a possible connection to our soul.

Our Senses: How Light and Shadow Affect Our Spatial Experience

“Vision reveals what the touch already knows.”⁴⁹

Juhani Pallasmaa

Our senses play a critical role in our perception of space. We have explored how tension in the relationship between light and shadow engages our senses to enhance our spatial experience. The role of our senses in our experience of aesthetics was not well understood until the 20th century. Prior to that time, it was believed that deduction and thought were the predominant factors affecting our aesthetic experiences rather than our senses.

Kent Bloomer and Charles Moore in their book *Body, Memory, and Architecture* describe the development from the 17th to the 20th century of our understanding of intellect versus senses in our perception of beauty. “After the 17th century the aesthetic debates and theories about the way we sense beauty were to influence, and indeed powerfully to prejudice, our understanding of how we experience architecture. Descartes was so skeptical about the reliability of the senses that he trusted only the act of thinking itself. Cartesian “rationalism” called for the assignment of objective meanings to things, and these meanings were to be deduced, not sensed. His followers were to declare that objective truth radiates from an internal world of ideas, not feelings. His detractors, on the other hand, noted that deduction does not account for many of the spontaneous manifestations of “genius” and imagination found in the great works of art and architecture. By regarding architectural problems and challenges as the province of deduction rather than feeling, the bodily senses, which were not considered to be prime instruments of thought, would acquire an inferior status....”⁵⁰ Therefore, it was thought that our senses played very little, if any, role in our experience of art and beauty.

⁴⁹ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 42.

⁵⁰ Quoted in Kent C. Bloomer and Charles W. Moore, *Body, Memory, and Architecture* (New Haven: Yale University Press, 1977), 23.

During the Enlightenment, others argued that feelings, instead of reason, indicated how we perceive beauty. However, by the end of the 18th century, Immanuel Kant proposed that feelings alone did not give us pleasure. His position was that feelings had to be considered, or thought about, in order to give us pleasure. “The effect was to intellectualize feeling by requiring the intervention of a judgmental activity.”⁵¹ Therefore, it was posited that both feeling and thought influenced our experience of art, rather than one or the other.

In the 19th century, philosopher Robert Vischer, who coined the word “empathy” described the experience of objects as being felt rather than deduced. He “surmised that we may empathize with objects by projecting our personal emotions into them.He suggested in this way that the feelings of the artist while making a work of art could become the content of the work of art. This was an extraordinary thought, for in the context of architecture it implied that feelings of the inner self might be projected to the walls, doorways, and domes of a building.”⁵² Such a thought can be applied to any of the creative arts. In essence, we project ourselves onto any creative work; drawing, painting, sculpture, ceramics, singing, or even architecture. Unfortunately, by the end of the 19th century our understanding of the perception of beauty changed once more. Feeling or sensing through only our visual sense was thought to impact our perception of beauty. The sense of touch was no longer considered important.

The focus changed once again in the 20th century. Environmental psychologist J.J. Gibson proposed five basic senses defined as “perceptual systems capable of obtaining information about objects in the world without the intervention of an intellectual process”.....Gibson lists the senses as the visual system, the auditory system, the taste/smell system, the basic/orienting system, and the haptic system. Of particular interest “are Gibson’s basic-orienting and haptic systems, for these two senses seem to contribute more than the others to our understanding of three-dimensionality, the sine qua non of architectural experience.”⁵³ With Gibson, it was recognized that the haptic sense related to the entire body, not just the instruments of touch such as the hands.

⁵¹ Quoted in Kent C. Bloomer and Charles W. Moore, *Body, Memory, and Architecture* (New Haven: Yale University Press, 1977), 25.

⁵² Quoted in Kent C. Bloomer and Charles W. Moore, *Body, Memory, and Architecture* (New Haven: Yale University Press, 1977), 27.

⁵³ Kent C. Bloomer and Charles W. Moore, *Body, Memory, and Architecture* (New Haven: Yale University Press, 1977), 33.

Other philosophies, such as Steinerian, went farther still and proposed that we have at least 12 senses.⁵⁴ In any case, all our senses and the feelings they generate are critical to our experience of architecture. Our senses; eye, ear, nose, skin, tongue, skeleton and muscle give us information as to the quality of the space, the scale, and the materiality. The resulting experience converges on all sensory levels deepening our response and our sense of being in the world. We cannot experience architecture by just seeing. We have to approach and enter, take in the view out the window and find our way within. As such, we engage all our senses, not just our visual sense. It has even been proposed that our senses, including vision, are extensions of our sense of touch, that they are specializations of the skin. In any case, our senses establish the interface between our environment and our body. Gibson gave us a framework to understand the perceptual process resulting from this interface.

The importance of multi-sensory engagement to our experience of architecture, as well as our experience of the bigger world, cannot be overemphasized. When we suppress our sensual experiences we suppress our identity. “One of the most hazardous consequences of suppressing bodily experiences and themes in adult life may be a diminished ability to remember who and what we are. The expansion of our actual identity requires greater recognition of our sense of internal space as well as of the space around our bodies. Certainly if we continue to focus radically on external and novel experiences and on the sights and sounds delivered to us from the environment to the exclusion of renewing and expanding our primordial haptic experiences, we risk diminishing our access to a wealth of sensual detail developed within ourselves – our feelings of rhythm, of hard and soft edges, of huge and tiny elements, of openings and closures, and a myriad of landmarks and directions which, if taken together, form the core of our human identity.”⁵⁵

Overemphasizing vision as the primary sense used to experience architecture leads us away from our bodies. This “ocular-centric” view is very one-sided and shallow. Seeing architecture is not experiencing architecture. Architecture is experienced deeply only when our other senses are engaged in the process of experiencing. When our

⁵⁴ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 41.

⁵⁵ Kent C. Bloomer and Charles W. Moore, *Body, Memory, and Architecture* (New Haven: Yale University Press, 1977), 44.

other senses are engaged, we use our entire body, including our vision, and our experience is more profound. Light and shadow engage our other senses when we experience architectural space. It is the tension that results from the dialectical relationship of light and shadow that engages our other senses.

For example, dimly lit space does not allow full comprehension using only the visual sense. Dim light or shadow forces one to engage other senses to interpret what is seen visually but is not entirely clear. There is a moment of pause and mystery between first visual engagement and complete sensual understanding. In this moment of mystery, light and shadow interact to create tension that plays upon our sensibility and ignites our imagination. This moment was described earlier by the Japanese concept of “ma”. In space, “ma” represents the temporal interval between two contradictory elements, such as light and shadow.

Similarly, a walk through the forest heals and invigorates because of constant interaction with all the senses. Philosopher Gaston Bachelard calls it the “polyphony of the senses”. “The eye collaborates with the body and the other senses. One’s sense of reality is strengthened and articulated by this constant interaction.”⁵⁶ Architecture that engages the “polyphony of the senses” extends the presence of nature into the built environment expanding our awareness of the larger world outside. Essentially, architecture becomes the template against which we experience the cycle of the seasons, the cycle of the sun and the cycle of each day.

We use our auditory sense to determine spatial boundaries. Our sense of hearing reduces sound to a measuring device helping us to approximate and understand the scale and configuration of space. In much of today’s architecture, however, we mask the scale with piped-in music continually over-running our fine-tuned sense of hearing. We design out all acoustic indicators with sound-absorbing materials and interiors and replace them with subliminal messages and “mood-enhancing” music. Essentially, our sense of hearing has been discarded as a tool available to evaluate and deepen our understanding three-dimensionally.

⁵⁶ Quoted in Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 41.

Architecture should enliven rather than deaden our senses. “The most essential auditory experience created by architecture is tranquility. Architecture presents the drama of construction silenced into matter, space and light. Ultimately, architecture is the art of petrified silence.”⁵⁷ We live for our vacations and travels to see and experience architecture that reconnects to the silence within each and every one of us. Instead, we can experience such architecture each and every day. The role of architects is to provide such an experience. Light and shadow connect us to such an experience.

The importance of our sense of smell in our experience of space must not be overlooked. We have all encountered a familiar smell from the past. All of our senses engage as the memory floods back. This sensory engagement on multiple levels results in a deeper experience of the space and the associated, profound response.

Sometimes senses are experienced as interrelated. The tactile sense and taste are one such sensual combination. “Vision becomes transferred to taste as well; certain colours and delicate details evoke oral sensations.”⁵⁸ As a baby, we first experience the world through sensations in our mouth. Visualize a baby grasp an object and put it in his mouth. The object is first evaluated orally in order to understand it and then later, visually. Similarly, we know certain colors stimulate appetite. They are used extensively in restaurants to increase sales. Through visual associations we make over time, such as the association of McDonald’s “golden arches” to tasty burgers and fries, we all have experienced this transference between our senses.

It is our sensory response to architecture, or to any work of art for that matter, and the resulting physiological response, that provides information to our body to establish a connection to the work. “The encounter of any work of art implies a bodily interaction..... When confronting a work of art we project our emotions and feelings on to the work. A curious exchange takes place; we lend the work our emotions, whereas the work lends us its authority and aura. Eventually, we meet ourselves in the work.....all human interaction implies projection of fragments of the self on to the

⁵⁷ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 51.

⁵⁸ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 59.

other person.”⁵⁹ Similarly, all human interaction during architectural design projects the self onto the architecture. In turn, the architecture projects back onto those who experience it.

Because our body acts as the sensory interface to architecture, “movement, balance and scale are felt unconsciously through the body as tensions in the muscular system.....As the work interacts with the body of the observer, the experience mirrors the bodily sensations of the maker. Consequently, architecture is communication from the body of the architect directly to the body of the person who encounters the work, perhaps centuries later”.

Similarly, “the pleasurable animated flow of a piece of music is subconsciously transformed into bodily sensations, the composition of an abstract painting is experienced as tensions in the muscular system, and the structures of a building are unconsciously imitated and comprehended through the skeletal system.”⁶⁰ In addition to the structure of a building understood through our skeletal system, we also sense tension through the paradoxical relationship between light and shadow. It is this tension that engages our senses on multiple levels. Our increased sensory awareness deepens our experience and connects us to the work. This experience can be positive or negative depending on the aura projected onto us by the work and our level of sensory awareness.

We have lost touch with our senses in experiencing architecture. So much of architecture is now a visual experience with very little input, if any, from our other senses. Our other senses have become deadened with artificial over-stimulation. Flashing lights, piped in music, uniform illumination, artificial ventilation, etc. drown out nature such that we have lost touch with nature’s cycles and rhythms. Fortunately, we, in the Western world, are starting to rediscover our neglected senses. “This new awareness is forcefully projected by numerous architects around the world today who are attempting to re-sensualize architecture through a strengthened sense of materiality

⁵⁹ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 66.

⁶⁰ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 67.

and hapticity, texture and weight, density of space and materialized light.”⁶¹ This new awareness leads us to architecture that connects to nature through patterns such as light and shadow and deepens our experience of the built environment.

“Architecture is the art of reconciliation between ourselves and the world, and this mediation takes place through the senses.”⁶² Our senses provide information to our body and mind forming the basis for our response to architecture. That response is determined by our sensory level of engagement; i.e. whether it is primarily visual or involves multi-sensory integration. Ideally, we experience architecture with multiple senses as this engages our body and mind on multiple levels and results in a deeper, more profound connection. Through paradox, light and shadow facilitate this multi-sensory engagement and become “the pattern which connects” us, through architecture, to the larger world. This connection satisfies many human needs including the need for refuge and withdrawal, for interaction, for tracking cycles of time, for security, for sunlight, for orientation and wayfinding, for coordination with our bio-rhythms, and our need to remember. Architecture that provides this connection to nature and to the larger world is described in the case studies that follow. First, let’s look at the process of visual perception.

⁶¹ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 37.

⁶² Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 72.

The Process of Visual Perception

“Between the idea
And the reality
Between the motion
And the Act
Falls the Shadow”

T.S. Elliot⁶³

We experience architecture through our senses. Our visual sense plays a more or less significant role in our experience depending on the level of information needed versus that readily available through our visual sense.

The process of visual perception is a complex one. Far from being a passive activity involving only the absorption of information, it is an active one also requiring selection, interpretation and storage of information considered relevant to meaningful perception. It is primarily a subconscious process, involving multiple “filters” or components to eliminate unnecessary information in a split second from the overwhelming amount of stimuli entering through the lens of the eye. The components of visual perception are primarily three and include an attributive component, expective component, and affective component.

Our process of perception starts with incoming patterns of light and dark through the eye that are focused on the nerve cells of the retina. These patterns have no inherent meaning at this point. This raw sensory data is then sent to the brain along the various pathways of the optic nervous system.

The next component of perception involves associating this raw sensory data in order to give it meaning. Our experience filter subconsciously sifts through prior experience interpreting and classifying this new sensory information according to its characteristics and context. Based on prior similar situations and objects, this sensory data is first simplified and then assigned meaning. For example, for a circle made up of 15 dots, the pattern of the circle is the recognizable characteristic rather than the 15 dots. This process of assigning meaning to the stimuli is called “attribution of meaning” by

⁶³ John Lobell, *Between Silence and Light: Spirit in the Architecture of Louis Kahn* (Boulder: Shambhala Publications, Inc., 1979), 70.

perceptual psychologists. When there is no similar pattern to which an incoming image can be associated, our attention is drawn to that which is still ambiguous and our curiosity is raised. Uncertainty and possible danger excites us, our biological defense mechanisms engage and sensory awareness increases until enough sensory information is collected to determine that no danger exists.

Following the assignment of meaning through classification of characteristics, the expective component of visual perception involves association through sequences of events. Wayfinding is an excellent example of how expectations play a role in visual perception. As one navigates through a strange city, we associate with signs of a certain shape mounted on poles of a certain height as providing needed information. As a result of this association, we selectively seek out such pole-mounted signs scanning with our eyes accordingly. Therefore, not only do expectations result from our perception, they also influence our selection of what stimuli to seek out next from those available. Particularly in times of danger when the biological need for orientation and security is high, consistent familiar design elements such as red exit signs are indispensable.

The last component of visual perception, the affective component, pertains to our emotional response to stimuli. Our emotional responses determine how we feel in a given situation or environment. These responses then influence how much attention is paid to a given stimulus. Therefore, even though these three components of visual perception; attributive, expective and affective, have been described individually, in reality they are interrelated and cannot be separated. Further, the entire basis of experience is constantly being updated as new stimuli are classified. These new updates to our experience then influence how we selectively evaluate future stimuli. The process of visual perception constantly changes as our “experience filter” is updated.

Therefore, seeing is not a passive activity. It involves active information seeking by the brain in response to patterns of light. Further, it is not the magnitude of a stimulus that determines its relevancy. Rather, it is the information content and context of that stimulus that determine its importance. Its importance, in turn, determines what we look at and how we perceive what is seen.

Case Studies of Designing With Light and Shadow: Ancient

The Solar Alignment of the Megalithic Tomb of Newgrange Boyne Valley, Ireland, 3100 B.C.

The megalithic tomb of Newgrange in Boyne Valley, Ireland is one of the largest burial monuments in western Europe. The tomb is located approximately 30 miles north of Dublin on a low ridge and faces south. Newgrange is noteworthy because of its solar alignment.

The orientation of the Megalithic Tomb of Newgrange in Boyne Valley, Ireland, is such that for up to one week before and after the winter solstice on December 21st each year the farthest depths of the burial chamber are illuminated by the sun's rays. As described by Michael J. O'Kelly in his book *Newgrange*, "As the thin line of light widened to a 17 cm band and swung across the chamber floor, the tomb was dramatically illuminated and various details of the side and end recesses could clearly be seen in the light reflected from the floor."⁶⁴ According to O'Kelly, the sun shines through a narrow slit at the outer end of the passage roof and which is actually positioned just below the roof-box (Figs. 5 and 6).⁶⁵

At sunrise at the winter solstice, around 3000 B.C., the rising sun would penetrate, for approximately two weeks. The phenomenon has been confirmed during observation for several days each year between 1970 and the early 1980's.⁶⁶

Observation for several years during winter solstice would have been necessary to correctly lay out the tomb for this solar phenomenon to occur. An analysis of the solar illumination provides perspective regarding the complexity of the tomb's design. Dr. Jon

⁶⁴ Michael J. O'Kelly, *Newgrange* (London: Thames and Hudson Ltd., 1982), 124.

⁶⁵ Michael J. O'Kelly, *Newgrange* (London: Thames and Hudson Ltd., 1982), 124.

⁶⁶ Michael J. O'Kelly, *Newgrange* (London: Thames and Hudson Ltd., 1982), 124.

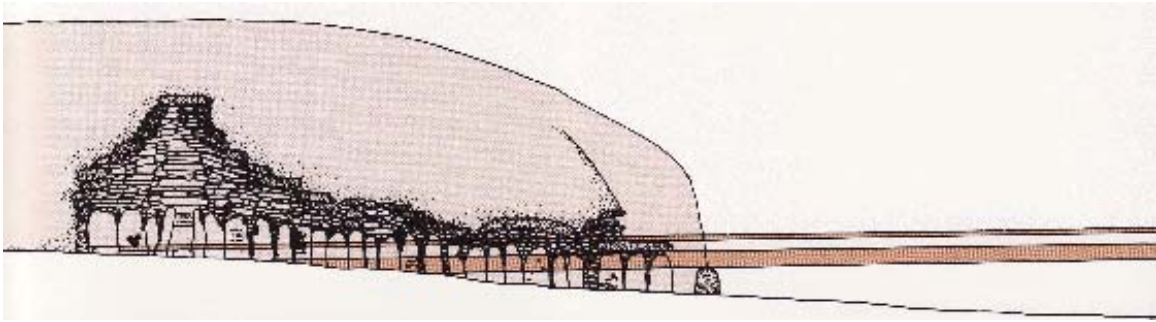


Figure 5



Figure 6

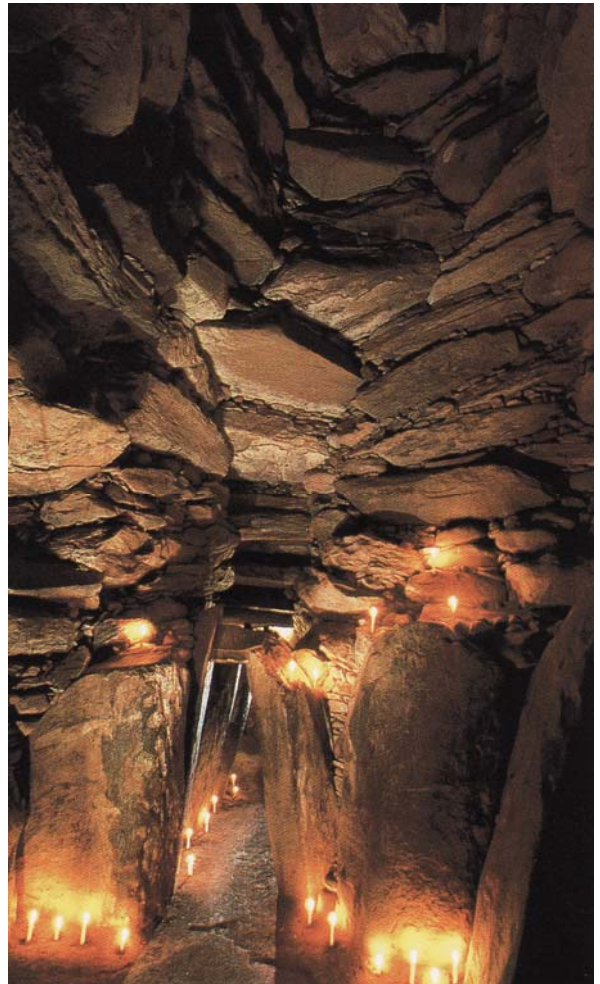


Figure 7

Patrick provides a detailed explanation of this solar phenomenon at Newgrange “The passage is in the form of two curves so that for a ray of light to travel directly from the roofbox to the back wall of the rear recess it must be in the azimuth range 133 degrees 42’ to 138 degrees 24’. The elevation of the distant horizon (0 degrees 51’) is the minimum elevation at which the sun’s direct rays can enter the slit. The floor of the chamber is about 15 cm lower than the roof-box, so at the minimum elevation sunlight will extend across the floor and into the rear recess. Light rays will not enter the chamber when the elevation exceeds about 1 degree 40’. This range of azimuths and elevations, reliable to about 15’ and 5’ respectively, means that the sun’s rays will shine directly into the chamber if its declination lies between -22 degrees 58’ and -25 degrees 53’. It therefore seems that the sun (in theory) has shone (into) the chamber ever since the date of its construction and will probably continue to do so forever, regardless of secular changes in the obliquity of the ecliptic.”⁶⁷ Dr. Patrick explains the effects of time on the beam of light saying “Unfortunately, the vagaries of time have had their effect on the passage and some of the stones are now leaning inwards, thus trimming down the width of the beam of light. At the time of construction, the beam would have been about 40 cm wide whereas now it is only 17 cm. The two principal orthostats (stones) causing the obstruction are L18 and L20. The first ten orthostats on either side of the passage have been straightened but there is no way of straightening the rest without dismantling the whole structure.”⁶⁸ Therefore, it appears this solar phenomenon will continue as long as the stones do not lean inwards sufficiently to completely block the sunlight (Fig. 7).

Newgrange is an excellent example of the use of light over 5000 years ago to connect to something larger than ourselves. The solar illumination of Newgrange inspires awe and reverence. Using the sun’s light to illuminate the burial chamber for a finite period at the same time each year connects us to cycles of time, to memory, allows wayfinding and provides for withdrawal. The solar alignment phenomenon at Newgrange provides a connection to something sacred and may symbolize rebirth following death. Certainly, “some kind of powerful force or motivation” led to the effort to construct Newgrange with its particular solar orientation.⁶⁹ The orientation of Newgrange was deliberate and not left to chance. Newgrange was designed and constructed for natural light to be the “pattern which connects” to nature, to something much larger than ourselves.

⁶⁷ Michael J. O’Kelly, *Newgrange* (London: Thames and Hudson Ltd., 1982), 124.

⁶⁸ Michael J. O’Kelly, *Newgrange* (London: Thames and Hudson Ltd., 1982), 124.

⁶⁹ Michael J. O’Kelly, *Newgrange* (London: Thames and Hudson Ltd., 1982), 124.

The Solar Alignment of the Great Temple of Ramesses II Abu Simbel, Egypt, 1265 B.C.

The Great Temple of Ramesses II at Abu Simbel, Egypt is carved from solid rock. The façade is comprised of four colossal seated statues of the king measuring approximately 72' high. An entrance between the statues is carved into the cliff and leads to the inner chambers of the temple. The Great Temple was rescued from the rising waters of the Aswan dam between 1964 and 1968 by dismantling and relocating the temple 213' above its original site.

The orientation of the Great Temple allows the sun's rays to shine directly into the deepest part of the sanctuary on or about October 22 and February 22 of each year. As described by William MacQuitty in his book *Abu Simbel*, "Inside, in the interior of the great temple, the eight huge Osiride statues of Ramses II wait for the first light. Beyond them lies the second chamber and beyond that the small antechamber leading to the sanctuary, cut 180 feet into the living rock. Suddenly, the sun rises and gradually the cold darkness is suffused with its warm golden light. It is only on two days of each year that the sun actually shines directly on the four gods in the innermost sanctuary, the 23rd of February and the 23rd of October. The effect, nevertheless, is always remarkable."⁷⁰

The entrance to the Great Temple is oriented almost due east⁷¹, an orientation that allows for solar illumination, similar to that of the Tomb of Newgrange in Boyne Valley, Ireland (Fig. 8). In the case of Newgrange, the illumination occurs for approximately one week before and one week after the winter solstice date of December 21st. This illumination results from a combination of azimuth and elevation of the sun at this specific time of the year. In the case of the Great Temple, the solar alignment occurs on or about October 22nd and on or about February 22nd of each year. These dates occur approximately 2 months before and 2 months after the winter solstice and correspond to the king's coronation date and his birthday, respectively.

⁷⁰ William MacQuitty, *Abu Simbel* (New York: G.P. Putnam's Sons, 1965), 96, 101.

⁷¹ William MacQuitty, *Abu Simbel* (New York: G.P. Putnam's Sons, 1965), 135.



Figure 8



Figure 9

Research into the site orientation indicates the solar illumination was intentional. Additionally, of the four statues in the temple, the statues of Amon, Hamarkhis and the pharaoh (Ramses II) are illuminated on these two dates while the fourth, Ptah the god of darkness, is never struck by the sun's rays.⁷² It appears that the lack of illumination of Ptah, the god of darkness, was intentional. A photo of this phenomenon is shown in Fig. 9.

Symbolically, life following death may have been intended by the solar alignment at the great temple. According to William MacQuitty, "It was clear that value was set upon preservation – some form of life after death was sought."⁷³ He goes on to state "At night the sun enters the Underworld, where all mankind goes after death. In the morning it rises again to make once more its triumphant journey across the Heavens. Egypt is a land of sun; for the Egyptians it was a god."⁷⁴ Perhaps Ramesses wanted the sun as a god to join the other "gods" in the sanctuary of the Great Temple in celebration of his birthday and his coronation. In any case, the sun's light connects the Great Temple to something sacred.

The great temple of Ramesses II is another excellent example of the use of light long ago, over 3000 years, to connect to something much larger than ourselves. It is on two dates before and after the winter solstice, on October 22 and on February 22 of each year that the position of the sun allows dramatic illumination of the farthest recesses of the Great Temple of Ramesses II at Abu Simbel, Egypt. These two dates are approximately 2 months before and after the winter solstice, December 21, and are Ramesses' coronation date and his birthday, respectively. Solar illumination enters through various chambers oriented along the east-facing entrance pathway, ending in the deepest chamber carved 180 feet into the mountain. This illumination connects us to cycles of time, to memory and provides wayfinding. Today, as well as in 1265 B.C., sunlight is the "pattern which connects" the great temple of Ramesses II to something larger than man.

⁷² "History of Egyptian Architecture Abu Simbel No.3," Web.Kyoto-inet website, N.d. <http://web.kyoto-inet.or.jp/org/orion/eng/hst/egypt/abusimbel2.html> (accessed 5 December 2005).

⁷³ William MacQuitty, *Abu Simbel* (New York: G.P. Putnam's Sons, 1965), 17.

⁷⁴ William MacQuitty, *Abu Simbel* (New York: G.P. Putnam's Sons, 1965), 18.

Case Studies of Designing With Light and Shadow: Modern

Church of the Light, Tokyo, Japan by Tadao Ando

“To me, there clearly is a “poetry of light,.....perhaps the most salient quality of Ando’s works.....”⁷⁵

The Church of the Light by Tadao Ando effectively uses natural light and shadow to create a space that is simple yet memorable. Illumination by natural light engages our other senses to fully experience this building. It is sensual engagement, whether tactile, visual, auditory and perhaps taste and smell to a lesser degree, that imprints our memory with this powerful space.

The Church of the Light was constructed in 1989 in a residential suburb of Osaka, Japan. Two pre-existing wood buildings were located on the site: a chapel and a house for the minister. The budget for the new church was very limited resulting in a simple solution constructed from only concrete and glass. The Church of the Light is basically a rectangular box composed of walls, floor and ceiling intersected along one side by a wall rotated 15 degrees. The very clear geometry of the parti is shown in Figure 10.

The intersecting wall encloses the entrance path to the church (outside the church) and then forms the entrance to the church (inside the church) as shown in the plan. This entrance pathway to the church descends initially before one enters the enclosed exterior space formed by the intersecting walls. Wayfinding and navigation are clear as one passes the cruciform cutout in the eastern wall and then ascends to the entrance to the church. Once inside, the naturally lit cruciform cutout in the eastern wall draws one down past the stepped pews to the altar and pulpit (Fig. 11). This entrance path prepares one to enter the sacred space, similar to the transformation experienced while navigating an ambulatory.

⁷⁵ Magnago Lampugnani, Vittorio, “Tadao Ando: Due Recenti Architetture Giapponesi.” *Domus* 712 (January 1990): 26.

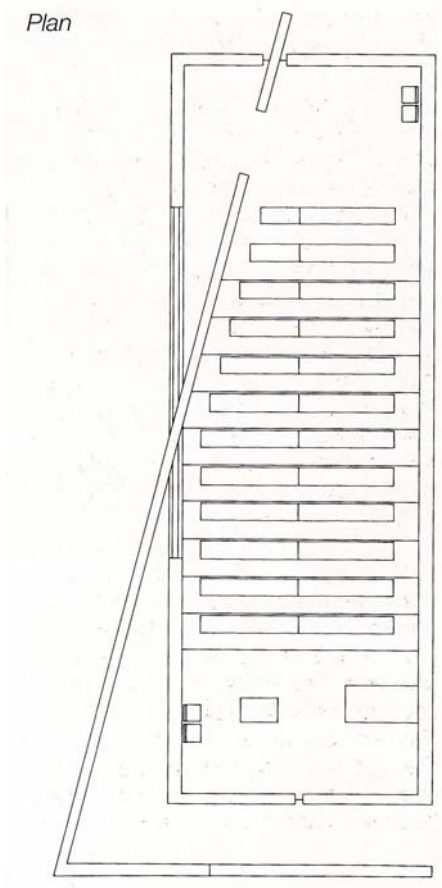


Figure 10



Figure 11

Flooring and benches constructed from scaffolding planks give a tactile quality to the otherwise austere space enclosed by the walls and ceiling of very smooth concrete. The simple geometry and smooth concrete walls allow nature to take center stage as natural light permeates the space through the cruciform cutout and illuminates the natural wood floors and benches. The very simple furnishings, finished with black oil stain, allow "the quality of the natural material to come through."⁷⁶ A connection to the earth is evident from Ando's use of natural materials and natural light.

"Well, first of all, I thought about the Japanese sense of spatial quality and the difference between Japanese and Western sense of space, and the material that is available."⁷⁷ This quote by Tadao Ando refers to the Japanese Screen Gallery at the Art Institute of Chicago, however, it also seems to apply to other Ando work. In the case of the Church of the Light, it seems to refer to the Japanese integration of inside and outside and integration with nature. Whether it be the natural light streaming into the church or the wood floors and benches, there is clearly a reference to nature in this space (see Fig. 11). According to Ando, "the light becomes brilliant only against a very dark background. The only natural element here is sunlight." It is Ando's use of contrasts such as light/dark, inside/outside, smooth/textured, nature/manmade, open/closed, etc. that creates tension and enhances our perception of the space. Also according to Ando, "In the shifting cross of light, one may come to recognize in a fundamental way the relationship of humanity to nature."⁷⁸ Ando clearly connects humanity with nature in his work. Furthermore, the Japanese sense of spatial quality emphasizes the space itself rather than the enclosure. On the other hand, the use of concrete and glass provides more of a reference to the west, developing further contrast.

"One of the essentials of Japanese traditional architecture can be said to be geometry."..... "the dim or restrained light of the space also represents the Japanese traditional space."⁷⁹ Even though Ando was referring to the Japanese Screen Gallery in this quote, he clearly used the same precedent, that of Japanese traditional

⁷⁶ Tadao Ando, *Details* (Tokyo: A.D.A. EDITA Tokyo Co., Ltd., 1991), 156.

⁷⁷ Betty Blum, "Interview with Tadao Ando" (Chicago, The Art Institute of Chicago, 2002), 4.

⁷⁸ Magnago Lampugnani, Vittorio, "Tadao Ando: Due Recenti Architetture Giapponesi." *Domus* 712 (January 1990): 29.

⁷⁹ Betty Blum, "Interview with Tadao Ando" (Chicago, The Art Institute of Chicago, 2002), 6.

space, in the design of Church of the Light. The geometry is very clearly a rectangular box. In addition, the purposefully low illumination of the space is reminiscent of traditional Japanese architecture and provides for withdrawal and detachment necessary for spiritual pursuit.

According to Ando, "Recent works of architecture seem to lack a tactile dimension."⁸⁰ He says "I have always used natural materials in those parts of a building that come into contact with the human hand or foot because I am convinced that substances such as wood and concrete are invaluable materials for architecture and that one becomes aware of the true quality of architecture through the body."⁸¹ The tactile sense, when fully engaged through materials used in architecture, results in a more memorable spatial experience. As Ando says, "a tactile experience enhances the perception of the architecture."⁸² In Church of the Light, "Here, the intention was to appeal to the senses."⁸³ Of course, the tactile sense is only one of our senses. However, it is the tactile sense that has the capacity to bring us closer, to establish an intimacy with the space, as with the Church of the Light.

According to Ando, "Natural materials age with time, and human memory is thus inscribed in the building."⁸⁴ His selection of materials is careful and thoughtful as shown in the Japanese Screen Gallery. His use of natural materials shows an awareness of and a connection to the cycles of time and to memory. For the gallery, he says "Of course, because when I chose to use wood as materials, I chose it because it could best express the quality of the element. For example, in this case, for the floor, I used to work with this cut of wood because it had a very good tactility when people walk on it. They feel at ease and they strongly feel their presence within the space. Conversely, another type of wood was selected for the pillars because it gives strength to the form of the pillars. So, in each case, each of the elements and materials was selected to fit with the

⁸⁰ Magnago Lampugnani, Vittorio, "Tadao Ando: Due Recenti Architetture Giapponesi." *Domus* 712 (January 1990): 29.

⁸¹ Magnago Lampugnani, Vittorio, "Tadao Ando: Due Recenti Architetture Giapponesi." *Domus* 712 (January 1990): 29.

⁸² Tadao Ando, *Light and Water* (New York: The Monacelli Press, Inc., 2003), 64.

⁸³ Tadao Ando, *Details* (Tokyo: A.D.A. EDITA Tokyo Co., Ltd., 1991), 156.

⁸⁴ Tadao Ando, *Details* (Tokyo: A.D.A. EDITA Tokyo Co., Ltd., 1991), 13.

expression, the spirit, of the elements.”⁸⁵ The result is an austere, sacred space that connects to nature and to the larger world.

⁸⁵ Betty Blum, “Interview with Tadao Ando” (Chicago, The Art Institute of Chicago, 2002), 10.

Salk Institute, La Jolla, California by Louis Kahn

“Without light there is no architecture.”

Louis I. Kahn⁸⁶

The benefits of designing environments that combine comfort, delight and inspiration is well documented. In particular, in research environments, this has become a primary focus to spur creativity and innovation. An excellent example of early success in this area is the Salk Institute in La Jolla, California, designed by Louis Kahn.

The Salk Institute was completed in 1965. It overlooks the Pacific Ocean from 27 acres of coastal bluffs edging the Torrey Pines mesa in La Jolla, California. It is Kahn's use of daylighting and his manipulation of light and shadow, both inside and out, at Salk that are memorable. Exceptional daylighting, visual orientation and interactive space foster collaboration, community and creativity in line with Jonas Salk's vision of a secular monastery.

The plan for the Salk involves two symmetrical, angled wings of labs and studies that straddle an austere stone plaza that faces due west and juts visually into the Pacific Ocean (Figs. 12 and 13). The stone plaza is dissected through its center by a narrow ribbon of water that appears to empty into the Pacific Ocean. At sunset the water in the long, thin watercourse aligns with the sun's fiery glow through its length and becomes the “pattern which connects” the Salk to nature and to the larger world. Paradoxically, the extreme austerity of the plaza heals but also unnerves with its direct connection to the heavens. The solar alignment of the plaza is strongly reminiscent of the solar alignment at the tomb of Newgrange in Boyne Valley, Ireland.

Luis Barragan was consulted during construction for landscaping ideas for what was to be a central garden. Barragan offered only that it should be fitted exclusively with stone. According to Kahn, Barragan said “I would not put a tree or blade of grass in this space. This should be a plaza of stone, not a garden.” So the plaza, which orients us, literally

⁸⁶ John Lobell, *Between Silence and Light: Spirit in the Architecture of Louis Kahn* (Boulder: Shambhala Publications, Inc., 1979), 47.

as well as spiritually, to the ocean and to the surrounding buildings, was left as “a façade to the sky.”⁸⁷

New York Times critic Herbert Muschamp “wrote of the courtyard’s poetic qualities:

‘First, sky; then, as you walk through the grove, the roof lines of the two laboratory buildings that rise up ahead on either side. The roof lines look saw-toothed....and as you move closer [they] slice through the sky like two serrated blades, carving it into a solid block of space that descends to fill the central court....The surroundings offer so little distraction....There are the proportions of the laboratories, the thickness of their concrete walls, and a mottled bloom on the surface of the concrete that picks up the light and gives the walls a mirage like shimmer.’⁸⁸

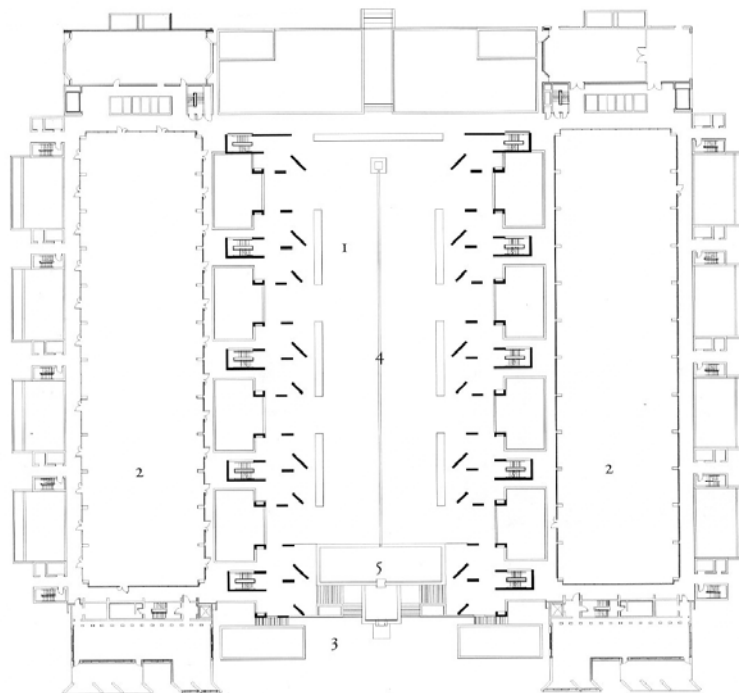


Figure 12

Salk Institute, courtyard level plan

- 1. COURTYARD
- 2. LABORATORY AND STUDY WINGS
- 3. LOWER GARDEN
- 4. CANAL

⁸⁷ Louis Kahn, *Silence* (VIA 1, 1968), 88-89; reprinted in *Writings*, 232-233.



Figure 13

⁸⁸ Quoted in Thomas Leslie, *Louis I. Kahn, Building Art, Building Science* (New York: George Braziller, Inc.), 170.

The Salk consists of six floors. However, to maintain a low site profile, the lower two floors (a lab floor and associated mechanical floor) were located below ground. To provide daylighting to these two below-grade floors, similar to that provided for the floors above, central courtyards are carved out adjacent to the lower floors. These central courtyards continue upwards, from the lower floors through the upper floors, as open shafts to the sky. The shafts provide a connection to the cycles of time through the cycle of the sun and the seasons. The labs and studies, along with porches and arcades, wrap around these open courtyards, creating numerous daylit spaces for work, study, withdrawal and contemplation.

The materials used for the Salk include concrete, wood, steel and glass. The detailing of the concrete and the construction joints is very exact and reveals the method of construction. Dozens of concrete blends were tested before selecting one that achieved the desired consistency and color. As the wood weathers and grays in the salty coastal air, the Salk connects to cycles of time and memory and provides a connection to the earth.

Unique to the Salk are the interstitial mechanical floors between lab floors made possible by the structural system consisting of Vierendeel trusses. The truss system allows for wide open lab floors below with maximum flexibility for mechanical system and lab re-arrangement. In addition, the open layout allows daylighting to partially illuminate the labs.

Ultimately, it is the courtyard at the Salk that provides the most emotionally powerful experience. In Kahn's words "The sensitivity of the building and this space to the many moods of the sky and the atmosphere will make the Plaza a place always changing, never static, full of the never ending anticipation of the rising and the setting of the sun."⁸⁹

⁸⁹ Thomas Leslie, *Louis I. Kahn, Building Art, Building Science* (New York: George Braziller, Inc.), 166.

Kimbell Art Museum, Fort Worth, Texas by Louis Kahn

“Silence to Light
Light to Silence
The threshold of their crossing
is the Singularity
is Inspiration
(Where the desire to express meets the possible)
is the Sanctuary of Art
is the Treasury of the Shadows
(Material casts shadows shadows belong to light)”

Louis I. Kahn⁹⁰

The Kimbell Art Museum, designed by Louis Kahn, was completed in 1972 in Fort Worth, Texas. It is composed of a series of simple, repeating, cycloid concrete vaults 100' long and 23' wide. The adjacent vaults are cut across by a variety of courtyards which allow views to the outside and light to penetrate the interior (Fig 14). The museum contains gallery space, a library, an eating area, bookstore and an auditorium.

One approaches the Kimbell entrance court from the west through open vaults or

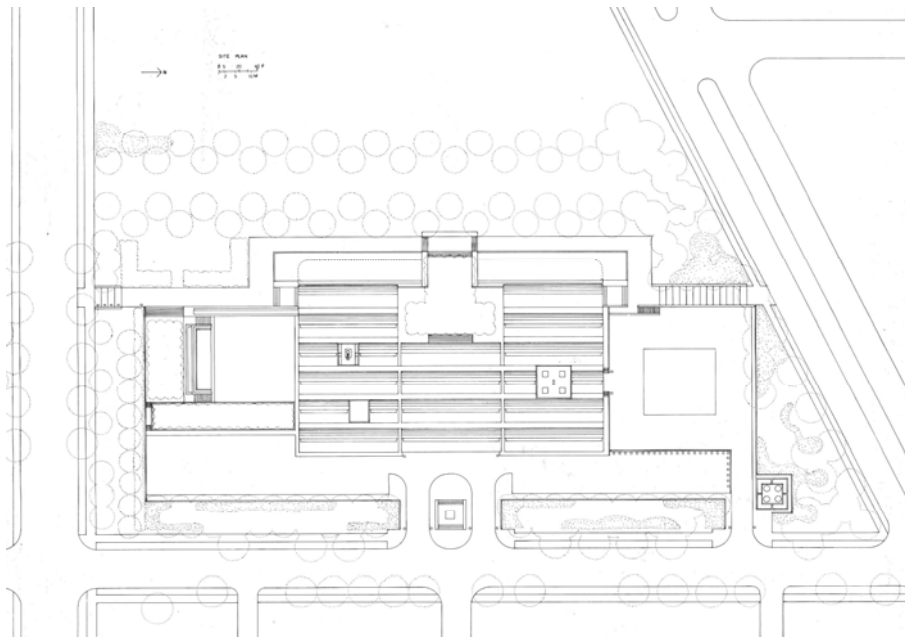


Figure 14⁹¹

⁹⁰ Louis Kahn, *Light is the Theme* (Fort Worth: Kimbell Art Foundation, 1978), 11.

⁹¹ Louis Kahn, *Light is the Theme* (Fort Worth: Kimbell Art Foundation, 1978), 66.

porticos oriented perpendicular to the court (Fig. 15). The porticos, which bear a similarity to the arcades of a Renaissance building, repeat the structure and form of the building's interior vaulted spaces. Structure and form are, therefore, revealed to the viewer prior to entry, honestly and openly.

Kahn referred to these porticos as "open porches" and described their inherent beauty as a result of their being so unnecessary. Slender support columns at each corner appear unable to carry the substantial load of these curved vaults. The viewer is caught in this apparent paradox, perceived as a "tension of contrasts". We become alert. Our multiple senses engage. Through heightened awareness, our architectural experience is deeply enhanced. We sense literal tension as well from post-tensioned cables used to develop the necessary structural strength in the curved vaults.

A similar contrast is evident in "served" versus "servant" space at the Kimbell. A 7' wide soffit between adjacent vaults contains HVAC and electrical systems for the museum (Fig. 16). From the soffit, strip diffusers project conditioned air horizontally into vaulted space. The soffits and vaults form a clear delineation and systematic repetition of alternating served and servant space as seen in other Kahn buildings such as the Salk Institute. This separation of served versus servant space is further clarified by alternating travertine flooring under the soffits and white oak flooring under adjacent vaults.

Our sensory experience of the Kimbell is further enhanced by the materiality of the building. The Kimbell is constructed of exposed concrete vaults and columns, glass and travertine infill panels (Fig. 17). Flaws within the concrete mimic flaws within the travertine creating the perception of a monolithic structure until viewed up close. Up close, differences in the two materials become evident. The concrete and travertine construction details and joints, typical of Kahn's other work, are very exact. To Kahn, ornament is the "adoration of the joint"⁹² and the Kimbell exhibits this ornamentation perfectly. Flaws in the concrete and travertine contrast sharply with the perfectly smooth and flawless glass walls bordering the courtyards.

⁹² "After Architecture: The Kimbell Art Museum." Design Book Review, no. 11 (Winter 1987): 35.



Figure 15



Figure 16

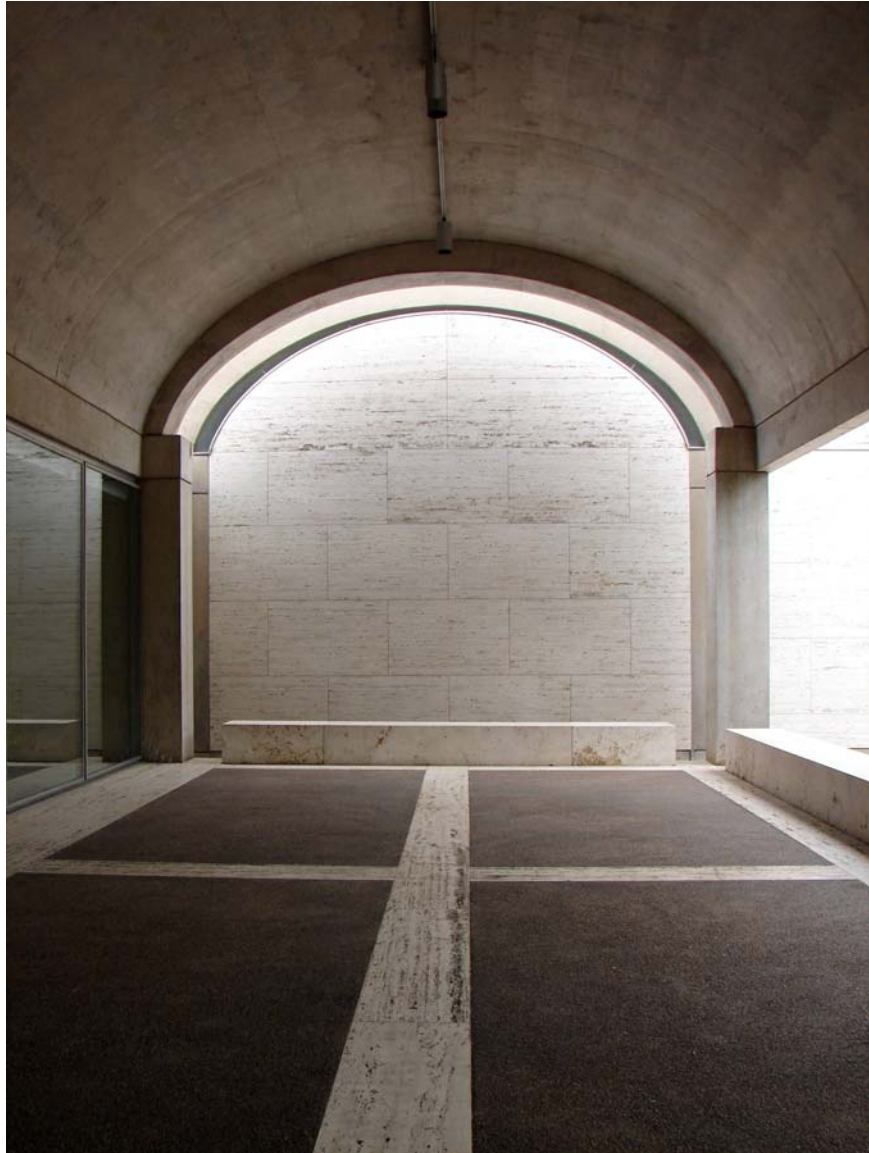


Figure 17

A similar material contrast becomes apparent inside the building. As described above, white oak is used for flooring in the galleries and other vaulted space while a 7' strip of travertine separates the oak floor under adjacent vaults. The wood produces a warm, familiar glow in contrast to the permanence of the travertine. We are connected to cycles of time and to memory as the natural wood ages. These contrasts in materiality enhance our experience of the Kimbell. However, it is the relationship of light and shadow and Kahn's orchestration of them that has the greatest impact.

Kahn's illumination of space with natural light became a trademark. He sought to draw movement and life into buildings using natural light. His buildings have been described as sacred because of his skill in articulating natural light and shadow using structure and form.

The plaza at the Salk Institute, La Jolla, California (1965) is an excellent example of space with such a presence. As described previously, at sunset a fiery reflection illuminates the central water trough splitting the plaza with a glowing torch of light. Awe overcomes us as we experience this sacred vista. Kahn's manipulation of the sunset linearly connects the Salk to the sun and to the heavens through light and shadow. Light and shadow are the "pattern which connects" us to nature through the Salk's architecture.

Similarly, natural light is the theme in the design of the Kimbell. However, Kahn introduced natural light to the interior spaces in a way never done before.

At the Kimbell, each curved vault contains a narrow, lengthwise slit to the sky (i.e. the heavens) along its apex, as well as a crescent-shaped slit at each end (Fig. 18). Daylight entering the apex is magnified by lengthwise, curved and perforated aluminum lighting reflectors. The reflector or "beam splitter" is suspended just below the apex of the vault and functions dually to reflect as well as filter daylight entering the slit above. This curved aluminum reflector manipulates incoming daylight, coloring it silver and reflecting it at infinite angles back toward the curved cycloid which further reflects the light at infinite angles into the space below (Fig. 19). The silvery glow and its shadow illuminate the vault's interior as if it were a moon lit sky, articulating form, surface and dimensionality. The curvature and matt surface of the concrete vault further reflects this



Figure 18

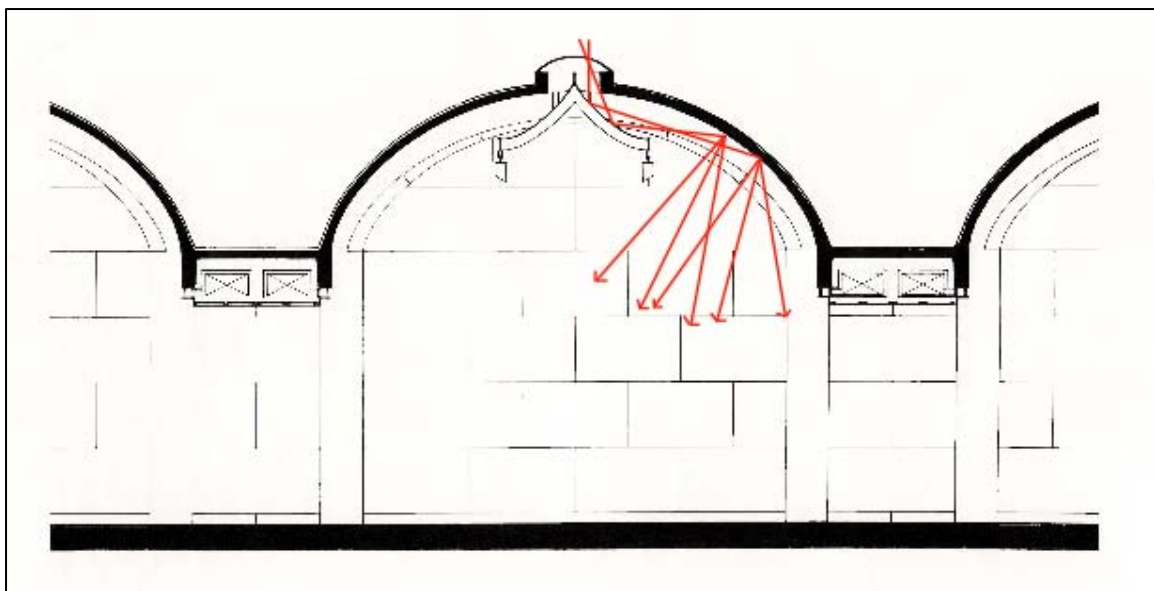


Figure 19

glow, shooting diffused ethereal light into the space below. The effect is of a sacred space that provides for withdrawal for the contemplation of art.

According to Kahn, natural light is “a light of mood”.⁹³ In describing the nature of the light at the Kimbell, he said “the museum would always be full of surprises. The blues would be one thing one day; the blues would be another thing another day, depending on the character of the light. Nothing static, nothing static as an electric bulb, which can only give you one iota of the character of light. So the museum has many moods as there are moments in time, and never as long as the museum remains a building will there be a single day like the other.”⁹⁴

The “tension of contrasts” produced by static conditions such as structure and materiality is quickly resolved once our senses determine no danger exists. However, the relationship between light and shadow produces a tension not so easily dismissed. Light and shadow are ever-changing. Sky conditions vary considerably based on latitude producing dramatic shifts in light and shadow. These shifts are amplified by architectural form, which captures the light and gives rise to its quality and mood. This constant state of flux forces continuous tuning as our senses re-evaluate shifting conditions. The Kimbell comes to life as we experience the sun’s movement across the sky and the cycles of time. It is this continuous, evolving tension from light and shadow that has the greatest impact on our architectural experience.

Had Kahn used different finishes or materials for the aluminum “beam splitter” and the concrete vault, the color and quality of the light reaching the interior spaces of the Kimbell would be completely different. His choice of silvery aluminum and cool concrete produce a silvery light that borders on ethereal or sacred. Further, his use of curved, rather than angled, vaults and “lighting reflectors” allows the incoming light to be reflected at infinite angles both from the reflector as well as from the vault. The resulting light is projected over a wide area in the vault below and is diffused uniformly throughout the space.

⁹³ Louis Kahn, *Light is the Theme* (Fort Worth: Kimbell Art Foundation, 1978), 17.

⁹⁴ Louis Kahn, *Light is the Theme* (Fort Worth: Kimbell Art Foundation, 1978), 16.

Kahn used secondary sources of light to provide natural illumination in the Kimbell as well as other buildings. These secondary sources include adjacent walls to skylights such as the smooth concrete walls, both flat and curved, at the Yale Center for British Art (Fig. 20) also designed by Kahn. Using the source-path-target concept developed by Professor Fuller Moore at Miami University, the perceived sources of illumination for various surfaces can be predicted during design as well as identified in an existing building (Fig. 21). This method predicts glare and the overall quality of light from both direct and indirect sources.

At the Kimbell, this same concept shows perceived illumination sources for the various horizontal and vertical surfaces (Fig. 22). The effect and quality of the diffused natural light generated by the curved vault is perceived throughout the space (Fig. 23).

The quality of light at the Kimbell set a new precedent for museums as well as other buildings constructed since. The De Menil Museum in Houston, Texas, designed by Renzo Piano and completed in 1987 is one example. Its ceiling of reinforced concrete reflectors, or curved “leaves” as they were also called, produces high quality “living and natural light responsive to the conditions outside.”⁹⁵ Even though Piano designed the De Menil, Kahn had the commission for two years before his death. Piano was given the commission in 1977, three years after Kahn died. According to architectural historian Patricia Cummings Loud, Kahn’s “insight, philosophy and accomplishment as a museum designer” seems to have influenced Piano in his design of the De Menil.

At the Kimbell, natural light reveals space, structure and material (Fig. 24). Over and over the building engages multiple senses as we interpret surface, light, shadow, and dimension in the various galleries and other areas. The affect is ever-changing because of the museum’s connection to the world outside, to the earth, i.e. to the world of nature. The Kimbell becomes the “pattern which connects” us to the ebb and flow of the natural world through its manipulation of light and shadow.

⁹⁵ Patricia Cummings Loud, *The Art Museums of Louis Kahn* (Durham: Duke University Press, 1989), 259.



Figure 20

Figure 21

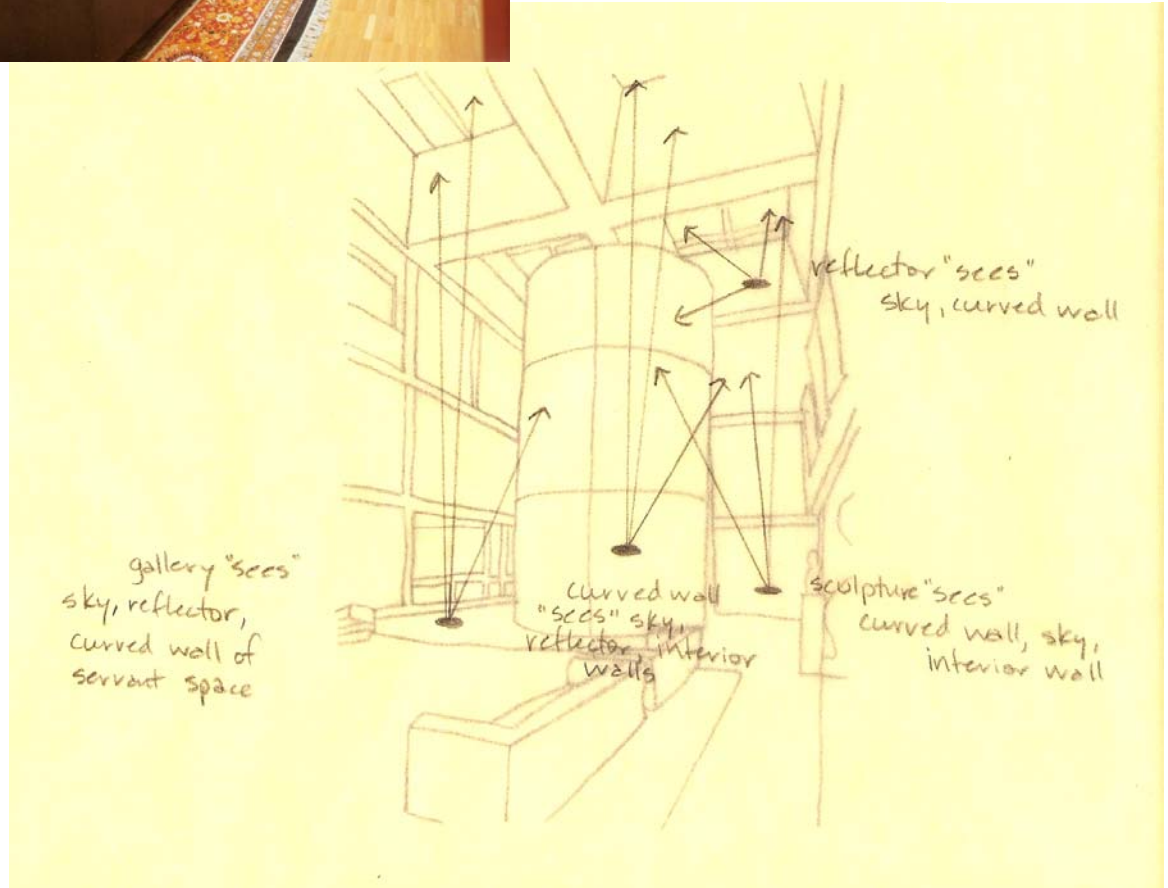


Figure 22

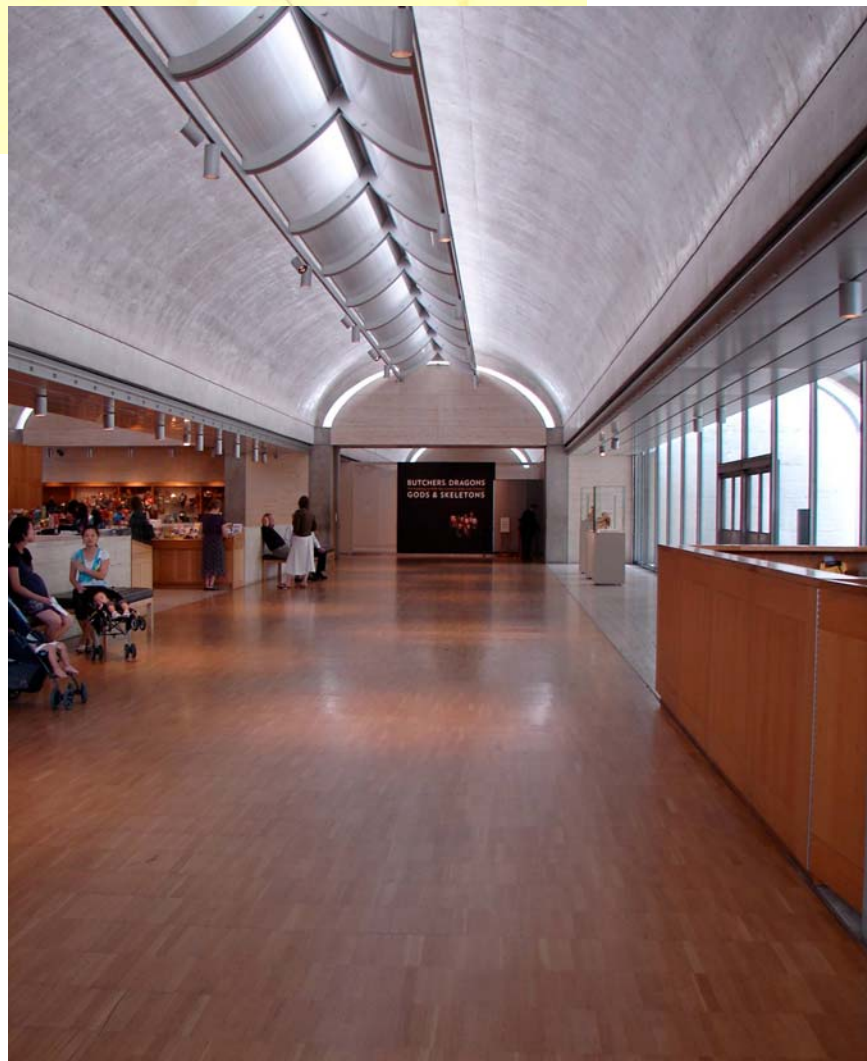
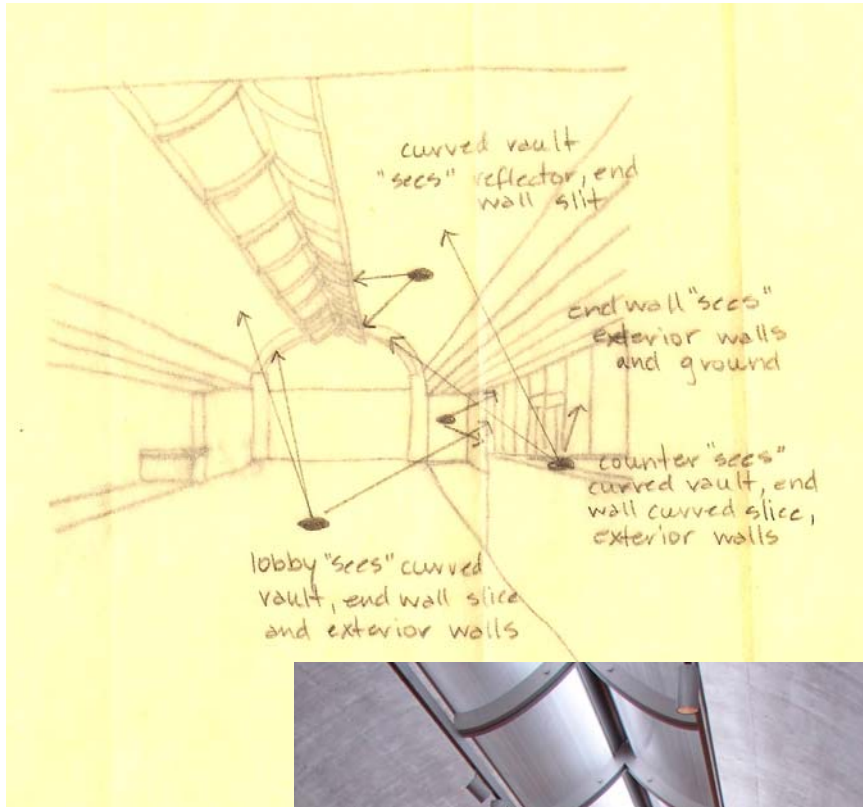


Figure 23

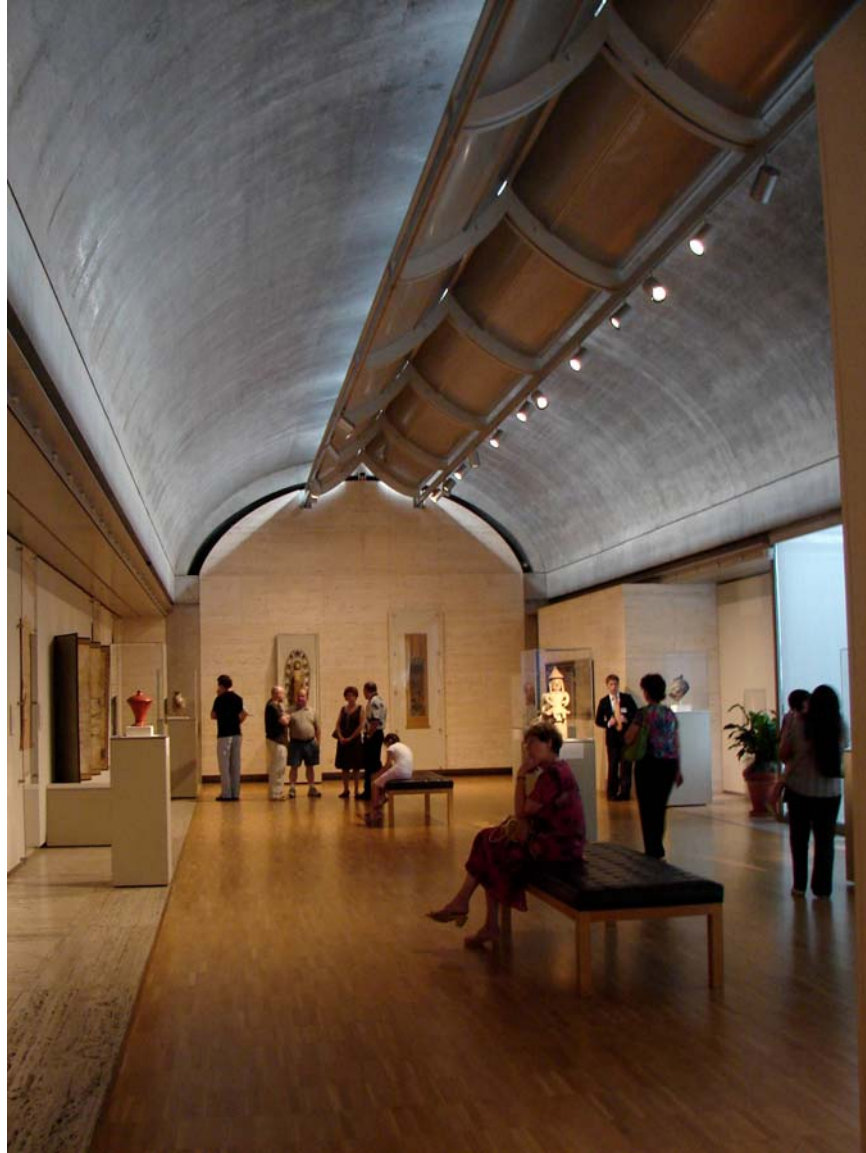


Figure 24

Alvar Aalto's Library, Mt. Angel, Oregon

“The very essence of architecture consists of variety and development reminiscent of natural organic life.”

Alvar Aalto⁹⁶

Alvar Aalto also created a multi-sensory experience with his architecture. According to Finnish architect Juhani Pallasmaa, “Alvar Aalto was consciously concerned with all the senses in his architecture.”⁹⁷ “Instead of the.....architecture of the eye, Aalto’s architecture is based on sensory realism. His buildings are not based on a single dominant concept or gestalt; rather, they are sensory agglomerations.”⁹⁸

An excellent example of Aalto’s work is the Mount Angel Abbey Library located in St. Benedict, Oregon. Completed in 1970 toward the end of his life, it is an exemplary example of Aalto’s orchestration of natural light to illuminate space. Clearly, light, an element of nature, is the theme here, as it is at the Kimbell Art Museum. The role of materiality and natural materials is also evident from the variety and contrast of surfaces; smooth versus naturally textured and cool versus warm.

The Mount Angel Abbey Library, one of only two buildings designed by Alvar Aalto in the United States and his last library, is located on the hilltop campus of the Mount Angel Benedictine Monastery in the center of the Willamette Valley of Oregon. From a rectilinear top floor entry facade that fits well into the context of the Abbey’s other buildings, the library branches out into a fan-like plan descending 3 floors from the edge of the hilltop knoll (Fig. 25). Its’ unassuming entry façade is single-story and in no way belies the profound architectural experience awaiting inside.

The predominant daylighting feature in the Mount Angel library is a north-facing, crescent-shaped skylight above the upper entry level apparently designed to follow the

⁹⁶ Alvar Aalto, as quoted in a brochure from the *Mt. Angel Centenary Celebration*, May 15-17, 1998.

⁹⁷ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 70.

⁹⁸ Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Great Britain, John Wiley & Sons Ltd., 2005), 71.

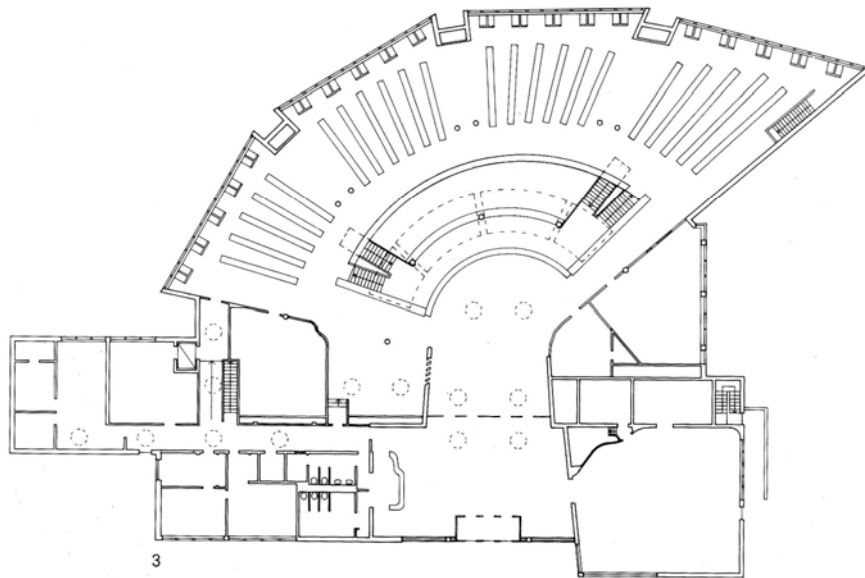


Figure 25

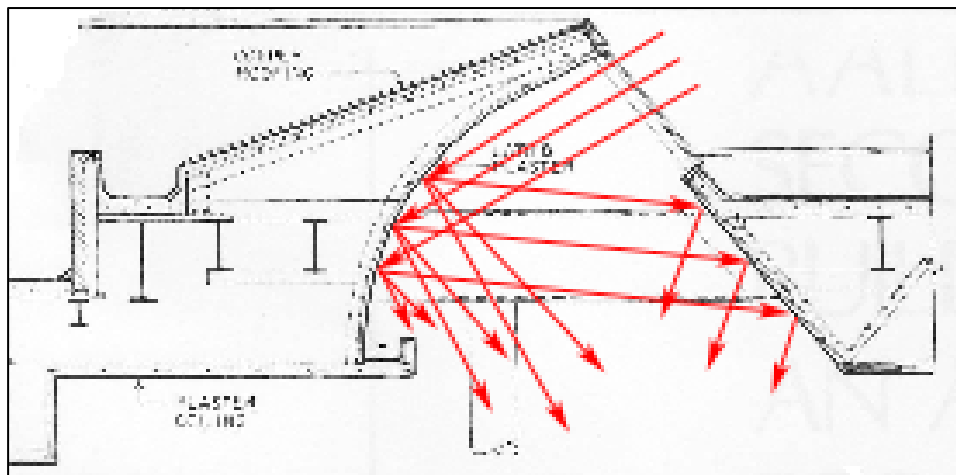


Figure 26

earth's daily cycle of revolution around the sun. As one enters the library from this upper, unassuming street level, the library space explodes into a luminous curved, daylight and vaulted ceiling that bounces light down through multiple open levels below. One is unprepared for the power and spirit of that moment.

The curved skylight bounces light at infinite angles toward the north reflector. This reflection produces even, high quality, diffuse natural light into the library below (Fig. 26).

The source-path-target concept shows the various sources of illumination for different surfaces within the library (Fig.27). The skylight illuminates three floors below that step down and hug the steep slope, containing stacks and open reading areas (Fig. 28). Daylighting strategies include parabolic roof wells over the circulation desk to admit diffuse sunlight during the day and artificial light during the evening from roof-mounted gooseneck fixtures, clerestories, and translucent interior walls which allow light to penetrate deep into the stacks and adjacent study carrels on the lower level. Aalto utilized curved soffits, called "scoops", and sloped soffits to direct the incoming northern light down into the mezzanine and basement levels below. The shallow depth of the crescent-shaped skylight allows direct light from the north as well as reflected light from the southern wall in the scoop. This abundant light from two directions provides even, high levels of illumination at the various study and research levels. The dark underside of the curved skylight reduces glare on the work surfaces below.

At the perimeter of the main reading room level, end walls perpendicular to the north-facing clerestory windows reduce the contrast of the bright sky visible through the window (Fig 29). Further, a ceiling soffit opposite the clerestory windows reflects northern light down to the wall below the window, again reducing the brightness contrast with the sky. The serene space provides a sense of withdrawal for study and contemplation. The source-path-target diagram shows the various illumination sources for this space (Fig. 30).

Aalto used a variety of natural materials to construct the library. Fir, birch, hemlock, oak, brass fittings and black laminate are used on the interior to contrast with the reflective white wall and ceiling surfaces. In combination with the profuse natural light, these materials produce a contrast of texture, color and organic versus man-made. Warm,

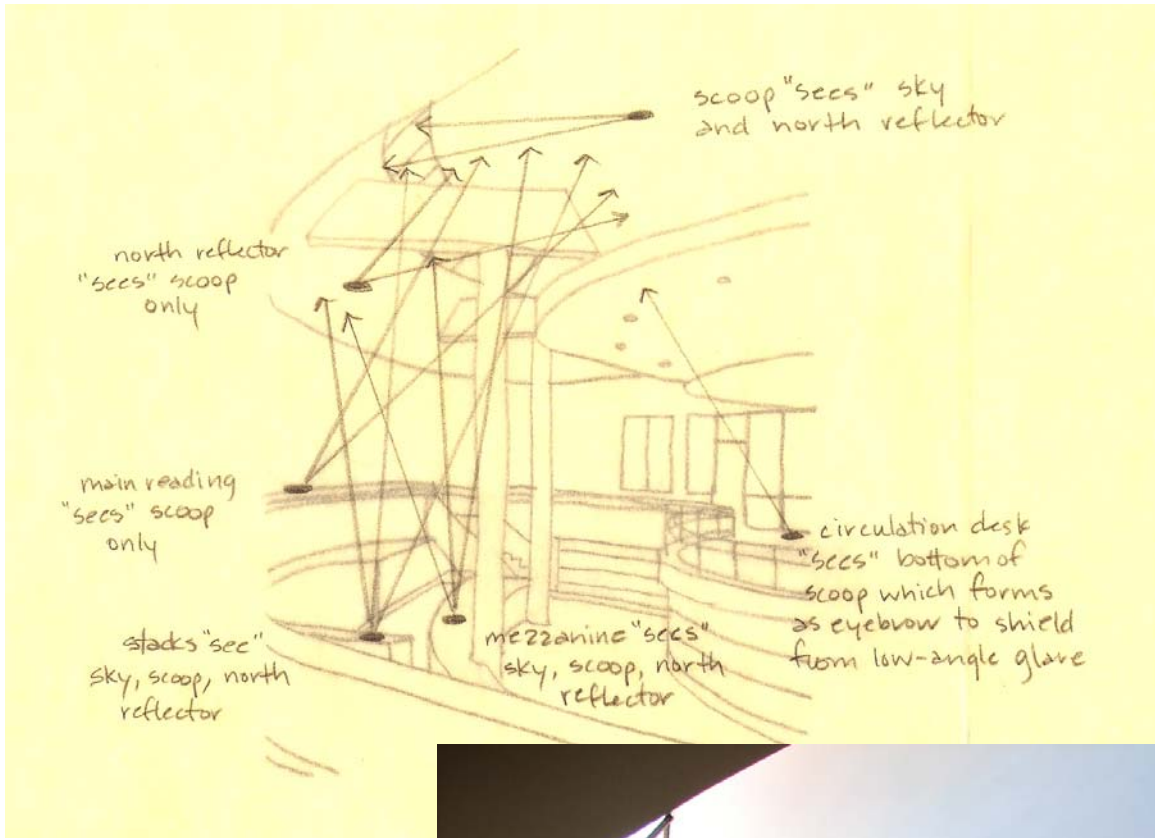


Figure 27



Figure 28



Figure 29

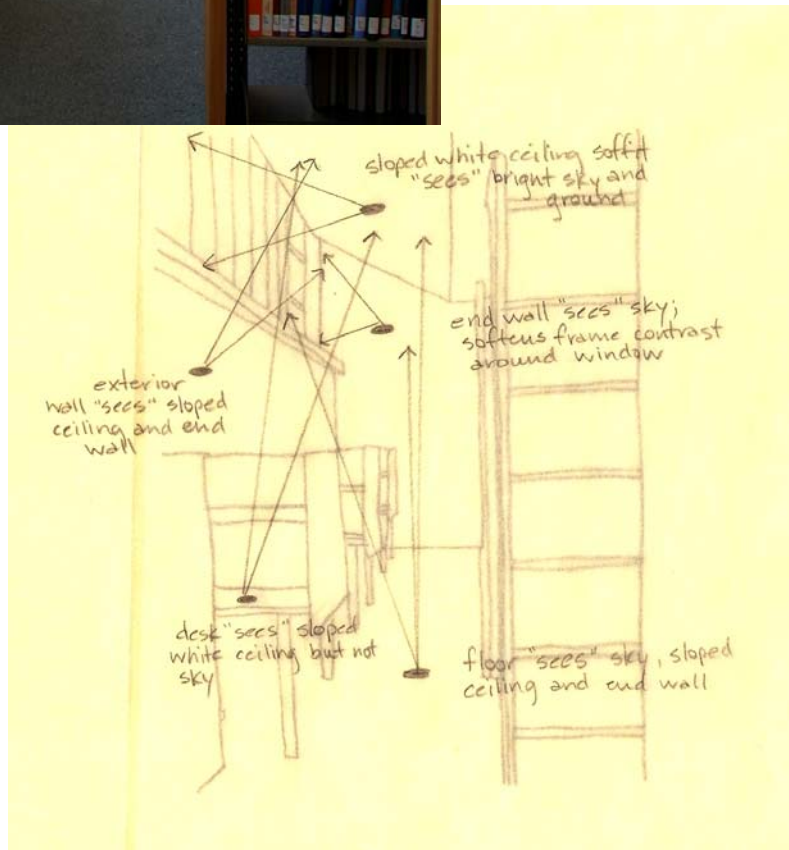


Figure 30

natural wood opposes the cool, man-made brass and black laminate. Material contrast engages our senses on multiple levels, deepening our experience of the space. The natural materials connect to cycles of time, to memory and to the earth as the materials age and develop a patina. On the exterior, redwood, buff-colored brick, and copper (on the roof) allow the building to tuck into the site in an unassuming way. Aalto also designed the simple, tasteful furnishings and hardware throughout the library.

As at the Kimbell, other contrasts enliven our experience of the library by more fully engaging our senses. Tension between rectilinear and curved space (see the plan in Fig. 25) repeats as the curved structure plays off the clean lines and smooth materials of the furniture, the rectilinear entry, the regularity of the stacks and the smooth white reflective surfaces. White surfaces contrast further with shadow revealing dimensionality, form and structure. Ultimately, it is the tension between light and shadow, “simultaneously unified and separated”⁹⁹, that impacts us most.

It is the smooth white reflective surfaces that so successfully illuminate the Mount Angel Abbey Library as well as Aalto’s other libraries. By utilizing these surfaces to provide a secondary light source, the natural light is very high quality with even illumination and minimal glare. Aalto designed for incoming natural light high above work surfaces or eye level, thus reducing glare and producing more even illumination (Fig. 31).

This strategy of using secondary light sources to provide high quality natural light is also evident in Aalto’s Nordic House Library in Reykjavik, Iceland shown in Fig. 32. A source-path-target diagram identifying these sources is shown in Fig. 33. Aalto’s use of roof skylights to illuminate secondary surfaces provides diffuse natural light to the sunken reading area, mezzanine, exterior wall below the windows and endwall as shown.

Natural light entering at an angle at least 45 degrees above horizontal allows equal illumination of both horizontal and vertical surfaces. Light entering at lower angles causes more glare as well as reduced illumination due to the “cosine law” of reduction. The “cosine law” states that the “illumination level ‘E’ on any surface varies with the

⁹⁹ Christian Norberg-Schulz, “Kahn, Heidegger and the Language of Architecture”, 37.



Figure 31



Figure 32

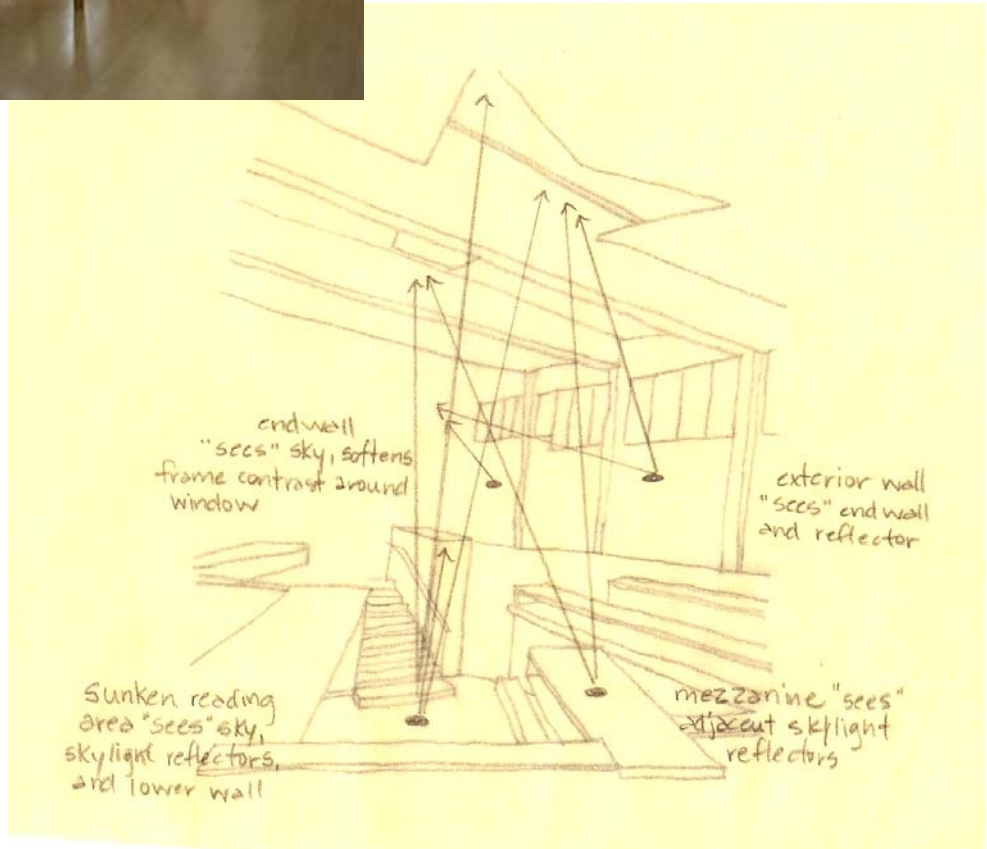


Figure 33

cosine of the angle of incidence”¹⁰⁰ for light striking that surface. In other words, the illumination level is reduced when the incident light is striking a surface at an angle less than 90 degrees. Therefore, light that enters at high angles, or toplighting, provides higher illumination per unit area of opening than sidelighting, up to three times the illumination. For this reason, toplighting is more efficient than sidelighting, particularly relative to its impact on heating, ventilation and air-conditioning systems. Further, toplighting draws our attention up. It uplifts our spirit. It connects us to something higher and bigger than ourselves, perhaps to something sacred.

Aalto understood this. He understood this in the context of man’s connection to nature. He emphasized the relationship of man to his environment, to the earth, by designing buildings to be the “pattern which connects” man to his environment, to nature. To quote Aalto, “true architecture—the real thing—is only to be found when man stands at the center.”¹⁰¹ This belief resonated with the Benedictines’ contemporary view of the world and led them to seek Aalto to design a “beautiful and intelligent”¹⁰² library for them.

The Mount Angel Abbey Library was Aalto’s 10th library. Aalto followed a similar overall theme in each one even although he loosened up his early symmetry into an asymmetric, fan-shaped plan. That overall theme, similar to that of the Kimbell Museum, was light, specifically diffused natural light. He introduced high quality, evenly distributed natural light into his libraries through his use of secondary sources of illumination. High illuminance white reflectors were created using angled and curved white walls and ceilings to reflect and diffuse incoming direct sunlight. By the time he designed the Mount Angel Library, he had fine-tuned his natural lighting strategies throughout his many libraries, no doubt leading to what some consider his best.

In conclusion, Church of the Light, the Salk Institute, the Kimbell Art Museum and the Mount Angel Abbey Library show that natural light can be orchestrated through the use of geometry, texture, material, and structure to create spaces that inspire. Tadao Ando understands and Louis Kahn and Alvar Aalto understood how to effectively manipulate

¹⁰⁰ M. David Egan and Victor Olgyay, *Architectural Lighting* (New York: McGraw-Hill Higher Education, 2002), 389.

¹⁰¹ “Aalto’s Second American Building: An Abbey Library for a Hillside in Oregon”, *Architectural Record*, v. 149, May 1971, 114.

¹⁰² “Aalto’s Second American Building: An Abbey Library for a Hillside in Oregon”, *Architectural Record*, v. 149, May 1971, 112.

natural light to achieve the greatest impact in their buildings. They understand the importance of form, structure, material and orientation to their designs. As architects, we too need to have this understanding and the ability to successfully design with natural light and its accompanying shadow.

Conclusion:

“Poetry is nothing other than the elemental way in which existence as Being-in-the-world is discovered....., that is comes into words. Through what is expressed the world becomes visible to others, who before this are blind”

Martin Heidegger

We can all learn how to think poetically. We can all develop an awareness of how we connect with nature and what that connection means to each of us. Similar to the design process that is an individual endeavor, our development of this awareness or understanding of the “territory” is an individual endeavor. Thinking poetically and being more aware can be taught or guided with a “poetic map”. The “poetic map” suggests a path or a set of ideas to reflect upon. It is from the “poetic map” that we explore and discover the “territory”, our way to think and to be.

Poetry stimulates thought unencumbered by ego, by pretense, and by daily priorities. However, one must be willing to shed those encumbrances, those layers of inhibition, to look deeper. One must be willing to admit they don’t know everything to be open to the possibility of learning and developing a deeper awareness. “For such an effort to succeed, we must be ready to learn thinking”.¹⁰³ This process does not happen by itself nor is it easy. It is a struggle and “must be brought forth—almost fought forth—into manifestation.”¹⁰⁴

The “poetic map” presented here is an offering. It offers a mirror or “looking glass” to peer into, if one is willing. It offers an opportunity for thought and contemplation with no specific end in mind other than exploration. Having an objective stunts the exploration offered by the “poetic map”. This exploration must be free and unhindered by a time frame or intended result. It must be ambiguous. Revelation, put into words in the

¹⁰³ David Halliburton, *Poetic Thinking: An Approach to Heidegger* (Chicago: University of Chicago Press, 1981), 113.

¹⁰⁴ David Halliburton, *Poetic Thinking: An Approach to Heidegger* (Chicago: University of Chicago Press, 1981), 134.

“poetic map”, lays open the door for others to be aware of possibility in thought and understanding.

No design process tells or shows us how to think and design. Design is an individual endeavor. It varies from person to person. For a good chef, a recipe provides a guideline or a set of ideas to consider. However, a good chef does not follow the recipe word for word. He or she only pulls the most important information, according to their needs, from the recipe. Likewise, a “map” guides a traveler along a journey. However, the map only suggests a path. Understanding the “territory” takes more than just following a “map”. The “territory” is a way to think and to be. Developing an understanding of the “territory” requires solitary exploration, thought, questioning, and study. To help develop this awareness, the “poetic map” presented here suggests a set of ideas to reflect upon, to explore and from which to discover new ideas.

Through poetry, we find our voice. Our voice expresses in words our way of thinking, or Being-in-the-world. “Existence as Being-in-the-world” is not determined once and for all. It is a lifelong endeavor. It reflects a particular view of the world and is fundamental to how we live our life. There is no single “ah-ha” moment but instead many moments over time during which our understanding deepens and gets richer.

Every work of architecture reflects this awareness, or lack thereof. Every work of architecture has the potential to inspire, to connect us to the larger world, to connect us to that which is sacred. We strive to experience such architecture a few days each year with travel to faraway places. Why not experience inspiring architecture in our own backyard? Why not experience great architecture daily? We can. As we develop our way of thinking and “Being-in-the-world”, we develop an ability to design with a consciousness that taps into the larger world. We are more aware of what it means to be human, of the human condition, and of our fellow man. We are more aware of nature, of our environment, and of our innate need to connect to nature. This multi-faceted awareness comes forth in our work. We produce architecture that inspires awe and reverence. We produce architecture that connects to nature, to the larger world and to that which is sacred. We have given a gift. The gift we offer is that of architecture that enriches each day with the “pattern which connects”. In the words of Louis Kahn, “A man who does a work of architecture does it as an offering to the spirit of

architecture....a spirit which knows no style, knows no techniques, no method. It just waits for that which presents itself.”¹⁰⁵

We have seen the architecture of those who have discovered the “territory”, their way to think and to be. Great architecture is an expression of this discovery. It reveals a coming into, a way of “Being-in-the-world”, a way of thinking about our work in the larger context. Great architecture reflects a deeper consciousness of what makes us human. It reflects a way of thinking about who we are, what our fundamental needs are and what our role is in the larger world. To develop this awareness, architects must “think about their thinking”. They must reflect on the impact of their thoughts and ideas on their work. “We achieve what is called thinking when we ourselves think”.¹⁰⁶ In doing so, architects will develop a deeper consciousness of the human impact of their design decisions. Having this awareness is fundamental to the design of great architecture.

We have lost this awareness and connection in our architecture today. We have lost our way and have become estranged from ourselves, from nature and from the larger world. It is this connection to nature that was missing at Pruitt-Igoe. The architecture at Pruitt-Igoe led to a complete disconnection from nature, from community and from the larger world. With this lack of connection, the buildings became a “pressure cooker” of crime and destruction.

At one time, this connection existed in architecture. The solar alignment of the Newgrange Tomb in Boyne Valley, Ireland, and the temple of Ramesses II in Abu Simbel, Egypt, show that it existed. Fortunately, today a handful of architects have maintained, or are working to re-establish, this connection. We saw modern examples of architecture which provides the “pattern which connects” to nature. In these examples, we saw how patterns of relationship such as that between light and shadow inspire us and provide a fundamental connection to nature. These patterns of relationship in natural light are many and include a “tapestry of light and dark”, pools of light to identify interactive space, dim light to provide refuge, and many others.

¹⁰⁵ Louis I. Kahn, *Conversations With Students* (Houston: Architecture at Rice Publications and Princeton Architectural Press, 1998), 32-33.

¹⁰⁶ David Halliburton, *Poetic Thinking: An Approach to Heidegger* (Chicago: University of Chicago Press, 1981), 113.

A similar direct connection to nature exists with the generation of a building's energy from the sun. Until recently, solar photovoltaic energy was generated through photovoltaic panels placed on top of a building's roof. We now see this capability integrated into the building envelope, including the roof, in a manner consistent with the integration and mutual dependence of systems we see within nature. This integration of multiple building systems produces a more functionally efficient, aesthetic design overall, similar to the beauty in nature.

On a larger scale, when a building's energy supply comes from distributed generation instead of on-site generation, we don't have this integration within a building's systems. For energy generation from fossil fuels, energy supply and energy consumption are separated by a distribution network made up of miles of power lines, multiple substations and other electrical infrastructure. This separation results in a "disconnection" at the building between the systems that supply, distribute and consume power. Recent movement away from distributed generation and toward on-site generation is one aspect of the current "green" movement that is re-integrating these, and other, building systems within the building. This re-integration of building systems mimics nature.

Years working in the oil industry gave me perspective regarding the negative impacts of fossil fuel power generation; environmental, human and financial. Alternatively, the energy of the sun gives us a clean, renewable power source as well as natural illumination. Energy and light from the sun can be integrated into building design in a way that mimics and, therefore, connects to nature. Pioneers in this effort to mimic nature's patterns and processes in building design, including Sim Van der Ryn, have worked for thirty to forty years to make this connection. The next generation of architects must now take over the helm and carry this responsibility. Similar to systems and processes in nature, we must advance building systems integration to the next level in the hierarchy. This integration does not require complexity in building systems. In fact, the most successful integration results from simple solutions that are efficiently applied. Our earth, and our very existence, depends on us to make this happen.

Great architects see these patterns of relationship between the various parts of a building just like they see the patterns of relationship in everyday life. Whether it be a pattern of relationship between two people or patterns of relationship in nature, great

architects sense and understand these patterns. Such mutual dependence is everywhere in our world. It is necessary for the efficient interconnected symbiosis we call life. Nature exists and thrives through this mutual dependence. We, as architects, must understand this interconnectedness, these patterns of relationship, this mutual dependence. Having such awareness is critical to the design of architecture that provides meaning to man through a connection to the larger world.

My life, my journey, has slowly revealed to me patterns of relationship. It is this developing awareness of patterns of relationship and mutual dependence that connects me to life each day. Architecture has become another “pattern which connects” me to nature and to the larger world. I now have a new “touchstone” to help orient me. Architecture that connects with nature, along with my earlier touchstones the ocean and the mountains, is that new “touchstone”.

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